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(The Effect Of Increasing Body Weight On Infertile Men)

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Contents

I-Acknowledgment

I Would Like To Show Sincere Gratitude For All Patients Who Participated In The Study. I Also Grateful For Fertility Clinic And Dr. Hussein Khalifa For Help And Support To Accomplish This Work.

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I I- Abstract

Background

Data at the impact of obesity and overweighting on seminal fluid characteristics and men fertility are collected . The goal of this research turned into to assess the effect of weight problems on semen characteristics in infertile men.

The Aim Of Study

To Explain The Effect Of Obesity And Increasing Body Weight On Men Fertility And Their Seminal Fluid Parameters.

Patient and method

A cross-sectional study was conducted on eighty one infertile men who met inclusion criteria . patients age , duration of infertility and type of infertility was taken .Seminal fluid results were collected and sperm concentration, volume, progressive motility, total motility and normal sperm morphology were assessed in accordance with WHO 1999 criteria. For each patient weight and height were measure and patients were divided by BMI into normal weight (BMI: 18.5–24.9 kg/m2, n = 23), overweight (BMI: 25–29.9 kg/m2, n = 28) and obese (BMI: ≥30 kg/m2, n = 30). Seminal fluid parameters were compared among the three groups.

Results

Mean age , Type and duration of infertility in these three groups were not different significantly .although Sperm concentration was lower in obese men but it did not differ significantly from those of normal weight and overweight infertile men ($P > 0.05$) . Type of infertility whether it is primary or secondary also wasn't significantly different. But Sperm progressive motility, total motility and normal sperm morphology were significantly different among the three groups. And was more significant in those obese and overweight than patients with average weight .

Conclusion

Our findings suggest that obesity and overweighting may have influence on sperm motility and normal morphology in infertile men. But have no effect on sperm concentration and volume.

III -Introduction

Infertility is defined as inability to conceive ofter one year of regular unprotected sexual intercourse .
15 percent of couples and 48.5 million couples in the world have this problem (1)
Male infertility affects over half of those couples due to a variety of problems including varicocele, prostate cancer, systemic disorders, and genetic factors.
In around 25% of couples, however, there is no underlying explanation for primary and secondary infertility (2).
According to WHO **Overweight and obesity** are defined as abnormal or excessive fat accumulation that presents a risk to health. A body mass index (BMI) over 25 is considered overweight, and over 30 is obese.Obesity and aberrant or poor semen parameters and quality, as well as male infertility, have been associated in recent publications and studies (3,4).

According to latest WHO figures, 650 million individuals worldwide were obese in 2016 (5) ,with more than 1.9 billion overweight. Obesity has been linked to an increased risk of a variety of health problems, including cardiovascular disease, sleep apnea, depression , (6,7)

Body mass index (BMI), skin folds caliper measurement, waist circumference, waist to hip ratio, and other measures are used to assess obesity.
According to The International Classification of Adult Weight Status (9) .weight is classified into four categories:
(1) underweight (BMI < or =18.5 kg/m^2).
(2) normal weight (BMI =18.5–24.9 kg/m^2).
(3) overweight (BMI =25.0–29.9 kg/m^2).
(4) Obese (BMI > or = 30 kg/m^2).
Although it is generally understood that obesity and overweight can influence female fertility, the effects of obesity and overweight on male fertility and semen parameters are less well understood (10).
Obesity has been linked to reduced sperm concentration, motility, morphology, and (6,11–13)in several studies. Other research, on the

other hand, have found no link between obesity and poor sperm quality (7,14).
Furthermore, according to a recent systematic review including meta-analysis, there is no link between BMI and poor sperm concentration or total sperm count (15).
Overweight and obesity may compromise testicular microenvironment **Spermatogenesis** is a process of producing male gametes its an ongoing differentiation process that happened with in the seminiferous epithelium in the testis in males to produce spermatozoa (sperm) and is continued by a tissue-specific stem cell termed the "spermatogonial stems. stemspermatogenesis requires intact endocrine communication through the hypothalamic-pituitary-gonadal axis (16).Spermatogenesis relies upon intratesticular and extratesticular hormonal regulatory processes and functions of the intertubular microvasculature, the Leydig cells and other cellular components of the intertubular space.However, the exact process through which extra body fat causes abnormal spermatogenesis and decreased fertility in males is uncertain.
In this study, we explored the effect of overweight and obesity on seminal fluid characteristics in infertile men.

IV-patient and Method.

4.1 Data collection

A cross sectional study was conducted on 81 infertile man who come to infertility clinic from 15/12/2021 to 1/3/2022 period.
Criteria for selection the patients is by
1-exclusion of any systemic illnesses,genital tract infections,trauma...
2- patients suffering from infertility more than 12 months despite regular unprotected sexual intercourse .
A questionnaire that designed for collect the patients data include (Name, Age,Duration of infertility, Type of infertility,Weight and Height for calculate the BMI using formula of BMI= (Weight in Kg divided by Height in square meters)
And Seminal fluid analysis comprised of (volume, concentration ,motility, morphology)

I divided patients to 3 categories of BMI
A/ normal weight (BMI 18-24.9 kg/m^2) total number is = 23 patient.
B/overweight (BMI 25-29.9 kg/ m^2) total number is = 28 patient.
C/ obese (BMI >or = 30 kg/ m^2) total number is = 30 patient.

4.2 Statistical analysis

The Statistical Analysis System- SAS (2012) program was used to detect the effect of difference factors in study parameters. Kruskal-Wallis test was used to significant compare between means. Chi-square test was used to significant compare between percentage (0.05 and 0.01 probability) in this study.(17).
P < or =0.05 was considered statistically significant ,P< or =0.01 considered highly significant while P > or = 0.05 mean not significant.

Table 1: Patients demographics and seminal fluid characteristics categorized Body mass index

Parameters	Normal weight (n=23	Over weight (n=28)	Obese (n=30)	P-value
Age (years)	28.17 ±4.69	31.07 ±5.93	31.50 ±6.61	P>0.05 NS
Body mass index-BMI (kg/ m2)	22.89 ±1.48	26.68 ±1.32	33.60 ±2.70	P<0.01 **
Duration of infertility (years)	3.21 ±3.04	4.46 ±4.31	4.96 ±4.81	P>0.05 NS
Semen concentration (million/ ml)	49.26 ±21.24	50.89 ±43.19	41.56 ±29.78	P>0.05 NS
Volume-cc (ml)	2.69 ±1.05	2.75 ±1.51	2.46 ±1.39	P>0.05 NS
Motility (A+B) (%)	36.00 ±6.96	25.53 ±6.74	28.06 ±5.16	P<0.05 *
Abnormal morphology (%)	29.78 ±6.45	44.28 ±10.20	33.33 ±7.55	P<0.05 *
Type of infertility: 1 ry 2 ry	16 (69.57%) 7 (30.43%)	19 (67.86%) 9 (32.14%)	20 (66.67%) 10 (33.33%)	P>0.05 NS
Abnormal spermatozoa: 1-Normozoospermia 2-Azoospermia 3-Asthenospermia 4-Oligoasthenospermia	8 (34.78%) 1 (4.35%) 14 (60.09%) 0 (0.00%)	7 (25.00%) 2 (7.14%) 13 (46.43%) 6 (21.43%)	8 (26.67%) 3 (10.00%) 14 (46.67%) 5 (16.67%)	P<0.01 **

Results are expressed as mean SD or number (proportion)., Kruskal-Wallis test used to compare means between groups and Chi-Square test was used to compare. ** (P≤0.01), NS: Non-Significant.

V-Results

Eighty one patients divided to three groups
Obese = 30 patient (37%)
Overweight = 28 patient (34%)
Average weight = 23 patient (28%)

Participated in this study. Patients with primary infertility constituted 55 patient (67.9%) and those with secondary infertility constituted 26 patient (32.09%).

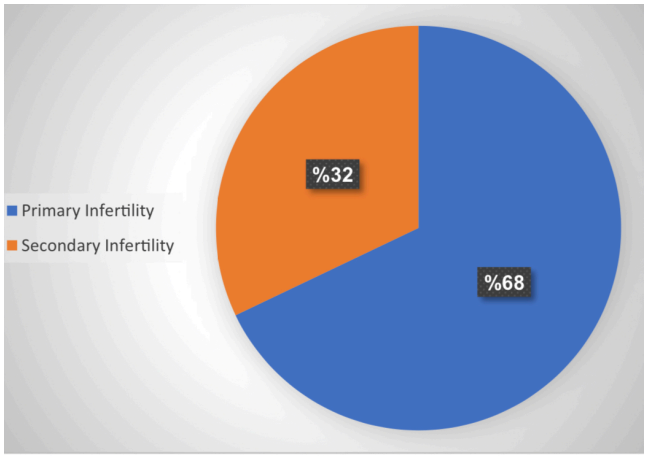


Fig. 1. Proportions of patients with primary and secondary infertility.

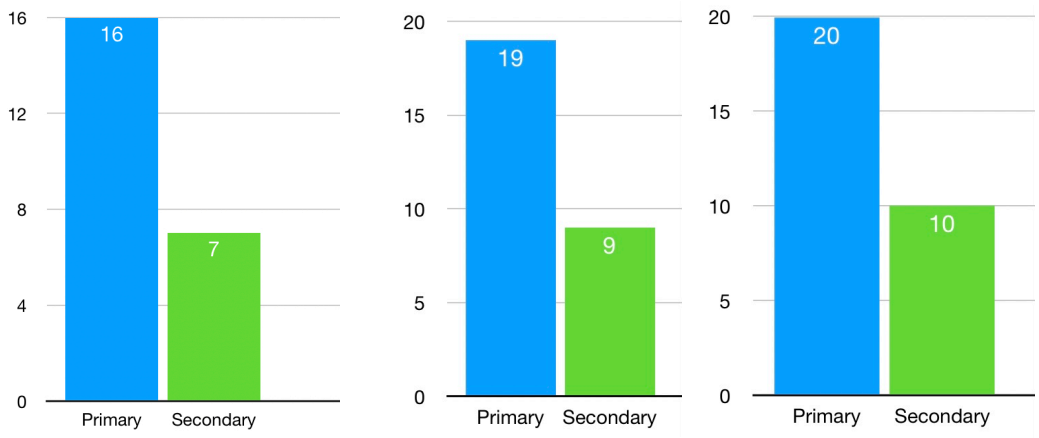
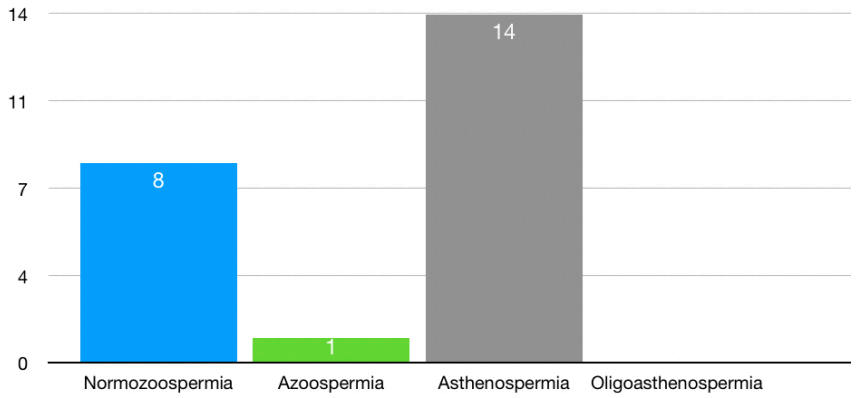
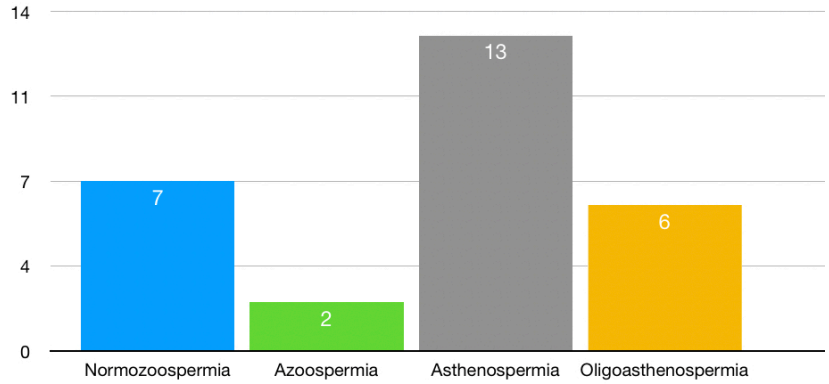


Fig. 2. Proportion of primary and secondary infertility in average and overweight and obese patients.

Patients demographics and seminal fluid characteristics by body mass index are shown in table 1.
Mean age didn't differ significantly among normal weight (28.17+_ 4.69)and overweight (31.07+_5.93)and obese(31.50+_ 6.61) . P value was> 0.05.
Duration of infertility was also not significantly different among Average normal weight (3.21+_ 1.48) and overweight (4.46 +_ 4.81) and obese (4.96 +_ 4.81) . P value was > 0.05 .
Type of infertility also wasn't statistically significant between average weight , overweight and obese P value was > 0.05.
(Fig 2)
Semen volume also was not significantly different among average weight (2.69+_ 1.05) and overweight (2.75+_ 1.51) and obese (2.46+_ 1.39). P value was also > 0.05.
While semen concentration was lower in those obese (41 .56+_ 29.78)compared to overweight (50.89+_ 43.19)and average weight (49.26+_ 21.24) but theses differences didn't reach to statistically significant level P value > 0.05.
The proportion of patients with abnormal or low progressive sperm motility was higher in obese and overweight (28.06+_ 5.16 , 25.53+_6.74) than in average weight (36.00+_ 6.96) P value was < 0.05 and it's statistically significant.
Also the proportion of abnormal morphology was higher in obese and overweight (33.33+_7.55 , 44.28+_10.20) than this in average weight (29 .78 +_6.45)
P value was < 0.05 and it is statistically significant.

Finally the proportions of abnormal spermatozoa or SFA result (Normozoospermia, azoospermia, asthenospermia, and oligoasthenospermia) was
In average weight (34% , 4.35% , 60.09% , 0%)
In overweight (25% , 7.14% , 46.43% , 21.43%)
And in obese (26.67% , 10% , 46.67% , 16.67%)
P value was highly significant < 0.01 . (Table 1) (Fig. 3)





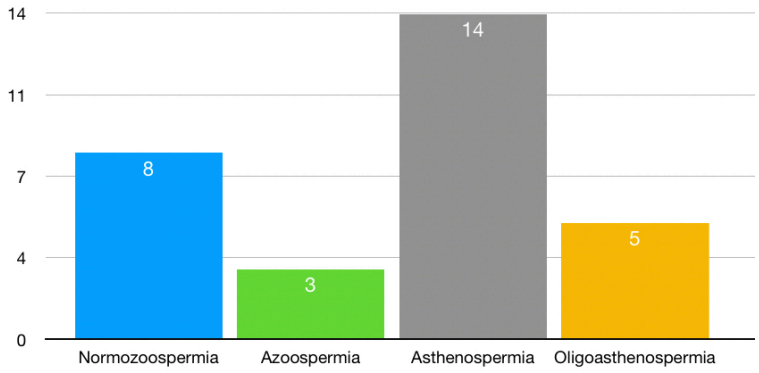


Fig. 3. Theses columns charts demonstrate the proportions of Normozoospermia/ Azoospermia/ Asthenospermia/ Oligoasthenospermia in average weight , overweight and obese patients.

VI-Discussion

Patients with normal weight, overweight, and obese patients had similar ages, durations of infertility in the current study. Semen volume did not differ across the three groups of infertile males. Our findings are agreed with those of another study (10).which found no link between BMI and sperm volume in infertile males. Chavarro et al., on the other hand, found a decrease in semen volume with increased BMI (18).

Despite the fact that sperm concentration was lower in obese men in this study, there was no significant difference between normal weight, overweight, and obese men with infertility. Obesity's effect on sperm concentration has been controversial in studies . Some research, like ours, found no link between obesity and low sperm quality (14,15,19) ,whereas others found obesity to have negative consequences (6,12). Our findings are in line with a previous Iraqi study by Al-Aridhi and Al-Ahmed, which investigated sperm concentration in males of different weights.normal and overweight and demonstrated no significant difference between these two groups (20) .

A study on 439 infertile men in Egypt showed no difference in mean sperm concentration among normal weight, overweigh and obese men (10).

The effect of hypertriglyceridemia on seminal parameters was investigated in Japanese infertile males and found no significant link with sperm concentration or motility, with the only effect being on sperm morphology (21). Furthermore, Sermondade et al. reported a higher prevalence of azoospermia and oligospermia among overweight and obese males but no significant influence on sperm concentration in a comprehensive review and meta-analysis (11). This was supported by a large research of 2110 infertile males, which found no link between BMI and sperm parameters, but an inverse relationship between testosterone and LH hormone levels. (22).

Conversely, other researches and studies showed a reduction in sperm concentration with increasing BMI (10,12,18,23). Anderson et al. Demonstrated the relationship between BMI and poor semen quality in 166 men and reported negative association between BMI and sperm concentration, but this study conducted on both fertile and infertile men (24). by Belloc et al. a large cohort study showed a decreasing in sperm concentration with increasing BMI in infertile men in France but semen analysis and BMI were self-reported (25). The impact of weight reduction on seminal fluid parameters is not clear and in a large study performed on

1558 Danish men, the under- weight men showed low sperm concentration (26). suggest that normal spermatogenesis needs an ideal BMI.
In the current study, the proportion of patients with normal and abnormal progressive and total sperm motility was comparable among the three BMI groups., unlike the sperm concentration data on the influence of obesity on sperm motility are significant and the sperm motility (A+B) was lower in obese and overweight than in those with average weight.Some reports showed no association between BMI and sperm motility (10,25,27) while others documented negative effect (25,28).
Our findings against those of a multi-institutional cohort study of infertile men in Canada that found a weak correlation between BMI and sperm motility (6).
Jensen et al. Showed a higher prevalence and incidence of oligozoospermia with increased BMI. However, no link was found between increasing male BMI and percentage of motile spermatozoon (26). Further, a study in New Zealand on infertile men explained no effect of increased BMI on all semen parameters except normal sperm morphology (19) .
As in our study, Koet et al. Showed a reduction in total sperm motility with increasing BMI in infertile men (23). Another research have also reported lower progressive sperm motility in overweigh and obese men with infertility in US (12).
The proportion of normal sperm morphology was influenced by increased BMI in our study. Chavarro et al. and MacDonald et al. reported that no effect on sperm morphology (15,18). While A large cohort study showed a reduction in sperm concentration and progressive motility but not sperm normal morphology with increasing BMI in infertile men (25) .Other studies have demonstrated no association between BMI and sperm morphology (22,29). In contrast, Hofny et al. Which agreed with our study and found a significant positive association between BMI and normal sperm morphology (30) .
The relationship between obesity and male infertility is multifactorial. Spermatogenesis requires optimal endocrine milieu and decrease in gonadotropins, testosterone hormone, inhibin B, SHBG,testosterone/ estradiol ration and increase estradiol level have been reported in infertile obese men (3).Higher serum insulin levels detected in

overweight men can downregulate SHBG synthesis withinside the liver whilst extra unbound testosterone is transformed to oestradiol through aromatase withinside the adipose tissue (24) .Higher degrees of oxidative stress and imbalance among oxidants and antioxidants were additionally located in overweighted men and connected to decreased fertility (31). Further, oxidative stress has been linked to impaired the sperm function, and sperm DNA fragmentation. These findings could partially explain abnormal sperm concentration , motility and morphology detected in infertile obese men in some studies above.

Our study also compared with study that published at April 2018 done by Ahmed T. Alahmar , Zahraa Ali, Zahraa Muhsin, Hadeel Qasim College of Pharmacy, University of Babylon, Iraq. Which demonstrate that there is no effect of increasing body weight on sprem concentration and motility and morphology (32).

Conversely, our study and different research did show negative impact for weight problems on seminal fluid measures and a few studies showed destructive impact on one parameter only. One reason of the contradictory findings of the aforementioned studies on the effect of weight troubles on seminal fluid parameters may be due to the heterogeneity of populations studies and inclusion of fertile and infertile men. There are also racial and geographical variations in the prevalence of weight troubles and semen terrific and a lot of those research carried out in Western countries (33). This variant has contributed to discount in overweight populations in posted research which disagree with our study and suggests that correlations among BMI and decreased fertility can be under appreciated and not significantly affects . While , a few research that have compared seminal fluid parameters amongst different BMI groups have now no longer excluded different situations that may adjust and affect on semen characteristics like varicocele, undescended testis; genital tract infections which can be enormous confounders. All those conditions had been excluded in our look at. Another potential confounder that impacts fertility control final results and pregnancy rate is women element which include women age. Interestingly, Ramlau- Hansen et al. Showed the effect of both partners weight on 47,835 pregnancies. The Odd's ratio (OR) for subfecundity accelerated among underweight and overweight women and men in a dose-reaction manner (34). Finally the results of SFA was highly significant in those obese and overweight compared to the average weight .

VII-Conclusion

While The effect of obesity and overweight on semen quality of men is still largely unexplored.Our findings suggest that obesity and overweight have Significant influence on sperm motility , normal morphology and results of SFA in infertile men.

Further studies is wanted to discover the etiologies of impaired semen parameters, therapeutic options obese and overweight mens with subfertility and the impact of weight reduction on men fertility.

VIII-Recommendations

According to our results in this study We recommend that decreasing body weight in obese and overweighted infertile men may affect on their fertility improve their seminal fluid parameters and increasing chance to having children.

IX-References

[1] J. Datta, M.J. Palmer, C. Tanton, et al., Prevalence of infertility and help seeking among 15 000 women and men, Hum. Reprod. 31 (9) (2016) –2118, https://doi.org/10.1093/humrep/dew123.

[2] D. Arcaniolo, V. Favilla, D. Tiscione, et al., Is there a place for nutritional supplements in the treatment of idiopathic male infertility?, Arch Ital di Urol e Androl 86 (3) (2014) 164, https://doi.org/10.4081/aiua.2014.3.164.

[3] A. Katib ,Mechanisms linking obesity with male infertility, Cent. Eur. J. Urol. 68 (1)2015 .https://doi.org/10.5173/ceju.2015.01.435.

[4] L.M. Davidson, K. Millar, C. Jones, M. Fatum, K. Coward, Deleterious effects of obesity upon the hormonal and molecular mechanisms controlling spermatogenesis and male fertility,Human fertility 18 (3) (2015) 184–193, https://doi.org/10.3109/14647273.2015.1070438.

[5] H.N. Moussa, M.A. Alrais, M.G. Leon, E.L. Abbas, B.M. Sibai, Obesity epidemic: impact from preconception to postpartum, Futur. Sci. OA 2 (3) (2016) FSO137, https://doi.org/10.4155/fsoa-2016-0035.

[6] J.M. Bieniek, J.A. Kashanian, C.M. Deibert, et al., Influence of increasing body mass index on semen and reproductive hormonal parameters in a multi- institutional cohort of subfertile men, Fertil. Steril. 106 (5) (2016) 1070–1075, https://doi.org/10.1016/j.fertnstert.2016.06.041.

[7] V.T. Dubeux, T. Renovato, A.C. Esteves, L. André, A. de Oliveira, I.A. Penna, The impact of obesity on male fecundity: a Brazilian study, JBRA Assist. Reprod. 20 (3) (2016) 137–141, https://doi.org/10.5935/1518-0557.20160031.

[8] M.O. Akindele, J.S. Phillips, E.U. Igumbor, The relationship between body fat percentage and body mass index in overweight and obese individuals in an urban african setting, J. Publ. Health Africa 7 (1) (2016) 515, https://doi.org/ 10.4081/jphia.2016.515.

[9] S. Moore, J.N. Hall, S. Harper, J.W. Lynch, Global and national socioeconomic disparities in obesity, overweight, and underweight status, J. Obes. 2010 https://doi.org/10.1155/2010/514674.

[10] S. Alshahrani, A.-F. Ahmed, A.H. Gabr, M. Abalhassan, G. Ahmad, The impact of body mass index on semen parameters in infertile men, Andrologia 48 (10) (2016) 1125–1129, https://doi.org/10.1111/and.12549.

[11] N. Sermondade, C. Faure, L. Fezeu, et al.BMI in relation to sperm count: an updated systematic review and collaborative meta-analysisHum. Reprod. Update, 19 (3) (2013), Hum. Reprod. Update 19 (3) (2013) 221–231, https://doi.org/10.1093/humupd/dms050.

[12] A.O. Hammoud, M. Gibson, C.M. Peterson, A.W. Meikle, D.T. Carrell, Impact of male obesity on infertility: a critical review of the current literature, Fertil. Steril. 90 (4) (2008) 897–904, https://doi.org/10.1016/j.fertnstert.2008.08.026.

[13] L. Wang, J. Southerland, K. Wang, et al., Ethnic differences in risk factors for obesity among adults in California, the United States, J. Obes. (2017) 2427483, https://doi.org/10.1155/2017/2427483.

[14] L. Hadjkacem Loukil, H. Hadjkacem, A. Bahloul, H. Ayadi, Relation between male obesity and male infertility in a Tunisian population, Andrologia 47 (3) (2015) 282–285, https://doi.org/10.1111/and.12257.

[15] A.A. MacDonald, G.P. Herbison, M. Showell, C.M. Farquhar, The impact of body mass index on semen parameters and reproductive hormones in human males: a systematic review with meta-analysis,. Update 16 (3) (2010) 293–311, https://doi.org/10.1093/humupd/dmp047.

[16] K. Leisegang, P.J. Bouic, R. Menkveld, R.R. HenkelObesity is associated with increased seminal insulin and leptin alongside reduced fertility parameters in a controlled male cohort and leptin alongside reduced fertility parameters in a controlled male cohort, Reprod. Biol. Endocrinol. 12 (1) (2014) , https:// doi.org/10.1186/1477-7827-12-34.

[17 **SAS. 2012.** Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA.

[18] J.E. Chavarro, T.L. Toth, D.L. Wright, J.D. Meeker, R. Hauser, Body mass index in relation to semen quality, sperm DNA integrity, and serum reproductive hormone levels among men attending an infertility clinic, Fertil. Steril. (7) (2010) 2222–2231, https://doi.org/10.1016/j.fertnstert.2009.01.100.

[19] A.A. MacDonald, A.W. Stewart, C.M. Farquhar, Body mass index in relation to semen quality and reproductive hormones in New Zealand men: a cross- sectional study in fertility clinics, Hum. Reprod. 28 (12) (2013) 3178–3187, https://doi.org/10.1093/humrep/det379.

[20] D.T. Al-Aridhi, H.I. Al-Ahmed, Study the relationship between obesity and fertility in diabetic Iraqi men, J. Biotechnol. Res. Cent. 9 (2) (2015).

[21] J. Hagiuda, H. Ishikawa, T. Furuuchi, Y. Hanawa, K. Marumo, Relationship between dyslipidaemia and semen quality and serum sex hormone levels: an infertility study of 167 Japanese patients 46 (2) (2014) 131–135, https://doi.org/10.1111/and.12057.

[22] B.M. Al-Ali, T. Gutschi, K. Pummer, et al., Body mass index has no impact on sperm quality but on reproductive hormones levels, Andrologia (2) (2014) 106–111, https://doi.org/10.1111/and.12051.

[23] H.I. Kort, J.B. Massey, C.W. Elsner, et al., Impact of body mass index values on sperm quantity and quality, J. Androl. 27 (3) (2006) 450–452, https://doi.org/10.2164/jandrol.05124.

[24] Y.C. Anderson, L.E. Wynter, K.R. Moller, The effect of a multi-disciplinary obesity intervention compared to usual practice in those ready to make lifestyle changes: design and rationale of Whanau Pakari, BMC Obes. 2 (2015) 41, https://doi.org/10.1186/s40608-015-0068-y.

[25] S. Belloc, M. Cohen-Bacrie, E. Amar, et al., High body mass index has a deleterious effect on semen parameters except morphology: results from a large cohort study, Fertil. Steril. 102 (5) (2014) 1268–1273, https://doi.org/ 10.1016/j.fertnstert.2014.07.1212.

[26] T. Jensen, A. Andersson, N. Jorgensen, et al., Body mass index in relation to semen quality and reproductive hormonesamong 1,558 Danish men, Fertil. Steril., https://doi.org/10.1016/j.fertnstert.2004.03.056.

[27] M.L. Eisenberg, S. Kim, Z. Chen, R. Sundaram, E.F. Schisterman, G.M. Buck Louis, The relationship between male BMI and waist circumference on semen quality: data from the LIFE study, Hum. Reprod. (2) (2014) 193–200, https://doi.org/10.1093/humrep/det428.

[28] L. Lazaros, E. Hatzi, S. Markoula, et al., Dramatic reduction in sperm parameters following bariatric surgery: report of two cases, Andrologia (6) (2012) 428– 432, https://doi.org/10.1111/j.1439-0272.2012.01300.x.

[29] F.H. Duits, M. van Wely, F. van der Veen, J. Gianotten, Healthy overweight male partners of subfertile couples should not worry about their semen quality, Fertil. Steril. (4) (2010) 1356–1359, https://doi.org/10.1016/j. fertnstert.2009.05.075.

[30] E.R.M. Hofny, M.E. Ali, H.Z. Abdel-Hafez, et al., Semen parameters and hormonal profile in obese fertile and infertile males, Fertil. Steril. 94 (2) (2010) 581–584, https://doi.org/10.1016/j.fertnstert.2009.03.085.

[31] S. Houfflyn, C. Matthys, A. Soubry, Male obesity: epigenetic origin and effects in sperm and offspring, Curr Biol. Rep. 3 (4) (2017) 288–296, https://doi. org/10.1007/s40610-017-0083-5.

[32] The impact of obesity on seminal fluid in men with infertility / University of Babylon / College of pharmacy 2018. https://pdf.sciencedirectassets.com . https://reader.elsevier.com/reader/sd/pii/S111056901830089X?token=B51E0F56862CA2B2DDE6906893FA335B3DBB80D6BF6CA00A5B6A9522A2817DD166771D5322EF0B76D76212B4A873DFE7&originRegion=eu-west-1&originCreation=20220404123336 .

[33] Y.S. Khandwala, C.A. Zhang, S. Li, B. Behr, D. Guo, M.L. Eisenberg, Racial variation in semen quality at fertility evaluation, Urology (2017) 96–102, https://doi.org/10.1016/j.urology.2017.03.064.

[34] C.H. Ramlau-Hansen, A.M. Thulstrup, E.A. Nohr, J.P. Bonde, T.I.A. Sørensen, J. Olsen, Subfecundity in overweight and obese couples,(6) (2007) 1634–1637, https://doi.org/10.1093/humrep/dem035.