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Original Research Article

A study on the association of body mass index and anthropometry, blood, seminal, and hormonal profile of infertile and fertile males: baseline data

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ABSTRACT

Background: Globally, people are drastically changing lifestyle behaviors include, unhealthy eating habit, physically inactive and poor sleep quality leads to accumulation of fat in the body including abdomen leads to obesity and it is one of the major risk factors for non-communicable diseases (NCDs) including male infertility.
Methods: This randomized control trail conducted in 80 male participants, were divided into four groups include non-obese infertile, obese infertile, non-obese fertile and obese fertile based on the body mass index (BMI) and semen parameters. The anthropometry, blood, seminal and hormonal and lifestyle parameters was analyzed. Association of BMI with the study parameter was analyzed by Pearson's correlation.
Results: Correlation analysis between BMI and anthropometry parameters include age (r=0.14), body weight (r=0.85), waist circumference (r=0.81), systolic blood pressure (BP) (r=0.14) and diastolic BP (r=0.16) shows positive association. Similarly, blood parameters include fasting blood sugar (FBS) (r=0.44), postprandial blood sugar (PPBS) (r=0.33), glycated haemoglobin (HbA1c) (r=0.45), cholesterol (r=0.28), triglycerides (r=0.32) show positive correlation and in contrast high density lipoprotein (HDL) (r=-0.02) shows negative association. Pearson correlation analysis shows that BMI with seminal parameters include volume (r=-0.25), count (r=-0.34), motility (r=-0.38) shows negative correlation. Similarly, hormonal parameters include follicle stimulating hormone (FSH) (r=-0.07), luteinizing hormone (LH) (r=-0.20), testosterone (r=-0.33) and vitamin D (r=-0.16) shows negative correlation. It was observed that unhealthy lifestyle and stress can also mainly cause for higher BMI leads to poor semen quality and hormonal imbalance.
Conclusions: The results of present study concluded that BMI is one major risk factor that directly influence the anthropometry, blood, seminal and hormonal parameters. Thus, BMI can be used as the potential marker to assess the tested variables in the study.

Keywords: Obesity, BMI, Male infertility, Semen, Sperm, Hormones, Diabetes

INTRODUCTION

Physically inactive, unhealthy eating habits, poor sleep quality and higher stress has results in accumulation of excessive body fat that increase the risk of cardiovascular disease, hypertension, diabetes and reproductive disorders. According to World Health Organization (WHO) adults were with body mass index (BMI) 25.0–29.9 kg/m^2, ≥29.9 kg/m^2 were considered has overweight and obese respectively.[1] The prevalence of male obesity gradually

increased from 3.2% to 10.8% in 2014, similarly in India it's increased from 2.2 to 5.1%.[2,3]

Food plays a vital role in the male obesity. Consumption of high calorie diet contains saturated and high energy fats higher the blood cholesterol level and interrupt the lipid metabolism in the testis. Men at reproductive age are modified their healthy eating habits, and nearly 70% of them consume junk and fast foods instead of fruits and vegetables.[4] Excess consumption of full-fat milk, cheese, sweets, coffee, alcohol leads to obesity and had a direct influence on semen quality and spermatogenesis.[5]

According to El Salam obesity defined as "enemy of male fertility".[6] Over the past three decades, men at reproductive age uncontrolled their body weight and become overweight and obese leads to reproductive problems. Male obesity shows adverse effects on the reproductive system include poor semen quality and morphological changes of the sperm and it also found that this impact inherited to next generation through sperm and affect the child metabolism and other physiological system including reproduction.[7] A retrospective study conducted in 390 men shows that higher BMI was positively associated with poor sperm concentration and motility.[8] Another surveillance study conducted by WHO found significantly lower sperm count in obese men as compared non-obese men.[9]

Male obesity altered the reproductive hormone level results to endocrine problems and level of circulating androgens decline with equal proportional to the level of central obesity.[10] Another mechanism linked to fat is insulin resistance, which similarly causes hypoandrogenism and has a negative correlation with testosterone levels. Testis maturation at reproductive age has been linked to abnormal thyroid production during testis development at a younger age.[11] Male testicular development and protection are impacted positively by the interaction of follicle stimulating hormone (FSH) and luteinizing hormone (LH).[12] FSH is the primary hormone in the male reproductive system, and aids in the activity of the sertoli and granulosa cells as well as the development of male gametes. Sperm production begins during adolescence and is maintained in a healthy state in men based on the level of FSH.[13] According to study, FSH treatment enhanced the rate of fertilization and pregnancy in infertile men.[14]

Increased prolactin levels directly impact the reproduction through the central nervous system by preventing androgen production. Testosterone produced by Leydig cells is required for the normal development of sperm and abnormal LH production impact the spermatogenesis result in male infertility.[15] Numerous locally released substances, including cytokines, activin, follistatin, and oestrogen, regulate sperm production in a paracrine and autocrine manner. According to Carani et al, sexual dysfunction is multifactorial; not all abnormal groups necessarily exhibit hyper- or hypothyroidism.[16] Seminal plasma LH level was several times higher than serum LH level in azoospermia than in the oligozoospermia and normozoospermia groups.[17] Hyperprolactinaemia, or high levels of prolactin in men, is associated with a decline in sex desire and erection.[18] In this view, in the present study, an attempt has been made to analysis the anthropometry, blood, semen, hormonal and lifestyle, parameters in obese infertile male.

METHODS

Study type and design

This prospective study was a randomized control trail. Infertile and fertile participants with age between 25-45 years with BMI <25 kg/m^2 and >25 kg/m^2 were included in the study. Participants <25 years and >45 years, who diagnosed with serious illness, under medication, or supplementation on weight loss, not willing to provide semen samples, erectile dysfunction were excluded from the study.

Study site and sample size

The study was carried out in the department of andrology, Kanmani Fertility Centre Private Limited., Chennai, Tamil Nadu, India during January 2021-July 2021. The study sample size was calculated in OpenEpi sample size calculator with 9.5% prevalence rate of male obesity in India.[19] The study needed 18 participants in each group and thus needed 72 participants for four groups which were rounded off to 80.

Participant's selection

Study participants were divided into four groups based on their BMI and semen parameters. The participants in the present study included obese and non-obese infertile males and obese and non-obese fertile males were recruited from male partner of female infertility, male participant's attendees and other general male population in and around the study site.

Group 1 included non-obese infertile male: BMI <25 kg/m^2 and abnormal semen parameters.

Group 2 included obese infertile male: BMI >25 kg/m^2 and abnormal semen parameters.

Group 3 included non-obese fertile male: BMI <25 kg/m^2 and normal semen parameters.

Group 4 included obese fertile male: BMI >25 kg/m^2 and normal semen parameters.

Anthropometric measurements

All study participants underwent anthropometric measurements which included height (cm), weight (kg), blood pressure (mmHg), and waist circumference (cm).

The height measurement was taken using the wall mount stadiometer. Weight was measured using the digital weight machine on a smooth floor. Blood pressure was measured using clinically validated Omeron BP monitor. Waist circumference was measured using a non-stretchable inch tape near the navel point.

Blood parameters

All study participants provided a 5 ml venous blood sample for analysis of their fasting and postprandial blood sugar levels using the GOD/POD method on a semi-auto Biochemistry Analyzer. An immunological assay was used to assess hemoglobin A1c (HbA1c) in order to track the average blood sugar level in diabetics over the course of three months. The CHOD-POD method was used to measure total cholesterol and HDL levels using a completely automatic analyzer.

Semen parameters

The study subjects were told to masturbate in a secluded room close to the lab to provide a semen sample, and the ejaculate was then collected into a sterile container. Any sample loss during collection was noted, and before the sample was sent for analysis, the container was marked with the participant's research ID, the date, and the time. The sample was left undisturbed at room temperature for 15 to 30 minutes as the liquefaction time was calculated in accordance with the WHO criteria for semen analysis.[20] By moving the sample to a sterile glass tube, the volume of the sample was calculated and its pH was evaluated using pH paper. After counting the sperm in the chamber's central square using a hemocytometer for five minutes at 20X and 40X magnifications, the concentration was determined as millions per milliliter of the semen sample. After liquefaction, the semen was immediately checked for motility, and the slides were inspected under a microscope to determine if they were immotile (IM), non-progressive (NP), or progressive (PR). Percentages (%) were used to calculate sperm motility. The percentage of normal, dead, and live sperm was calculated after the sperm morphology was examined under a microscope.

Hormone profile

The study subjects provided fasting venous blood samples, which were centrifuged at 3000 rpm for 15 minutes to obtain serum samples. The serum samples were stored at -20°C until hormone analysis. Thyroid stimulating hormone (TSH), follicle stimulating hormone (FSH), luteinizing hormone (LH), prolactin (PRL), testosterone (TST), and vitamin D were measured in the serum using electro-chemiluminescence immunoassay (ECLIA).

TSH assay

Anti-hTSH, which is coated on the solid phase, binds to serum hTSH. Goat anti-hTSH-alkaline phosphatase conjugate produces a catalytic reaction, and the non-reacted enzyme is washed away. A luminometer is used to measure the amount of light produced in the reaction vessels by the addition of Lumi-Phos 530, a chemiluminescent substrate. The amount of thyroid stimulating hormone present in the sample has a direct correlation with the light's intensity.[21]

FSH assay

In the assay, the serum sample is mixed with mouse anti-hFSH complexes and TRIS buffered saline containing protein. The hFSH in the sample binds to the immobilized mouse anti-hFSH on the solid phase. Any unbound materials are then washed away. Next, an enzyme alkaline phosphatase conjugated goat anti-hFSH is introduced, which binds to the previously bound hFSH on the particles, while unbound materials are washed away. Subsequently, a chemiluminescent substrate is added to the vessel, leading to a reaction that generates light. This light is quantified using a luminometer, and the intensity of the light is directly proportional to the amount of hFSH present in the sample.[21]

LH assay

The serum sample undergoes a reaction with mouse anti-hLH complexes and TRIS buffered saline containing protein. The hLH in the sample binds to the immobilized mouse anti-hLH on the solid phase. Following this, any unbound materials are washed away. An enzyme alkaline phosphatase conjugated goat anti-hLH is subsequently introduced, which binds to the previously bound hLH on the particles, while unbound materials are washed away. The chemiluminescent substrate is then added to the vessel, resulting in a reaction that generates light. This light is measured using a luminometer, and the intensity of the light is directly proportional to the amount of hLH present in the sample.[21]

Prolactin assay

In the reaction vessel, a serum sample is mixed with paramagnetic particles coated with mouse monoclonal anti-PRL antibody and polyclonal goat anti-PRL alkaline phosphatase conjugate. The goat anti-PRL-alkaline phosphatase helps the serum PRL to bind with anti-PRL, resulting in the formation of an antigen-antibody complex. The formation of this complex generates light, the intensity of which is directly proportional to the concentration of prolactin in the given serum sample.[22]

Testosterone assay

The serum sample is combined with a solution containing mouse monoclonal anti-testosterone antibody, testosterone alkaline phosphatase conjugate, and paramagnetic particles coated with goat anti-mouse polyclonal antibody. This results in the formation of an antigen-antibody complex. After incubation, unbound materials are removed by washing. The intensity of the light generated

by the antigen-antibody complex is then measured using a luminometer. The concentration of testosterone in the sample is directly proportional to the intensity of the light.[23]

Vitamin D assay

A serum sample is mixed with a DBP releasing agent and paramagnetic particles coated with sheep monoclonal anti-vitamin D antibody in a reaction vessel. The DBP releases the vitamin D which then binds to immobilized monoclonal anti-vitamin D in the presence of an analogue-alkaline phosphatase. The reaction vessel is then washed to remove any unbound materials. After that, the addition of chemiluminescent substrate Lumi-Phos 530 forms an antigen-antibody complex, which produces light that is measured using a luminometer. The intensity of the light is inversely proportional to the concentration of vitamin D present in the sample.[24]

Ethical statement

This study was conducted with the approval from institutional ethical committee Kanmani Fertility Center Private Limited, Chennai, Tamil Nadu. All experiments in the study were done according to the ethical standards given in the Declaration of Helsinki. Consent for the willingness to participate in the study was obtained from all study participants after explain the study protocol.

Statistical analysis

Data was collected using general questionnaire including the lifestyle, stress, medical and family history variable. All collected data was quality checked and entered in the online entry tool. Data was analyzed using statistical package for the social sciences (SPSS) software of version 25. P value <0.05 considered as significant and data was checked for normality using histograms. The clinical, semen and hormone variables are treated as continues variables and mean and standard deviation was done by one sample t test. Pearson's correlation was using to study the association of BMI with the study variables. Lifestyle and stress variables are treated as categorical variables (yes/no) and reported as in numbers.

RESULTS

Anthropometry of the study participants shown in Table 1. Analysis shows that, the participant's age ranges from 26-45 years (mean: 34.1±0.7), height between 135.5-176.6 cm (mean: 153.8±0.9), weight between 33.8-110 kg (mean: 67.9±2.5), BMI ranges from 15.6-34.9 kg/m^2 (mean: 25.3±0.6), waist circumference ranges between 55.8-111.0 cm (mean: 82.0±1.3), systolic BP ranges from 91-156 mmHg (mean: 124±2) and diastolic BP ranges from 59-90 mmHg (mean: 76±7). Among the study groups obese infertile (group 2) participants had higher body weight, BMI, waist circumference, systolic and diastolic BP as compared to other groups. The present study did not find any statistically significant difference in age, height, blood pressures among the four BMI groups.

The results of blood parameters data analysis show that the study participant's FBS ranges from 68.0 to 365 mg/dl (mean: 116.6±4.7), PPBS ranges between 76-299 68.0-365 mg/dl (mean: 165.9±6.8), HbA1c ranges from 4.1 to 11.8% (mean: 6.2± 0.2), total cholesterol between 45-389 mg/dl (mean: 194.3±15.5), triglyceride ranges from 41 to 478 mg/dl (mean: 194.3±17.1) and HDL between 21.0-67.0 mg/dl (mean: 39.6±1.1). The present found that obese infertile participants (group 2) had a significantly higher FBS, PPBS, cholesterol, triglyceride level and non-significant lower HDL level as compared with group non-obese infertile (group 1), non-obese fertile (group 3) and obese fertile (group 4) participants (Table 2).

Table 3 represents the seminal parameters of the study participants. Overall the participants had the abstinence days ranges from 2 to15 with mean 5 days, liquefaction time range between 8-30minutes with mean 27.3±0.5 minutes, pH range from 7.4 to 7.0 with mean 7.8±0.2, semen volume range between 0.8-6.0 ml with mean 3.0±0.3 ml, sperm count ranges from 6.0-99.4 million/ml with mean 52.2±3.2 million/ml, total motility ranges from 5 to 75% with mean 45.2±2.3%, rapid motility ranges between 0-30% with mean 7.6±0.8%, moderate motility ranges from 1.0-50.0% with mean 21.1±1.6%, sluggish motility ranges from 0-40% with mean 15.4±1.6%, live sperm ranges between 6.0-93% with mean 73.8±2.1%, dead sperm ranges from 7.0-72.0% with mean 25.6±2.0% and normal sperm ranges between 0-24% with mean 7.5±0.8%. It was found that the incidence of low pH, semen volume, sperm count, total motility including rapid, moderate and sluggish motility, live and normal sperm percentage found higher in group 2 (obese infertile) as compared group 1 (non-obese infertile), group 3 (non-obese fertile) and group 4 (obese fertile) participants respectively.

Hormonal profile of the study participants shown in Table 4. It was found that the mean TSH (range between 0.3-17.8 mIU/ml), FSH (ranges from 0.8 to 89.67 mIU/ml), LH (ranges between 1.5-35.47 mIU/ml), PRL (ranges from 1.1 to 36.27 mIU/ml, testosterone (ranges between 148.4-518 mIU/ml) and vitamin (ranges between 5.6 to 93.57 mIU/ml) was 2.7±0.3 mIU/ml, 9.4±1.7 mIU/ml, 6.4±0.7 mIU/ml, 11.8±0.7 mIU/ml, 372.3±17.6 mIU/ml, 24.7±2.7 mIU/ml respectively.

The association of BMI and anthropometry, blood, seminal, and hormonal parameters was analysed by Pearson correlation and the result show that among the anthropometry parameters body weight, and waist circumference had statistically significant strong positive correlation and age, blood pressure had non-significant moderate correlation with BMI. Similarly, the blood parameters show significant moderate positive correlation, except HDL which shows non-significant weak negative correlation with BMI. It was observed that all tested semen

parameters show statistically significant negative correlation except dead sperm which shows positive correlation with BMI. Regarding hormonal profile, it was observed that TSH, and PRL shows positive correlation and FSH, LH, testosterone and vitamin D shows negative correlation with BMI (Table 5).

Figure 1 shows the life style behavior of the study participants. It was reported that 77.5% of partcicipants consume excess tea/coffee, 63.7% are sedentary life style, 71.2% of non-vegetratian food habit, 52.5% consume alcohol, 51.2% habit of smoking, 22.5% usally travel long, 13.7% habit of wearing tight underwear, and 10% of them using pan parag respectively.

Figure 2 shows the level of various stresses among the study participants. It was found that 88.7% of participants under occupational stress, 83.7% of them feel stressed due to family, 61.2% stressed due to social surroundings and 45.0% of the stressed due to financial problems.

Table 1: Anthropometry parameters of the study participants.

Variable	Group 1 (n=20) non-obese infertile (Mean±SD)	Group 2 (n=20) obese in-fertile (Mean±SD)	Group 3 (n=20) non-obese fertile (Mean±SD)	Group 4 (n=20) obese fertile (Mean±SD)	P value*
Age (years)	32.5±7.7	36.6±4.6	34.0±7.0	33.2±4.7	0.311
Height (cm)	150.7±6.3	156.3±10.5	152.8±7.5	155.3±8.3	0.149
Weight (kg)	42.4±5.7	89.5±12.8	51.0±9.8	86.8±10.9	0.001
BMI (kg/m^2)	18.8±2.2	31.2±2.5	21.3±2.0	29.3±2.0	0.001
Waist circumference (cm)	65.5±4.5	92.5±9.8	79.5±5.3	89.7±5.3	0.001
Systolic BP[1] (mmHg)	121±14	128±12	123±9	127±10	0.485
Diastolic BP[1] (mmHg)	76±6	80±7	74±7	79±9	0.171

*Significance between study groups, [1]blood pressure

Table 2: Blood parameters of the study participants.

Variable	Group 1 (n=20) non-obese infertile (Mean±SD)	Group 2 (n=20) obese infertile (Mean±SD)	Group 3 (n=20) non-obese fertile (Mean±SD)	Group 4 (n=20) obese fertile (Mean±SD)	P value*
FBS[1] (mg/dl)	94.4±15.7	139.1±12.6	96.8±17.1	133.8±8.8	0.002
PBS[2] (mg/dl)	138.0±10.2	204±13.6	136.4±9.5	180.8±14.9	0.001
HbA1c[3] (%)	5.3±0.7	7.3±0.4	5.3±0.6	7.0±0.4	0.001
Cholesterol (mg/dl)	128.3±10.2	252.2±37.3	157.4±12.8	225.7±15.1	0.009
Triglyceride (mg/dl)	94.4±11.3	252.2±30.3	161.7±27.4	230.7±23.5	0.003
HDL[4] (mg/dl)	41.9±9.2	36.0±8.7	40.8±12.8	38.6±11.5	0.408

*Significance between study groups, [1]fasting blood sugar, [2]post-prandial blood sugar, [3]hemoglobin A1c, [4]high density lipoprotein

Table 3: Seminal parameters of the study participants.

Variable	Group 1 (n=20) non-obese infertile (Mean±SD)	Group 2 (n=20) Obese infertile (Mean±SD)	Group 3 (n=20) non-obese fertile (Mean±SD)	Group 4 (n=20) Obese fertile (Mean±SD)	P value*
Abstinence (days)	5±1	4±2	6±1	5±2	0.240
Liquefaction time (mins)	26.4±2.3	28.7±1.1	16.3±1.7	17.8±1.9	0.702
pH	7.9±0.2	7.8±0.3	8.4±0.4	8.2±0.3	0.499
Semen volume (ml)	1.80.5	1.2±0.2±	2.9±0.5	2.5±0.3	0.045
Sperm count (million/ml)	10.0±2.7	8.5±1.4	79.2±10.3	55.4±11.4	0.001
Total motility (%)	29.4±4.8	24.3±4.6	81.3±5.2	68.5±9.9	0.032
Rapid motility (%)	4.8±1.7	4.0±1.4	35.6±7.9	39.6±8.3	0.002
Moderate motility (%)	8.7±3.6	5.2±3.3	41.0±4.1	23.0±6.2	0.001
Sluggish motility (%)	15.9±2.2	15.1±2.4	4.7±1.0	5.9±2.3	0.001
Live sperm (%)	86.2±3.2	81.5±3.5	95.5±4.6	90.9±4.8	0.001
Dead sperm (%)	13.8±4.6	18.5±3.7	0.5±0.1	9.1±1.8	0.002
Normal sperm (%)	4.1±1.0	3.8±1.2	18.8±1.7	18.3±1.5	0.004

*Significance between study groups

Table 4: Hormonal parameters of the study participants.

Variable	Group 1 (n=20) non-obese infertile (Mean±SD)	Group 2 (n=20) obese infertile (Mean±SD)	Group 3 (n=20) non-obese fertile (Mean±SD)	Group 4 (n=20) obese fertile (Mean±SD)	P value*
TSH[1] (mIU/ml)	1.8±0.7	3.2±0.7	3.1±0.8	2.8±0.8	0.043
FSH[2] (mIU/ml)	9.9±3.2	5.2±3.1	12.2±0.7	32.1±3.2	0.033
LH[3] (mIU/ml)	6.4±1.6	4.0±0.4	9.2±0.2	5.1±2.1	0.017
PRL[4] (mIU/ml)	10.6±1.0	18.8±1.2	11.9±1.2	16.5±1.2	0.009
Testosterone (mIU/ml)	756.2±43.9	433.1±41.4	618.1±44.2	518.4±23.9	0.013
Vitamin D3 (mIU/ml)	29.7±8.9	12.1±5.2	28.7±3.0	18.5±2.0	0.427

*Significance between study groups, [1]thyroid stimulating hormone, [2]follicle stimulating hormone, [3]luteinzing hormone, [4]prolactin

Table 5: Correlation between BMI with clinical, seminal and hormonal profile of study participants.

Variable	Pearson correlation coefficient	P*
Anthropometry parameters		
Age (years)	0.143	0.072
Weight (kg)	0.853	0.001
Waist circumference (cm)	0.813	0.001
Systolic BP[1] (mmHg)	0.148	0.145
Diastolic BP[1] (mmHg)	0.160	0.140
Blood parameters		
FBS[2] (mg/dl)	0.448	0.001
PBS[3] (mg/dl)	0.333	0.002
HbA1c[4] (%)	0.458	0.001
Cholesterol (mg/dl)	0.287	0.009
Triglyceride (mg/dl)	0.326	0.003
HDL[5] (mg/dl)	-0.024	0.834
Seminal parameters		
Abstinence (days)	-0.109	0.033
Liquefaction time (mins)	-0.171	0.012
pH	-0.078	0.048
Semen volume (ml)	-0.251	0.017
Sperm count (million/ml)	-0.340	0.050
Total motility (%)	-0.382	0.043
Rapid motility (%)	-0.035	0.057
Moderate motility (%)	-0.053	0.036
Sluggish motility (%)	-0.122	0.049
Live sperm (%)	-0.045	0.027
Dead sperm (%)	0.120	0.049
Normal sperm (%)	-0.022	0.044
Hormonal parameters		
TSH[6]	0.059	0.002
FSH[7]	-0.070	0.034
LH[8]	-0.203	0.068
PRL[9]	0.120	0.038
Testosterone	-0.336	0.002
Vitamin D3	-0.168	0.013

*Significance between study groups, [1]blood pressure, [2]fasting blood sugar, [3]post-prandial blood sugar, [4]hemoglobin a1c, [5]high density lipoprotein, [6]thyroid stimulating hormone, [7]follicle stimulating hormone, [8]luteinzing hormone, [9]prolactin

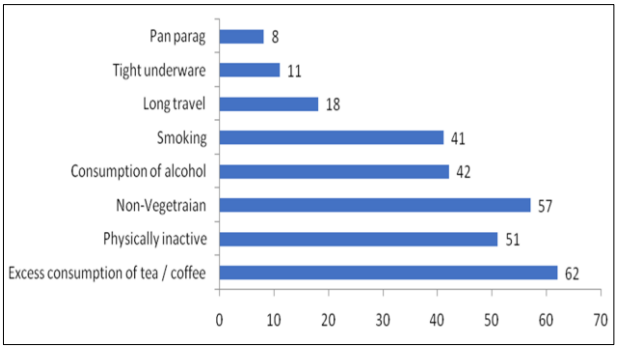

Figure 1: Lifestyle behavior of the study participants.
*Data was expressed in number of participants

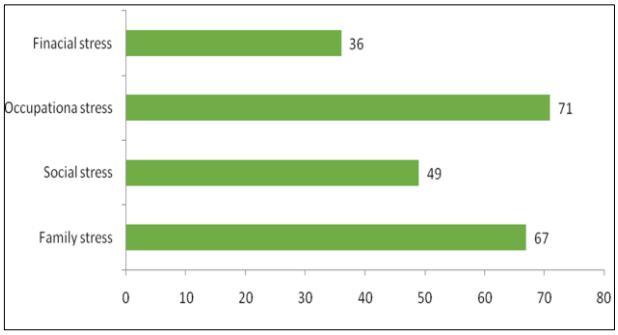

Figure 2: Stress level of the study participants.
*Data was expressed in number of participants

DISCUSSION

Globally, BMI is used as marker to consider obesity, the fat is distributed all over the body, particularly it deposited more in abdominal region consider as central obesity. So currently, apart from BMI, waist circumference can also use as marker for considering obesity. The present investigated the anthropometry, blood, semen and hormonal parameters of four groups differ in their BMI and semen parameters.

Age is a non-modifiable vital factor for obesity and increase during early and middle age and may decrease at elder age. Across the study groups, the highest age (36.6 years) was observed in obese infertile participants, this could be due to sedentary life style, along with intake of higher energy leads to accumulation of fat and become

obese. The present study found the positive correlation between age and BMI, similar results we also observed in a study conducted in 858 infertile male age between 18-55 years.[25] The present study shows that obese participants having higher waist circumference (92.5 cm) than non-obese participants and shows the positive correlation between BMI and waist circumference similarly a Nigerian cross- sectional study conducted in 5392 participants reported that waist circumference shows stronger positive correlation with BMI than waist to hip ratio.[26] A study conducted in 7907 participants found that 10 mmHg of systolic and 5 mmHg of diastolic blood pressures was increased significantly along with normal BMI moves towards high.[27] Similarly, the present shows that both systolic and diastolic blood pressures found higher in obese participants than non-obese.

Indian is with overweight; obesity and central obesity are higher risk of diabetes and cardiovascular diseases. Body converts the excess blood glucose into fatty acid and increase the body fat content leads to higher body weight thus blood sugar level may correlate with BMI. In the present study shows that blood sugar level at fasting, post-prandial, HbA1c was significant positive correlation with BMI. In contrast a study not found significant correlation between random blood sugar and BMI.[28] A study conducted in Jharkhand population shows that fasting blood sugar increasing along with BMI of the study population.[29] A study conducted during 2012-2019 in age group of 18-44 reported that higher BMI was positive correlated with higher HbA1c levels.[30] The present shows that the obese participants having higher cholesterol, triglycerides level and positive correlation with BMI and in contrast the HDL found lower in same population with negative correlation. Supportive results were also found in a study conducted in 305 participants in Peshawar from January 2016 to July 2016.[31]

Obesity causes adverse effects in many physiological systems in the body including reproductive system. The association between BMI and sperm quality was recently validated by a systematic review and meta-analysis, which also raised the possibility that obesity may be detrimental to male fertility.[32] The present study investigated the correlation between semen parameters and different BMI of both infertile and fertile groups and we observed that BMI was negatively associated with semen parameters including semen volume, sperm count and motility, and sperm morphology. Supportive results were as reported the negative correlation between obesity and sperm counts.[33] A observational study conducted in 3966 semen samples found that obese and overweight have 4.2% lower semen volume than normal BMI participants.[34] The study conducted by Raad et al reported the sperm motility was lower in obese participants as compared to non-obese and similar results were also found in the present study.[35]

Spermatogenesis is a complex process and it under the control of hypothalamus, pituitary endocrine glands, Leydig and Sertoli cells in the testis. Obesity directly influences the hormonal profile by several physiological mechanisms. The present investigated the hormonal profile of study groups and found hormonal imbalance in obese participants as compared to non-obese participants. A study shows that elevated TSH level was observed in obese participants and similar results also found in the present study.[36] Other hormones include FSH and LH level was observed low in obese participants as compared non-obese group participants, similar trend was also observed in study conducted by MacDonald et al.[37] A study shows that the excess of body weight leads to increase the prolactin level, which supports our results that obese are found to have higher prolactin level than non- obese participants.[38] It is well known that obesity lower the testosterone level. A study reported that long term testosterone therapy decreased the body weight, BMI and waist circumference in obese male.[39] Vitamin D concentration plays an important role in human sperm. In the present study it was observed that obese participants have lower level of vitamin D. similarly a study conducted by Pooladi et al in 64 men shows that serum vitamin D level was found lower in participants with higher BMI.[40] Occupational and environmental factors also influence the semen quality. Lifestyle factors include excess consumption of coffee, tea and alcohol, smoking, physically inactive, excess uses of cell phone, poor sleep quality, unhealthy eating habits, stress are drastically affected the semen quality. Sample size of the study is small and it not representing the Tamil Nadu or India. Hence the study needs to conduct in other ethnic groups. Participants were recruited by purposive sampling and hence the randomization process was not blinded are few limitations of the study. Another limitation is stress was assessed by simple yes or no questions and not used any standardized stress tool.

CONCLUSION

The present study was designed to examine the association of BMI with anthropometry, blood, seminal and hormonal parameters in obese infertile and fertile males. The study finding indicates that higher BMI directly influence the anthropometry and blood parameters of the study participants. Despite the limitation, we can conclude that our results finding shows that BMI play a potential role in male infertility, which influence the semen and blood parameter, but this finding should be confirmed and further explored to other ethnic groups.

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