

The Role of Antibodies in Preventing Natural Conception: Mechanisms and Complications

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Abstract

Background: Infertility is a complicated trouble that impacts a large number of couples across the globe. While different factors make contributions to infertility, immune disorder has emerged as a key player in each male and girl reproductive fitness. Autoimmune reactions directed against the reproductive organs, such as the endometrium, sperm and ovary, may affect fertility and lead to miscarriage. Objective: This study was designed to assess the prevalence of different auto-antibodies like Anti-Sperm Antibodies (ASA), Anti-Phospholipid Antibodies (aPL), Anti-Endometrial Antibodies and thyroid autoantibodies in girls with infertility and their correlation. The observe also sought to investigate the possible influence of these autoantibodies on fertility. Methodology: Over 8 months from January 2023 to August 2023, 500 samples were collected from Tikrit Teaching Hospital in Iraq; 300 of which were non-reproductive and 200 healthy subjects. Blood was taken to determine the levels of specific antibodies by Enzyme-Linked Immunosorbent Assay (ELISA) and thyroid function testing was carried out to determine the impact of thyroid dysfunction on reproductive outcome. Findings: The prevalence of ASA, aPL, anti-endometrial antibodies and higher thyroid autoantibodies were found in the birth control group compared to the control group. The results indicate that there is a close relationship between the immune response and infertility. Also, the relationships between ASA and other immune-stimulating factors are exhibited in this study. A combination of several immune stimulants is suggested as a possible cause for disruption of fertility. Conclusions: This study confirms the role of immune system in female infertility and confirms that it is a very important role. This indicates that general immunity plays a role in non-menopausal women, and so early detection and management of auto-immune diseases can affect reproductive outcomes and decrease unexplained infertility.

Keywords: Infertility, Autoimmune Markers, Anti- Antibodies, Thyroid Function and Pregnancy Loss.

Introduction

Infertility is a complicated medical condition that impacts numerous couples globally. Infertility can be multifactorial [1] but hormonal imbalance and structural abnormalities are of major importance. But the complex relationship between the immune response and reproductive health has become an increasingly important issue in reproductive research [2]. The importance of the immune system as a field of study has come to be of strong and great interest and challenge [3].

Antibodies, which are defense mechanisms created by the immune system to fight foreign invaders Able to target the body's own cells in some cases [4], this immune response can manifest in many ways. and if aimed at the perinatal system or placenta can cause severe reductions in fertility [5]. Anti-sperm steroids (ASAs), for instance, are able to bind to sperm. It affects motility and fertilization capacity of eggs [6]. Antiphospholipid proteins (aPLs) can cause damage to blood cells. This leads to blood clots and failure of the placenta. This puts women at higher risk of miscarriage. The other type of antibodies can attack the

lining of the uterus (endometrium). Prevents implantation and initiation of pregnancy [7].

There are many causes of infertility including those of antibiotics. Certain antibiotics may have a direct effect on the reproductive system. Resulting in inflammation and lesions. Some disrupt some of the functions of cells, e.g., the separation of sperm and egg cells, or the implantation [8]. ASA can, for instance, prevent the acrosome reaction. This is an important step for sperm to enter the ovary. Furthermore, immune cells have the ability to activate the complement pathway. This leads to disruption of reproduction [9]. The presence of antibodies can also cause infertility by damaging tissue and interfering with hormone regulation [10].

Acquired immune deficiency syndrome (AIDS) symptoms vary widely. Women with sperm antagonists may experience difficulty with conception such as unexplained infertility, repeated pregnancies [11]. Women with anti-phospholipid antibodies can have recurrent miscarriages [12]; the severity of the disease depends on the type of antigen, number, and specific comorbidities [13]. Epidemiological diagnosis involves taking a clinical history, physical examination and joint laboratory testing. Blood tests to measure antibody levels are important to confirm the diagnosis. It is important to note, however, that antibody does not always coincide with infertility [14]. There are various treatment options for congenital abnormalities caused by viral infections, depending on the cause and severity of the disease [15], including immunosuppressive drugs like corticosteroids or other immune modulating drugs to make the immune system go into the "off" position and stop the production of antibody. Birth control therapy (ART), including in vitro fertilization (IVF) can be considered, particularly if other treatments fail [16]. Treatment of immunologic infertility has also been reported in a large clinical series [17].

The correlation between thyroid function and fertility is complicated. Thyroid disorders have a negative effect on reproductive health in both hypothyroidism and hyperthyroidism [18]. Too much or too little thyroid hormone may have a huge impact on the hormonal balance needed for proper ovulation and implantation [19]. Low thyroid hormone levels in women with thyroiditis can affect the functioning of the hypothalamus, pituitary gland and the ovaries, which can cause irregular periods, abnormal cholesterol and infertility [20]. Anemia on the other hand can interfere with menstruation and ovulation. It also increases the risk of miscarriage. In addition, both arthritis and rheumatoid arthritis can have an impact on the quantity and mobility of the sperm. This leads to infertility in men [21]. Also, the abnormalities in the sperm may have an impact on the environment of the placenta. This is not a favorable situation for implantation [22]. This makes individuals with schizophrenia more likely to have issues with ovulation and pregnancy until the end of term [23]. For many, the successful treatment of RA with medication and lifestyle changes can have a major impact on their reproductive health [24]. The aim of the study was to assess the prevalence and linkage of different immune markers. It also seeks to understand the potential effect of these immune factors on the congenital outcome.

Materials and Methods

The study aimed to study the preventive effect of different antibiotics on the completion of full-term pregnancy. Over 8 months from January 2023 to August 2023, 500 women were recruited from the gynecology and obstetrics clinic of Tikrit University Hospital in Salah Al-Din, Iraq for unexplained infertility, abortion, that require travel and contraception, and 200 women were also recruited as health care providers. The women ranged in age from 20–40 years, and there were no other chronic diseases. The exclusion criteria were: Participants who used assisted reproductive technology (ART); Participants with an autoimmune disease, such as lupus, or rheumatoid arthritis, except for those who had been excluded due to infertility.

All participants had blood samples taken to test for certain antibodies that could lead to infertility. Such antibodies as anti-sperm antibody (ASA), anti-phospholipid antibody (aPL), anti-ovarian antibody (AOA), anti-trophoblast antibody (ATA) and anti-thyroid antibody. In addition to the virological testing Peroxidase

(anti-TPO), anti-thyroglobulin antibody (Anti-Tg), anti-antibody antibody (ANA), anti-inflammatory Cardiolipin (aCL), anti-inflammatory and anti-gluten immune cells will be tested by Peroxidase (anti-TPO) antibody and anti-thyroglobulin antibody (Anti-Tg) anti-antibody antibody (ANA) anti-inflammatory, Cardiolipin (aCL), anti-inflammatory, anti-gluten immune cells. TSH, T3 and T4 levels are measured to assess thyroid function [25]. Clinical markers of general immunity and hormones are measured at a laboratory. To be able to analyze these antibodies in more detail to study their effects on infertility. The study was conducted for 8 months where all samples were analyzed in the laboratory department of Tikrit University in addition to the study department. This in-depth research gives valuable insights into the immune and hormonal factors that could impact female infertility.

Statistical Analysis

This study used SPSS version 22 for statistical analysis, to determine the relationship between autoimmune markers (ASA, aPL, Anti-Endometrial Antibodies and thyroid autoantibodies) and infertility in the participants. The analysis inclusive multiple components to show a comprehensive understanding of the information collected from 500 women, inclusive 300 with infertility and 200 healthy women (controls). For continuous variables (age, hormone concentrations, e.g. thyroid function) means and standard deviations (SD) were examined. Categorical variables (presence of various antibodies (ASA, aPL, Anti-Endometrial Antibodies, thyroid autoantibodies) and the classification of individuals (infertile vs. healthy) were computed in terms of frequencies and percentages. The diagnostic performance of the various autoantibodies was determined using the sensitivity and specificity. Sensitivity is the percentage of positive cases (those with infertility who test positive for the antibody) and specificity is the percentage of negative cases (those without infertility who test negative for the antibody). These steps are so important because they assess the predictive value of antibodies for infertility. Pearson's correlation coefficients were calculated to determine the relationships between the different autoimmune markers and the combined effect of these markers on infertility. Correlation of the antibodies like anti-endometrial antibodies, anti-platelet antibodies and ASA was also performed to study possible interactions between these immune factors and their role in contributing to infertility. The p values were computed for every comparison and correlation. The significance level for statistical significance of the relationships found between autoimmune markers and infertility was set at $p < 0.05$. Any results with p values < 0.05 were considered statistically significant and in that case, the associations observed were believed not to be chance.

Result and Discussion

Results

The average age of the control group was 32.5 years and that of the control group was 30.1 years in the sterilization group. A significant difference was found between the recurrent miscarriage rate (30%) and the control group (6%). The presence of anti-sperm antibodies (ASA) was significantly higher in the infertility group (30%). compared to the control group (8%) ($p < 0.05$). This implies that ASA might have a part in female reproduction through influencing the motility, functionality and capacity to ovulate. This may lead to unexplained infertility and repeated miscarriages.

In the group of women with infertility, the sensitivity of the ASA test was 70%, and this means that 70% of women who had the test positive were women with infertility. This means the test was fairly sensitive at detecting women with infertility. Specificity of 92% means no false positive results due to the high accuracy of the test to correctly identify the women who did not have infertility as being non-affected. Overall, the prevalence (or observed incidence) of ASA was 40%, which indicates that 40% of the entire sample (both the infertile and control groups) had detectable levels of ASA. This indicates that ASA may be fairly common in the general population, but their increased frequency in the group of people with fertility problems highlights their potential association with fertility problems. Results are statistically significant ($p < 0.05$) and combined results further support the contribution of ASA to infertility and thus when

evaluating for unexplained infertility, the presence of ASA is an important factor to consider (Table 1 and Figure 1).

Table 1. Prevalence of Anti-Sperm Antibodies (ASA)

Group	Prevalence of ASA (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	30%	70%	92%	40%	<0.05
Control Group	8%				

The birth control group had a much higher incidence of anti-phospholipid (aPL) antibodies than the control group (20% vs. 5%, $p < 0.05$). This result suggests that There is a clear association between aPL and infertility. This is particularly the case in women who have experienced multiple or previous miscarriages. The presence of aPL has been linked to APL (antiphospholipid syndrome) which can lead to pregnancy complications like recurrent miscarriages, stillbirth, and implantation problems.

The frequency of aPL screening in the obstetrics group was 65%, that is, 65% of obstetric women screened for aPL had a positive response. This means that screening can be performed in those who are diseased. It is easily recognizable that most of these are clearly identified. The specificity was 90%, meaning 90% of women in the control group who did not have infertility were also positive for aPL, thus showing that there was an accuracy difference between women with and. In the absence of disease, the precision (or observed incidence) of aPL was 12.5% of all participants in the study. Evaluation of aPL levels (infertile group + control group) were possible. This corroborates the hypothesis that aPL is fairly common. However, the greater proportion of those with these in the prenatal group indicates that these may be more important in the perinatal and pregnancy outcomes. This finding has a p-value <0.05, which means that there is a potential association between aPL and pregnancy complications and reproductive problems in women. Thus, women who have unexplained infertility or repeated pregnancies should be screened for aPL (Table 2 and Figure 1).

Table 2. Prevalence of Anti-Phospholipid Antibodies (aPL)

Group	Prevalence of aPL (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	20%	65%	90%	12.5%	<0.05
Control Group	5%				

Anti-Ovarian Antibodies (AOA) were significantly increased in the infertility group (18%) than in the control group (4%) ($p < 0.05$). This discovery points to a significant relationship between AOA and female infertility, especially in women who have lesser ovarian reserve or poor eggs. AOA are antibodies which affect the ovary and cause affected functions and decrease in fertility potential. High concentrations of AOA may damage the ovaries and cause premature loss of the eggs (oocytes) and affect egg quality, thereby increasing the difficulty of women to get pregnant. The sensitivity of AOA was found to be 60% in the infertility group, which means that 60% of all the women who were tested for AOA were diagnosed as being positive in the group of women who were infertile. This means that the test has a moderate ability to detect people who have AOA. The specificity of the AOA test was 92% indicating that the test is very accurate to differentiate controls (women without infertility) who do not have AOA.

In the overall sample, the observed occurrence (or accuracy) of AOA was 11%, or 11% of the total sample had detectable levels of AOA (the infertility and control groups). This discovery highlights the relative rarity of AOA in the general population and their higher prevalence among women with fertility problems, which suggests that they may be associated with fertility problems. The p-value of <0.05 favors the hypothesis that AOA could be a contributing factor to infertility, and is a significant parameter to consider

in the evaluation of women who are not able to conceive, especially those with diminished ovarian reserve or recurrent miscarriage (Table 3 and Figure 1).

Table 3. Prevalence of Anti-Ovarian Antibodies (AOA)

Group	Prevalence of AOA (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	18%	60%	92%	11%	<0.05
Control Group	4%				

The birth control group (14%) had significantly more Anti-Trophoblast Antibodies (ATA) than the control group (3%) ($p < 0.05$). This discovery implies that ATA may be a cause of infertility. ATA is an immunomodulatory agent which acts on trophoblast cells of the growing embryo, specifically affecting the ability of the embryo to implant. This is essential for a successful penetration into the embryo. The presence of ATA may prevent proper attachment of the embryo. This causes the failure of the implant, and may lead to repeated pregnancy. The frequency of ATA testing in the fertility group was 55%, that is, 55% of women in the fertility group tested positive for ATA, indicating a moderate sensitivity of the test to detect ATA in women with a history of ATA. reproductive problems that they have specificity of the ATA test was 96%, indicating that 96% of women in the control group tested negative for ATA, indicating the accuracy of the test in identifying childless women without ATA.

The accuracy (or observed use) of ATA was 8.5% of the total sample, that is, 8.5% of all subjects, including the prenatal and control groups, had detectable levels of ATA. This indicates that ATA is available. difficult in the general population but the high frequency in the prenatal group suggests a possible role in fertility problems. The difference between the parenting and control groups was statistically significant with a p value of <0.05 . This further establishes the linkage of ATA with parenting. These findings highlight the importance of ATA testing in women with difficult or unsuccessful pregnancies, as ATA may be an important factor in reproductive risk (Table 4 and Fig. 1).

Table 4. Prevalence of Anti-Trophoblast Antibodies (ATA)

Group	Prevalence of ATA (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	14%	55%	96%	8.5%	<0.05
Control Group	3%				

The difference in the thyroid function tests including TSH, T3 and T4 between control and control was statistically significant. The T3 level was slightly lower in the birth control group (1.10 ± 0.25 ng/mL) than in the control group (1.40 ± 0.30 ng/mL) ($p < 0.01$) - - - but with T3 levels Low, there is still a possibility of clinical hypothyroidism. This can impact fertility in that it can alter the metabolism needed for optimum reproductive function.

Also, the birth control group (6.70 ± 1.80 µg/dL) had lower mean T4 levels than the control group (7.80 ± 1.50 µg/dL) and this difference was statistically significant ($p < 0.05$). In the group of infertile women, the T4 level is also Low, suggesting hypothyroidism. This may result in infertility. The thyroid hormones, particularly T4, are important to reproductive health, controlling menstruation and follicle development. These thyroid function values, in general, suggest the significance of thyroid health among women. The difference in the mean TSH and T4 levels between the two groups were statistically significant indicating thyroid dysfunction as a factor for infertility. It highlights the importance of routine thyroid screening on women with infertility. The information gathered also helps to determine the potential association of thyroid disease with congenital abnormalities (Table 5 and Figure 2).

Table 5. Thyroid Function (TSH, T3, T4) in Infertility and Control Groups

Group	TSH (mU/L) Mean ± SD	T3 (ng/mL) Mean ± SD	T4 (µg/dL) Mean ± SD	P-Value
Infertility Group	4.95 ± 2.40	1.10 ± 0.25	6.70 ± 1.80	<0.05
Control Group	2.30 ± 1.10	1.40 ± 0.30	7.80 ± 1.50	

Anti-Thyroglobulin Antibodies (Anti-Tg) were significantly elevated in the infertility group (16%) than in control group (4%) ($p < 0.05$). Anti-Tg antibodies are commonly associated with autoimmune thyroid disorders, such as Hashimoto's thyroiditis and Graves' disease. These ailments may affect the thyroid's ability to regulate its function, creating hormonal imbalances that can affect reproductive activities. High Anti-Tg antibody levels can lead to other thyroid-related conditions, including menstrual irregularities, ovulatory dysfunction, and miscarriage, that can lead to a decrease in fertility. The Anti-Tg test had moderate sensitivity in the infertility group (60%), that is, 60% of women with infertility were positive for the thyroid test. The specificity of the test was 93%, meaning that the test was accurate in 93% of the control group (women who did not have any complaint about their fertility) who tested negative for Anti-Tg. In the overall sample (infertility and control groups combined), the level of Anti-Tg was found in 10% of them, which is termed as accuracy/observed occurrence. This indicates that although Anti-Tg antibodies are rare in the general population, their much higher levels in women with infertility may indicate a role in infertility. The p-value of <0.05 further strengthens the statistical significance of the difference between the infertility and control group, and supports the hypothesis that thyroid autoimmunity (Anti-Tg) might be a factor in infertility. Thyroid screening should be considered in women with reproductive problems, particularly when no other reason for infertility is evident (Table 6).

Table 6. Prevalence of Anti-Thyroglobulin Antibodies (Anti-Tg)

Group	Prevalence of Anti-Tg (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P- Value
Infertility Group	16%	60%	93%	10%	<0.05
Control Group	4%				

Infertility group had significantly higher levels of anti-thyroid peroxidase (Anti-TPO) and anti-thyroglobulin (Anti-Tg) autoantibodies against the thyroid gland as compared to the control group. The prevalence of anti-TPO was 22% in the group. infertile while in the control group it was only 6% ($p < 0.05$). Similarly, Anti-Tg was found in 16% in the infertility group compared to 4% in the control group ($p < 0.05$). This finding indicates that A clear link between thyroid autoimmunity and infertility. This can result in irregular periods and infertility. The sensitivity of the thyroid autoantibody test in the infertility group was determined to be 65% or 65% of infertile women tested were resistant. Anti-TPO or anti-TG antibody tests are fairly good at identifying thyroid autoimmunity in women who are infertile. The specificity was 90%, which indicates that these antibodies were negative in 90% of women who did not have an underlying cause for infertility (control group). Validates the accuracy of the test for diagnosing thyroid autoimmune disorders.

14% of the total sample (14% of all the subjects) had abnormal thyroid autoantibodies, or controlled activity (or controlled activity). A small number of subjects (including children and controls) had anti-TPO or anti-Tg antibodies which is a rare condition in the general population. But it is often found in groups with infertility. This indicates that they may be involved in infertility. The association between prostate avoidance and infertility also is supported by statistical significance ($p < 0.05$). It is recommended that prostate screening should be considered in the evaluation of women with unexplained infertility.

Antithyroid antibodies such as Anti-TPO and Anti-Tg can affect the normal functioning of the thyroid. This leads to a hormonal imbalance and to the suppression of menstruation, ovulation and overall fertility (Table 7)

Table 7. Prevalence of Thyroid Autoantibodies (Anti-TPO & Anti-Tg)

Group	Prevalence of Anti-TPO (%)	Prevalence of Anti-Tg (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	22%	16%	65%	90%	14%	<0.05
Control Group	6%	4%				

Anti-Nuclear Antibodies (ANA) (12% infertility group vs. 3% control group) was significantly elevated in the infertility group ($p < 0.05$). ANA are antibodies which attack the nucleus of cells, and are commonly seen with certain autoimmune conditions, such as systemic lupus erythematosus (SLE), that can impact fertility. ANA can interfere with normal immune activity, resulting in inflammation and damage to the reproductive organs and infertility. ANA may also cause miscarriage and other problems.

In the infertility group, the sensitivity of the ANA test was 50%, indicating that 50% of the women with infertility had a positive test for ANA. Specificity was 94%, meaning there was a high level of accuracy in detecting ANA in the control group. Overall, the observed occurrence (or observed prevalence) of ANA was 7.5%, indicating that ANA were relatively uncommon in the general population, but were more common in women with infertility (Table 8).

Table 8. Prevalence of Anti-Nuclear Antibodies (ANA)

Group	Prevalence of ANA (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	12%	50%	94%	7.5%	<0.05
Control Group	3%				

The Anti-Cardiolipin Antibodies (aCL) was significantly elevated in the infertility group (18%) vs the control (4%) ($p < 0.05$). APS is linked to aCL and can lead to miscarriage and other pregnancy complications. These antibodies are capable of disrupting the normal circulation to the placenta, causing pregnancy loss, implantation failure, and other reproductive problems.

In the infertility group, the aCL test was sensitive for 70% of the women with infertility, which means 70% of them had a positive test for aCL antibodies. Specificity of 92% suggested that the test was accurate at detecting aCL in the control group. Overall, aCL had a 11% accuracy, indicating that antibodies to aCL may be more common in women having infertility than in the general population (Table 9).

Table 9: Prevalence of Anti-Cardiolipin Antibodies (aCL)

Group	Prevalence of aCL (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	18%	70%	92%	11%	<0.05
Control Group	4%				

AEA levels were significantly higher in women from the infertility group than in the control group (15% vs 2% respectively, $p < 0.05$). These antibodies attack the uterine lining that is needed for the embryo to successfully implant. Anti-Endometrial Antibodies may disrupt the implantation, causing repeated pregnancy loss or infertile.

In the infertility group, the sensitivity of the Anti-Endometrial Antibody test was 55% (55% of women who had infertility were positive for these antibodies). Specificity of the test for detection of Anti-Endometrial Antibodies in women not suffering from infertility was 93%, indicating high test accuracy in this group of women. The Accuracy was 9.5%, showing that Anti-Endometrial Antibodies occur less often in the general population, but more often in women with infertility (Table 10).

Table 10. Prevalence of Anti-Endometrial Antibodies

Group	Prevalence of Anti-Endometrial Antibodies (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	15%	55%	93%	9.5%	<0.05
Control Group	2%				

Anti-gluten antibodies were found in 10% of women taking birth control pills, and 1% of the control group ($p < 0.05$). Celiac disease often goes hand in hand with gluten sensitivity. May cause reproductive problems Causes hormonal imbalance Disturbing the menstrual cycle and it affects ovulation. In some cases, testing for gluten can cause inflammation of the immune system. This may impact reproductive capability and fertility.

The anti-gluten antibody test was ordered in 60% of the women in the infertility group, meaning 60% of women who were infertile were found to have anti-gluten antibodies. Specificity of the test was 94%, meaning that the test is accurate at identifying infertile people who are not sensitive to gluten. Decay of the anti-gluten immune response was 6.5%, suggesting that there is a greater incidence of gluten sensitivity in infertile women than in the general population.

The presence of these antibodies and antibodies, like ANA, aCL, anti-endometrial antibodies and anti-gluten antibodies, are significant and warrant consideration in the evaluation and treatment of women with unexplained infertility or recurrent pregnancies.

Table 11. Prevalence of Anti-Gluten Antibodies

Group	Prevalence of Anti-Gluten Antibodies (%)	Sensitivity (%)	Specificity (%)	Accuracy (%)	P-Value
Infertility Group	10%	60%	94%	6.5%	<0.05
Control Group	1%				

Anti-sperm antibody (ASA) and individual antibodies are correlated (r) to determine the strength and direction of the association. Values near +1, suggest a high positive correlation. If the value is near 0, there is little or no relationship, but if the value is less than 0.05, then there is some evidence of a relationship. Considering values generally less than 0.05, strong positive correlations were found between ASA and Anti-Cardiolipin Antibody (aCL) ($r = 0.60$) and Anti-Endometrial Antibodies ($r = 0.65$). Strong correlation with the values for both showed $p < 0.05$, thus meaning that these antibodies might play an important role in the infertility compared to ASA. Moderate correlations were found between Anti-TPO ($r = 0.50$) and Anti-Tg ($r = 0.55$) suggested an association with the gland dysfunction. There was a possible correlation with antinuclear antibody (ANA) ($r = 0.30$), but there was no correlation with thyroid or reproductive problems. Although less significant with a p -value of 0.08, these results suggest that some antibodies

especially Anti-Cardiolipin Antibodies and Anti-Endometrial Antibodies may have a greater impact on reproduction compared to ASA, indicating that the antibodies are important for reproductive problems (Table 12).

Table 12. Correlation Between Anti-Sperm Antibodies (ASA) and Other Antibodies

Antibody Pair	Correlation Coefficient (r)	P-Value
Anti-Sperm Antibodies (ASA) & Anti-Phospholipid Antibodies (aPL)	0.45	0.03
Anti-Sperm Antibodies (ASA) & Anti-Ovarian Antibodies (AOA)	0.35	0.05
Anti-Sperm Antibodies (ASA) & Anti-Trophoblast Antibodies (ATA)	0.40	0.04
Anti-Sperm Antibodies (ASA) & Anti-TPO	0.50	0.02
Anti-Sperm Antibodies (ASA) & Anti-Tg	0.55	0.01
Anti-Sperm Antibodies (ASA) & Anti-Nuclear Antibodies (ANA)	0.30	0.08
Anti-Sperm Antibodies (ASA) & Anti-Cardiolipin Antibodies (aCL)	0.60	0.003
Anti-Sperm Antibodies (ASA) & Anti-Endometrial Antibodies	0.65	0.002
Anti-Sperm Antibodies (ASA) & Anti-Gluten Antibodies	0.48	0.04

Discussion

The present study aimed at assessing the prevalence and associations of various immune markers such as Anti-Sperm Antibody (ASA), Anti-Phospholipid Antibody (aPL), Anti-Endometrial Antibody and Thyroid Autoantibody in infertile women. These results suggest an important association between these proteins and infertility in women. This could offer some useful clues to the doctors while they're diagnosing and treating infertility. Especially unexplained infertility. This study showed a higher prevalence of ASA in nonpregnant women compared to controls. There have been previous studies which have found an association between ASA and reproduction problems. This is primarily done via genital and genital inhibition [26]. These results are confirmed by Koide et al. [27]. Xu et al. [28] also reported findings relevant to anti-sperm antibody expression and natural pregnancy. ASA has been demonstrated to not only disrupt sperm function. It may also disrupt pregnancy and cause multiple miscarriages, though. Anti-Cardiolipin Antibodies (aCL) and Anti-Endometrial Antibodies as well as thyroid autoantibodies are related to ASA. The results of this study also warrant the inclusion of the autoimmune pathway in the infertility. It implies that both males and females could be affected by infertility due to autoimmune disorders.

The correlation among aPL and infertility has been nicely-mounted. Lots of studies linking aPL to miscarriage and recurrent implantation failure have been done. Loncar [29] reported an association involving anticardiolipin antibodies and infertility. McIntyre [30] discussed antiphospholipid antibodies in implantation failures. Our findings verified that aPL became a much more common finding in the infertile clinic, and strongly correlated with ASA. These results are aligned with the hypothesis of Bennett and Gupta [31] that autoantibodies targeting phospholipids may induce vascular thrombosis and reduce placental function, which may affect the chances of a successful being pregnant. Therefore, aPL isn't only a chance component for infertility however also an essential marker for diagnosing antiphospholipid syndrome (APS) in ladies with unexplained infertility.

Anti-Endometrial Antibodies is a significant locating upon this have a look at, which corresponds with earlier research on autoimmune-mediate implant failure. Gajbhiye et al. [32] pointed out that such

dysregulated autoimmune responses against the endometrial lining may be responsible for the failure to implant the embryo, a key event in early pregnancy. The Anti-Endometrial Antibodies (AEA) found more often in the infertility association highlights the relevance of immune components in the implantation system. These antibodies can also be responsible for chronic endometrial inflammation, which negatively affects the receptivity of the endometrium, thereby altering the embryo's ability to implant correctly [33]. In mild of these findings, it is seriously recommended that testing for AEA may be crucial if patients have suffered from recurrent implantation failure as this could also indicate a low likelihood of getting a successful embryo implant.

The present study also showed that there was a significant relationship between ASA and thyroid autoantibodies (Anti-TPO and Anti-Tg). This is similar to other reports which found that these thyroid proteins can contribute to thyroid deficiency and can adversely affect fertility [34]. Additionally, our study reveals that women with Auto-TPO or Auto-Tg were more likely to be prescribed ASA, and that there was a higher prevalence of both antibodies in these women, further highlighting the complex relationships between immunosuppression and associated outcomes in women without reproductive disease.

It is interesting that the findings linking different immune markers, particularly ASA and anti-phospholipid antibodies, are made. This association indicates another area of possible immune system response that may cause infertility in women, other than anti-endometrial antibodies, which are thyroid autoantibodies. Instead, it is a complex mix of immune factors. This is in line with the findings of Deroux et al. [35] that multiple immune modulating factors can have a synergistic detrimental impact on fertility. In women affected by several autoantibodies (as in our study), there may be a higher risk of infertility because of the interaction of these immune responses. Furthermore, Ruan et al. [36] reported a relationship between autoimmune thyroid antibodies and anti-nuclear antibodies. The relationship between these marks such as seen between ASA and Anti-TPO or anti-endometrial antibodies. It is suggested that these immune modulators may have similar pathways in affecting reproductive health.

Conclusion

The results of the present study showed that there is a significant association between anti-sperm antibodies (ASA) and some other immune markers, suggesting that anti-sperm antibodies (ASA) might be involved in female infertility: anti-cardiolipin antibodies ($r = 0.60$) and anti-endometrial antibodies ($r = 0.65$) were observed. The strong positive correlations indicate the strong impact of the antibodies. Of these fertility related effects, aCL and Anti-Endometric Antibodies were found to be strongly associated with ASA which may be related to reproductive issues. This is particularly true in women with recurrent miscarriage and/or failed implants. The moderate correlation between ASA and anti-TPO ($r = 0.50$) and anti-TG ($r = 0.55$) also suggests that thyroid dysfunction plays a role in infertility in women with high ASA levels and For this reason, in the evaluation of infertility, especially in women with autoimmune thyroid disorders, the importance of thyroid testing has been increasingly emphasized.

Although weaker correlations were located between ASA and Anti-Nuclear Antibodies (ANA) ($r = 0.30$), this nonetheless shows a ability however much less huge hyperlink, warranting similarly investigation into the function of autoimmune diseases in woman infertility. The overall results highlight the importance of understanding the role of immune components in the diagnosis and therapy of infertility, particularly the role of ASA. In an unexplained infertility, an increase in the levels of ASA with the presence of various antibodies such as aCL, Anti-Endometrial, Anti-TPO and Anti-Tg may also act as potential markers for unexplained infertility and related reproductive problems. Further research is required to investigate the mechanisms behind these immune elements and therapeutic approaches targeting these elements of the immune system.

Finally, the fact that many antibodies are found in infertile girls underlines the significance of immune factors in reproduction. Sperm antibodies can hinder the processes involved in fertility, such as

implantation, ovulation and hormonal balance, with the same going for other antibodies targeting other organs that are associated with autoimmune diseases. The results highlight the need for comprehensive immune assessments in women with infertility, and that correcting immune issues can also help achieve better fertility outcomes. If immune-related infertility can be detected early and targeted remediated, it will provide valuable opportunities for enhanced interventions and reproductive health management.

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