CHAPTER- 7

Discussions

7.0 DISCUSSIONS

The stress response involves complex pathways of neurons and body cells. The chronic stress and weight gain are associated in the misalignment of functioning of HPA (Hypothalamus Pituitary Adrenal) axis. The excessive hormonal secretion of cortisol as a result of stress response inhibits the release of leptin. The leptin reduces the appetite after sufficient eating. The inhibition of leptin will cause excessive food carving and binge eating behavior. This reduces the metabolic rate and fat burning. Thus fat is getting stored and in abdominal and other sites. Also the cortisol inhibits production of serotonin and dopamine. The imbalance in the hormonal secretions will result in further stress, mood changing and increased binge eating. When the feedback system in the HPA axis is disrupted the person's eating disorder will become a habit. Also the sleep deprivation affects adversely the HPA axis in the feedback regulation and also in the immune system. The increased cortisol is also associated with disruption of sleep. Thus the mental stress and deregulation of HPA axis is prompting the visceral fat accumulation (Rutters, Nieuwenhuizen, Lemmens, Born, & Westerterp-Plantenga, 2009).

Stress is cause for many diseases in urban life as reported in many previous studies. The stress causes the immediate and long term disturbance in the psycho neuro endocrine and immunological pathways. The HPA axis and sympathetic nervous system, gets adversely affected and hyper activated by influx of emotions from limbic system under the mental stress (Innes & Vincent, 2007). Further this increases the release of hormones of cortisol and catecholamine. The repeated state of 'fight or flight' mode makes the HPA axis firing continuously and disrupting the homeostasis leading to metabolic disorders.

Most of the yogic practices promote parasympathetic activation and regulation and normalization of HPA axis (Innes & Vincent, 2007). Also the yoga practices give vagal stimulation

reducing heart rate and blood pressure. Thus the metabolic and psychological parameters were improved by balance in the HPA axis, insulin resistance and lipid metabolism.

a) Changes during intervention:

i. Anthropometric

The anthropometric parameters and psychological parameters were improved in the Yoga group.

In an earlier study of a two week residential yoga intervention, improvement was noted in the anthropometric parameters on obese male and female participants (Telles, Sharma, Yadav, Singh, & Balkrishna, 2014). The BMI, WC, HC were reduced and reductions were significant. The WHR was not changed in this previous study and in another short term yoga study on obesity also (Telles, Naveen, Balkrishna, & Kumar, 2010). In the previous studies, there was no difference in reduction of fat in the waist and hip. In the current study WHR increased in the yoga group but difference was not significant.

This shows that in the current study, reduction of fat in the Yoga group resulted in more reduction in hip area than in waist area and in the Control group more reduction in waist than in Hip. The yoga practices were containing practices for reduction of fat in both waist and hip areas. This included Warm up practices and *Surya Namaskāra.*

Meanwhile the control group continued their routine normal physical activities which might have resulted in improvement in their anthropometric parameters. They were asked to continue their regular physical activities and they were given their all respective assessment readings and sample food plan details, also.

The reduction in MAC of both left and right upper arm was significant in Yoga group. In earlier study of short duration, found decrease in MAC and concluded that the reduction may be due to reduction in muscle or skin layer as muscle circumference was not measured separately (Telles et al., 2010). In a previous study the MAC reduction was not significant in the yoga group

(Telles et al., 2014). It was reported that it was due to the short duration of two weeks intervention among other factors. In the current study, in the Yoga group both left and right MACs were improved with significance which shows the effectiveness of the intervention.

The suprailiac skin fold thickness was reduced with significance in the yoga group alone. This indicates the effective fat reduction in abdominal area in the Yoga group. In both the groups, all four skin fold thickness values showed reducing trend except that in the Control group sub scapular skin fold thickness was increased. This increase in fat at shoulder area may be due to lack of physical activities involving hand and shoulder muscles by the Control group. Previous studies state that anthropometry and skin fold thickness will give best predictors for obesity assessments (Sarría et al., 1998). It is notable that the SKF reduction was significant in suprailiac of Yoga group alone, out of all four SKFs. Also in the Yoga group alone the percentage body fat reduced and with significance. This shows that the IAYT yoga intervention is effective in reducing the fat and also reduction at different sites for male.

ii. Body composition

There was a trend of improvement in all the body composition parameters in Yoga group. In the current study of first time yoga practitioners, the sleep quality and the habitual sleep efficiency scores improved 34.6% and 54 % respectively. This shows the possibility of the yoga intervention in combating the obesity difficulties in urban setting. Further as reported earlier, sleep parameters play a key role in energy metabolism (Markwald et al., 2013; Spaeth, Dinges, & Goel, 2013) and the current study shows improvement in both sleep quality and body composition parameters.

In the body composition results, the body weight Obesity degree (current weight divided by ideal weight multiplied by 100) and BMI were reduced (improved) with significance in the Yoga group alone. This trend of improvement after yoga practice, is supporting the previous study (Dhananjai et al., 2013).

The bone mineral content and mineral mass were reduced in both the groups but reduction was significant in Yoga group alone. The reduction in bone mineral content may be reversed after sufficient longer yoga practice (Lara et al., 2016). Also it is noted that the serum leptin is inversely associated with bone mineral density and leptin is strongly associated with fat mass (Morberg et al., 2003). The relationship between visceral fat and bone mineral density in sedentary obese showed that the visceral fat and bone density are negatively correlated (Júnior et al., 2013). Though in the current study obesity degree (reduced) and body fat (reduced) at trunk improved after three and half month intervention, bone density did not increase. The bone mineral content did not increase because of the insufficient duration for effective improvement in bone mineral density.

Ideally the fat is to be reduced and lean body mass at all parts is to be increased after doing yoga (Gadham, Sajja, & Rooha, 2015). In control group in addition to improvements in arm lean mass, trunk lean mass also increased. This may be due to the physical exercise of the control group.

iii. Psychological

The perceived stress scale score (PSS) reduced in both groups but reduction was significant in Yoga group alone. Further the AAQW score was reduced in both the groups. Earlier study (both male/female) of 24 weeks showed that greater decrease in weight related experiential avoidance was linked to more weight loss (Niemeier, Leahey, Palm Reed, Brown, & Wing, 2012). The current study with male subjects only, also confirms this point. In the current study, the decrease of AAQW score is significant in Yoga group. Hence after the IAYT intervention the experiential avoidance of weight related difficulties got reduced in the Yoga group.

Earlier studies showed that ten days of short term yoga interventions involving *Āsana Prāṇāyāma* Relaxation techniques give anxiety reduction (Gupta, Khera, Vempati, Sharma, & Bijlani, 2006). Further previous residential weight reduction yoga study did not get significance in mood disturbance, when assessed at three month followup (Yoshihara et al., 2011). In the current

study scores in both PSS and AAQW were significant in the Yoga group. This may be due to the effect of different relaxation techniques used in intervention namely MSRT (Mind Sound Resonance Technique) 'OM' meditation Cyclic meditation and Śavāsana.

The psychological stress is found to increase cortisol secretion and abdominal fat in an exploratory RCT on female (Daubenmier et al., 2011). The mindfulness training improves eating pattern and reduces fat. The current study also support that the reduction of abdominal fat in male is consistent with reduction in the perceived stress.

Further, the previous studies showed that the insufficient sleep is also linked to increase in obesity (Jarrin, Mcgrath, & Drake, 2013; Taheri, Lin, Austin, Young, & Mignot, 2004) especially the visceral adipose tissue (Calvin et al., 2013; Chaput, Bouchard, & Tremblay, 2014). In the current study the sleep duration of yoga group increased consistent with the significant reduction in abdominal obesity degree. The relation between sleep duration and obesity is not linear, and the poor sleep and emotional stress are mediating factors in obesity (Theorell-Haglöw & Lindberg, 2016). Thus in the real life setting, the extending of sleep is found to promote reducing the desire for high energy foods (Tasali, Chapotot, Wroblewski, & Schoeller, 2014). This might have affected the weight reduction.

Moreover as reported previously (Theorell-Haglöw & Lindberg, 2016), the emotional stress and poor sleep are mediating factors in the relationship between obesity and sleep duration. The sleep duration affects the body composition (Schafer et al., 2016) and may be more time period of yoga intervention needed to get more significant results. Also studies reported the role of certain type of diet pattern affecting the quality of sleep (St-Onge, Mikic, & Pietrolungo, 2016). In the current study there was no restriction on food though the sample meal plan was provided to both the groups and the inputs on diet information were equal to both the groups.

Further the circadian misalignment in urban life style is a predominant factor and this leads to adverse effect in the energy balance. The endocannobinoid system is signaling the pathways to modulate the metabolic functions (Bellocchio, Vicennati, Cervino, Pasquali, & Pagotto, 2007; Di Marzo, Ligresti, & Cristino, 2009). The uncontrolled binge eating behavior inherent with easy availability of junk food, prevalent in the urban lifestyle further promotes the unbalance in the energy intake and expenditure. The endocannobinoid signaling is reported as neuro chemical mechanism in response to stress (Di Marzo et al., 2009) and endocannobinoid system is chronically unregulated due to stress, promoting the drive to eat merely out of pleasure, in the absence of any energy deficit. A recent study (Gamelin et al., 2016) on effect of exercise on endocannobinoid on male rats with high fat diet induced obesity, indicated a reversal of metabolic syndrome (Touati et al., 2011). In the current study of yoga intervention included loosening exercises and *sūryanamaskāra* along with other yoga techniques. The over activation of the endocannobinoid system was reduced by the yoga practices as evident from the metabolic improvements.

The sleep quality and weight gain are associated. In the current study the habitual sleep efficiency was improved along with weight reduction. The lesser sleep is attributed to weight gain in some of the studies (Taheri et al., 2004). In a previous study the duration of sleep reduced along with change in traits of eating habits (Filiatrault, Chaput, Drapeau, & Tremblay, 2014). There are previous studies showing improvement in sleep quality due to yoga practice (Filiatrault et al., 2014; Hariprasad et al., 2013). In the current study, the quality of sleep improved significantly, in consistent with improvements in weight reduction and body composition parameters.

iv. Other points

To find the relative improvement from pre to post among the variables, correlation among the differences was checked. It was found that PSS and weight related psychological inflexibility are positively correlated similar to previous mixed gender study (Dhananjai et al., 2013). Further the

weight and WC are positively correlated. Thus higher positive correlations of body weight with HC and WC were found in male obesity similar to previous the mixed gender studies. Further there is positive correlation of weight with SKF suprailiac. The SKF suprailiac and sub scapular are also positively correlated. This may be due to the similar increase in fat deposition in trunk portion.

The BMI was found strongly correlated to FFM (fat free mass) and BMR (Basal Metabolic Rate) which is supportive of previous study (Lazzer et al., 2010). The eating behavior and sleep act together and affect weight reduction (Filiatrault et al., 2014). The current study showed that BMI is positively correlated to PSQI global score and sleep quality is mediated by weight reduction. Thus the weight reduction in the Yoga group may be also due to the improvement in the eating behavior caused by the yoga training.

b) Follow up:
i. Anthropometric

In the anthropometric measures, there was improvement in anthropometric parameters compared to base line data after three months. In the yoga group, improvement in percentage body fat, based on skin fold thickness, was significant The earlier study (Seo et al., 2012) of eight week yoga on boys, showed a significant decrease in fat percentage. Also earlier short term study on two weeks yoga and walking with diet control (residential), showed significant improvements in anthropometric parameters, with no change in WHR (Telles et al., 2014). In the current (nonresidential) study, without diet control (only guidelines on diet were given), the WHR was unchanged in the Yoga group but increased in the Control group during the follow up.

The WC and HC were found reduced in both the groups with significance. In the Yoga group, the fat stored centrally and at peripherally was reduced in a similar way. Similar trend was noted in a previous short duration trial on obese adults (Telles et al., 2014).

In the current study, the skin fold values and percentage body fat were reduced and the anthropometry and skin fold thickness are the best predictors for obesity assessment (Sarría et al., 1998).

Further the changes on anthropometric parameters from Post to followup were statistically significant in the Yoga group which shows that long term effect of IAYT.

ii. Body composition

In the body composition measures, the BMI and obesity degree (current weight divided by ideal weight multiplied by 100) were significant in the Yoga alone. This shows that the yoga practice was effective in obesity control. This is similar to earlier studies (Dhananjai et al., 2013). The body fat mass, percentage body fat, abdominal obesity degree were reduced. Further the percentage body fat of limbs and trunk were reduced with statistical significance.

This showed that the weight reduction was due to change in the fat mass.

In both the arms and trunk, the lean masses increased and both legs lean mass reduced in the Yoga group though these were significant. The trend of changes in fat and lean mass is similar in the Control group also.

The skeletal lean mass showed increasing trend in the Yoga group but decreasing trend in the Control group, and both skeletal muscle mass and fat free mass increased in yoga and both decreased in control, though these were not statistically significant. The resistance exercises can attenuate or reverse the age related decrease in muscle mass (Janssen et al., 2014). After yoga practice fat is to reduced and muscle is to be strengthened (Telles et al., 2010). The current study showed that after yoga intervention the muscle mass is getting increased and fat mass is getting decreased.

Bone mineral content and mineral mass showed decreasing trend in Control group and in Yoga group there was no reduction trend. After sufficient duration of physical exercise these parameters can be improved (Lara et al., 2016; Lu, Rosner, Chang, & Fishman, 2016). The BMR was strongly correlated with fat free mass supporting the earlier study (Lazzer et al., 2010).

Further the changes on body composition parameters (segmental fat mass, water mass, BMR) during followup were statistically significant in the Yoga group which shows that long term effect of IAYT.

iii. Psychological

In the psychological measures, the AAQW score improved in both the groups, indicating significant reduction in weight related difficulties. This showed that the stress levels are reduced in both the groups and acceptance and commitment for weight reduction is improved. Earlier studies showed Psycho Immunological effects of yoga and reduction of various stress levels including positive effects on obesity linked to cardio vascular diseases (Sarvottam & Yadav, 2014; Gupta et al., 2006). Previous study showed that the decrease in weight related experiential avoidance is linked to more weight loss in a male female combined batch (Niemeier et al., 2012). The current study on exclusively obese male showed that the weight loss was linked to experiential avoidance.

The PSQI global score was above five in the Yoga group in the baseline reading. This is generally considered as poor sleeper score but follow up value was improved to lesser than five. though the reduction was not significant (Filiatrault et al., 2014). Also the PSQI global score of the Yoga group was higher than that of the Control group in the baseline, however after the intervention, the value of Yoga group became lower than that of the Control group. This also shows that Yoga intervention improved the sleep quality.

Short sleep duration is linked to gaining in weight in some studies (Taheri et al., 2004). In the followup, sleep duration was increased in the Yoga group alone, along with improvements in the body composition parameters. Earlier study reported improvement in sleep quality by yoga practice for subjects of age more than 60 in an urban setting in India (Bankar, Chaudhari, & Chaudhari, 2013). In the current study during followup, the Yoga group showed increasing trend in sleep duration but control group showed decreasing trend. These changes of slpd during followup, were not statistically significant. The decreasing trend in Control group shows the deterioration of sleep quality and could be associated with weight gain. The sleep quality of Yoga group was better and hence might have showed the reverse trend. The Yoga group had specific yoga practices like *Śavāsana,* Mind Sound Resonance Technique, Cyclic Meditation etc., which might have reduced the stress and improved the sleep quality. Thus the yoga training might have improved the sleep quality and eating habits which is in line with the weight reduction trend (Filiatrault et al., 2014).

iv. Other points

To check the relative improvements from pre to follow up, among the variables, correlation was tested. The BMI was positively correlated to WC, cumulative skin fold, HC and AAQW. It was found that PSS was negatively correlated to MACL. The higher score of MAC indicate chronic energy deficiency (Chakraborty, Bose, & Bisai, 2009). Thus anthropometric and psychological parameters are found to be correlated in obese. The BMI was positively strongly correlated with BMR, fat mass, protein mass, skeletal mass, fat free mass, total body water and mineral mass. Also the BMI was not strongly correlated to PSQI.

The mindfulness and glucose regulation is associated as per the previous studies. The mindfulness score of the Yoga group showed trend of improvement after the intervention and the trend was sustained during followup.

A very recent study showed that one of the important drivers of the association between cardiovascular health and mindfulness is BMI and the mindfulness improved the cardiovascular health (Loucks, Britton, Howe, & Eaton, 2015). Further recent study showed that the yoga intervention increases the distress tolerance and emotional eating tendencies due to mediation of one particular component of cognitive process of distress, called absorption. This might have mediated the effects of yoga on disordered eating (Medina, Hopkins, Powers, Baird, & Smits, 2015).

Thus the anthropometric, body composition and psychological improvements were sustained during followup, and this shows the effectiveness of IAYT on urban obese adults.