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Spermiological Profile and Factors Associated with Male Infertility at the Laboratory of Histo-Embryology, Cytogenetics and Cellular Pathology "Pr Ag Moumouni Hassane" of Niamey: About 1000 Cases

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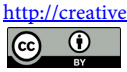
Abstract

Background: According to the World Health Organization, the worldwide prevalence of infertility is 17.5%. The male share of responsibility is undeniable. Several factors, such as smoking, alcoholism, obesity and environmental pollution are sources of infertility in men. The aim of this study was to determine the spermological profile of infertile men and the factors associated with sperm parameter abnormalities. **Methods:** This retrospective study analysed 1000 sperm samples over an 11-year period, from January 2010 to December 2021. **Results:** The average age was 37.52 ± 8.66 years. Surgical history of varicocele and teratozoospermia were associated (p-value = 0.0001). Candida albicans was associated with a 2.27-fold risk of necrozoospermia and a 3.14-fold risk of oligozoospermia. The link between the reason for requesting a spermogram and the age range between 38 and 47 was significant (p-value < 0.001). Occupation and azoospermia were related (p-value < 0.001), as were occupation and oligozoospermia (p-value = 0.0002). Occupation was significantly associated with teratozoospermia (p-value = 0.0125). Age was associated with



hypospermia (p-value = 0.0257) and oligozoospermia (p-value = 0.0293). Age was significantly associated with pH (p-value = 0.0166). Patients with alcoholism had a 2.31-fold risk of developing agglutination (p-value = 0.0195). Smoking was correlated with teratozoospermia (p-value = 0.0114), with a 1.66-fold risk. Coffee consumption was associated with teratozoospermia (p-value < 0.001), with a 6.75-fold risk. **Conclusion:** Today, lifestyle and environmental pollution play a major role in sperm parameter abnormalities.

Keywords

Male Infertility, Risk Factors, Niamey, Niger

1. Introduction

Infertility is a disease of the reproductive system and is defined as the inability to become pregnant after 12 months or more of regular unprotected sexual intercourse. It can cause major distress, stigmatization and financial difficulties, affecting the mental and psychosocial well-being of those concerned [1] [2]. It is a public health issue, according to the World Health Organization (WHO). By 2022, around one in six people worldwide had experienced infertility at some point in their lives, and the global prevalence of infertility was estimated at 17.5% [1]. Male factors contribute significantly to couple infertility through various mechanisms, including sexual dysfunction linked to psychological stressors and physical health factors, such as hormonal imbalances and lifestyle factors that affect sperm quality [1]. Factors such as smoking, excessive alcohol consumption, and obesity can affect fertility. In addition, exposure to pollutants and toxins in the environment can have a direct toxic effect on gametes (ova and spermatozoa), leading to a reduction in the number of gametes and serious impairment of gamete quality [3] [4]. Studies have shown that excess body weight and metabolic disorders can have a negative impact on sperm parameters, including motility and DNA integrity. Conversely, lifestyle interventions such as regular exercise have been associated with improvements in sperm quality, underlining the importance of maintaining a healthy lifestyle for reproductive health [5]. Dietary habits also have a significant influence on male fertility. Diets rich in omega-3 fatty acids, antioxidants, vitamins and minerals have been shown to improve sperm quality. For example, the consumption of nuts, rich in essential nutrients, has been associated with increased sperm motility and vitality [6]. On the other hand, diets rich in processed meats, soy products and sugary drinks can have a detrimental effect on sperm quality [6]. The role of the microbiome in male reproductive health has become a new area of study [7]. Differences in sperm, urine and gut bacterial populations have been associated with infertility, suggesting that microbial health may influence sperm quality and fertility outcomes [7]. Studies conducted in Niger [8]-[10] on small samples have reported factors associated with male infertility, such as hormonal disturbances, infectious or genetic factors. The link between infertility

and smoking, alcoholism or other toxic substances was not examined in these studies. Also, given the socio-economic and sometimes unfavorable aspects of infertility in developing countries such as Niger, several factors contributing to male infertility were not considered in the preparation of this study. It was also important to analyse, on a larger sample, the sperm profile of infertile men and the factors associated with disturbances in their spermogram parameters in Niger.

2. Material and Method

2.1. Type, Period and Sampling

This retrospective, descriptive, and analytical study included 1000 patients who requested a spermogram from the Histo-Embryology, Cytogenetics, and Cellular Pathology Laboratory "Pr Ag Moumouni Hassane" at the Abdou Moumouni University in Niamey, Niger. The study involved semen samples analyzed in this laboratory from January 2010 to December 2021, i.e., 11 years. The specific population included all patients who underwent biomedical analysis in the laboratory during the study period, and the sample size was 1000 spermograms. Patients who underwent spermogram exams and whose records were complete were included in the study. Patients with incomplete records were not included.

2.2. Sperm Analysis Techniques

Before any semen analysis, each patient underwent an interview to collect personal information and to explain the sampling procedures, which consisted of the following:

- Abstinence of 3 - 7 days maximum;
- Laboratory visit for sampling either by coitus interruptus or masturbation;
- Urination, washing of hands and genitalia before sampling (this also applies to the spouse if coitus interruptus is involved);
- Unsealing the sterile jar containing the sperm sample;
- Closing and tightening the jar without shaking it;
- Finally, the time at which ejaculation occurred was noted.

Once in the laboratory, the sample was placed in a water bath at 37˚C for analysis. Before proceeding with the actual analysis, the sperm were homogenized by rotating the container in circles with the wrist for 15 - 20 s, thus loosening the sperm from the container. After homogenization, semen is examined as follows:

- Appreciate the sperm appearance;
- Viscosity 30–60 min after ejaculation;
- Determining sperm volume.

Microscopic analysis follows macroscopic analysis to determine:

- Mobility;
- Vitality;
- Count;
- The presence of round cells;
- Agglutination;

- Morphological abnormalities after smearing and Papanicolaou staining. The WHO 2010 (Kruger classification) classification was used.

2.3. Data Sources, Tools, Collection and Processing Techniques

Data were collected from the laboratory register and sperm analysis report sheet. A survey form was used to extract data (Appendix). This form included the following variables: age, duration of infertility, reason for requesting sperm analysis, profession, ethnicity, marital status, polygamy, type of infertility, medical and surgical history, number of children, medication history, macroscopic appearance of semen, semen volume, semen viscosity, pH, presence of parasites, presence of sperm agglutination, sperm vitality, motility, and morphological abnormalities. Data was entered, processed, and analyzed using Microsoft office 2019 (Excel), and Epi Info version 7.2.6.0.

2.4. Statistical Analysis

The statistical Chi-square test or Fisher's test as appropriate, with a significance level of 5%, was used to determine associations between some of the variables.

2.5. Ethical Consideration

The information obtained in this study was treated anonymously. Patient confidentiality was strictly respected. A research authorization request was obtained under N˚ 000887/UAM/FSS/SS dated October 08, 2021.

3. Results

During this study period, 1000 semen samples were collected. The most represented age group was 28 - 37 years, i.e., 45.50% of cases (n = 455), and the mean age was 37.52 ± 8.66 years, with extremes of 18 and 70 years (Table 1).

Table 1. Patient distribution by age group.

Age range (years)	Number (%)	Average	Standard deviation	Minimum	Maximum
[18 - 27]	96 (9.60)	37.52	8.66	18	70
[28 - 37]	455 (45.50)				
[38 - 47]	300 (30.00)				
[48 - 57]	136 (13.60)				
[58 - 67]	12 (1.20)				
>67	1 (0.10)				
N = 1000					

The most frequent reason for requesting a spermogram was infertility testing, i.e., 88.4% of cases (n = 884), and primary infertility was the predominant cause, i.e., 68.20% of cases (n = 682). The duration of infertility was between 2 and 4 years

in 22.50% of cases (n = 225) and 1 and 2 years in 20.10% of patients (n = 201). The average duration of infertility was 4.89 ± 3.47 years, with extremes of 1 and 14 years (Table 2). The most frequent ethnic groups were Djerma, followed by Haoussa in 45.40% (n = 454) and 27.40% (n = 274) of cases respectively.

Table 2. Breakdown by the duration of infertility.

Duration of infertility	Number (%)	Average	Standard deviation	Minimum	Maximum
[1 - 2[	201 (20.10)	4.89	3.47	1	14
[2 - 4[	225 (22.50)				
[4 - 6[	198 (19.80)				
[6 - 8[	144 (14.40)				
[8 - 10[	120 (12.00)				
≥10	112 (11.20)				
N = 1000					

Civil servant followed by tradesman were the common occupation seen, in 46.10% (n = 461) and 24.50% (n = 245) of cases respectively. Of the 1000 patients, 946 (94.6%) were married. They were monogamous in 61.40% of cases (n = 614). Most patients had no children, i.e. 69.70% (n = 697) of cases, and for those who did, the average number of children was 0.76 ± 1.67, with extremes of 0 and 14 children per patient.

Surgical histories of varicocele, mumps and inguino-scrotal hernia surgery were reported in 12.30% (n = 123), 8.80% (n = 88) and 8.70% (n = 87) respectively.

Hypospermia and hyperspermia were found in 16.40% (n = 164) and 7.80% (n = 78) of patients respectively, with an average volume of 3.33 ml ± 2.11 ml and extremes of 0.2 and 11ml. Viscosity was high in 18.50% of patients (n = 185), and *Candida albicans* was present in 3.90% (n = 39).

Agglutination was found in 43.80% (n = 438) of cases, asthenozoospermia in 37.60% (n = 376), azoospermia in 18.30% (n = 183), necrozoospermia in 15.30% of cases (n = 153), oligozoospermia in 20.70% of cases (n = 207), polyzoospermia in 34% of cases (n = 340) and teratozoospermia in 44.60% of cases (n = 446). Infertility work-up was the most frequent reason for requesting a spermogram in relatively young patients, aged between 28 and 47. There was a statistically significant correlation between the reason for requesting a spermogram and age (p-value < 0.001). There was a statistically significant link between surgical history and teratozoospermia (p-value = 0.0001).

Civil servants, followed by trademen, had infertility tests as their reason for requesting a spermogram in 40% (n = 400) and 22.30% (n = 223) respectively. There was no statistically significant difference between profession and reason for requesting a spermogram (p-value = 0.1190). Spermogram abnormalities affected

all professions, with a statistically significant difference between profession and azoospermia (p-value < 0.001); between profession and oligozoospermia (p-value = 0.0002); between profession and polyzoospermia (p-value < 0.001) and between profession and teratozoospermia (p-value = 0.0125) (Table 3). Sperm abnormalities affected all age groups, with a statistically significant difference between age and hypospermia (p-value = 0.0257) and between age and oligozoospermia (p-value = 0.0293) (Table 4).

Table 3. Distribution of patients by profession and sperm abnormalities.

		Profession										
		Other*	Driver	Retailer	Cook	Cultivator	Civil servant	Not specified	Total	Chi^2	df	p-value
Spermogram abnormalities		Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)			
Agglutination	No	34 (53.13)	55 (59.78)	148 (60.41)	5 (71.43)	52 (61.18)	237 (51.41)	31 (67.39)	562 (56.20)	10.64	6	0.1002
	Yes	30 (46.87)	37 (42.22)	97 (39.59)	2 (28.57)	33 (38.82)	224 (48.59)	15 (32.61)	438 (43.80)			
Asthenozoospermia	No	43 (67.19)	64 (69.57)	142 (57.96)	6 (85.71)	63 (74.12)	280 (60.74)	20 (56.52)	376 (37.60)	12.51	6	0.0514
	Yes	21 (32.81)	28 (30.43)	103 (42.04)	1 (14.29)	22 (25.88)	181 (39.26)	20 (43.48)	376 (37.60)			
Azoospermia	No	47 (73.44)	73 (79.35)	195 (79.59)	6 (85.71)	52 (61.18)	406 (88.07)	38 (82.61)	817 (81.70)	40.55	6	< 0.001
	Yes	17 (26.56)	19 (26.65)	50 (20.41)	1 (14.29)	33 (38.82)	55 (11.93)	8 (17.39)	183 (18.30)			
Hyperspermia	No	61 (95.31)	82 (89.13)	232 (94.69)	6 (85.71)	78 (91.76)	421 (91.32)	42 (91.30)	922 (92.20)	5.16	6	0.3989
	Yes	3 (4.69)	10 (10.87)	13 (5.31)	1 (14.29)	7 (8.24)	40 (8.68)	4 (8.70)	78 (7.80)			
Hypospermia	No	53 (82.81)	74 (80.43)	199 (81.22)	7 (100.00)	65 (76.47)	395 (85.68)	43 (93.48)	836 (83.60)	10.97	6	0.0894
	Yes	11 (17.19)	18 (19.57)	46 (18.78)	0 (0.00)	20 (23.53)	66 (14.32)	3 (6.52)	164 (16.40			
Necrozoospermia	No	59 (92.19)	75 (81.52)	199 (81.22)	7 (100.00)	70 (82.35)	402 (87.20)	35 (76.09)	847 (84.70)	12.26	6	0.0565
	Yes	5 (7.81)	17 (18.48)	46 (18.78)	0 (0.00)	15 (17.65)	59 (12.80)	11 (23.91)	153 (15.30)			
Oligozoospermia	No	60 (93.75)	73 (79.35)	171 (69.80)	7 (100.00)	71 (83.53)	376 (81.56)	35 (76.09)	793 (79.30)	26.10	6	0.0002
	Yes	4 (6.25)	19 (20.65)	74 (30.20)	0 (0.00)	14 (16.47)	85 (18.44)	11 (23.91)	207 (20.70)			
Polyzoospermia	No	39 (60.94)	64 (69.57)	182 (74.29)	1 (14.29)	72 (84.71)	274 (59.44)	28 (60.87)	660 (66.00)	39.74	6	< 0.001
	Yes	25 (39.06)	28 (30.43)	63 (25.71)	6 (85.71)	13 (15.29)	187 (40.56)	18 (39.13)	340 (34.00)			
Teratozoospermia	No	33 (51.56)	57 (61.96)	148 (60.41)	2 (28.57)	55 (64.71)	230 (49.89)	29 (63.04)	554 (55.40)	16.24	6	0.0125
	Yes	31 (48.44)	35 (38.04)	97 (39.59)	5 (71.43)	30 (35.29)	231 (50.11)	17 (36.96)	446 (44.60)			

*bricklayers, carpenters, laborers, workers, fishermen, warehousemen, shoemakers, upholsterers, hairdressers.

Table 4. Distribution of patients by age and sperm abnormalities.

	Age range (years)								
	[18 - 27]	[28 - 37]	[38 - 47]	[48 - 57]	[58 - 67]	>67			
Spermogram abnormalities	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)	Chi^2	df	p-value
Agglutination	38 (8.68)	214 (48.86)	126 (28.77)	57 (13.01)	2 (0.46)	1 (0.23)	8.09	5	0.1349
Asthenozoospermia	34 (9.04)	153 (40.69)	124 (32.98)	61 (16.22)	3 (0.80)	1 (0.27)	10.56	5	0.0512
Azoospermia	14 (7.65)	72 (39.34)	63 (34.43)	30 (16.39)	4 (2.19)	0 (0.00)	7.54	5	0.1473
Hyperspermia	11 (14.10)	37 (47.44)	18 (23.08)	12 (15.38)	0 (0.00)	0 (0.00)	4.51	5	0.4410
Hypospermia	16 (9.76)	67 (40.85)	44 (26.83)	34 (20.73)	2 (1.22)	1 (0.61)	14.03	5	0.0257
Necrozoospermia	16 (10.46)	64 (41.83)	50 (32.68)	22 (14.38)	1 (0.65)	0 (0.00)	1.82	5	0.8597
Oligozoospermia	13 (6.28)	81 (39.13)	76 (36.71)	35 (16.91)	2 (0.97)	0 (0.00)	11.73	5	0.0293
Polyzoospermia	36 (10.59)	172 (50.59)	91 (26.76)	37 (10.88)	3 (0.88)	1 (0.29)	10.42	5	0.0548
Teratozoospermia	54 (12.11)	198 (44.39)	123 (27.58)	63 (14.13)	8 (1.79)	0 (0.00)	10.40	5	0.0525

The pH range between 7 and 7.9 was the most frequent in 61.80% of patients (n = 618). The average pH was 7.16 ± 0.56, with extremes of 6 and 9 (Figure 6). The pH was acidic (pH between 6 and 6.9) in patients aged between 18 and 67, i.e. 30.10% of cases (n = 301). The difference between age and pH was statistically significant (p-value = 0.0166) (Table 5). Patients on alcohol had an acidic pH (pH between 6 and 6.9) in 9.63% of cases and a basic pH (pH between 8 and 8.9) in 6.78% of cases, with a statistically significant difference (p-value < 0.001). Patients on coffee had an acidic pH (pH between 6 and 6.9) in 9.97% of cases and a basic pH (pH between 8 and 8.9) in 54.24% of cases, with a statistically significant difference (p-value < 0.001). Smoking patients had an acidic pH (pH between 6 and 6.9) in 16.94% of cases and a basic pH (pH between 8 and 8.9) in 42.37% of cases, with a statistically significant difference (p-value < 0.001). Patients on tea also had an acidic pH (pH between 6 and 6.9) in 80.07% of cases and a basic pH (pH between 8 and 8.9) in 54.24% of cases, with a statistically significant difference (p-value < 0.001) (Table 6). There was a statistically significant difference between pH and teratozoospermia (p-value = 0.0013).

Table 5. Patient repair by age and pH.

	pH range							
	[6 - 6.9]	[7 - 7.9]	[8 - 8.9]	≥9	Total	Chi²	df	p-value
Age range (years)	Number (%)	Number (%)	Number (%)	Number (%)	Number (%)			
[18 - 27]	31 (3.10)	48 (4.80)	15 (1.50)	2 (0.20)	96 (9.60)	28.899	15	0.0166
[28 - 37]	130 (13.00)	295 (29.50)	21 (2.10)	9 (0.90)	455 (45.50)			
[38 - 47]	91 (9.10)	190 (19.00)	12 (1.20)	7 (0.70)	300 (30.00)			
[48 - 57]	42 (4.20)	80 (8.00)	10 (1.00)	4 (0.40)	136 (13.60)			
[58 - 67]	7 (0.70)	4 (0.40)	1 (0.10)	0 (0.00)	12 (1.20)			
>67	0 (0.00)	1 (0.10)	0 (0.00)	0 (0.00)	1 (0.10)			
Total	301 (30.10)	618 (61.80)	59 (5.90)	22 (2.20)	1000 (100.00)			

Table 6. Impact of toxic substances on sperm pH.

	pH range						
	[6 - 6.9]	[7 - 7.9]	[8 - 8.9]	≥9	Chi²	df	p-value
Toxics	Number (%)	Number (%)	Number (%)	Number (%)			
Alcohol							
No	272 (90.37)	618 (100.00)	55 (93.22)	22 (100.00)	61.929	3	<0.001
Yes	29 (9.63)	0 (0.00)	4 (6.78)	0 (0.00)			
Coffee							
No	271 (90.03)	610 (98.71)	27 (45.76)	22 (100.00)	238.856	3	<0.001
Yes	30 (9.97)	8 (1.29)	32 (54.24)	0 (0.00)			

Continued

Tobacco							
No	250 (83.06)	583 (94.34)	34 (57.63)	22 (100.00)	90.147	3	<0.001
Yes	51 (16.94)	35 (5.66)	25 (42.37)	0 (0.00)			
Tea							
No	60 (19.93)	195 (31.55)	27 (45.76)	15 (68.18)	37.662	3	<0.001
Yes	241 (80.07)	423 (68.45)	32 (54.24)	7 (31.82)			

It should also be noted that 69.93% of patients with necrozoospermia also had asthenozoospermia. The risk of these patients with necrozoospermia developing asthenozoospermia was 4.99 times higher (Odds ratio = 4.99; CI = [3.436 - 7.269]), with a statistically significant difference (p-value < 0.001). Teratozoospermia was associated with asthenozoospermia in 48.65% of patients. Patients with teratozoospermia were 2.35 times more likely to develop asthenozoospermia (Odds ratio = 2.35; CI = [1.813 - 3.058]), with a statistically significant difference (p-value < 0.001). Teratozoospermia was also associated with polyzoospermia in 45.29% of cases. Patients with teratozoospermia were 2.5 times more likely to develop polyzoospermia (Odds ratio = 2.5; CI = [1.909 - 3.263]), with a statistically significant difference (p-value < 0.001). Oligozoospermia was associated with asthenozoospermia in 66.67% of cases, and the risk of oligozoospermia carriers developing asthenozoospermia was 4.66 times higher (Odds ratio = 4.66; CI = [3.365 - 6.464]) with a statistically significant association (p-value < 0.001) (Table 7).

Table 7. Association between different sperm abnormalities.

	Necrozoospermia			
	Number (%)	Number (%)	$OR_{CI95\%\ [lower\ -\ upper]}$	p-value
Asthenozoospermia	No	Yes		
No	578 (68.24)	46 (30.07)	4.99 [3.436 - 7.269]	< 0.001
Yes	269 (31.76)	107 (69.93)		
Teratozoospermia				
Necrozoospermia	No	Yes		
No	466 (84.12)	381 (85.43)	0.90 [0.638 - 1.279]	0.5672
Yes	88 (15.88)	65 (14.57)		
Asthenozoospermia	No	Yes		
No	395 (71.30)	229 (51.35)	2.35 [1.813 - 3.058]	< 0.001
Yes	159 (28.70)	217 (48.65)		
Polyzoospermia	No	Yes		
No	416 (75.09)	244 (54.71)	2.50 [1.909 - 3.263]	< 0.001
Yes	138 (24.91)	202 (45.29)		

Continued

	Oligozoospermia			
Asthenozoospermia	No	Yes		
No	555 (69.99)	69 (33.33)	4.66 [3.365 - 6.464]	< 0.001
Yes	238 (30.01)	138 (66.67)		

Among alcoholic patients, 4.79% had agglutination. The risk of these alcoholic patients developing agglutination was 2.31 times higher (Odds ratio = 2.31; CI = [1.122 - 4.745]), with a statistically significant difference (p-value = 0.0195) (Table 8). Smoking patients had hypospermia in 23.42% of cases. The risk of these patients developing hypospermia was 1.67 times higher (Odds ratio = 1.67; CI = [1.035 - 2.678]), with a statistically significant difference (p-value = 0.0340). Smoking was also associated with teratozoospermia in 55.86% of cases, with a 1.66-fold increased risk (Odds ratio = 1.66; CI = [1.118 - 2.476]) and a statistically significant difference (p-value = 0.0114). Coffee intake was also associated with teratozoospermia in 82.86% of patients, and the risk of developing teratozoospermia in these coffee patients was 6.75 times higher (Odds ratio = 6.75; CI = [3.578 - 12.742]), with a statistically significant difference (p-value < 0.001) (Table 9).

Table 8. Association between alcoholism and various sperm abnormalities.

	Alcoholism			
	Number (%)	Number (%)	$OR_{CI95\%\ [lower\ -\ upper]}$	p-value
Agglutination	No	Yes		
No	550 (97.86)	417 (95.21)	2.31 [1.122 - 4.745]	0.0195
Yes	12 (2.14)	21 (4.79)		
Asthenozoospermia	No	Yes		
No	603 (62.36)	21 (63.64)	0.95 [0.460 - 1.947]	0.8815
Yes	364 (37.64)	12 (36.36)		
Azoospermia	No	Yes		
No	793 (82.01)	24 (72.73)	1.71 [0.781 – 3.741]	0.1752
Yes	174 (17.99)	9 (27.27)		
Hyperspermia	No	Yes		
No	891 (92.14)	31 (93.94)	0.76 [0.178 - 3.221]	0.7048
Yes	76 (7.86)	2 (6.06)		
Hypospermia	No	Yes		
No	806 (83.35)	30 (90.91)	0.50 [0.151 - 1.660]	0.2489
Yes	161 (16.65)	3 (9.09)		

Continued

Necrozoospermia	No	Yes		
No	818 (84.59)	29 (87.88)	0.76 [0.262 - 2.185]	0.6059
Yes	149 (15.41)	4 (12.12)		
Oligozoospermia	No	Yes		
No	764 (79.01)	29 (87.88)	0.52 [0.180 - 1.494]	0.2161
Yes	203 (20.99)	4 (12.12)		
Polyzoospermia	No	Yes		
No	640 (66.18)	20 (60.61)	1.27 [0.625 - 2.589]	0.5059
Yes	327 (33.82)	13 (39.39)		
Teratozoospermia	No	Yes		
No	538 (55.64)	16 (48.48)	1.33 [0.665 - 2.668]	0.4164
Yes	429 (44.36)	17 (51.52)		

Table 9. Association between smoking and various sperm abnormalities.

	Smoking			
	Number (%)	Number (%)	$OR_{CI95\%\ [lower\ -\ upper]}$	p-value
Agglutination	No	Yes		
No	501 (56.36)	61 (54.95)	1.06 [0.712 - 1.574]	0.7792
Yes	388 (43.64)	50 (45.05)		
Asthenozoospermia	No	Yes		
No	555 (62.43)	69 (62.16)	1.01 [0.673 - 1.519]	0.9562
Yes	334 (37.57)	42 (37.84)		
Azoospermia	No	Yes		
No	728 (81.89)	89 (80.18)	1.11 [0.680 - 1.837]	0.6605
Yes	161 (18.11)	22 (19.82)		
Hyperspermia	No	Yes		
No	819 (92.13)	103 (92.79)	0.91 [0.425 - 1.943]	0.8049
Yes	70 (7.87)	8 (7.21)		
Hypospermia	No	Yes		
No	751 (84.48)	85 (76.58)	1.67 [1.035 - 2.678]	0.0340
Yes	138 (15.52)	26 (23.42)		
Necrozoospermia	No	Yes		
No	757 (85.15)	90 (81.08)	1.34 [0.804 - 2.228]	0.2613
Yes	132 (14.85)	21 (18.92)		

Continued

Oligozoospermia	No	Yes		
No	706 (79.42)	87 (78.38)	1.06 [0.658 - 1.720]	0.7994
Yes	183 (20.58)	24 (21.62)		
Polyzoospermia	No	Yes		
No	592 (66.59)	68 (61.26)	1.26 [0.839 - 1.893]	0.2637
Yes	297 (33.41)	43 (38.74)		
Teratozoospermia	No	Yes		
No	505 (56.81)	49 (44.14)	1.66 [1.118 - 2.476]	0.0114
Yes	384 (43.19)	62 (55.86)		
		Coffee		
Teratozoospermia	No	Yes		
No	542 (58.28)	12 (17.14)	6.75 [3.578 - 12.742]	< 0.001
Yes	388 (41.72)	58 (82.86)		

The presence of *Candida albicans* was a factor associated with the occurrence of asthenozoospermia in 53.85% of cases, with a 1.99-fold increased risk (Odds Ratio = 1.99; CI = [1.047 - 3.789]) and a statistically significant difference (p-value = 0.0326). *Candida albicans* infestation was also a source of necrozoospermia in 28.21%, with a 2.27-fold higher risk of developing necrozoospermia in patients infested with *Candida albicans* (Odds Ratio = 2.27; CI = [1.103 - 4.654]). The difference was statistically significant (p-value = 0.0224). *Candida albicans* parasites were also a cause of oligozoospermia in 43.59%, with a 3.14-fold increased risk of being oligozoospermic in case of albicans candidiasis (Odds Ratio = 3.14; CI = [1.633 - 6.022]). The difference was also statistically significant (p-value = 0.0003) (Table 10).

Table 10. Impact of *Candida albicans* on spermograms parameters.

	Candida albicans			
	Number (%)	Number (%)	$OR_{CI95\%\ [lower\ -\ upper]}$	p-value
Asthenozoospermia	No	Yes		
No	606 (63.06)	18 (46.15)	1.99 [1.047 - 3.789]	0.0326
Yes	355 (36.94)	21 (53.85)		
Necrozoospermia	No	Yes		
No	819 (85.22)	28 (71.79)	2.27 [1.103 - 4.654]	0.0224
Yes	142 (14.78)	11 (28.21)		
Oligozoospermia	No	Yes		
No	771 (80.23)	22 (56.41)	3.14 [1.633 – 6.022]	0.0003
Yes	190 (19.77)	17 (43.59)		

4. Discussion

The present study, carried out at the Laboratory of Histo-Embryology, Cytogenetics and Cellular Pathology "Pr Ag Moumouni Hassane" at Abdou Moumouni University in Niamey, collected 1000 sperm samples over an 11-year period (from January 2010 to December 2021). The main age of the patients was 37.52 ± 8.66 years old, with extremes of 18 and 70 years. A similar average age was reported by Fouda *et al*. [11] and by Mumbere *et al*. [12], with 36.34 and 34.8 years old respectively. This predominance of relatively young subjects, reported by several African studies [8]-[10] [13] [14] and by our study, could be explained by the fact that this age category is more frequent in the African population in general, and in Niger in particular.

Infertility testing was the most frequent reason for requesting a spermograms in 88.40% of the patients concerned by our study. This high frequency of infertility tests reflects both the growing awareness among men that infertility is not just a female problem, and the increase in male fertility problems. Primary infertility was the most common type of infertility (68.20%). In Africa, and particularly in Niger, custom and culture dictate that the purpose of marriage is to procreate. This ancestral consideration leads couples to worry about their procreative status after a certain period of married life, and to consult their doctor accordingly.

WHO defines infertility as a disease of the male or female reproductive system, resulting in an inability to achieve pregnancy after 12 months or more of regular unprotected sexual intercourse [1]. This 12-month duration was exceeded in most of the patients concerned in our study. The average duration was 4.89 years ± 3.47 years, with extremes of 1 year and 14 years old.

The Djerma ethnic group was the most frequent in our study, accounting for 45.40% of patients. This predominance could be explained by the fact that our study area (Niamey) is essentially inhabited by the Djerma ethnic group, which is the majority ethnic group in the western region of Niger.

The occupational environment is a major source of exposure to chemical and physical agents with a toxic effect on fertility [15] [16]. The patients concerned by the present study were mainly civil servants (46.10%) and tradesmen (24.50%). Occupation was associated with disturbance of several sperm parameters such as azoospermia (p-value < 0.001), oligozoospermia (p-value = 0.0002), polyzoospermia (p-value < 0.001) and teratozoospermia (p-value = 0.0125). Kadima *et al*. [17] reported a frequency of 37.7% in motorcycle taximans, compared with only 5.5% in civil servants. Occupational exposure was reported in 12% of patients by Kbirou *et al*. [14], with farmers predominating in 8% of cases.

Almost all the patients concerned were married (94.6%), with monogamy predominating in 61.40% of cases. Niang *et al*. [18] also reported monogamy in 83.10% of cases. This frequency of monogamy could be explained by the fact that monogamous couples worry much more quickly about their reproductive status than polygamous couples, most of whom have one or more children from their

previous marriage. Over the majority (67.70%) of those concerned by the study had no children. The average number of children was 0.76 ± 1.67 (extremes 0 and 14). Savey *et al*. [19] had reported an average number of children of 0.9 (extremes 0 and 5 children).

Medical and surgical history was reported in many of the patients, with varicocele cure predominating in 12.30% of cases, and there was a significant difference between this history and teratozoospermia (p-value = 0.0001). Several authors report medical and/or surgical antecedents in the genesis of male fertility disorders, including varicocele cure, inguino-scrotal hernia cure, orchi-epididymitis, diabetes, sexually transmitted infections [8] [12] [14] [17] [20].

Sperm volume was normal in just over 3/4 patients, with hypospermia being the most common sperm volume abnormality (16.40%). Epoupa *et al*. [21] also reported a similar predominance of hypospermia in 16.4% of cases. Hypospermia is a decrease in sperm volume that can result from multiple etiological factors, involving genetic, hormonal, environmental or lifestyle aspects [22]-[24].

Semen viscosity plays a crucial role in male fertility by influencing sperm motility and thus their ability to move through the female reproductive tract [25] [26]. Patients included in the study had high sperm viscosity in 18.50% of cases.

The presence of *Candida albicans* parasites was statistically associated with asthenozoospermia (p-value = 0.0326), necrozoospermia (p-value = 0.0224) and oligozoospermia (p-value = 0.0003). The evidence of parasitic infections on the disruption of sperm parameters has been described by several authors in the literature [27]-[29]. Nourollahpour *et al*. [30] reported in a metanalysis an association of *Trichomonas vaginalis-type* parasitic infection with asthenozoospermia and teratozoospermia.

Spermograms abnormalities found in our patients were agglutination (43.80%), asthenozoospermia (37.60%), azoospermia (18.30%), hyperspermia (7.80%), hypospermia (16.40%), necrozoospermia (15.30%), oligozoospermia (20.70%), polyzoospermia (34%) and teratozoospermia (44.60%). Some patients had more than one of these abnormalities at the same time. Necrozoospermia was associated more than 4 times with asthenozoospermia, teratozoospermia more than 2 times with asthenozoospermia and polyzoospermia, and oligozoospermia more than 4 times with asthenozoospermia. African series [10] [12] [14] [21] also report these different sperm abnormalities with associations between them.

Infertility work-up was the most frequent reason for referral in relatively young patients (p-value < 0.001). For Kone *et al*. [31], the desire for a child was found to be the reason for consultation in 83.5% of cases. The frequency of the infertility test as a reason for referral could be explained by the fact that the spermogram is the first-line examination requested in men in the event of infertility.

All age groups were affected by abnormal sperm parameters, with, for example, a statically significant difference between age and hypospermia (p-value = 0.0257) and between age and oligozoospermia (p-value = 0.0293). In the literature, advanced age is described as a factor significantly associated with various

sperm abnormalities, including increased sperm DNA fragmentation, altered sperm morphology and reduced sperm parameters such as motility and concentration. These alterations contribute to reduce fertility outcomes and increase risks of infertility [32]-[34].

The pH was acidic (pH between 6 and 6.9) in 30.10% of patients aged between 18 and 67, and basic (pH between 8 and 8.9) in 5.90% of the same age group (p-value = 0.0166). Alcoholism, coffee drinking, smoking and tea drinking were associated with acidic or basic pH in our study, with a statistically significant difference (p-value < 0.001 for each association). The difference was also statistically significant between pH and teratozoospermia (p-value = 0.0013). pH plays a crucial role in sperm viability, directly influencing motility, concentration and cellular integrity. Environments that are too acidic or too basic can compromise sperm survival and functionality, affecting overall fertility [35]-[37].

Lifestyle factors such as age, overweight, smoking, alcohol consumption, sleep patterns and dietary habits are closely associated with abnormal sperm parameters [15]. Maintaining an ideal weight, reducing smoking, moderating alcohol consumption, ensuring regular sleep patterns and consuming antioxidant-rich foods can positively influence sperm quality and reduce spermograms abnormalities [38]-[40]. In our study, alcoholism, smoking and coffee intake were associated with sperm abnormalities such as sperm agglutination, hypospermia, teratozoospermia with statistically significant differences for some.

Conclusion

The problem of infertility in black African couples remains unresolved. Women are almost always blamed for infertility, even though men are very much to blame. Today's increasingly polluted lifestyle and environment play a major role in the disruption of sperm parameters. Smoking, alcoholism, coffee and tea consumption have been associated with the disruption of several sperm parameters. Occupational environment, medical and surgical history and infections were also factors associated with abnormal sperm parameters. Taking these behavioral and/or environmental factors into account could help reduce the adverse impact of sperm parameter disturbances.

Study Limits

Our study could have included hormone assays, radiological analyses, cytogenetic analyses, weight gain and sleep disorders. However, due to the financial constraints of the patients, the availability of some of these medical analyses and the type of study (retrospective), these examinations or lifestyle parameters were not performed. Their completion would have enabled us to detail many more factors associated with disturbances in sperm parameters.

Conflicts of Interest

Authors declare no conflict of interest.

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Appendix

Survey sheet: Spermiological profile and factors associated with male infertility.

Examination no.:			**Date of sampling:**	**Time of sampling:**
Age: ..... Profession: ..... Ethnicity: ..... Married: Monogamy: Polygamy: Tobacco: Alcohol: Tea: Coffee:	Yes □ Yes □ Yes □ Yes □ Yes □ Yes □ Yes □	No □ No □ No □ No □ No □ No □ No □	Reason for request: ..... Type of infertility: Primary □ Secondary □ Number of children: ..... Duration of infertility: ..... Known medical and surgical conditions: .... …… ……	

Parameters analyzed		**Results**		
Volume	.....ml	Hypospermia □	Hyperspermia □	
pH	.....	Acid □	Basic □	
Viscosity		Normal □	High □	
Vitality		Necrozoospermia: Yes □	No □	
Agglutination		Yes □	No □	
Numeration		Oligozoospermia □	Polyzoospermia □	Azoospermia □
Mobility		Asthenozoospermia: Yes □	No □	
Morphology		Teratozoospermia: Yes□	No □	
Parasite		Candidas albicans □	Trichomonas vaginalis □	

*According to WHO 2010 classification (Kruger classification).

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