A study of male infertility using some hormonal and immunological indicators in Thi Qar city

ABSTRACT

Background: The current study aims to identify some of the causes that may cause male infertility especially the secondary type, which has recently increased in urban life more than rural life, using some hormonal factors such as FSH, LH, testosterone, and biochemical parameters such as lipoprotein alpha and some immune indicators such as anti-insulin antibody.
Study Design: This case control study was carried out on infertile males at Al-Hussein Teaching Hospital, Thi Qar city, over a six-month period from September 2017 to March 2018.
Methods: Hormonal evaluations were performed on those with abnormalities in their sperm count.
Results: The total number of patients evaluated for infertility was 97. The mean age of the patients was 33.5 years. 81 patients (83.5 %) had primary infertility and 16 patients (16.5 %) had secondary infertility, and according to the study, there was a significant association with the problem. Hormones change according to the age of the patients as there is a significant difference in FSH and testosterone with no significant difference in LH. While hormonal changes between the age groups of the study were normal with FSH and no change in the values of both LH and testosterone these results apply with regard to the duration of infertility for the time group 2-5 years. The opposite is true regarding the presence or absence of varicocele. Regarding alpha-lipoprotein the most affected age groups are G2 and G3 with a 2-5 year infertility period and secondary infertility with varicocele. What this study has addressed about anti-insulin antibody affects the age group G2 by increasing the periods of secondary infertility by 2-3 years and is not related to the presence or absence of varicocele.
Conclusion: Varicocele plays a major and important role in male infertility especially if it is associated in any way with insulin resistance or high alpha lipoprotein.

Keywords: lipoprotein alpha, anti-insulin antibody and secondary male infertility

1. INTRODUCTION

The definition of infertility is the failure to conceive after 12 months of unprotected intercourse [1]. Infertility was classified as: primary and secondary. Primary infertility occurs when a male does not produce any offspring, and secondary infertility occurs when reproduction stops after a previous birth. About 15% of couples trying to conceive for the first time fail, and another 10% suffer from secondary infertility [2].

Therefore, about 50% of cases were attributed to the male factor. Infertile couples were evaluated in a previous study conducted by our center, and the cause of the disease was in the man alone in 28.6% of cases, while both women and men had abnormalities in 30% of cases. Infertility present in about 1 in 7 couples of reproductive age, may cause psychological distress. Infertility may be resulted from poor sperm quality (eg low motility) or low sperm count. Azoospermia or oligospermia is usually of unknown cause , but may be due to hypogonadism. Microdeletion of the Y chromosome is

increasingly recognized as a cause of severe spermatogenesis. In many couples, more than one cause is involved in infertility, and in a large proportion no cause can be identified [3].

Male fertility depends on a healthy hypothalamic-pituitary-testicular axis to initiate and maintain normal spermatogenesis in terms of semen quality, and sperm quantity, and to maintain normal secondary gonadal and sexual functions [2]. Up to 20% of male infertility can be attributed to endocrine disorders, so it is surprising how rarely infertile males have identifiable endocrine disorders. In fact, endocrine disorders remain an important factor to consider in determining the etiology of male infertility, which may also be related to important medical conditions because they are not treatable. However, in clinical practice, endocrine evaluation is usually performed only in males with severe oligozoospermia or azoospermia [4].

Hormones evaluated include luteinizing hormone (LH), follicle stimulating hormone (FSH), prolactin, and testosterone [3]. Other studies, such as estradiol measurement, thyroid function testing, hormone binding globulin, etc., may be performed depending on the clinical scenario and the results of the initial studies [2]. Depending on the results of hormonal evaluation, an optimal endocrine diagnosis such as hypergonadotropic hypogonadism can be made, and the patient managed accordingly. The aim of our study was to reveal the prevalence and pattern of endocrine abnormalities in males screened for infertility in our setting [1].

2. MATERIALS AND METHODS

This is a retrospective research study of males infertility at Al-Hussein Teaching Hospital in 2018. Hormonal evaluation (FSH, LH and testosterone) was performed for males with abnormalities in their sperm count. Data include: age, sperm count, and hormonal levels were extracted from the patient record and chemical pathology department records.

Then they were divided according to age groups into three sections: G1 (ages under 25), G2 (ages between 26 and 40) and finally G3 (ages over 40) [2-4]. Semen analysis was performed according to the procedure mentioned by the World Health Organization. At least two separate samples were obtained before confirmation of semen abnormality [3-4]. Hormone levels were determined using a non-competitive ELISA with a Microwell slide reader.

The hormonal tests which included: FSH, LH and testosterone, when both gonadotropins (FSH and LH) and testosterone were low, the hypogonadism was diagnosed. The Hypogonadotropic hypogonadism was diagnosed when gonadotropin levels were high and testosterone levels were low.

The partial androgen resistance was diagnosed when LH and testosterone levels were high, and germinal epithelial failure was diagnosed when only FSH levels were high [3-4].

3. RESULTS

4. **1. Age**:
5. The mean age of the patients that showed in table (1) was 33.5 years while 81 (83.5 percent) of patients noted as a primary infertility and the reminders noted as 16 (16.5 percent) of patients as a secondary infertility so, according for subjects studied we can say; there were significant relationship with the problem between G2 and primary infertility as showed in Figures (1), (2) .

Table 1: hormonal and age group characteristic of infertility and control .

Studied indicators	Infertile patients	Control	P value
Age	30 ± 9.2	28 ± 10.1	0.9
FSH	5.1 ± 3.3	8.1 ± 5.1	0.001
LH	6.3 ± 3.3	4.3 ± 1.7	0.6
Testosterone	167 ± 222	376 ± 130	0.01
Duration	4.1 ± 2.8	2.9 ± 05	0.03
Sperms concentration	22.18 ± 23	80.2 ± 10.1	0.000

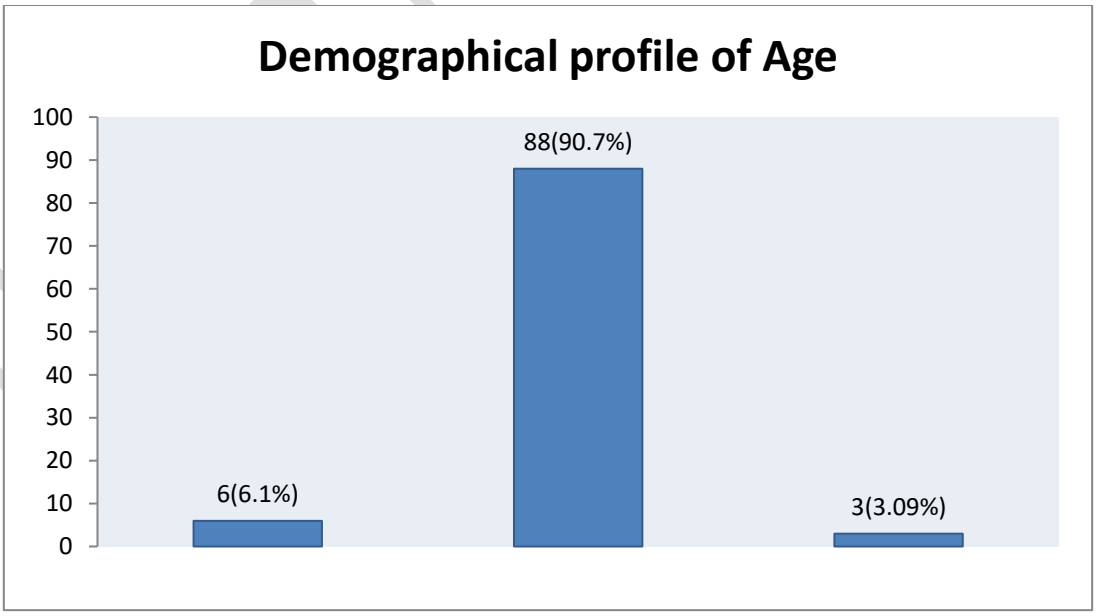

Figure 1. showsHormonal Profile according to Age group.

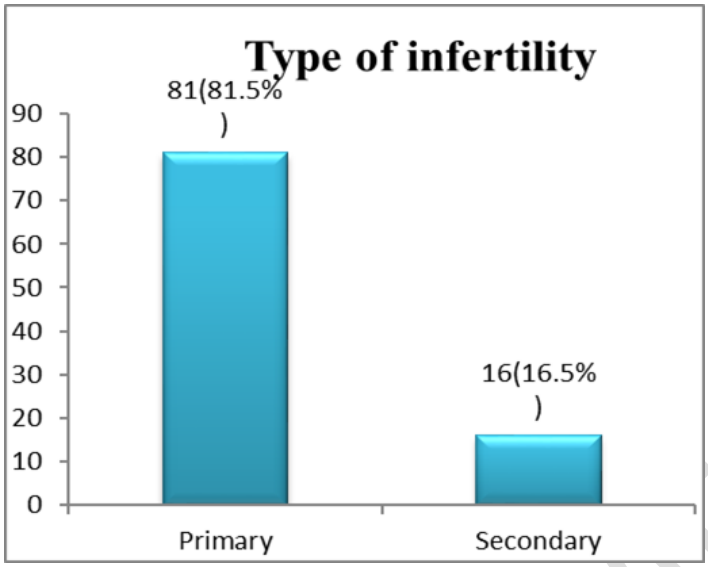

Figure 2: Type of infertility and sperm count of subjects.

1.1 FSH:

This study show a low significant relationship depending on age between G2 (5.1 ± 3.3) and control group (8.1 ± 5.1) with P value (0.001) as showed in table (1) and figure (3) that support primary infertility.

1.2 LH:

This study show no significant differences depending on age between G2 (6.3 ± 3.3) and control group (4.3 ± 1.7) with P value (0.6) as showed in table (1) and figure (3) that support primary infertility.

1.3 Testosterone:

This study show a significant relationship depending on age between G2 (167 ± 222) and control group (376 ± 130) with P value (0.01) as showed in table (1) and figure (3) that support primary infertility.

1.4 Duration

This study show a significant relationship depending on age between G2 (4.1 ± 2.8) and control group (2.9 ± 05) with P value (0.03) as showed in table (1) and figure (3) that support primary infertility.

For scientific integrity, we measured the results of comparing the reproductive period between primary infertility patients and the control group because the human race does not give birth every year due to control over living matters and the type of economic environment.

1.5 Sperms concentration

This study show a huge significant relationship depending on age between G2 (22.18 ± 23) and control group (80.2 ± 10.1) with P value (0.000) as showed in table (1) and figure (3) that support primary infertility due to poor hormonal balance.

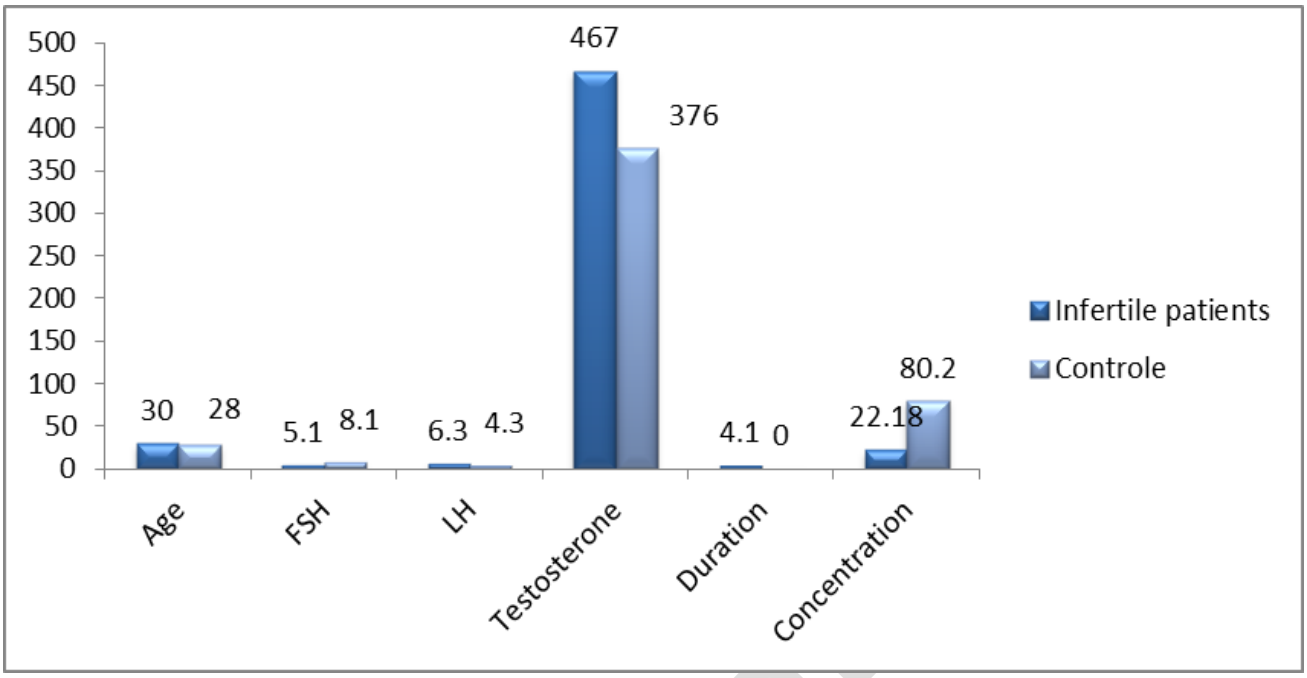

Figure 3: Hormonal characteristic depending on age between G2 infertility and control .

1. Hormonal change between ages groups (G1, G2 and G3)

In this section: we will show the statistic study for the hormonal results between patients subjects to gather for explaining; what is the hormone that may cause or share with the primary infertility.

Table 2: Hormonal changes between age of patient groups

Parameters	G1	G2	G3	P. value
FSH	6.4 ± 2.0	5.2 ± 3.4	3.9 ± 2.7	0.03
LH	3.0 ± 1.8	3.7 ± 33.2	3.3 ± 1.7	0.5
Testosterone	490 ± 220	479 ± 243	467 ± 170	0.8

2.1 FSH:

The study show data that recorded in table (2) showed there are an significant relationship in FSH results between G1 (6.4 ± 2.0), G2 (5.2 ± 3.4) and G3 (3.9 ± 2.7) when compared statically to gather that give P value (0.03) figure (4) that stopped the Sertoli cells in the testes to promote sperm production.

2.2 LH:

On another hand; Our data that recorded in table (2) showed there are no significant differentiated in LH results between G1 (3.0 ± 1.8), G2 (3.7 ± 33.2) and G3 (3.3 ± 1.7) when compared statically to gather that give P value (0.5) figure (4).

2.3 Testosterone

On another hand; Our data that recorded in table (2) showed there are no significant differentiated in LH results between G1 (490 ± 220), G2 (479 ± 243) and G3 (467 ± 170) when compared statically to gather that give P value (0.8) figure (4).

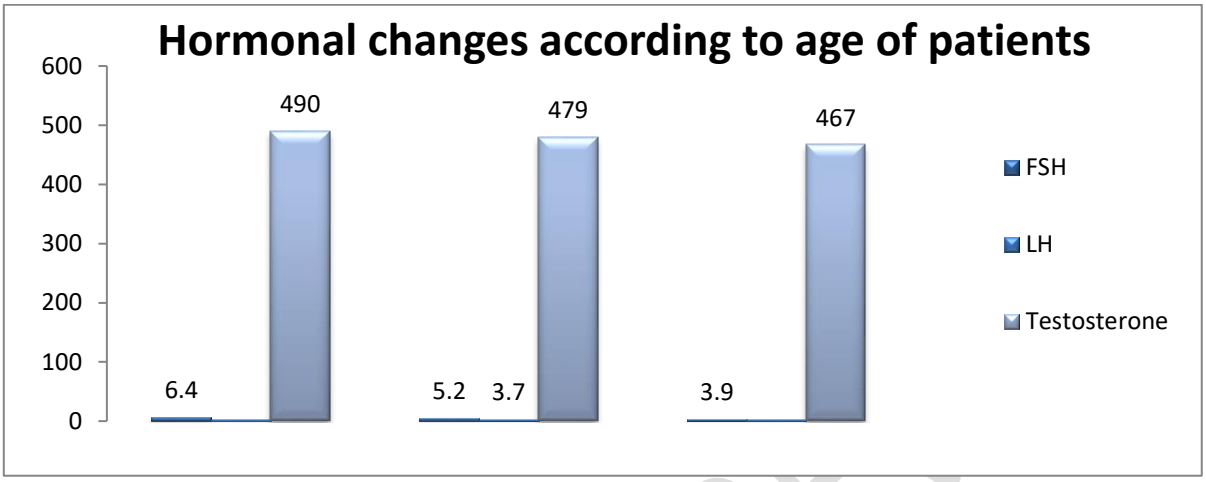

Figure 4: Hormonal changes between age of patient groups

2. Hormonal change depended on the duration of infertility:

In this study; we will study the hormonal change that depend on the time how duration occur for male in order to make a woman pregnant with three specific periods (less than 2 years, 3-5 years and more than 5 years).

Table 3: Hormonal change depended on the duration of infertility

Parameters	< 2 years	3-5	>5	P. value
FSH	2.5 ± 4.5	5.6 ± 3.4	4.2 ± 2.7	0.1
LH	3.5 ± 1.7	8.4 ± 37.2	3.5 ± 1.8	0.7
Testosterone	476 ± 217	466 ± 247	467 ± 190	0.9

3.1 FSH:

In this section; our data that recorded in table (3) show that in case FSH results a significant relationship for duration in patients with (<2 years) (2.5 ± 4.5) P value (0.02) when compared with other tow duration (5.6 ± 3.4) and (4.2 ± 2.7) those showed no significant differences where P value (0.1) as in figure (5).

3.2 LH:

This study show a significant relationship in case of (<2 years) (3.5 ± 1.7) and (>5years) (3.5 ± 1.8) where P value (0.05) when compared with (3-5 years) (8.4 ± 37.2) and show no significant change when compared (<2 years) with (3.5 ± 1.7) where P value (0.7) as recorded in table (5) figure (5).

3.3 Testosterone

In case of testosterone; our data show no significant change in case of (<2 years) (476 ± 217), (3-5 years) (466 ± 247) and (>5years) (467 ± 190) where P value (0.9) as recorded in table (5) figure (5).

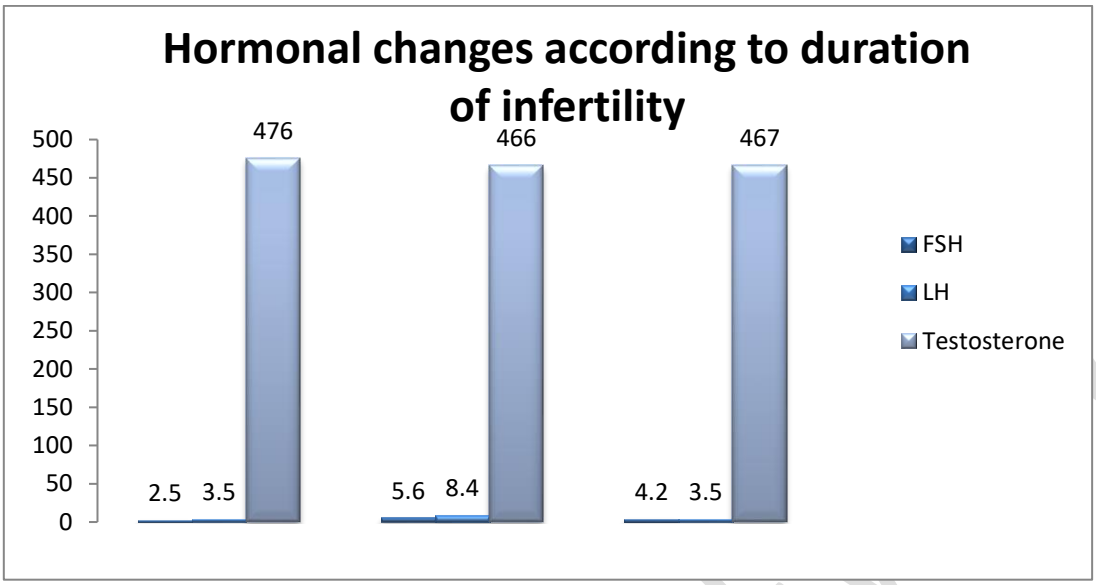

Figure 5: Hormonal changes according to duration of infertility

3. Hormonal change depended on the type of infertility:

At this point, we will shed light on hormonal changes by comparing research samples on primary infertility and secondary infertility to demonstrate the connection between these hormones as a cause of any type of infertility.

Table 4: Hormonal changes according to the type of infertility

Parameters	Primary	Secondary	P. value
FSH	5.3 ± 3.5	4.2 ± 2.0	0.2
LH	7.0 ± 3.9	3.0 ± 1.3	0.01
Testosterone	461 ± 230	496 ± 175	0.5

4.1 FSH:

In this section our data that recorded in table (4) and figure (6) show that no significant change in FSH results between the patients with Primary (5.3 ± 3.5) or Secondary infertility (4.2 ± 2.0) where P value (0.2)

4.2 LH:

In LH results; the study show a significant decrease between the Primary infertility (7.0 ± 3.9) and the Secondary infertility (3.0 ± 1.3) in P value (0.01) as recorded in table (4) figure(6). This hormone may be considered an important reagent for distinguishing between primary infertility and secondary infertility, as shown by the current study.

4.3 Testosterone

In this section our data that recorded in table (4) and figure (6) show that no significant change in testosterone results between the patients with Primary (461 ± 230) or Secondary infertility (496 ± 175) where P value (0.5).

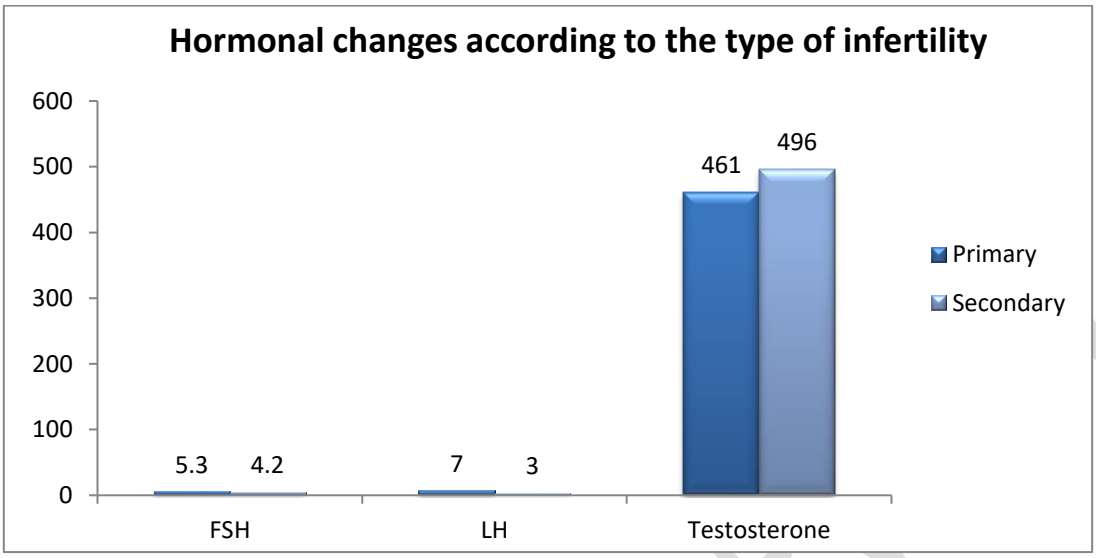

Figure 6: Hormonal changes according to the type of infertility

4. Hormonal change depended on to presence or not of Varicocele:

In this part, we will discuss the variables affecting the hormones presented in the current research for patient samples, depending on the presence or absence of varicocele, which may be a cause of male infertility. The number of people with varicocele was 29 and those without was 68.

Table 5: Hormonal changes according to presence or not of Varicocele

Parameters	No Varicocele no. 29	Varicocele no. 68	P. value
FSH	5.3 ± 3.5	4.9 ± 2.6	0.3
LH	7.4 ± 32.4	2.9 ± 1.9	0.01
Testosterone	493 ± 222	385 ± 205	0.04

5.1 FSH:

In this section our data that recorded in table (5) and figure (7) show that no significant change in FSH results between the patients with No Varicocele (5.3 ± 3.5) and Varicocele (4.2 ± 2.0) where P value (0.3).

5.2 LH:

Our data that recorded in table (5) and figure (7) show that increase significant change in LH results between the patients with No Varicocele (7.4 ± 32.4) and Varicocele patients (2.9 ± 1.9) where P value (0.001). This gives a good sign of distinguishing between infertility caused by varicocele and infertility occurring without it.

5.3 Testosterone

In case of testosterone results; this study show a significant increase between No Varicocele (493 ± 222) and Varicocele patients (385 ± 205) where P value (0.04) as recorded in table (5) figure (7). This may be another factor that distinguishes between varicocele infertility and others.

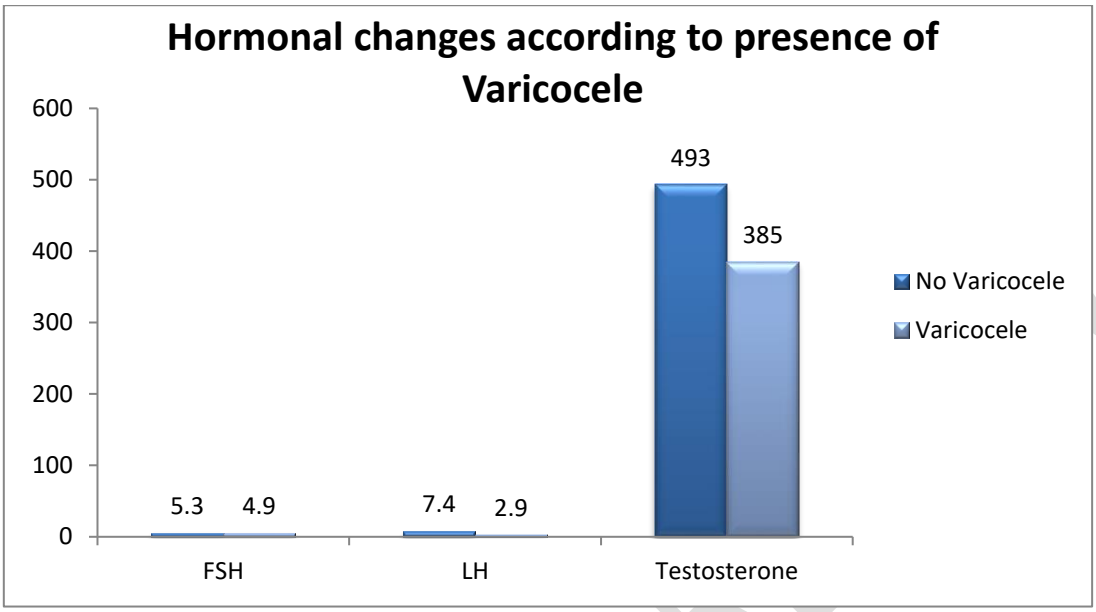

Figure 7. Hormonal changes according to presence or not of Varicocele

5. α lipoprotein:

In this part of the current study, we will discuss the relationship of factor alpha lipoprotein and its effect on secondary infertility in terms of age, duration of infertility, type of infertility and the presence or absence of varicocele.

6.1 α lipoprotein between ages groups (G1, G2 and G3)

Our data that recorded in table (6) and figure (8) show no significant differences when compared G1 (22.19 ± 7.4) group with control group (20.32 ± 5.5), However, there is a clear increase significantly in comparison between groups G2 (39.18 ± 3.7) and G2 (42.11 ± 2.9) with the control group. This indicates that an increase in the α lipoprotein factor is closely linked to secondary male infertility in these two age groups.

Table 6: α lipoprotein between ages groups (G1, G2 and G3)

Parameter	G1	G2	G3	Control
α lipoprotein	22.19 ± 7.4	39.18 ± 3.7	42.11 ± 2.9	20.32 ± 5.5
P value	0.73	0.03	0.01	

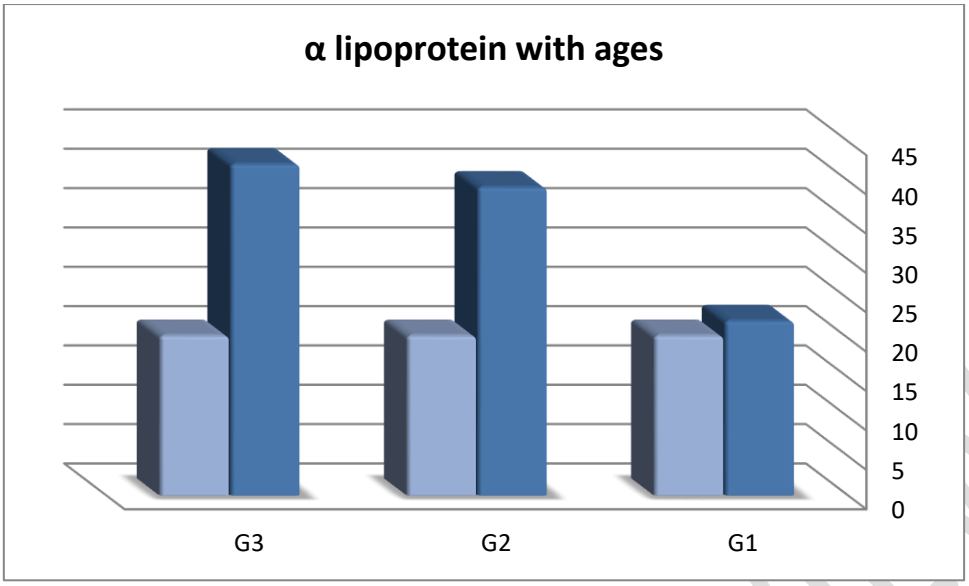

Figure 8: α lipoprotein between ages groups (G1, G2 and G3)

6.2 α lipoprotein with the duration of infertility

In this current study; show significant increase just with (2-3 years) (32.11 ± 1.2) when compared with the control group while there is no change in case of (< 2 years) (20.10 ± 0.4) and (> 5 years) (19.31 ± 2.1) in table (7) figure (9).

Table 7: α lipoprotein with the duration of infertility

Parameter	< 2	2-5	> 5	Control
α lipoprotein	20.10 ± 0.4	32.11 ± 1.2	19.31 ± 2.1	20.32 ± 5.5
P value	0.9	0.04	0.7	

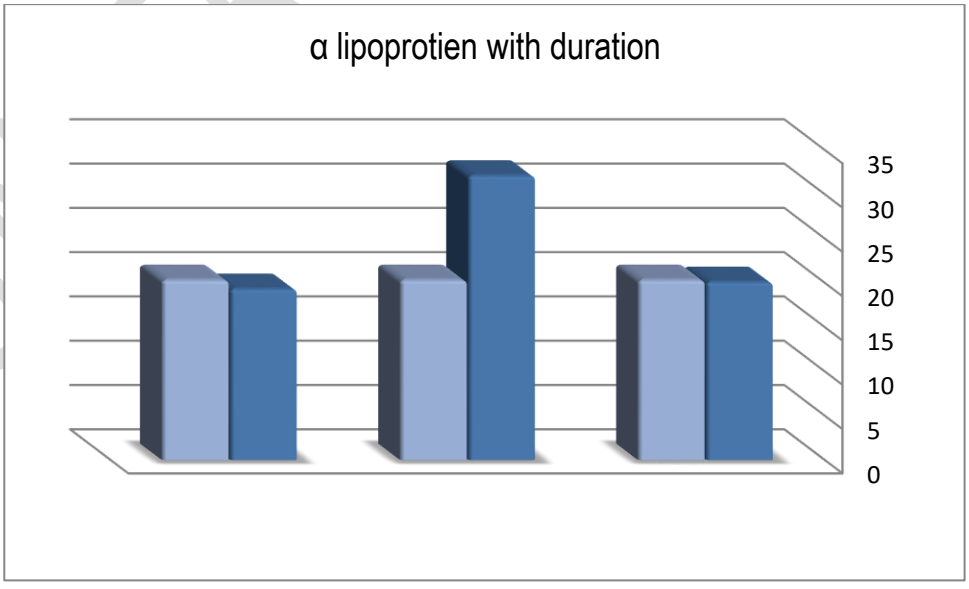

Figure 9: α lipoprotein among duration of infertility

6.3 α lipoprotein among type of infertility

Our study data that recorded in table (8) and figure (10) show no significant change between primary infertility (19.89 ± 2.4) and this parameter when compared with control (21.20 ± 3.0) while there significant increase with secondary infertility (28.11 ± 3.1) in P value (0.05).

Table 8: α lipoprotein among type of infertility

Parameter	Primary infer.	Secondary infer.	Control
α lipoprotein	19.89 ± 2.4	28.11 ± 3.1	21.20 ± 3.0
P value	0.7	0.05	

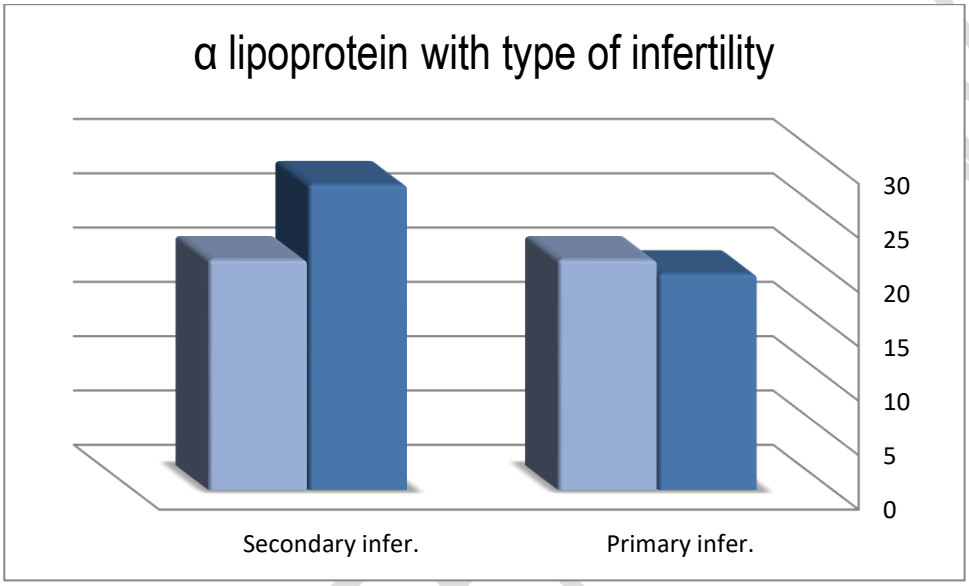

Figure 10: α lipoprotein among type of infertility

6.4 α lipoprotein between presence or absence of varicocele

Our study results that recorded in table (9) and figure (11) show no significant change between absence of varicocele subjects (19.89 ± 2.4) and this parameter when compared with control (21.20 ± 3.0) while there significant increase with presence of varicocele (28.11 ± 3.1) in P value (0.001).

Table 9: α lipoprotein between presence or absence of varicocele

Parameter	Presence of varicocele	Absence of varicocele	Control
α lipoprotein	35.89 ± 1.4	20.11 ± 1.1	21.20 ± 3.0
P value	0.7	0.05	

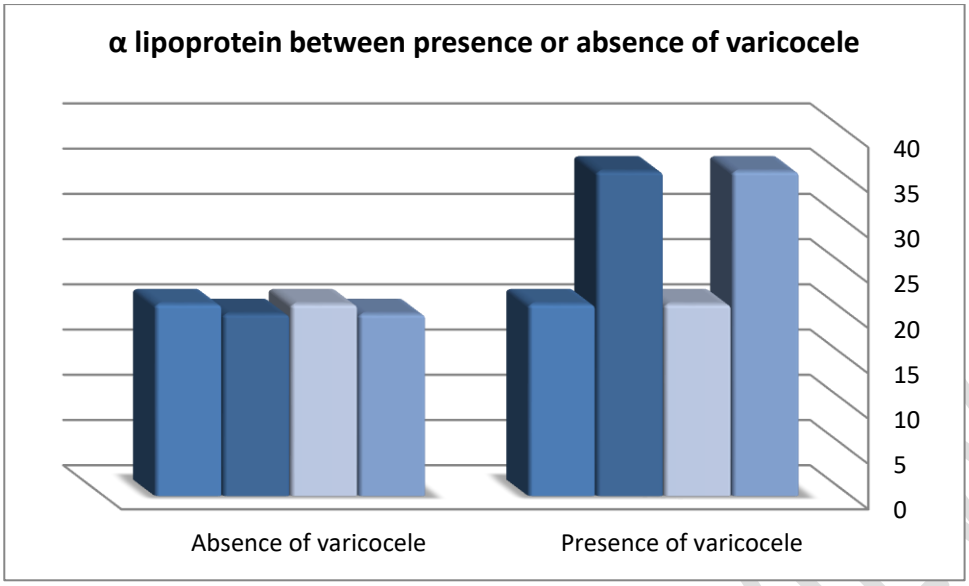

Figure 11: α lipoprotein between presence or absence of varicocele

6. Anti-insulin Ab:

In this section of the research, we will delve into an immunological study on providing anti-insulin to current research samples, which may be linked to secondary male infertility, and discuss it in terms of age, period of infertility, type of infertility, as well as the presence or absence of varicocele.

7.1 Anti-insulin Ab between ages groups (G1, G2 and G3)

Our data that recorded in table (10) and figure (12) show no significant differences when compared G1 (5.19 ± 7.4) and G2 (3.98 ± 1.0) groups with control group (4.12 ± 1.5), However, there is a clear increase significantly in comparison between groups G3 (20.21 ± 2.1) with the control group. This indicates that an increase in the Anti-insulin Ab factor is closely linked to secondary male infertility in these G3 age groups.

Table 10: Anti-insulin Ab between ages groups (G1, G2 and G3)

Parameter	G1	G2	G3	Control
α lipoprotein	5.19 ± 7.4	3.98 ± 1.0	20.21 ± 2.1	4.12 ± 1.5
P value	0.73	0.03	0.01	

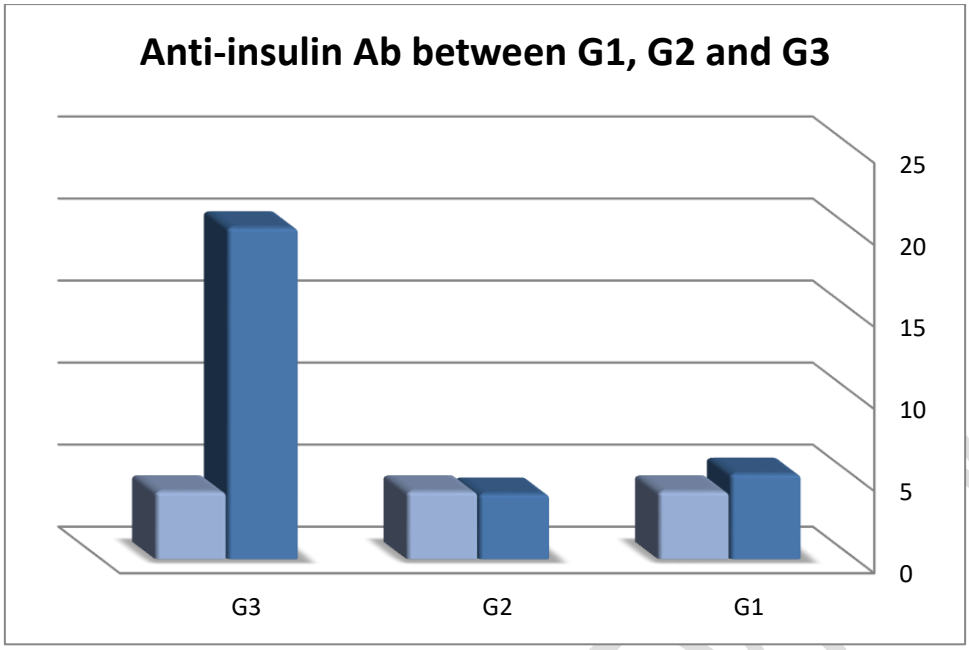

Figure 12: Anti-insulin Ab between ages groups (G1, G2 and G3)

7.2 Anti-insulin Ab with the duration of infertility

The study show significant increase just with 2-3 years (23.11 ± 3.2) when compared with the control group (4.12 ± 1.5) P value (0.04) while there was no change in case of < 2 years (5.2 ± 1.4) and > 5 (4.23 ± 2.1) in table (11) figure (13).

Table 11: Anti-insulin Ab with the duration of infertility

Parameter	< 2	2-5	> 5	Control
α lipoprotein	5.2 ± 1.4	23.11 ± 3.2	4.23 ± 2.1	4.12 ± 1.5
P value	0.9	0.04	0.7	

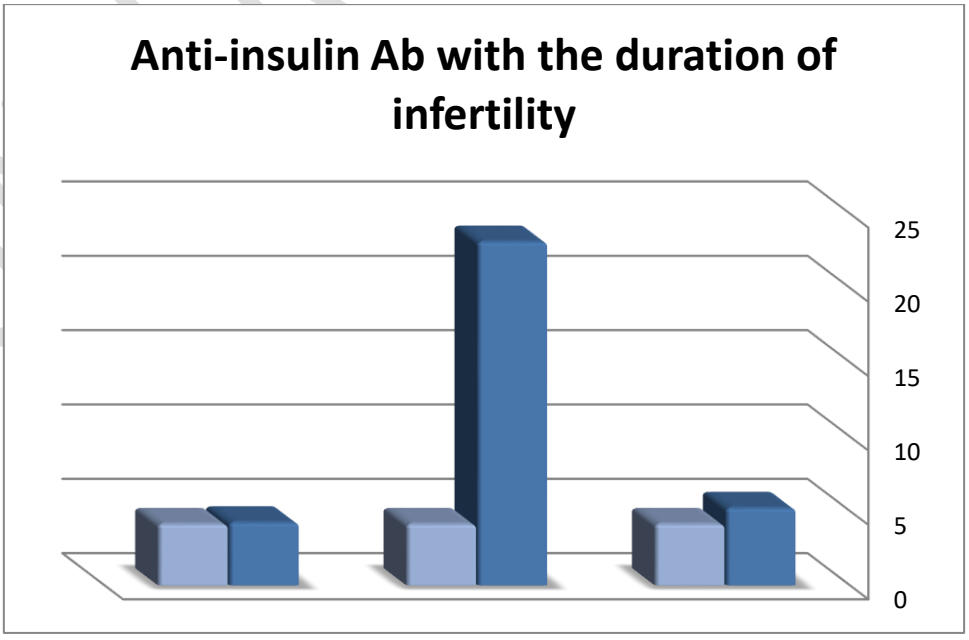

Figure 13: Anti-insulin Ab with the duration of infertility

7.3 Anti-insulin Ab among type of infertility

The study data that recorded in table (12) and figure (14) show no significant change between primary infertility (5.00 ± 1.5) in this parameter when compared with control (4.12 ± 1.5) while there significant increase with secondary infertility (19.9 ± 0.1) in P value (0.02).

Table 12: Anti-insulin Ab among type of infertility

Parameter	Primary infer.	Secondary infer.	Control
α lipoprotein	5.00 ± 1.5	19.9 ± 0.1	4.12 ± 1.5
P value	0.9	0.02	

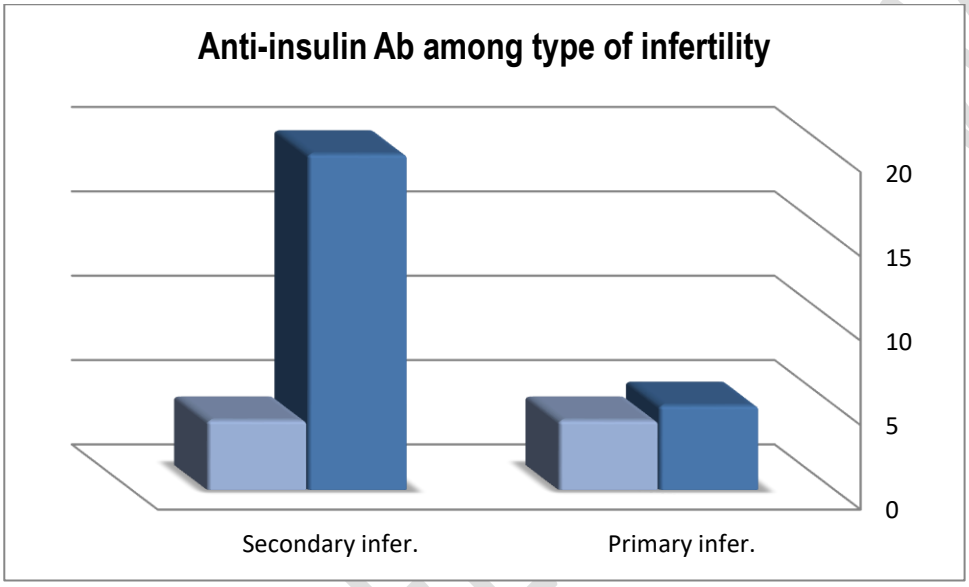

Figure 14: Anti-insulin Ab among type of infertility

7.4 Anti-insulin Ab between presence or absence of varicocele

The study results that recorded in table (13) and figure (15) show no significant change between absence (6.89 ± 0.4) and presence (5.89 ± 1.1) of varicocele subjects for this parameter when compared with control (4.12 ± 1.5) in P value (0.9).

Table 13: Anti-insulin Ab between presence or absence of varicocele

Parameter	Presence of varicocele	Absence of varicocele	Control
α lipoprotein	5.89 ± 1.1	6.89 ± 0.4	4.12 ± 1.5
P value	0.67	0.9	

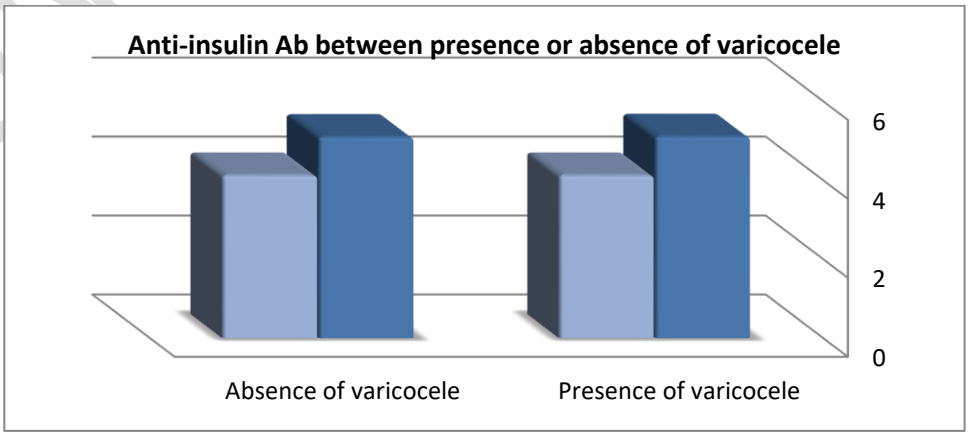

Figure 15: Anti-insulin Ab among type of infertility

1. DISCUSSION

According to the results of this study showed that the age group most affected by infertility is G2 and the type of infertility that this group is most affected by the secondary infertility and it is significantly associated with low FSH and testosterone.

While all age groups share a deficiency in FSH compared to the control group. Which showed a significant difference with increasing periods of infertility as well as a decrease in the number of sperm in this group, which could be attributed to hormonal disturbances as the main cause of infertility.

The result were agreement with Hibi et al., [5] who recorded that the age period were 36 years With the same hormonal effect explaining that (The median age of the couples in this study was 35 years. In general, we would advocate for a man over 35 to have his health checked. Because infertility is a common problem for both men and women [6].

Katib et al., [7] and Lee et al., [8] agreed with the results of our current study regarding G2, while he did not agree with us regarding G3, as it was shown that it is the group most susceptible to infection for many reasons, the most important of which is diabetes or prostate enlargement, and it is not related to the reasons for our study related to hormones and their effect on sperm production.

According to the period of infertility for men in general, research still has not proven a clear cause for this condition like McKie [9] explained that sperm counts in western men have halved confirmed what experts already knew The real problem is that no one knows why. However, our study gave a significant difference regarding the infertility period of less than two years, directly affected by the decrease in the FSH hormone among the hormones of the current study, and this is consistent with Davis [10] who studied age groups based on sperm concentration, where he explained that the group most exposed to secondary infertility is the age group above 40 due to hormonal disorder.

In one scientific article, one of the researchers [11] pointed out that one of the most important causes of infertility among Eastern men is the modern way of life, which may be closely linked to the hormonal imbalance that causes secondary infertility, due to the lack of desire among parents to have children by using or not using contraceptive medications.

In this current study, it was shown that varicocele was directly affected by the formation of secondary infertility in a significant way with regard to the hormones LAG and testosterone, without a significant change in FSH. Although varicocele is present in 15% of the normal male population, it is present in up to 40% of patients with male infertility. In infertile men who previously had normal fertility (called secondary infertility) varicocele is the cause of up to 70% of cases.

May due to the mechanism by which varicocele disrupts sperm structure, function, and production is unknown, but scientists believe that it disrupts testicular thermoregulation. Varicoceles are reported to be more common in secondary male infertility than in primary infertility [7].

Our data agree with Łukasz et al., [12] and Choi and Kim [13] who recoded that It is believed to be the cause of up to 35% of cases of primary infertility and 69-81% of secondary infertility . The

causes of varicocele are multifactorial, but the ultimate result is pathological dilatation of the veins draining the testicles.

The results of our current study prove that high alpha-lipoprotein is significantly associated with secondary male infertility for age groups G2 and G3, which may be a reason for an increase in the period of infertility for years between 2-5 years, especially in the case of the presence of varicocele, reinforcing the idea of hormonal disturbance for these age groups.

The data are agreeing with Abbasi et al., [14] who noted that Patients treated with ALA therapy to reduce the effects of apoprotein alpha have effectively increased their sperm concentration as well as Haghighian et al., [15] who explain According to the results, medical therapy of asthenoteratospermia with ALA supplement could improve quality of semen parameters. However, further investigation is suggested in this regard.

Regarding the anti-insulin drug, our study showed that the G3 age group has a significant standard increase compared to the control group, in contrast to the G1 and G2 groups, and is significantly associated with a period of infertility of 2-5 years as secondary infertility and is not professionally related to the presence or absence of varicocele.

The data agree with Huang et al., [16] who recorded that high insulin resistance directly affects the decrease in male sperm production and effectiveness, which may cause secondary infertility in the age groups targeted for induction.

Condorelli et al., [17] agree with our results when recorded increasing insulin resistance may directly cause an increase in microbes in the semen, thus increasing leukocyte immune resistance, causing a decrease in sperm count and ineffectiveness.

2. CONCLUSION

Varicocele may be played a major and important role in secondary male infertility especially if it is associated in any way with insulin resistance or high alpha lipoprotein leading to a hormonal disorder that disrupts the endocrine gland's feedback, which is responsible for increasing sperm concentration and movement.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

CONSENT

A written informed consent was obtained from all participants of this study.

ETHICAL APPROVAL

Ethical approval was obtained for the Ethics Committee of Faculty of Medicine, University of Thi Qar, Iraq.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

REFERENCES

1. El-Migdadi F, Banihani I, Banihani SA. Clinico -hormonal correlation of oligospermic patients in the below sea level environment (Jordan Valley). Neuro Endocrinol Lett. 2005; 26:13-18.
2. Idrisa A, Ojiyi E. Pattern of infertility in North - Eastern Nigeria. Trop J Obstet-Gynaecol. 2000; 17:27-29.
3. Jarow JP. Endocrine causes of male infertility. Urol Clin North Am 2003;30:83-90.
4. Martin D and Pan RC. Etiology of male infertility and oligo- astheno-, teratospermia (OAT). Arch Androl. 1997;39:19.
5. Hibi H, Sugie M, Ohori T, Sonohara M, Fukunaga N, Asada Y. Secondary male infertility: the importance of the urological assessment for couples who desire children in later life. Nagoya Journal of Medicine Science. 2022;84(1):133–138.
6. Schummers L, Hutcheon JA, Hernandez-Diaz S. Association of short interpregnancy interval with pregnancy outcomes according to maternal age. JAMA Intern Med. 2018;178(12):1661–1670.
7. Katib AA, Al-Hawsawi K, Motair W, Bawa AM. Secondary infertility and the aging male, overview. National Library of Medicine. 2014;67(2):184–188.
8. Lee HD, Lee HS, Park SH, Jo DG, Choe JH, Lee JS, Seo JT. Causes and classification of male infertility in Korea. Clin Exp Reprod Med. 2012;39:172–175.
9. McKie R. The infertility crisis is beyond doubt. Now scientists must find the cause". The Guardian. Retrieved 2018;10:10.
10. Davis N. Sperm counts among western men have halved in last 40 years – study. The Guardian. Retrieved 2018;10:10.
11. Johnston I. Western men's sperm counts plunge 60% in 40 years due to 'modern life". The Independent. 2018;10:10.
12. Łukasz K, Piotr AD, Piotr R. Varicocele as a source of male infertility – current treatment techniques). National Library of Medicine. 2015;68(3):365–370.
13. Choi WS, Kim SW. Current issues in varicocele management: a review. World J Mens Health. 2013;31:12–20.
14. Abbasi B, Molavi N, Tavalaee M, Abbasi H, Nasr-Esfahani MH. Alpha-lipoic acid improves sperm motility in infertile men after varicocelectomy: a triple-blind randomized controlled trial. National Library of Medicine. 2020;41(6):1084-1091.
15. Haghighian H, Haidari F, Mohammadi-Asl J, Dadfar M. Randomized, triple-blind, placebo-controlled clinical trial examining the effects of alpha-lipoic acid supplement on the spermatogram and seminal oxidative stress in infertile men. National Library of Medicine. 2015;104(2):318-24.
16. Huang R, Chen J, Guo B, Jiang C, Sun W. Diabetes-induced male infertility: potential mechanisms and treatment options. Molecular Medicine.2024; 30:11.
17. Condorelli RA, Vignera S, Mongioì LM, Alamo A, Calogero AE. Diabetes Mellitus and Infertility: Different Pathophysiological Effects in Type 1 and Type 2 on Sperm Function).). National Library of Medicine. 2018;9:268.