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Research Article

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The Prevalence of Sperm Anomalies in Seminal Fluid of Males in Nigeria- A Retrospective Study

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Abstract

Background: *Infertility is defined as the inability to achieve pregnancy after a year or more of regular unprotected sex. The infertility in some parts of African continent exposes women to stigmatization, causing emotional stress and straining marital relationships. Growing awareness of male infertility in African continent is leading to more men getting screened, making local data on this issue available across various regions. The aim of this study was to assess the prevalence and types of sperm defects in the seminal fluid among males seeking infertility screening at Jos University Teaching Hospital, Plateau State, Nigeria.*

Methods: *This study is a retrospective study and seminal fluid analysis record, patient files were selected by simple random sampling technique from 2013 to 2023 at Jos University Teaching Hospital, Plateau State, Nigeria.*

Results: *The current study has analyzed 440 male patient files with semen samples and recorded that 38.60% of male partners had abnormal sperm results at Jos University Teaching Hospital, Plateau State, Nigeria. The most common abnormalities were oligoasthenoteratozoospermia and oligoasthenozoospermia. In addition, a primary infertility in male patients were prevalent (74%) than secondary infertility (26%). The civil servants made up the largest occupation group in this study with 34.80% patients.*

Conclusion: *This study concludes that sperm anomalies are common among male patients presenting for infertility screening. The findings of the current study highlight the need for future comprehensive evaluation and management of male infertility at Jos University Teaching Hospital, Plateau State, Nigeria and Nigeria as a country.*

Keywords: Male factor Infertility, Semen quality, Oligozoospermia, Asthenozoospermia, ligoasthenoteratozoospermia

Abbreviations

USA:United State of America; WHO: World Health Organization; DNA:DeoxyribonucleicAcid;OAT: Oligoasthenoteratozoospermia; ART: Assisted Reproductive Technology

1. Background

Infertility is defined as the inability to achieve pregnancy after a year or more of regular, unprotected sexual activity [1]. It affects approximately 15% of couples in the United state of America (USA) and over 180 million couples worldwide. A World Health Organization (WHO) reports that 1 in 4 couples in developing nations struggle with infertility [2]. In Nigeria, infertility is considered a significant reproductive health and social issue, particularly for women. However, male patients contribute to about 40% - 50% of infertility cases, making it essential to evaluate and treat both partners [2-5]. In addition, the study reports that the most consultations by gynecologists at the level of tertiary health institutions in the Nigerian population records that 60-70% of consultations are related to infertility cases [6]. Additionally, the study reports that the sub-Saharan African population faces a high burden of infertility with pathological origins, warranting public health attention [6]. Another study done at a private fertility clinic in Abakaliki, Nigeria established with diagnosis of primary and secondary infertility that a significantly high proportion of 70% of the study population had low sperm count with significantly high defective parameters 64% [7]. It has been reported that in the region of Southwestern Nigeria the prevalence of male patients' infertility is at an elevated level of 65% in primary infertility and only 35% in secondary [36]. Hence, the regional differences in infertility exist in the Nigerian population. However, most infertility cases are avoidable and such high scale of the infertility issue requires urgent action in all regions of Nigeria.

Furthermore, most couples conceive within the first year of regular, unprotected sex. It is the fact that many couples aim to have children, but some face infertility that can cause enormous emotional distress [1]. In many African cultures, childlessness can strain marriages, with women often bearing the blame and stigma unfairly. Nevertheless, the cultural taboo around male infertility leaves women to carry the emotional burden alone [1]. In man infertility can have unknown causes, but some known contributing factors include abnormal semen parameters, obstruction of genital ducts and urogenital infections and these can lead to conditions like obstructive oligospermia, impacting fertility [8,9].

The seminal fluid analysis is a key diagnostic tool for male infertility, but it has its own limitations. It does not directly measure sperm function tests and has poor predictive value for fertility [1]. Conversely, advanced tests like sperm penetration assays or deoxyribonucleic acid (DNA) integrity tests may provide more accurate insights [7]. Likewise, it has been reported by research studies that the semen analysis assesses quantity and quality, and abnormalities are recorded by semen analysis in up to 60% of infertile couples [10-13]. The common semen abnormalities include oligospermia, azoospermia, motility abnormalities (asthenozoospermia), teratozoospermia and when multiple abnormalities coexist, it is referred to as oligoasthenoteratozoospermia (OAT syndrome). Additionally, factors impacting fertility include age, certain medications, surgical history, environmental toxins, genetic issues, and underlying medical conditions. These factors can affect fertility individually or combined [10].

The goals of the fertility assessments are identifying underlying reasons, treatment of the reversible disorders and evaluation of eligibility for assisted reproductive technology (ART) and providing counseling for irreversible cases [15]. In the male patients the infertility can sometimes signal a more serious underlying health issue. Therefore, the evaluation of male partners is crucial for identifying and treating any potential severe medical conditions that could be part of the infertility [15]. As awareness grows about the significant role of the male patients in infertility, especially in African continent an increasing number of male partners in infertile unions are tested for infertility, and the conventional techniques and modalities in assisted reproductive technology to manage them are applied more frequently [14,16-20]. The burden of infertility is typically greater in developing nations due to limited medical resources, high treatment costs, and cultural stigmas, taboos, and fears [21].

An estimated 48.5 million couples were infertile worldwide in 2010, and both men and women shared equal responsibility for this condition [21]. The African continent and Central/Eastern Europe had the greatest rates of male infertility, whereas North America and Australia had rates ranging from 4.5–6% and 8–12%, respectively [22]. In Iran, a male factor accounts for 50.5% of infertility which was comparable to research conducted in the southeast region of Nigeria (42.4%), South Africa (21%) and in Iraq the 36.8% of population were infertile [23]. Worldwide, infertility impacts about 13-15% of couples, with 1 in 5 couples facing difficulty getting pregnant within their first year of trying [24,20]. In the USA almost half of young, healthy couples who were unable to conceive during their first year of unprotected sexual activity will do so during the next 12 months even though there is no availability of any special therapy [25].

Since male infertility is not a disorder that can be reported, its precise prevalence is unknown. What's more, male infertility is frequently treated in outpatient settings, which makes it difficult to monitor and enter data in sizable clinical databases and the male infertility needs new perspective of "infertility as a disease," through enhanced understanding of the epidemiology of male infertility [26]. The study reported and estimated in the year 2015 that the overall percentage of infertility caused by solely male causes might range from 2.5% to 12% [22]. In addition, in North America the male patient's infertility rates are estimated to be between 4.5% and 6%, in Australia 9%, and in Eastern Europe the male infertility rate may be as high as 8% to 12% [22]. A study conducted in 2004 calculated that 25.6% of infertility cases in Bangal were mostly caused by male partners [28].

In a research study that reported on the abnormalities in semen analysis among male partners of infertile couples, the results indicated that 7.45% samples were of inadequate quantity, 19.87% of cases had oligospermia, 12.42% had azoospermia and 4.35% of males had asthenozoospermia and pus cells were detected in 12.42% cases. This study concluded that majority of infertility cases in males is due to oligospermia followed by azoospermia while less sperm motility or less amount of semen are also responsible in some cases [27, 28]. Furthermore, the study reports that the following on patterns of semen fluid abnormalities in male partners, azoospermia was encountered in 10% of the subjects of whom 36% had low ejaculate volume and 64% had normal volume, single factor abnormality was encountered in 52.7% of screened males, 97% teratozoospermia, 2% isolated oligospermia and 1% asthenozoospermia. Oligospermia was collectively evident in 27.2% patients either isolated or combined with other spermogram defect, and 6.1% had a sperm concentration less than 5 million/ml, 41% had sperm concentrations of 5-10 million/ml and 52.9% with concentrations of more than 10 million/ml [29].

Also, in 2010 the study carried out descriptive study research on semen quality in male partners of infertile couples in Lagos, Nigeria, African continent revealing that asthenozoospermia was the most common disorder among the study population with 24.9% and 3.1% were azoospermic while 15.4% were oligospermic with 4.3% of the subjects that had teratozoospermia. According to this study, some of the abnormal seminal samples demonstrated combine defects with oligoasthenospermia occurring in 10% of the entire study population and more than two-thirds of the male partners of infertile couples in the study had certain degree of seminal fluid abnormality [5].The Sudanese research study studied semen parameters for the patients attending an infertility clinic and reported results of 69.9% of the specimens that had normal parameters, and abnormal findings were detected with 27% teratozoospermia, 8.4% azoospermia, 21.7% oligospermia, 0.4% hyperthermia, 11.2% hypothermia, 19.2% hyperviscosity, 6.1% sperm agglutination, and 19.2% leukocytopenia [30].

Primary infertility is when a couple has never achieved pregnancy, while secondary infertility is when a couple has had at least one prior pregnancy but struggles to conceive again after trying for over a year. The causes of secondary infertility are divided into thirds: male factors (about 1/3), female factors (about 1/3), combined male and female factors or unexplained (about 1/3). Despite receiving less attention, secondary infertility is just as prevalent as primary infertility [31]. In the USA, about 11% of couples who already have a child struggle with secondary infertility, making it difficult to conceive again. Notwithstanding this, their struggles are often minimized or overlooked by others simply because they already have a child [32]. There have been different reports on the prevalence of primary and secondary infertility in various regions [31]. A study reported 32.8% of primary infertility and a prevalence of 67.2% of secondary infertility. This study shows the dominance of secondary infertility with probable genital tract infection being a major contributor [31]. Another study reported 75.7% of the secondary infertility compared to 24.3% of the primary infertility in Lagos, Nigeria [5]. On the other hand, in eastern Saudi Arabia primary infertility (78.99%) was more common than secondary infertility and the result for semen parameters showed that 68.5% were azoospermic [29].

Nevertheless, the prevalence in the African continent, Nigeria of primary infertility was recorded at 19.6 % and at 80.4% for secondary infertility; and at 46% and 54.11% respectively for primary and secondary infertility [7, 37]. A study done in Southwestern Nigeria found that 22.5% of cases were primary infertility and 77.5% were secondary infertility [34]. In addition, a study reported a secondary infertility was approximately 66% of infertility cases, this was also like a finding reported in Ilorin and Nwajiakwu in contrast to studies in Nnewi [35- 37]. Also, the patterns of infertility among couples seeking treatment at a secondary health care facility in Delta State Southern Nigeria has found that 32% of cases at this healthcare facility were related to infertility, consistent with findings from other regions in Nigeria [38]. What is more, the azoospermic men are particularly vulnerable to cancer, and a considerable proportion (5-8%) of testicular cancer cases are associated with azoospermia [39, 40]. In addition, the research suggests that infertile men, particularly those with azoospermia, may have a higher risk of developing cancer compared to the general population [39]. Therefore, males with azoospermia will be advised to also ensure they screen for testicular cancer.

There is limited research on the prevalence and types of sperm abnormality in Nigeria's Middle belt region (north central region) inclusive of Jos facility. Infertility is a significant reproductive health issue affecting many couples, and male factor infertility is a contributing factor in a substantial proportion of cases. Despite its importance, there is limited data on the seminal fluid profiles of infertile males in Jos, Nigeria. Hence, this study aimed to determine the prevalence and types of sperm anomalies in seminal fluid of males who presented for infertility screening and the 3 Jos University Teaching Hospital, Jos, Nigeria.

2. Methods

2.1 Study Design

This is a retrospective cohort study of infertility patient cases presented at Jos University Teaching Hospital, Jos North Local Government Area, Plateau State, Nigeria over a period of ten years from 2013- 2023. This study was done with ethics approval no. / DCS/IRE/127/XXX1/554 at the Jos University Teaching Hospital, Jos, Nigeria, and the research was conducted by management's permission and clearance from ethics committee on research ethics.

2.2 Study Population and Sampling Strategy

The study population consisted of male adults who presented for infertility investigation at Jos University Teaching Hospital, Jos, Nigeria, African continent. The participants underwent seminal fluid analysis as part of their evaluation. The population

was composed of males aged 18-65 years. All participants were experiencing male factor infertility, defined as the inability to get a fertile female pregnant after one year of unprotected, regular sexual intercourse. All subjects within the age range of 18-65 years who had regular sexual intercourse were included in the study while those with incomplete results were not included. The data was collected retrospectively at the microbiology laboratory of the teaching hospital where the seminal fluid analyses were done under standard laboratory techniques using WHO criteria which include oligospermia (spermatozoa count below the reference limit of 16 million/ml, azoospermia (absence of spermatocytes), asthenozoospermia (sperm motility below reference limit of 32%) and teratozoospermia (normal forms below the reference value of 4%).

The demographic characteristics of the population included males who were married, and among the study population were males of various occupation such as civil servants, traders, farmers, drivers and artisans. The seminal fluid analysis results showed results of sperm count, motility, and morphology. This study population represents a cohort of males seeking medical evaluation for infertility at Jos University Teaching Hospital, providing valuable insights into the characteristics and seminal fluid parameters of this specific patient group.

2.3 Sample Size

The calculations of the sample size were done according to the formula of Dean and colleagues [50].

$n = (Z_{\alpha})^2 \times P(1-P)/Precision^2$
Where, n = sample size
Z value = 1.96
Precision = 0.05
p= expected prevalence of the condition under study.
50% = 0.5

$$\frac{(1.96)^2 \times 0.5(1-0.5)}{0.052}$$

$= 384.16$
$n = 384.$
$n = 384.$

However, the sample size was increased to 440 patient files to enhance more accurate statistical results.

2.4 Sampling Technique

A simple random sampling technique was used for this study, this is a statistical technique used to select a subset of individuals or data points from a larger population, in a way that every individual in the population has an equal chance of being selected. In this study, computer-generated random numbers using Microsoft excel were used to generate folders of infertile males who presented for seminal fluid analysis at Jos University Teaching Hospital between 2013 to 2022.

2.5 Data Collection

A study proforma designed with Microsoft Excel was used to record data. We developed the study proforma through a thorough literature review and expert input to ensure it accurately captured relevant information. Pilot testing confirmed its face validity and helped refine it. The proforma effectively assessed key variables, including sperm anomalies, infertility duration, lifestyle factors, and demographics. To maintain data accuracy and consistency, we implemented quality control measures, including double data entry and verification.

2.6 Data Collection

Over the 10-year study period, a total of 1017 patient folders were identified and collected (Table 1).

The year of distribution	Patient folders
2013	83 folders (8.2% of total; 83/1017)
2014	81 folders (8.0% of total; 81/1017)
2015	95 folders (9.3% of total; 95/1017)
2016	107 folders (10.5% of total; 107/1017)
2017	105 folders (10.3% of total; 105/1017)
2018	78 folders (7.7% of total; 78/1017)
2019	95 folders (9.3% of total; 95/1017)
2020	82 folders (8.1% of total; 82/1017)
2021	190 folders (18.7% of total; 190/1017)
2022	101 folders (9.9% of total; 101/1017)

Table 1: The annual distribution of patient folders

The percentage contribution of each year to the total population was calculated using the formula: (Number of folders in each year / Total number of folders) x 100. Furthermore, to determine the number of folders to select per year, a proportionate sampling approach was applied. The calculated sample size of 440 patient files was allocated each year based on its percentage contribution to the total number of folders (n=1017).

The formula:
Number of folders to select per year = (Percentage contribution of year / 100) × Total sample size (440) (Table 2).

The year of distribution	The number of patient folders
2013	35/83 (8% of 440)
2014	35/81 (8% of 440)
2015	40/95 (9% of 440)
2016	48/107 (11% of 440)
2017	44/105 (10% of 440)
2018	35/78 (8% of 440)
2019	40/95 (9% of 440)
2020	36/82 (8% of 440)
2021	83/190 (18.7% of 440)
2022	44/101 (9.9% of 440)

Table 2: The number of folders selected per year

The folders were ranked, labeled, and selected using computer-generated random numbers. This ensured a representative sample for data collection.

2.7 Statistical Analysis

Statistical analysis was conducted with SPSS software, version 23 (IBM Inc., Chicago, ILS.A). Analysis of variables was summarized using means and Chi-square (X2) With the level of significance set at less than 0.05 ($p<0.05$). Frequencies and proportions were used for qualitative variables.

3. Results

Out of 1,017 male patients who presented at fertility facilities within the study period of 10 years 440 patient files were included in the current study. A total of 440 case notes were accessed during the study period, and a total of 170 (38.60%) semen analysis revealed abnormalities in the male partners, while 270 (61.4%) cases weren't attributed to seminal fluid anomalies. The percentage incidence of primary and secondary infertility among the study population was 74% patients presented with primary infertility while 26% had secondary infertility (Figure 1).

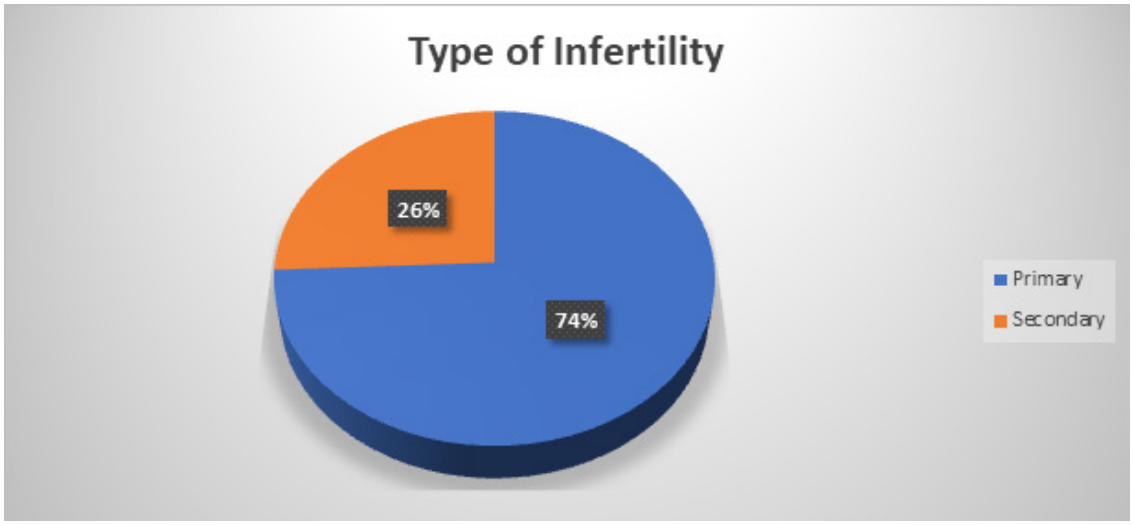

Figure 1: This figure shows the percentage incidence of primary and secondary infertility among the study population. Out of 440, 327 (74%) presented with primary infertility while 113 (26%) had secondary infertility.

Furthermore, Table 3 represents the mean age and occupation of the study population. The study reviewed case notes of men with diverse backgrounds and ages averaging 36.36±5.670 out of 440 patient folders reviewed, 153(34.8%) of the men who turned up for infertility investigation were civil servants making them the highest in the study population, whereas just 33(7.5%) of the men were farmers making the lowest occupation in the study population, the reason been that civil servants in addition to being aware of the

potential role of male factor in infertility problems are financially empowered to seek medical interventions. In resource-poor countries like Nigeria, low literacy rates and widespread poverty hinder access to medical care for fertility issues, exacerbating the problem. This is evident in the low number of other professionals that turned out to seek treatment for their infertility issues (Table 3).

Parameters	Values
Age Mean±SD	36.36± 5.670
Occupation	Number (percent)
Artisan	88(20.0%)
Civil Servants	153(34.8%)
Professional Drivers	47(10.7%)
Farmers	33(7.5%)
Traders	119(27.0%)

Table 3: The distribution of occupation in the study population

Table 4 presents the prevalence of seminal fluid abnormality in the study population.

A review of the folders revealed the following outcomes regarding seminal abnormalities, 74(43.53%) had Oligospermia, the most common combined abnormality was Oligoasthenozoospermia 27(15.96%) followed by OAT 9 (5.29%) while 1(0.59%) had Asthenoteratozoospermia, while the rest of the population had a normal semen fluid parameter.

SFA abnormality	Description	Prevalence
Asthenozoospermia	Reduced sperm motility	18.82%
Azoospermia	Total absence of sperm in ejaculate	14.71%
Asthenoteratozoospermia	Combination of reduced sperm motility and abnormal morphology	0.59%
Oligoasthenozoospermia	Combination of low sperm count(oligospermia) and reduced motility(asthenozoospermia)	15.88%
Oligospermia	Low sperm count, where the concentration of sperm is below the normal range.	43.53%
Oligoasthenoteratozoospermia	Combination of low sperm count, reduced sperm motility and abnormal sperm morphology.	5.2%
Teratozoospermia	Abnormal sperm morphology where a high percentage of sperm have irregular shapes or structures	1.8%

Table 4: Seminal fluid results

Tables 5 and 6 present the effects of alcohol consumption and cigarette smoking on seminal fluid abnormality. Even though more people took alcohol and fewer people smoked cigarette compared to those that did not in this study population, there is no statistically significant difference among them as P>0.05 indicating that alcohol and cigarette did not contribute to their seminal fluid abnormality.

Alcohol Consumption in (%) SFA Abnormality	YES	NO	χ^2	P
Asthenozoospermia	13(22.10%)	19(32.30%)	8.449	0.391
Azoospermia	10(17.00%)	15(25.50%)	-	-
Oligoasthenoteratozoospermia	6(10.20%)	3(5.10%)	-	-
Oligoasthenozoospermia	15(25.50%)	9(15.30%)	-	-
Oligospermia	40(68.00%)	34(57.80%)	-	-

Teratozoospermia	0	2(3.40%)	-	-
Asthenoteratozoospermia TOTAL	1(1.70%) 85(50.00%)	0 82(48.23%)	-	-

Table 5: Effect of alcohol on sperm parameters

Cigarette Smoking in (%) **SFA Abnormality**	**YES**	**NO**	χ^2	**P**
Asthenozoospermia	7(11.90%)	25(32.30%)	9.640	0.291
Azoospermia	3(5.10%)	22(37.40%)	-	-
Oligoasthenoteratozoospermia (OAT).	5(8.50%)	4(6.80%)	-	-
Oligoasthenozoospermia (OA)	5(8.50%)	9(32.30%)	-	-
Oligospermia	13(22.10%)	61(103%)	-	-
Teratozoospermia	0	2(3.40%)	-	-
Asthenoteratozoospermia TOTAL	0 33(47.60%)	1(1.70%) 124(216.90%)	-	-

Table 6: Effect of cigarettes on seminal fluid abnormality

4. Discussion

The aim of the current study was to determine the prevalence and types of sperm anomalies in seminal fluid of male patients' population who presented for infertility screening and the 3 Jos University Teaching Hospital, Jos, Nigeria.

In the current study, primary infertility had a higher prevalence of 74% compared to secondary infertility which had a prevalence of 26%. This finding corroborates the findings done in Saudi Arabia where primary infertility had a prevalence of 78.99% [46]. Another study reported 67.37% of primary infertility and 32.63% of secondary infertility rates in Morocco [41]. Also, it has been revealed by study done in the middle Anatolian region that there is a high prevalence of primary infertility (77.3%) [42]. However, the current study contrasted with some other studies on the prevalence of primary and secondary infertility in Nigeria, African continent. The research study done in rural Nigerian networks on the prevalence of infertility revealed a prevalence of only 9.2% cases of primary infertility and 21.1% cases of secondary infertility [43]. Also, a study reported 32.8% primary infertility and 67.2% secondary infertility in 2014 from the Southeastern Nigeria region [47]. Another research study commenced in the Lagos region, Nigeria reported a 75.7% of secondary infertility and a 24.3% of a primary infertility in male patients of this region [5]. Meanwhile, the study reporting the prevalence of infertility in women in a southwestern Nigerian community stated prevalence of primary infertility at 19.6% and 80.4% for secondary infertility [33]. Conversely, the sexually transmitted infections and other underlying health issues might be key factors in the observed primary infertility rates [51,52].

In addition, this study results report in couples seeking infertility treatment that 38.6% of male partners had abnormal semen parameters, highlighting the significant role of male factor infertility in the causes of infertility. This finding is like studies reporting male patients having abnormal semen parameters at 41%, and at 40.7%; and at 42.5% in southwest Nigeria, as well as 38.2% prevalence reported in Ado Ekiti, Nigeria [1, 4, 44,45]. However, this was at variance with the findings of semen quality in male patients of infertile couples in Lagos, Nigeria where the findings were at 69.1% and 71% [5,17]. This prevalence may be because men in Nigeria are becoming more aware of the importance of male factor screening and the contribution to infertility treatment.

Likewise, the high prevalence of 74% of oligospermia in the present study corroborates earlier reports which identified oligospermia/ azoospermia as the major contributory factors in sub – fertile/ infertile Nigerian couples [7, 43]. In addition, the results of another study corroborate the findings on abnormalities in semen analysis among male partners of infertile couples where 19.87% of cases had oligospermia which concluded that most infertility cases in males are due to oligospermia in Riyad, Saudi Arabia [28]. As well as, in Abakiliki, Ebonyi State, in Nigeria a research report had 33% of patients with oligospermia that had the highest prevalence among other seminal fluid abnormalities [1].

The oligoasthenozoospermia (14.12%) and OAT (5.29%) in the current study were the major combined factors of the detected seminal abnormalities and these findings corroborate to the findings of research study done in southeastern region of the Nigeria where oligoasthenozoospermia was found in 14.7% of patients and OAT at 13.2% [47]. Moreover, the current study results highlight that oligospermic men had the highest prevalence of seminal fluid abnormality while men with teratozoospermia

and asthenozoospermia had the lowest prevalence of seminal fluid abnormality. These results are not exclusive to the fact that the high occurrence of oligospermia could be linked to sexually transmitted infections, environmental toxins, and occupational hazards. Nevertheless, in the current study the effects of alcohol consumption and cigarette smoking on seminal fluid abnormality were not significant.

There is a need for wider studies with bigger population samples and much wider correl. In addition, the infertile men, especially those with azoospermia, are at increased risk of testicular cancer and incorporation of the testicular cancer screening into their treatment plan is advisable. The future research studies should be done across multiple centers or regions of Nigeria, African continent, to capture diverse populations and longitudinal follow-up studies can be conducted to assess the impact of sperm anomalies on fertility outcomes and offspring health.

5. Conclusion

The current study has shown that oligospermia and oligoasthenozoospermia contributed significantly to infertility of the male patients' population Jos University Teaching Hospital, Jos, Nigeria as the most common combined abnormality in the current studies population pool. Also, the study recorded a high incidence of primary infertility compared to secondary infertility. Hence the need for public enlightenment, prompt treatment of sexually transmitted infections, and lifestyle modifications are evident.

Contributions

This research identifies sperm abnormality frequencies, guiding targeted male infertility interventions. The findings support integrating reproductive health services into primary care which aligns with the scope of the Journal. The study can inform policy and practice to improve health outcomes in Nigeria and the African continent.

Authors'Contributions

➢ Odey, VE. performed data analyses and was a major contributor in writing the manuscript.
➢ Wahzi MA. assisted data analyses and produced all tables and figures.
➢ Nyango PU. provided critical inputs on result interpretation and contributed to writing the manuscript.
➢ Edeh CN. assisted with data pre-processing and performed chart review.
➢ Mohammed B. major contributor of study materials and data collection and provided administrative and logistic support.
➢ McNeil RT was a major contributor of study materials and data collection and provided administrative and logistic support and research supervision.
➢ Tangban CN. contributed to result interpretation and manuscript writing.
➢ Petkova M and Karic V. contributed to result interpretation and manuscript writing, and provided academic, administrative and logistic support.
➢ Ekwere E.O. contributed study data and critical inputs in result interpretation and manuscript preparation.
➢ Naidoo, V. contributed to the study design, conducted data analyses, provided technical inputs and research supervision, and contributed to writing the manuscript.

All authors read and approved the final manuscript.

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Data Availability

The data is included in the article.

Declarations

Ethics Approval

This study was done with ethics approval no. /DCS/IRE/127/XXX1/554 at the Jos University Teaching Hospital, Jos, Nigeria and the research was conducted by management's permission and clearance committee on research ethics.

Consent for Publication

Not applicable.

Competing Interest

The authors have declared that there is no competing interest.

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