African Urology 2026;6:84-88
https://doi.org/10.36303/AUJ.0286

AFRICAN UROLOGY
ISSN 2710-2750 EISSN 2710-2750

ORIGINAL RESEARCH

Prevalence of male infertility, characteristics of semen parameters, and endocrine profiles at Kilimanjaro Christian Medical Centre: a five-year retrospective study

M Kimolo,[1,2] JS Mbwambo,[1,2] A Mremi,[2,3] OJ Mbwambo,[1,2] F Bright,[1,2] Z Cheyo,[1,2] BN Ngowi[1,2]

[1] *Department of Urology, Kilimanjaro Christian Medical Centre, Tanzania*
[2] *School of Medicine, KCMC University, Moshi, Tanzania*
[3] *Department of Pathology, Kilimanjaro Christian Medical Centre, Tanzania*

Corresponding author, email: drkimolomathias@gmail.com

Purpose: Globally, male infertility is a public health concern. Semen analysis and endocrine profile evaluation are crucial diagnostic tools that uncover factors contributing to infertility. This study aimed to determine the prevalence of male infertility by examining patterns and characteristics of semen parameters and endocrine profiles among men attending the fertility clinic at Kilimanjaro Christian Medical Centre (KCMC) in northern Tanzania.

Materials and methods: A descriptive study spanning five years (2017–2022) involved 482 semen samples from men seeking fertility services at KCMC, a zonal referral hospital. Data were sourced from the pathology laboratory registry book, medical records with hospital numbers, and the electronic health management system for demographic details. Endocrine profiles were obtained via data-intensive systems and applications. After excluding 229 samples with single semen samples or analyses conducted elsewhere, 253 eligible semen samples were analysed, using privacy-preserving serial numbers for data extraction.

Results: Among the analysed samples, 192 (75.9%) exhibited abnormal semen parameters. Asthenozoospermia was the most common abnormality, present in 125 subjects (49.4%), followed by necrozoospermia, teratozoospermia, and oligozoospermia. Azoospermia was found in 48 subjects (19%). Regarding hormonal profiles, low testosterone (TT) was the most frequent abnormality, affecting 197 (77.9%). High follicle-stimulating hormone (FSH) levels were detected in 66 subjects (26.1%), while luteinising hormone (LH) levels were within the normal range for 251 subjects (99.2%). Notably, a significant proportion of subjects (193, 76.3%) with low TT had normal LH levels.

Conclusion: A high prevalence of male infertility was noted through significant findings of semen abnormalities, with a predominance of asthenozoospermia and abnormal endocrine profiles. Most had low TT and normal LH levels.

Keywords: endocrine profiles, male infertility, semen parameters

Introduction

Infertility refers to the inability of a couple to conceive after 12 months of regular, unprotected sexual intercourse.[1] It can be classified as primary infertility (no history of previous conception) or secondary infertility (a history of prior conception).[2] Infertility affects both men and women.[3,4] The prevalence of male factor infertility varies globally, with rates ranging from 2.5% to 12% across different regions.[5,6] Sub-Saharan Africa, including countries like Nigeria, Sudan, and Cameroon, has shown high rates exceeding 30%.[7] Infertility may result in devastating effects, such as low self-esteem, stress, depression, and societal stigmatisation.[1] These may further exacerbate the psychological effects, leading to a decline in productivity, among others.[1]

Semen analysis and endocrine profiles are the cornerstone for evaluating male fertility, as they play a significant role in diagnosis and management.[9] Evaluating semen parameters is a vital initial step in diagnosing and treating male factor infertility. Abnormal semen parameters may indicate a high infertility burden. Some African studies reported the prevalence of abnormal semen parameters reaching as high as 86.8%.[10] The higher prevalence can be explained by the retrospective and hospital-based nature of the study involving a cohort with infertility problems, which was referred for semen analysis for confirmation.[10]

The endocrine system plays a pivotal role in male fertility by regulating the production of hormones critical for spermatogenesis through the hypothalamic–pituitary–gonadal (HPG) axis. Hormones like FSH, LH, and TT are necessary for spermatogenesis.[11,12] Endocrinopathies that lead to raised or reduced levels of these hormones are associated with impaired quantity and quality of sperm production, affecting the overall male fertility potential.[13] Among male factor infertility cases with a predominance of abnormalities in their sperm quality, approximately 15% of cases have low TT levels.[14]

KCMC, a zonal referral hospital in Tanzania, is one of the few centres in the country to provide comprehensive reproductive health services for males and females since 2017. The centre attends a significant number of couples with fertility problems each year. However, the burden, patterns, and characteristics of abnormal semen parameters and endocrine profiles among males seeking fertility services at KCMC have not been evaluated. Therefore, we lack evidence to convince the authorities of the necessity for control measures. Consequently, this study aimed to assess the prevalence, patterns, and characteristics of semen parameters and endocrine profiles of men attending fertility services at KCMC, thereby generating region-specific data.

Materials and methods

Study area, design, and population

This hospital-based retrospective study was conducted at KCMC and involved all men attending the fertility clinic from January 2017 to June 2022. The hospital is located in the Moshi district of the Kilimanjaro Region. KCMC is a zonal referral hospital serving the northern zone, comprising four regions (Kilimanjaro, Tanga, Arusha, and Manyara). The KCMC catchment area has a population of over 8.7 million (census 2022).

The hospital has a well-organised pathology laboratory that performs various analyses for research purposes and clinical care. Some of these analyses include tissue diagnosis, immunohistochemistry, post-mortem, and semen analysis. An experienced technologist leads the laboratory with special training in handling and analysing semen and other body fluids. The Southern African Development Community Accreditation Services (SADCAS) accredited the laboratory (ISO number 15189).

Sample size determination and sampling technique

The pathology laboratory registry book for semen analyses was used to identify 482 men who attended the KCMC fertility clinic and had semen analysis performed from 2017 to 2022. After applying the study's inclusion criteria, 253 subjects were obtained.

Data collection

A data extraction form was used to gather the appropriate information. The form was divided into three parts. Part one collected information on sociodemographic characteristics (age, marital status, area of residence). Part two included pre-examination data (duration of sexual abstinence, method of sample collection). Part three collected information regarding the seminal profiles (semen volume, sperm concentration, total sperm number, total motility, morphology and vitality, endocrine profiles including TT, FSH, and LH levels).

The principal investigator identified all subjects who visited KCMC for fertility concerns and investigated semen analyses from the pathology registry book. Patients' hospital identification numbers were used to access their medical records. Data were extracted from patient files by two trained research assistants and recorded in the data extraction form. Each subject was given a unique identification number. All the collected data were checked by the principal investigator at the end of each day to confirm that each patient's required information was complete.

Procedures

Semen analysis was performed by collecting a semen sample through masturbation. The sample is collected into a wide-mouthed sterile specimen container following sexual abstinence of > 3 days (3–7 days range). No written instructions were provided; lab staff communicated them, and the collection area is a private room at the lab facility. Reference numbers were 1.5–6 ml for volume, > 39% for motility, and > 15 million/ml for concentration. For morphology, the Kruger strict was used for semen analysis. No advanced semen analysis was performed, but the lab performs sperm preparations for intrauterine insemination, a development that started in November 2023. Regarding the endocrine profiles, kits used were MAGLUMI® Testosterone (CLIA) for TT, MAGLUMI® FSH (CLIA) for FSH, and MAGLUMI® LH (CLIA) for LH, with normal reference values for TT (2.2–10.5 ng/ml), FSH (2–10 mIU/ml) and LH (3–12 mIU/ml).

Ethical approval

This study was approved by the Kilimanjaro Christian Medical University College Research Ethics and Review Committee and given an ethical clearance number (PG75/2022).

Results

Sociodemographic characteristics

A total of 482 men attended the KCMC fertility clinic from 2017 to 2022. Of these, 121 subjects had single semen analysis results, and 108 had either one or both semen analyses performed elsewhere; these subjects were excluded from our study. The remaining 253 subjects had a mean age of 33.7 ± 7.2 years, with most (182, 71.9%) aged 25–39 years. Most of the study subjects (170, 67.2%) resided in the Kilimanjaro Region, with 231 (91.3%) being married (Table I).

Table I: Sociodemographic characteristics of study subjects (*n* = 253)

Characteristic	*n*	%
Age of participants (years)		
18–24	26	10.3
25–39	182	71.9
40–59	45	17.8
Mean age (SD)	**33.7 (7.2)**	
Marital status		
Married	231	91.3
Cohabiting	22	8.7
Region of residence		
Kilimanjaro	170	67.2
Arusha	36	14.2
Tanga	34	13.4
Manyara	9	3.6
Other regions*	4	1.6

* Mbeya, Mwanza, Dar es Salaam, and Dodoma.

Characteristics of semen parameters

All study subjects abstained from sexual activity for 2–5 days before providing semen samples for analysis. All the semen samples were collected via masturbation in a dedicated room near the laboratory. Most subjects (192, 75.9%) exhibited abnormalities in their semen parameters. The most common semen abnormality was abnormal motility (174, 68.8%), followed by low sperm count (114, 45.1%). Of those who had abnormal motility, asthenozoospermia was the most frequent abnormality (125, 49%) (Table II).

Table II: Characteristics of semen parameters (*n* = 253)

Parameter	*n*	%
Semen volume (ml)		
Low volume	25	9.9
Normal volume	228	90.1
Total sperm count (millions/ejaculate)		
Azoospermia	48	19
Oligospermia	66	26.1
Normospermia	129	54.9
Sperm motility		
Asthenozoospermia	125	49.4
Non-motile	49	19.4
Progressive motility	79	31.2
Sperm morphology		
Teratozoospermia	68	26.9
Normal morphology	185	73.1
Sperm vitality		
Necrozoospermia	102	40.3
Alive	151	59.7
Overall semen abnormality	192	75.9

Endocrine profiles

Low TT and high FSH levels were the two most prevalent hormonal abnormalities, accounting for 197 (77.9%) and 66 subjects (26.1%), respectively. Notably, a significant proportion of subjects (193, 76.3%) with low TT levels had normal LH levels (Table III).

Table III: Endocrine profile distribution (*n* = 253)

Endocrine profile	*n*	%
Follicle-stimulating hormone		
Normal	182	71.9
High	66	26.1
Low	5	2.0
Testosterone		
Normal	56	22.1
Low	197	77.9
Luteinising hormone		
Normal	251	99.2
High	1	0.4
Low	1	0.4

Discussion

The current study investigated the semen characteristics and endocrine profiles of men attending the zonal referral hospital for fertility concerns to determine the burden of male infertility among those who sought fertility services during the study period. The findings revealed a significant proportion of the men exhibiting abnormal semen parameters. Of the 253 analysed semen samples, 75.9% had one or more abnormalities, including low semen volume, low sperm count, abnormal sperm motility, abnormal sperm morphology, and non-viable sperm. The observed prevalence of semen abnormalities is concerning and suggests potential male infertility issues among the study participants. These findings align with previous studies from Senegal, Sudan, and Ethiopia, which reported high rates of semen abnormalities in subfertile or infertile men, ranging from 80% to 86.4%.[5,10,15]

Compared with our study's findings, India, Saudi Arabia, and Nigeria have a relatively lower prevalence of semen parameter abnormalities, ranging from 30.5% to 56.4%.[8,16-18] These studies had larger sample sizes (nearly double our sample size), possibly contributing to the observed disparities. This suggests a likely overestimation of prevalence in our study. Additionally, lifestyle differences influenced by cultural and religious factors might play a role. A study conducted by Al-Turki et al.[17] in Saudi Arabia, a non-secular country, found a lower prevalence of abnormal semen parameters, which could partly be influenced by religion acting as a protective factor against predisposing risk factors, such as alcohol, cigarette smoking, and cannabis use in their population. Further investigation is required to identify the specific causes underlying these semen abnormalities in the study population.

Proportions of specific abnormalities may vary among different populations. For instance, the overall high proportion of motility abnormalities (68.8%) with a predominance of asthenozoospermia (49.4%) in our study is similar to, though relatively higher than, findings from several other studies in the United States (25.9%), India (35.11%), and Nigeria (16.7%).[19-22] This is equally alarming because reduced motility or non-motile spermatozoa significantly undermine a man's fertility potential.[19] Risk factors, such as tobacco and cannabis use and excessive alcohol consumption, play significant roles in abnormal motility.[23-25] These modifiable risk factors are commonly practised among men, underscoring the importance of further research in this region to capture the underlying causes.[23-25]

Azoospermia had a prevalence of 19% in this study. While lower than the Ethiopian study (24.4%), it is significantly higher than the results from India (4.26%) and the two Nigerian studies (1.4% and 6.7%).[5,22,26] The difference could be due to variability in the study samples. It should be noted that our study sample was almost twice the size of the Ethiopian study, but nearly half the size of the studies from India and Nigeria. This relatively small sample size likely causes an overestimation of the percentage of azoospermic subjects. Regardless of sample size, azoospermia was a notable finding in all studies.[5,22,26] Azoospermia management is relatively complex and depends on the aetiological factors obtained from comprehensive history-taking and physical examination. Treatment options range from complex surgeries to Assisted Reproductive Technologies (ARTs), and for some, the possibility of fatherhood is limited to either donor sperm insemination or adoption.[1,9,27,28]

Our study subjects' endocrine profiles revealed interesting results. A significant proportion of subjects (77.9%) exhibited low serum TT levels, partially attributed to higher levels of endocrine disruptors, such as bisphenol A, found in the coatings of food-storage cans, alongside high oestrogen levels in drinking water designated for daily use.[29] Also, a sedentary lifestyle leads to obesity and excessive alcohol consumption.[24,30,31] However, low TT levels are

not limited to environmental factors, and other risk factors should be considered too.

Additionally, a notable proportion of subjects (26.1%) had high FSH levels, often associated with impaired testicular spermatogenesis and small testicular volume, and it is one of the causes of non-obstructive azoospermia.[27] This hormonal imbalance could further contribute to subfertility or infertility. A similar finding was observed in northern Nigeria by Geidam et al.,[32] where most of their subjects with abnormal semen parameters had abnormalities in their endocrine profiles too, with 66.7% and 50% having high FSH and low TT levels, respectively. The same study design and cohort could account for the similarities observed in both studies' findings.

Moreover, another interesting finding in the current study is that most subjects (193, 76.3%) had normal LH levels while having low TT. This phenomenon is usually observed in individuals with secondary hypogonadism, which can be idiopathic in aetiology but might also denote a pathology of the pituitary gland.[33] Obesity also results in secondary hypogonadism due to increased peripheral aromatisation of TT to oestradiol, driven by the increased number of adipocytes, which exerts negative feedback on the HPG axis, reducing serum TT levels further while maintaining low/normal LH levels.[33] This is unlike primary hypogonadism or primary testicular failure, in which Leydig cell dysfunction occurs with elevated LH levels.[33,34] Unfortunately, there is no locoregional study for comparison with the current study.

Similar findings were discovered in a study conducted in Italy by Ventimiglia et al.,[14] which included 786 men diagnosed with infertility. These men were divided into four categories based on their total TT and LH levels: eugonads (normal TT and LH), secondary hypogonadism (low TT and low/normal LH), primary hypogonadism (low TT and high LH), and compensated hypogonadism (normal TT and high LH). Most men (80%) were eugonads, and the hypogonadism categories accounted for the remaining 20%. A predominant percentage of men (15%) were in the secondary hypogonadism category and had a higher likelihood of being obese. This is contrary to our study's findings, which showed that most (77.9%) had low TT. The discrepancy could be due to the time of day the endocrine evaluation was performed, which may affect TT levels, or the varying clinical characteristics of the study participants, many of whom may have been obese. Regardless, these aspects were difficult to note or control because of the retrospective nature of our study. Importantly, the four categories were adopted from the European Male Ageing Study (EMAS) and primarily used to categorise ageing European males. However, based on the findings of Ventimiglia et al.'s[14] study, they proposed that these four categories may also be applied to the infertile population. A prospective study design is needed to capture the clinical characteristics of the subjects for a more accurate comparison.

Study strength

This is the first study of its kind conducted in the northern zone and Tanzania as a whole. It can be a stepping stone to encourage other research in the subject of male infertility.

Study limitations

As a single-centre, retrospective study with a specific cohort, the generalisability of the study's findings is limited. Furthermore, our study did not include subjects' oestradiol levels because this is not routinely performed in our setting and could not be obtained due to the retrospective study design. This information could have shed light on the phenomenon of low TT and normal LH levels, mainly attributed to an increase in oestradiol, among other factors.

Another limitation related to the study's retrospective nature is the clinical features of the study participants, including a history of previous hernia repair, mumps orchitis, exposure to gonadotoxins, sexually transmitted infections, and lifestyle risk factors, which could not be studied. Equally important are findings from general and physical examinations, such as the development of male secondary sexual characteristics and testicular volume.

Conclusion

A high prevalence of male infertility was observed due to the high prevalence of semen abnormalities with a predominance of asthenozoospermia, as well as abnormal endocrine profiles, with most having low TT and normal LH levels. Due to the study's limitations, further research with a prospective design is warranted to identify the contributing factors and potential therapeutic interventions to improve fertility outcomes in this population.

Acknowledgements

The authors thank the laboratory scientists DE Mbwambo, U-K Koosa, and MS Alute for their tireless cooperation and assistance with data acquisition and safe storage.

Conflict of interest

The authors declare no conflict of interest.

Funding source

None.

Ethical approval

Ethical approval was obtained from the Kilimanjaro Christian Medical University College Research Ethics Committee (PG75/2022).

ORCID

M Kimolo https://orcid.org/0000-0002-8611-6498
JS Mbwambo https://orcid.org/0000-0003-1754-3346
A Mremi https://orcid.org/0000-0001-7226-0168
OJ Mbwambo https://orcid.org/0000-0001-6689-3452
F Bright https://orcid.org/0009-0005-8290-3493
Z Cheyo https://orcid.org/0009-0004-0333-1320
BN Ngowi https://orcid.org/0000-0002-1898-9772

References

1. Sigman M, Lipshultz LI, Howards SS. Office evaluation of the subfertile male. In: Lipshultz LI, Howards SS, Niederberger CS, editors. Infertility in the male. Cambridge University Press; 2010 p. 153-76. https://doi.org/10.1017/CBO9780511635656.011.
2. Abebe MS, Afework M, Abaynew Y. Primary and secondary infertility in Africa: systematic review with meta-analysis. Fertility Research and Practice. 2020;6(20). https://doi.org/10.1186/s40738-020-00090-3.
3. Gyasi-Sarpong AC, Patrick Opoku MM, Koranteng AK. The pattern of male infertility in Kumasi, Ghana. African Journal of Reproduction and Gynaecological Endoscopy. 2017;2(1):3-5. https://doi.org/10.4103/ajiac.ajiac_3_18.

4. Agarwal A, Mulgund A, Hamada A, Chyatte MR. A unique view on male infertility around the globe. Reproductive Biology and Endocrinology. 2015;13(37). https://doi.org/10.1186/s12958-015-0032-1.
5. Tilahun T, Oljira R, Getahun A. Pattern of semen analysis in male partners of infertile couples in Western Ethiopia: retrospective cross-sectional study. SAGE Open Med. 2022;10:20503121221088100. https://doi.org/10.1177/20503121221088100.
6. Jafari H, Mirzaiinajmabadi K, Roudsari RL, Rakhshkhorshid M. The factors affecting male infertility: a systematic review. International Journal of Reproductive BioMedicine. 2021;19(8):681-8. https://doi.org/10.18502/ijrm.v19i8.9615.
7. Abarikwu SO. Causes and risk factors for male-factor infertility in Nigeria: a review. African Journal of Reproductive Health. 2013;17(4):150-66.
8. Tamrakar SR, Bastakoti R. Determinants of infertility in couples. Journal of Nepal Health Research Council. 2019;17(1):85-89.
9. Lindsay TJ, Vitrikas KR. Evaluation and treatment of infertility. American Family Physician. 2015;91(5):308-14.
10. Ali AFM, Modawe G, Rida MA, Abdrabo AA. Prevalence of abnormal semen parameters among male patients attending the fertility center in Khartoum, Sudan. Journal of Medicine and Life Sciences. 2022;4(1):1-8. https://doi.org/10.21608/jmals.2022.229304.
11. Ramaswamy S, Weinbauer GF. Endocrine control of spermatogenesis: role of FSH and LH/testosterone. Spermatogenesis. 2015;4(2):e996025. https://doi.org/10.1080/21565562.2014.996025.
12. McLachlan RI, O'Donnell L, Meachem SJ, et al. Hormonal regulation of spermatogenesis in primates and man: insights for development of the male hormonal contraceptive. 2002;23(2):149-62. https://doi.org/10.1002/j.1939-4640.2002.tb02607.x.
13. Sengupta P, Dutta S, Karkada IR, Chinni SV. Endocrinopathies and male infertility. Life (Basel). 2022;12(1):10. https://doi.org/10.3390/life12010010.
14. Ventimiglia E, Ippolito S, Capogrosso P, et al. Primary, secondary and compensated hypogonadism: a novel risk stratification for infertile men. Andrology. 2017;5(3):505-10. https://doi.org/10.1111/andr.12335.
15. Diallo MS, Diallo AS, Fotso P, et al. Semen abnormality patterns and parameters in male partners of infertile couples in Dakar (Senegal). Open Journal of Urology. 2015;5(9):155-60. https://doi.org/10.4236/oju.2015.59024.
16. Aduloju OP, Adegun PT. Factors predictive of abnormal semen parameters in male partners of couples attending the infertility clinic of a tertiary hospital in south-western Nigeria. South African Journal of Obstetrics and Gynaecology. 2016;22(2):57-61. https://doi.org/10.7196/SAJOG.2016.v22i2.1082.
17. Al-Turki HA. A 5-year analysis of semen parameters in Saudi Arabian men attending infertility clinics. Journal of International Medical Research. 2016;44(3):656-61. https://doi.org/10.1177/0300060516632108.
18. Garg J, Meena R, Shukla S, Sharma S, Choudhury R. Abnormal semen parameters among males in infertile couples: a cross-sectional study from a tertiary care centre. International Journal of Reproduction, Contraception, Obstetrics and Gynecology. 2020;9(8):3398. https://doi.org/10.18203/2320-1770.ijrcog20203330.
19. Guzick DS, Overstreet JW, Factor-Litvak P, et al. Sperm morphology, motility, and concentration in fertile and infertile men. New England Journal of Medicine. 2001;345(19):1388-93. https://doi.org/10.1056/NEJMoa003005.
20. Jarow J, Kolettis PN, Lipshultz LR, et al. The optimal evaluation of the infertile male: AUA best practice statement. American Urological Association Education and Research, Inc. ; 2010.
21. Juneja P, Phukan PK, Changmai D. A study of abnormal semen parameters in infertile couples in Assam, India. International Journal of Reproduction, Contraception, Obstetrics and Gynecology. 2019;8(3):997-1000. https://doi.org/10.18203/2320-1770.ijrcog20190870.
22. Ugboaja JO, Monago EN, Obiechina NJA. Pattern of semen fluid abnormalities in male partners of infertile couples in southeastern, Nigeria. Nigeria Journal of Medicine. 2010;19(3):286-8. https://doi.org/10.4314/njm.v19i3.60192.
23. Sharma R, Harlev A, Agarwal A, Esteves SC. Cigarette smoking and semen quality: a new meta-analysis examining the effect of the 2010 World Health Organization laboratory methods for the examination of human semen. European Urology. 2016;70(4):635-45. https://doi.org/10.1016/j.eururo.2016.04.010.
24. Sansone A, Di Dato C, de Angelis C, et al. Smoke, alcohol and drug addiction and male fertility. Reproductive Biology and Endocrinology. 2018;16(3). https://doi.org/10.1186/s12958-018-0320-7.
25. Payne KS, Mazur DJ, Hotaling JM, Pastuszak AW. Cannabis and male fertility: a systematic review. Journal of Urology. 2019;202(4):674-81. https://doi.org/10.1097/JU.0000000000000248.
26. Adeniji RA, Olayemi O, Okunlola MA, Aimakhu CO. Pattern of semen analysis of male partners of infertile couples at the University College Hospital, Ibadan. West Africa Journal of Medicine. 2004;22(3):243-5. https://doi.org/10.4314/wajm.v22i3.27959.
27. Pastore AL, Palleschi G, Silvestri L, Leto A, Carbone A. Obstructive and non-obstructive azoospermia. In: Bashamboo A, McElreavey KD, editors. Male fertility. IntechOpen; 2012.
28. Barratt CLR, Björndahl L, De Jonge CJ, et al. The diagnosis of male infertility: an analysis of the evidence to support the development of global WHO guidance-challenges and future research opportunities. Human Reproduction Update. 2017;23(6):660-80. https://doi.org/10.1093/humupd/dmx021.
29. Gonsioroski A, Mourikes VE, Flaws JA. Endocrine disruptors in water and their effects on the reproductive system. International Journal of Molecular Sciences. 2020;21(6):1929. https://doi.org/10.3390/ijms21061929.
30. Purohit V. Can alcohol promote aromatization of androgens to estrogens? A review. Alcohol. 2000;22(3):123-7. https://doi.org/10.1016/S0741-8329(00)00124-5.
31. Priskorn L, Jensen TK, Bang AK, et al. Is sedentary lifestyle associated with testicular function? A cross-sectional study of 1,210 men. American Journal of Epidemiology. 2016;184(4):284-94. https://doi.org/10.1093/aje/kwv338.
32. Geidam AD, Yawe KD, Adebayo AE, Idrisa A. Hormonal profile of men investigated for infertility at the University of Maiduguri in northern Nigeria. Singapore Medical Journal. 2008;49(7):538-41.
33. Dandona P, Rosenberg MT. A practical guide to male hypogonadism in the primary care setting. International Journal of Clinical Practice. 2010;64(6):682-96. https://doi.org/10.1111/j.1742-1241.2010.02355.x.
34. Kumar P, Kumar N, Thakur DS, Patidar A. Male hypogonadism: symptoms and treatment. Journal of Advanced Pharmaceutical Technology and Research. 2010;1(3):297-301. https://doi.org/10.4103/0110-5558.72420.