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EVALUATION OF MALE REPRODUCTIVE HEALTH USING CONVENTIONAL SEMEN ANALYSIS IN THE POPULATION OF DISTRICT KARAK, KHYBER PAKHTUNKHWA, PAKISTAN

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ABSTRACT

The evaluation of male reproductive health using traditional semen analysis is a crucial method in identifying male infertility. This approach determines a man's reproductive potential by assessing important semen factors such as sperm concentration, motility, and morphology. The aim of semen analysis in District Karak is to assess male fertility levels and identify potential reproductive health issues within the population. A cross-sectional analysis in Tehsil karak, Takht-e-Nasrati, and Banda Daud Shah assessed semen quality in 250 male patients aged 18 -60.Data was collected via semen samples obtained after 2-6 days of abstinence. Laboratory analysis evaluated semen volume, pH, color, viscosity, sperm concentration, motility, and morphology. The study analyzed 250 semen samples from male patients in district karak using WHO 2021 guidelines. The overall abnormality rate was 18%, with the highest irregularity in Tehsil Karak (20%) and the lowest in Tehsil Banda Daud Shah (14.28%).Age-wise, the highest abnormality 20% was in the 46-55 age group. Key findings showed 10% at semen volume <1.4ml, 11.2% had sperm concentration <16million/ml, 8.8% had motility <42%, 10% had abnormal morphology, 8% had motility <54% ,7.2% had pH<7.2, and 4.8% had low viscosity among the form of semen abnormalities, normospermia was found in 82%, teratozoospermia in 10%, oligozoospermia in 11.2%, necrozoospermia in 8%, asthenozoospermia in 8.8%, and other

combined abnormalities in varying lower percentages. Despite its limitations, conventional semen analysis is crucial for evaluating male fertility. Findings from District Karak underscore the necessity for routine semen analysis and further research to enhance diagnostic accuracy for male infertility.

Introduction

1.1 Semen

Human semen is a protein-rich fluid produced by the male reproductive organs, consisting of a complex suspension of spermatozoa and secretions from various glands, including the testes, epididymis, seminal vesicles, prostate, Cowper's gland, and glands of Littre [1]. During ejaculation, semen is released as a mixture containing spermatozoa, which are produced in the testes and matured in the epididymides, combined with secretions from accessory sex organs [2]. Semen quality is assessed through multiple parameters, including sperm count, volume, concentration, motility, viability, and morphology, all of which play a crucial role in male fertility [3].

1.2 Semen Analysis

Semen analysis is a fundamental diagnostic tool in evaluating male reproductive potential, aiding in the identification of infertility causes [4]. Despite its limitations, it remains a widely used method to assess sperm production, motility, and morphology [5]. Conventional semen analysis includes macroscopic (volume, pH, color) and microscopic (motility, concentration, viability, morphology) examinations [6]. However, it does not evaluate sperm functional capacity, such as fertilization potential or DNA integrity [7]. While semen analysis provides indirect insights into testicular and accessory gland function, its subjective nature and inter-observer variability necessitate complementary functional assays [8].

1.3 Fertility and Infertility

Male infertility contributes to approximately **40%** of infertility cases in couples, with combined male and female factors accounting for an additional **20%** [9]. In Pakistan, infertility affects **21.9%** of couples, with male factors contributing significantly [10]. Common causes include oligospermia (low sperm count), asthenospermia (poor motility), teratospermia (abnormal morphology), and necrospermia (reduced sperm vitality) [11]. Oxidative stress (OS) has emerged as a key factor in male infertility, where excessive reactive oxygen species (ROS) damage sperm membranes, DNA, and proteins [12]. Beyond biological factors, infertility has profound psychosocial impacts, including marital dissatisfaction and psychological distress, particularly in societies where male infertility carries stigma [13].

1.4 Prevalence

Infertility affects 15%of couples globally, with 180 million cases worldwide [14]. In Pakistan, the reported infertility rate is 22% with 35%attributed to male factors [15]. Rising infertility rates are linked to delayed parenthood, environmental factors, and lifestyle changes [16]. Despite advances in diagnostics, conventional semen analysis remains the cornerstone of male infertility evaluation, though its predictive value is limited by technical variability [17].

1.5 Sperm Motility and Morphology

Sperm motility (percentage of moving sperm) and morphology (percentage of normally shaped sperm) are critical determinants of fertility [18]. Abnormalities in these parameters significantly contribute to infertility [19]. While semen analysis provides essential data on sperm production and quality, it does not assess functional competence, such as fertilization ability or chromatin integrity [20]. Thus, integrating advanced diagnostic markers (e.g., DNA

fragmentation tests) with conventional analysis is increasingly recommended for a comprehensive evaluation of male infertility [21].

Material and Methodology

1.6 Study Design and Setting

A descriptive cross-sectional study was conducted across all three Tehsils of District Karak, Pakistan (Karak, Takhte-e-Nasrati, and Banda Daud Shah). The study aimed to evaluate semen quality parameters in male patients visiting the clinic for fertility assessment.

1.7 Sample Size and Selection

Sample Size: 250 semen samples were analyzed. The sample size was determined based on the average number of consenting patients visiting the laboratory over the study period.

Sampling Technique: Convenience sampling was employed.

Inclusion Criteria

1. Males aged 18–60 years, residing permanently in District Karak.
2. No history of chronic diseases (e.g., diabetes, hypertension) or conditions affecting sperm quality.

Exclusion Criteria

1. Age <18 or >60 years.
2. Chronic illnesses (e.g., diabetes, hypertension) or genetic disorders impacting fertility.
3. History of substance abuse (alcohol, smoking, or drugs) known to impair reproductive health.

2.0 Results

The results has been Designed according to WHO 2021 manual for semen analysis

Volume of semen per ejaculation	≥1.4ml
Sperm concentration per ml	≥16ml
Total motility	≥42%
Normal morphology	≥4%
zVitality	≥54%

1.8 Data Collection

Patient Information

A structured questionnaire recorded medical history, lifestyle factors, and abstinence duratio

Semen Sample Collection

Participants refrained from ejaculation for 2–6 days prior to sample collection. Samples were obtained via masturbatio into sterile containers in a private clinic room.

Sample Handling

Samples were transported immediately to the laboratory under controlled conditions (room temperature) for analysis.

1.9 Laboratory Analysis

Macroscopic Examination

Each semen sample Volume (mL), pH (digital pH meter), color, viscosity, and liquefaction time.

Microscopic Examination

1. **Sperm Concentration**

Diluted samples were counted using a **hemocytometer** (Neubauer chamber) per WHO guidelines.

2. **Sperm Motility**

A 10µL drop was placed on a pre-warmed slide and analyzed under a **light microscope (400x magnification).

Motility categories: Progressive, non-progressive, or immotile.

3. **Sperm Morphology**

Papanicolaou staining was applied to sperm smears. Abnormalities in the head midpiece and tail were assessed under oil immersion (1000x magnification).

PH	≥7.2

2.1 Over all cases in district karak

There are 250 semen samples were examined in the current study by following the WHO's 2021 semen analysis guidelines. Forty-five out of 250 hosts tested abnormal for different semen parameters, resulting in a total abnormality rate of 18%.

Table 2.1: Over all cases in district karak

District karak	No. of total examined host	Normal hosts	Percentage (%)	Abnormal hosts	Percentage %
	250	205/250	82	45/250	18

2.2 Tehsil wise distribution of cases

The hosts under examination were from a number of Karak district tehsils. Tehsil-specific distribution was therefore also recorded. Tehsil Banda Doud Shah had the lowest irregularity, at 14.28% 10/70, while Tehsil Karak had the highest, at 20% 20/100.

Table 2.2: Tehsil wise distribution

S.NO	Tehsil	No of total examined hosts	Normal Hosts	Percentage%	Abnormal hosts	Percentage %
1	**Karak**	100	80/100	80	20/100	20
2	**Takht-e-Nasrati**	80	65/80	81.25	15/80	18.75
3	**Banda Daud Shah**	70	60/70	85.71	10/70	14.28
4	**Total**	**250**	**205/250**	**82**	**45/250**	**18**

2.3 Age wise distribution of cases

The analyzed hosts were split into four age groups, such as 16 to 25 years old (n = 58), 26 to 35 years old (n = 62), and 36 to 45 years old (n = 60), in order to determine the age-wise distribution .The results indicated that the older group had a higher rate of abnormality than the younger age group. The age group of 46 to 55 years had the highest abnormality, 20% (12/60), while the age group of 16 to 25 years had the lowest abnormality, 15.51 (9/58).

Table 2.3 Age wise distribution of cases

S.NO	Age group	No of total examined hosts	Normal hosts	Percentage%	Abnormal hosts	Percentage %
1	**16-25 Years**	58	49/58	84.48	9/58	15.51
2	**26-35 Years**	62	51/62	82.25	11/62	17.74
3	**36-45 Years**	70	57/70	81.42	13/70	18.57
4	**46-55 Years**	60	48/60	80	12/60	20

Total		**250**	**205/250**	**82**	**45/82**	**18**

2.4 Semen analysis parameters

Semen volume per ejaculation, sperm cell count per millimeter (ml), sperm cell motility, sperm cell morphology, sperm cell vitality, and semen pH and viscosity are among the analytical parameters of semen that are shown in Table 2.4 and 25/250 (10%) of the samples had a semen volume of less than 1.4 ml, while 225/250 (90%) of the samples had a semen volume of 1.4 ml or more. While 222/250 (88.8%) of cases had a sperm cell count within the normal range, 28/250 (11.2%) cases had a sperm count below the reference. While total sperm cell motility was within the normal range, 22/250 (8.8%) of the samples had total sperm motility of less than 42%. 25/250 (10%) of the cases had abnormal sperm morphology, whereas 225/250 (90%) did.The sperm cell morphology of the patients was normal. Twenty out of 250 cases (8%) had sperm cell vitality below the reference range, while 230 out of 250 cases (92%), on the other hand, had normal sperm cell vitality. 18/250 (7.2%) of patients had semen PH below 7.2, whereas 232/250 (92.8%) of cases had semen PH within the usual range. Semen viscosity was found to be low in 12 out of 250 cases (4.8%), normal in 228 out of 250 cases (91.2%), and high in 10 out of 250 cases (4%) in the sample.

Table 2.4 Parameters for semen analysis

S.NO	Parameters	Categories	frequency	Percentage %
1	**Semen volume per ejaculation**	<1.4 ml	25/250	10
		≥1.4 ml	225/250	90
2	**Sperm concentration per ml of semen**	<16 millions	28/250	11.2
		≥16 millions	222/250	88.8
3	**Total sperm cell motility**	<42%	22/250	8.8
		≥42%	228/250	91.2
4	**Sperm cell morphology**	<4%	25/250	10
		≥4%	225/250	90
5	**Sperm cell vitality**	<54%	20/250	8
		≥54%	230/250	92
6	**Ph of semen**	<7.2	18/250	7.2
		≥7.2	232/250	92.8
7	**Viscosity**	Low	12/250	4.8
		Normal	228/250	91.2
		High	10/250	4

2.5 Forms of semen found among study participants

This study identified many semen analysis parameters in accordance with the 2021 WHO standard reference values. All sperm parameters were normal in 205 out of 250 (82%) of the analyzed samples. Asthenozoospermia 8.8%, oiligoasthenozoosperma 4%, Asthenoteratozoospermia 5.6%,

oligozoospermia 11.2%, necrozoospermia 8%, azoospermia 2%, teratozoospermia 10%, and Oligoasthenoteratozoospermia 2.4% were found in this study.

Table 2.5: Forms of semen found among study participants

S.NO	Categories	Frequency	Percentage %
1	**Normospermia**	205	82%
2	**Teratozoospermia**	25	10%
3	**Oligozoospermia**	28	11.2%
4	**Necrozoospermia**	20	8%
5	**Asthenozoospermia**	22	8.8%
6	**Oligoasthenozoospermia**	10	4%
7	**Oligoteratozoospermia**	12	4.8%
8	**Asthenoteratozoospermia**	14	5.6%
9	**Oligoasthenoteratozoospermia**	6	2.4%
10	**Azoospermia**	5	2%

Discussion

Human semen is a protein-rich biological fluid composed of spermatozoa suspended in secretions from the male reproductive glands, including the testes, epididymides, prostate, seminal vesicles, and bulbourethral glands. Its composition is critical for fertility, as it supports sperm viability, motility, and function. Semen analysis remains a cornerstone in evaluating male reproductive potential, with key parameters—such as sperm concentration, motility, morphology, and seminal plasma composition—providing insights into fertility status and potential abnormalities. In this study, 250 semen samples from District Karak were analyzed following WHO (2021) guidelines, revealing an overall abnormality rate of 18% (45/250). Regional disparities were observed, with the highest abnormality rate in Tehsil Karak (20%) and the lowest in Tehsil Banda Daud Shah (14.28%). These findings align with global studies demonstrating geographic variability in semen quality, often attributed to environmental, lifestyle, and genetic factors [22].

Age-Related Trends

A notable age-dependent decline in semen quality was observed, with the highest abnormality rate (20%) in men aged 46–55 years and the lowest (15.51%) in those aged 16–25. This corroborates studies by who linked advancing age to reduced sperm concentration, motility, and morphology, likely due to oxidative stress and hormonal changes [23].

Semen Parameter Abnormalities

Key deviations from reference values included:

Low semen volume (<1.4 mL): 10% of cases.

Reduced sperm concentration: 11.2%.

Impaired motility (<42% progressive motility): 8.8%.

Abnormal morphology: 10%.

Suboptimal vitality: 8%.

PH deviations(<7.2): 7.2%.

Altered viscosity: 8.8% (4% hyperviscous; 4.8% hypoviscous).

These deviations are clinically significant, as aberrant viscosity and pH can impair sperm function

Spectrum of Semen Abnormalities

Normospermia was observed in 82% of samples, while 18% exhibited abnormalities, including:

Teratozoospermia (10%)

Oligozoospermia(11.2%)

Necrozoospermi (8%)

Asthenozoospermia(8.8%)

Combined defects (e.g. oligoasthenoteratozoospermia, 2.4%)
Azoospermi (2%)

The diversity of abnormalities underscores the multifactorial etiology of male infertility, consistent with findings by the prevalence of semen abnormalities such as teratozoospermia, oligozoospermia, and asthenozoospermia in this study mirrors global trends reported by [24].

Global Context and Implications

The observed decline in semen quality mirrors trends reported by [25] potentially linked to environmental pollutants, endocrine disruptors, and lifestyle factors. Targeted interventions—such as public health campaigns on reducing toxin exposure and promoting reproductive health—are warranted in District Karak to address these trends.

Conclusion

The study on the assessment of male reproductive health through conventional semen analysis in District Karak revealed significant insights into the prevalence and patterns of semen abnormalities among the local population. The analysis of 250 semen samples, conducted in accordance with WHO 2021 guidelines, identified an overall abnormality rate of 18%, with variations across tehsils and age groups. Tehsil Karak exhibited the highest abnormality rate (20%), while the lowest was observed in Tehsil Banda Daud Shah (14.28%). Age-wise, the 46–55 age group had the highest rate of abnormalities (20%), suggesting a correlation between advancing age and declining semen quality. The Key findings highlighted deviations in critical semen parameters, including volume, concentration, motility, morphology, pH, and viscosity. Notably, 10% of cases showed low semen volume (<1.4 ml), 11.2% had reduced sperm concentration (<16 million/ml), and 8.8% exhibited impaired motility (<42%). The study also documented various forms of semen abnormalities, such as teratozoospermia (10%), oligozoospermia (11.2%), and asthenozoospermia (8.8%), underscoring the multifactorial nature of male infertility in the region. Despite its limitations, conventional semen analysis remains a vital tool for evaluating male fertility. The findings emphasize the need for routine semen analysis in clinical practice to identify and address reproductive health issues early. Additionally, further research is warranted to explore the underlying causes of these abnormalities, including environmental, lifestyle, and genetic factors, to enhance diagnostic accuracy and develop targeted interventions. This study contributes to the growing body of knowledge on male infertility and advocates for increased awareness and access to reproductive health services in District Karak and similar regions.

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