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Seasonal Variation in Semen Quality in Sub-Sahara Africa

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Abstract
Semen analysis is the cornerstone for the investigation of male infertility. Semen quality can be influenced by geographical location, age, ejaculatory abstinence, and season. While studies evaluating seasonal variations in semen analysis parameters are conflicting, limited data are available for men residing in sub-Saharan African countries. Therefore, the current cohort study was designed to retrospectively analysing the effects of seasonal changes on semen parameters. Semen analysis reports (n=70,765) were collected from records of fertile and infertile men residing in sub-Saharan African countries. Semen parameters such as pH, volume, sperm concentration, total sperm count, progressive motility, sperm morphology normed sORP were collected for the purpose of the study. A seasonal change in semen parameters of men residing in sub-Sahara Africa was found, with sperm concentration and total sperm count higher in winter compared to summer and autumn. The lowest sperm concentration was found in summer. Semen parameters of men residing in sub-Saharan African countries showed seasonal variations. Consequently, seasonal shifts should be considered in the management of infertile patients in sub-Saharan African countries.

Keywords: Sperm, Semen, Infertility, Seasonal variation

Introduction
Infertility is the failure to achieve a clinical pregnancy after 12 months or more of regular unprotected sexual intercourse (1). The global prevalence indicates that infertility affects 8–12% of couples, with male factor being a primary or contributing cause in approximately 50% of couples (2). Semen analysis is the cornerstone for the investigation of male infertility (3) and provide a better understanding of male infertility causes. (4, 5). Male factor infertility is defined as the presence of one or more seminal parameter abnormalities or when there is a problem with sexual or ejaculatory function (6).

There are several factors that can cause male infertility, including chromosomal disorders, unfavourable lifestyle, gonadotoxin exposure, hormonal dysfunction and male hypogonadism, varicocele, testicular failure, ejaculatory disorders, environmental exposure to toxicants, infectious diseases, and reproductive tract obstruction (7-12). Adding to these factors, male factor infertility is reported to be associated with seasonal variation (13, 14).

In Germany, the sperm count in spring is significantly higher than in summer, autumn, and winter. Furthermore, the study showed that the peak chromatin condensation was observed in summer (15). In Chinese males, a significantly lower semen volume, sperm concentration and normal sperm morphology in midsummer (average highest temperature > 30°C) than other seasons of the year has been reported (16). This is reflected in a significant increase in sperm morphology during spring in comparison to summer in a retrospective study from European patients, with better semen parameters for normozoospermic and oligozoospermic men in spring and winter (17). Furthermore, in Italy, a higher sperm motility was observed in summer, this highest percentage with normal semen pH was observed in spring, and significantly higher semen volume was observed in winter (18). In America, sperm concentration was found to be significantly higher in winter than in fall, while normal sperm morphology was significantly higher in winter than summer and spring (19). The impact of seasonal variation on semen characteristics is well-documented in Asia (16, 20), Europe (15, 17, 18, 21), and America (19, 22). However, studies investigating the impact of seasonal shifts on human semen quality in Africa remain limited.

The current study investigates the effects of seasonal variations in semen characteristics of patients residing in sub-Saharan African countries.

Materials and Methods
This study aimed to retrospectively analyze semen analysis of males residing in sub-Saharan Africa within the context of the World Health Organization (2010)

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guidelines (23). A comparison of semen characteristics such as pH, volume, sperm concentration, total sperm count, progressive motility, normal morphology, percentage of elongated and duplicated spermatozoa, and normed static oxidation-reduction potential (sORP), according to seasons was evaluated. The normed sORP was obtained by dividing the sORP to the sperm concentration (sORP (mV) / sperm concentration (10^6/mL)). Semen parameters were obtained from patients residing in sub-Saharan African countries located below the equator (Lesotho, Mozambique, South Africa, Swaziland, Rwanda, Zambia, Zimbabwe) and visiting South African Laboratories (Androcryos Andrology Laboratory, Ampath Laboratory and Lancet Laboratory) for andrology services. For group comparison, semen reports dated between the 1st December and 28/29 February were classified as summer, while those between 1st of March and 31st of May were categorized as autumn. All semen reports from the 1st June to the 31st August were classified as winter and those between the 1st September and 30th November were classified as spring (Season of the year, www.seasonsyear.com). This study was conducted in line with the Declaration of Helsinki for medical research. Institutional approval was granted by the Biomedical Research Ethics Committee (BMREC), University of Western Cape (UWC), South Africa (Ethics Reference Number: BM19/9/7). Permissions to use data confidentially were obtained from participating laboratories. No personal identification data such as name, ID or laboratory requisition number was extracted.

Statistical analysis was performed using the medcalc® statistical software version 19.5 (medcalc software ltd, Ostend, Belgium; https:www.medcalc.org; 2020). Comparisons between these seasonal groups were done using appropriate non-parametric statistical tests which was based on data distribution. The chi-square test was used to determine the distribution of all the data sets. For all statistical tests, a p-value of<0.05 was considered statistically significant.

Results

The results obtained from different seasons (winter (n=17,812), spring (n=17,011), summer (n=15,042) and autumn (n=17,750) are reported in Table 1 while significant differences are highlighted in Figures 1, 2,3 and 4.

No significant differences were observed for semen pH, progressive motility and normal morphology (Table 1). However, the sperm concentration is significantly ($P<0.05$) higher in winter (median (IQR)=43.54 (16.5-85) x 10^6/mL) than summer (median (IQR)=40.10 (15-81) x 10^6/mL) and autumn (median (IQR)=40.40 (15-81) x 10^6/mL). Total sperm count in winter (median (IQR)=110.40 (38.9-236) x 10^6) is significantly ($P<0.05$) higher than in summer (median (IQR)=105.04 (34-228) x 10^6) and autumn (median (IQR)=102.30 (33-224) x 10^6).

Semen volume is significantly ($P<0.05$) lower in winter (median (IQR)=2.8 (2-3.9) mL) and autumn (median (IQR)=2.70 (2-3.9) mL) compared to spring (median (IQR)=2.8 (2-4) mL) and summer (median (IQR)=2.8 (2-4) mL). Significantly ($P<0.05$) higher numbers of elongated spermatozoa are observed in spring (median (IQR)=2 (1-6)%) and summer (median (IQR)=2 (1-6)%) in comparison to winter (median (IQR)=2 (1-5)%) and autumn (median (IQR)=2 (1-6)%), while the lowest percentage of duplicated spermatozoa is found in winter (median (IQR)=1 (0-2)%).

Table 1. Analysis of semen quality associated with seasonal variations

Seasons		pH	Volume (mL)	Concentration (x 10^6/mL)	Total sperm count (x 10^6)	Progressive motility (%)	Sperm morphology (%)			Normed sORP (mV/10^6 sperm/mL)
							Normal	Elongated	Duplicated	
Winter (n=17,812)	Mean ± SD Median (IQR) n	7.71 ± 0.83 7.68 (7.4-8.0) 16,703	3.02 ± 2.27 2.80 (2-3.9) 15,222	61.59 ± 66.88 43.54 (16.5-85) 16,641	177.58 ± 302.2 110.40 (38.9-236) 15,136	36.62 ± 15.34 39.00 (25-48) 1,976	7.07 ± 4.68 6.00 (4-10) 5,706	4.19 ± 6.24 2.00 (1-5) 10,970	6.46 ± 19.18 1.00 (0-2) 9,796	8.68 ± 9.25 3.60 (1.1-18.7) 8
Spring (n=17,011)	Mean ± SD Median (IQR) n	7.79 ± 0.89 7.80 (7.5-8.1) 15,603	3.09 ± 1.90 2.80 (2-4) 14,241	61.05 ± 68.64 43.00 (16-84.8) 15,576	178.86 ± 240.28 112.0 (37.5-240) 14,107	36.40 ± 16.29 40.00 (25-49) 1,892	6.94 ± 4.65 5.00 (4-10) 5,455	4.67 ± 6.38 2.00 (1-6) 10,007	8.11 ± 21.64 1.00 (0-2) 9,089	1.14 ± 0.001 1.14 (1.13-1.14) 6
Summer (n=15,042)	Mean ± SD Median (IQR) n	7.77 ± 0.44 7.70 (7.5-8) 13,888	3.04 ± 1.67 2.80 (2-4) 12,128	59.69 ± 102.00 40.10 (15-81) 13,944	172.15 ± 236.73 105.04 (34-228) 12,051	36.30 ± 16.40 39.00 (25-49) 1,705	7.12 ± 4.75 6.00 (4-10) 4,433	4.55 ± 6.70 2.00 (1-6) 9,436	8.52 ± 22.12 1.00 (0-2) 8,621	1.14 ± 0.001 1.14 (1.14-1.15) 3
Autumn (n=17,750)	Mean ± SD Median (IQR) n	7.78 ± 0.88 7.70 (7.5-8) 16,565	2.97 ± 1.64 2.70 (2-3.9) 14,446	58.30 ± 62.55 40.40 (15-81) 16,576	166.76 ± 200.02 102.30 (33-224) 1, 376	36.92 ± 15.90 40.00 (26-49) 2,217	7.14 ± 4.82 6.00 (4-10) 5,519	4.49 ± 6.78 2.00 (1-6) 11,167	8.51 ± 22.18 1.00 (0-2) 10,147	1.47 ± 0.36 1.63 (1.1-1.8) 74

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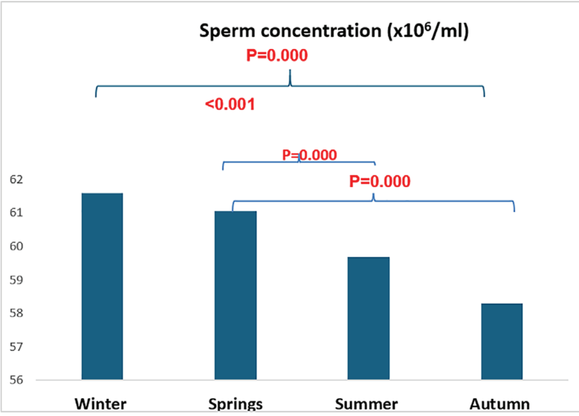

Figure 1. Differences in sperm concentration according to seasonal variations

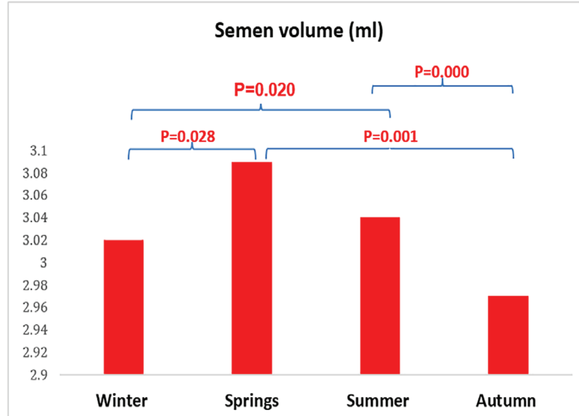

Figure 2. Impact of seasonal variations on semen volume

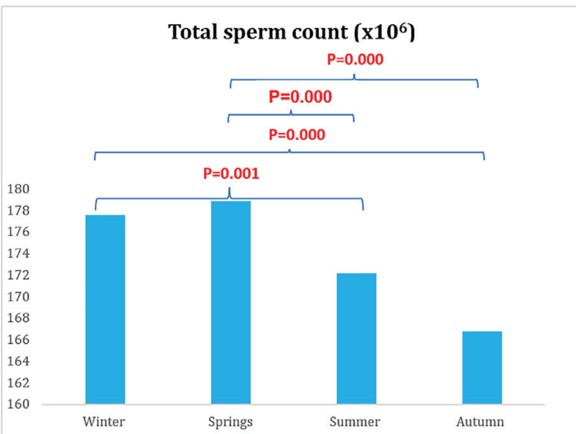

Figure 3. Differences in total sperm count according to seasonal variations

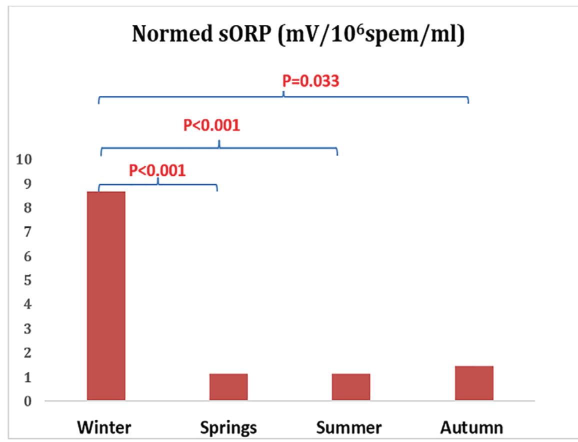

Figure 4. Variations in normed sORP according to seasonal changes

Significantly ($P<0.05$) higher normed sORP is indicated in winter (median (IQR)=3.60 (1.1-18.7) mV/10^6 sperm/mL) than in spring (median (IQR)=1.14 (1.13-1.14) mV/10^6 sperm/mL), summer (median (IQR)=1.14 (1.14-1.15) mV/10^6 sperm/mL) and autumn (median (IQR)=1.63 (1.1-1.8) mV/10^6 sperm/mL).

Discussion

The possible changes in semen parameters according to seasonal variations have been investigated in the literature (15, 16, 24, 25), with conflicting results. Some reports indicated changes in semen parameters such as semen volume (18), sperm concentration and total sperm count (16, 26), progressive motility (16, 18), normal morphology (16) and chromatin condensation (15), while others reported no seasonal variations in semen parameters (21). However, there has not been any data about seasonal changes in semen parameters in sub-Sahara Africa.

The current study found that sperm concentration and total sperm count were significantly higher in winter season compared to summer and autumn, with the lowest sperm concentration reported in summer (Table 1). It was previously found that sperm concentration was highest in winter in United States and in Asia (19, 27), and the lowest semen volume in summer in China (16). A study in Europe, analysing 2697 semen analysis results showed a decrease sperm concentration during summer season (28). Furthermore, sperm concentration was found to be lowest during summer in Inda (29).

In the current study, no significant seasonal changes in semen pH, progressive motility and normal morphology were found (Table 1). Although the results for semen pH were not significant, a higher semen pH was observed during spring (Table 1). This is consistent with previous findings by De Giorgi et al. (2015) (18). Semen volume was found to be higher in spring compared top winter and autumn (30). This was observed in the current study.

In the current study, sperm abnormalities (elongated and duplicated) were found to be higher in summer and spring than in winter. Testicular heat stress has frequently been associated with a decrease semen quality (10, 24). Sperm elongation is well recognized as a stress-induced sperm morphology aberration (31).

Data on possible changes in semen ORP is limited, and almost non-existent. In the current study, significantly higher normed sORP was found in winter, although the sample size was extremely very low (n=8) (Table 1). To our knowledge this is the first study to analyze the seasonal variations of ORP in sub-Saharan Africa. The current study suggests evident seasonal changes in semen parameters with respects to semen volume, sperm concentration, total sperm count, and normed sORP obtained from men residing in sub-Saharan Africa.

Conclusion

This study is the largest evaluating seasonal variations in semen parameters in sub-Sahara Africa below the equator. Seasonally, sperm concentration and total sperm count were higher in winter compared to summer and autumn, with the lowest sperm concentration reported in summer in males from sub-Sahara Africa below the equator. The findings of this study might support the impact of seasonal variations in semen quality, especially among those using assisted reproductive technologies such as artificial insemination where threshold levels for semen parameters are required.

Limitations

Since most data from Africa in this study originates from men residing in South Africa, and do not include men residing in Central and West Africa, further evaluations using comparable sample sizes between regions and including all 4 African regions (North, South, East and West Africa) are necessary to support the findings.

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Conflicts of interest

The author declares that they have no conflict of interest.

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