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Semen Parameters Associated With Male Infertility in a Sub-Saharan Black Population: The Effect of Age and Body Mass Index

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Abstract

Background: Available evidence on the role of age and BMI on male infertility has been controversial or inconclusive. With 30-50% of infertility being related to the male and up to 35% of couple's having more than one problem, the male work-up is equally as important as the female. The synergy of Age and BMI in male infertility has not been much considered.

Objective: To investigate the synergy of age and BMI on seminal fluid parameters of Black Africans.

Methodology: This facility-based study, carried out on 907 sub-fertile males between 2010 and 2015, was descriptive, analytic and cross-sectional. Age (years) was categorized into <45 and ≥45. BMI (kg/m^2) was divided into underweight (<18.5), normal (18.5-24.9), overweight (25.0-29.9) and obese (≥30). Sperm was collected by masturbation and examined within 60 minutes of collection. STATA 13 statistical software was used for data analysis. Level of significance was set at P-value <0.05.

Results: Overall means (±SD) of age, BMI and sperm count (x10^6) were 42.67 (7.12), 27.01 (3.68) and 22.23 (23.04), respectively. Mean sperm volume (ml.) at age <45 years (2.40±1.41) was significantly higher (t=3.37; p=0.0004) than at age ≥45years (2.05±1.58). Compared to normal weight men, semen volume (t=-1.59, P-value=0.05), sperm count (t=-2.02, P-value=0.02) and motility (t=-2.95, P-value=0.002) were significantly lower in obese men. Overweight men aged ≥45 years were approximately 2½ times more likely to produce semen <1.5 ml. In the synergy between age and BMI, age provided a stronger correlation with semen volume than BMI (coef. = -0.030, t=-4.45, P-value=0.00001) while BMI provided a stronger correlation with sperm count (coef. = -0.411, t=-1.98, P-value=0.048) and with progressive motility (coef. = -0.668, t=-3.47, P-value=0.00001) than age.

Conclusion: Our data suggest evidence of synergy of age and BMI in the quantity and quality of semen parameters such as volume, liquefaction time, progressive motility and sperm count.

Keywords: Age/BMI synergy; Semen parameters; Male infertility; Black Africa; Nigeria;

Abbreviations: APA = Advanced paternal age; ART = Assisted Reproduction Technique; BMI = Body Mass Index; DNA = Deoxy-ribonucleic Acid; WHO = World Health Organization

Introduction

Fathering a child at an advanced age of over 50 years is not rare among Black African population and it is assumed that each man can father a child from adulthood onwards. Anecdotal reports however indicate that certain percentage of the population in Africa suffer from infertility. Advanced Paternal Age (APA) is attributed to delay in setting up a family due to some factors among which are prolonged life expectancy, postponed marriage age, several socio-economic factors and a global transformation in women's role in society [1]. More than before, females are now more exposed to both male and female contraceptive methods such as pills, Copper-T and condoms; a higher proportion of females are now more educated and there has been a global entry of females into the labor market [2]. Further, increase in life expectancy noted globally, has been linked to alteration in marriage system and structure and to high divorce rate resulting in the wish to father a child at a new marital life [2]. Certain male conditions are however associated with fathering a child, the most important of which are adequate sperm volume, normal sperm morphology and good motility, among others. Seminal fluid characteristics are consequent upon the health of the individual and may be jeopardized by congenital or acquired conditions such as undescended testes, systemic illnesses, trauma, habits, life style, nutrition and environmental conditions [1]. However, significant association between decline in male fertility and advanced paternal age has been reported [3], though a proportion of males are expected to be infertile and therefore unable to naturally father a child unless through Assisted Reproduction Technique (ART). Certain conditions have also been linked to male infertility such as high body mass index. Fejes et al., [4] reported a correlation between waist circumference (an index of body fat) and sperm count, progressive motile sperm count and total sperm count while MacDonald et al., [5] reported a negative correlation between testosterone and increased Body Mass Index (BMI). In the developed world, infertility affects about 10% of the population [6] and roughly 15% of matrimonial couples suffer from infertility, 25% of which may be ascribed to the male partners [7]. The influence of paternal age on sperm parameters have been studied extensively [1-2, 8-11]. The interaction between BMI, spermatogenesis and male fertility has also been well documented [12-16]. To give some examples, an earlier study documented the effect of aging, malnutrition and illness on testicular size [17] which was corroborated by the study of Juul and Skakkebaek [18] who reviewed changes of endocrine testicular function of the aging male. In addition, volume of ejaculate

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and sperm motility have been reported to decrease [19] while percentage of abnormal sperm morphology was observed to increase with increasing male age [20, 21], though others maintain that advancing age does not affect sperm count [22, 23]. While some studies argued that increased BMI is not only related to systemic diseases such as diabetes and hypertension but also associated with overall male infertility [24-26], others claimed no such correlation exists between BMI and male reproductive functions [15,16]. Earlier studies reported observed consequences of advanced paternal age such as aneuploidy which occurs in 30-50% of all pregnancies and are mostly lethal [27, 28], structural chromosomal aberration which comprise 0.25% of births [29, 30]; single gene mutation which is common in germ line cells, increases with age and triggers replication errors during meiosis [31, 32]; and DNA fragmentation associated with defective mismatch repair [32, 33]. Advanced paternal age has also been associated with conditions such as autism, schizophrenia, neurocognitive impairment Dyslexia, bipolar disorders and Alzheimer disease [34]. There are very few studies that have looked at the factors of advanced paternal age, body mass index, independently and synergistically, and semen parameters of Africans. Most studies carried out were in the developed countries and extremely few were conducted among indigenous Black African population such as Nigerians. This study attempted to report the outcome of independent and synergistic relationship of age and BMI on sperm parameters with the objective of documenting alterations in volume, liquefaction time, motility and sperm count at age less than 45 years and at age 45 years and above.

Subjects and Methods

This study, which was approved by the Nigerian Institute for Medical Research Institutional Review Board (NIMR IRB/18/007), took place at Nordica Fertility Center in Lagos where the medical records of men aged 23-73, who presented because of infertility at three Nigerian cities - Lagos, Asaba and Abuja - were retrieved, entered into a laptop computer, cleaned and analyzed. Of the initial 3138 women who consulted for infertility-related problems, 2367 (75.4%) were accompanied by their male spouses, and of these, 1054 (44.5%) needed to produce semen under strict compliance with World Health Organization regulations for semen analysis [35]. Of the 1054, 52 (4.9%) declined to provide their semen for analysis, the main reasons being that they were in a religious fasting period; 26 (2.5%) absconded and 32 (3.0%) sperm samples were discarded because 14 (1.3%) had inadequate data, time of collection was not specified in 9 (0.8%) and days of abstinence were not provided by 10 (0.9%) men. Others were excluded from the study because of confounding factors such as undescended testis, surgical operations on the testis, urethral disease, chronic liver disease, HIV infection, Renal failure, TB of the Genitourinary system and Diabetes Mellitus and BMI of <18.5kg/m^2, leaving only 907 patients whose data were analyzed. In general, most of the patients consulted for ART because their wives were not getting pregnant after regular and constant sexual intercourse, while others complained of low sperm count as detected at other laboratories. A few came not because of infertility but for gender selection for male child preference.

Semen Sample Collection

Semen sample was collected by masturbation after a minimum/maximum of 2-7 days of sexual abstinence and transported almost immediately to the laboratory for analysis. Each patient or couple was counselled on (i) the need for accuracy in the collection of semen, (ii) the kits (wide-mouth measuring cylinder) to be used for the collection and (iii) the need to report any loss of semen during collection. Each patient has a medical record file with his data such as name, age (or date of birth), days of abstinence, date and time of collection, if there was any loss in semen volume during collection (incomplete collection) and the commencement of seminal fluid analysis in the laboratory. Socio-demographic data of patients as well as medical, surgical and social histories were also taken.

Semen Analysis

All semen samples were received in the laboratory within 30-60 minutes of production. After liquefaction for 30-60 minutes, routine semen analysis was performed according to WHO guidelines [35] to detect semen volume, total sperm count, motility, and morphology (reported in another paper). Just one semen sample per patient was taken for seminal fluid analysis. The reasons for taking one sample per patient were (i) availability of male partner to come for repeated diagnostic test is always a challenge in our societal environment (ii) the cultural and superstitious attachment that men have to semen production, questioning the relevance of more than one semen production for analysis (iii) the cost implication.

Sperm volume

The volume of each collected semen sample was evaluated according to WHO criteria [35]. The volume of the ejaculate was determined by directly reading it on a wide-mouth measuring cylinder provided for each patient. A volume of 3-5μL of semen sample was transferred to the center of the chamber; mean progressive motility was determined using light microscope (x40).

Sperm count

Sperm count was performed in 10 squares of the chamber according to WHO [35] standard counting at least 200 spermatozoa and expressed as 10^6 spermatozoa/ml.

Sperm motility

Sperm progressive motility was assessed in 100 random spermatozoa by characterizing them as (i) rapidly forward, fast progressive motility, ii) moderately forward, slow progressive motility, (iii) jerky non-progressive motility and iv) immotile/no movement. These were expressed as percentages. The temperature for motility assessment was 20°C.

Abnormal semen parameters were defined using WHO [35] criteria, paternal age was stratified into <45 and ≥ 45 years old. The conventional categorization of BMI as underweight (BMI <18.5), normal weight (BMI 18.5-24.9), overweight (BMI 25.0-29.9) and obese (BMI ≥30) was adopted. All consenting men who presented for fertility assessment; those who were currently or within two weeks prior to analysis, not on any medication, particularly anabolic steroids, antibiotics and antimalarials, or any medication that would have interfered with spermatogenesis were included into the study. Men with azoospermia and those with past or current history of undescended testis, surgical operations on the testis, urethral disease, chronic liver disease, HIV infection, Renal failure, TB of the Genitourinary system and Diabetes Mellitus. The 4 men with BMI <18.5 kg/m^2 were excluded

Data were analyzed using STATA 13; chi-square was used to determine correlations, Odd ratio and 95% Confidence Interval; ANOVA was used to determine significance of means of two variable and multivariate regression analyses were used to determine correlation coefficients. Data were presented as Tables, Graphs

Results

Seminal fluid characteristics by age and BMI groups

All the 907 men in the study were Black sub-Saharan Africans. The overall means (±sd) of age (years) and body mass index (BMI in Kg/m^2) of the study subjects were 42.57 (7.12) and 27.01 (3.68) respectively. The means (±sd) of semen volume (ml.), sperm count (x10^6/ml) and progressive motility (%) were 2.26±1.47, 22.26±23.08 and 38.18±21.51 respectively. A significant difference (t = 3.37, P-value = 0.0004) was observed in the mean semen volume (ml.) of men aged <45 years (2.28 ml.) compared with that of men aged 45 years and above (2.05ml), indicating that, regardless of the BMI, age was a significant factor in the production of semen volume (Figure 1). There was no noteworthy alteration in the sperm count or progressive motility of the younger and the older men.

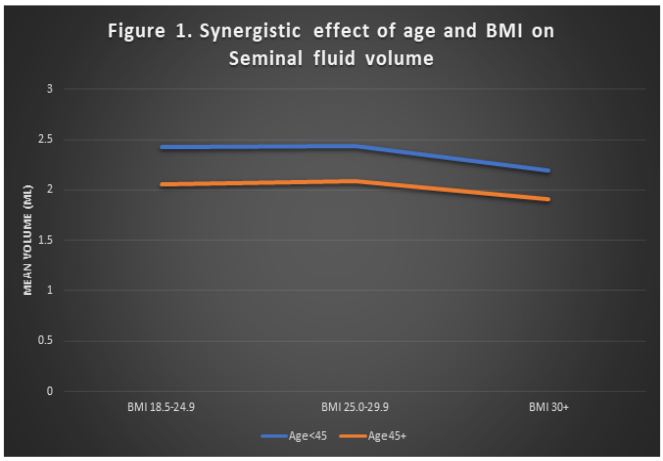

Figure 1: Synergistic effect of age BMI on seminal fluidvolume

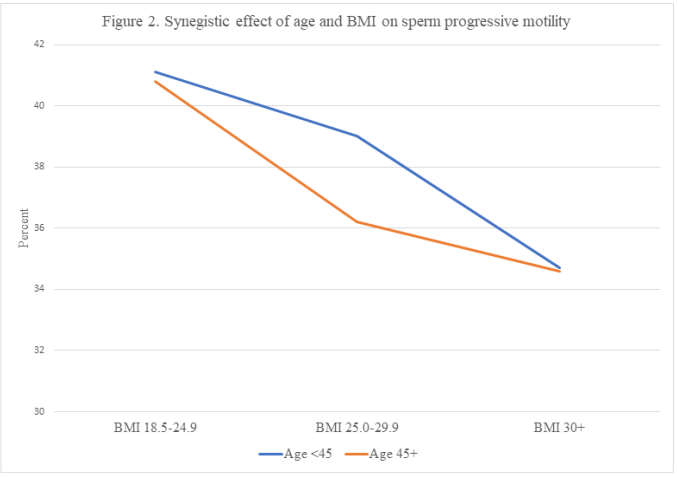

Figure 2 : Synergistic effect of age and BMI on sperm Progressive motility

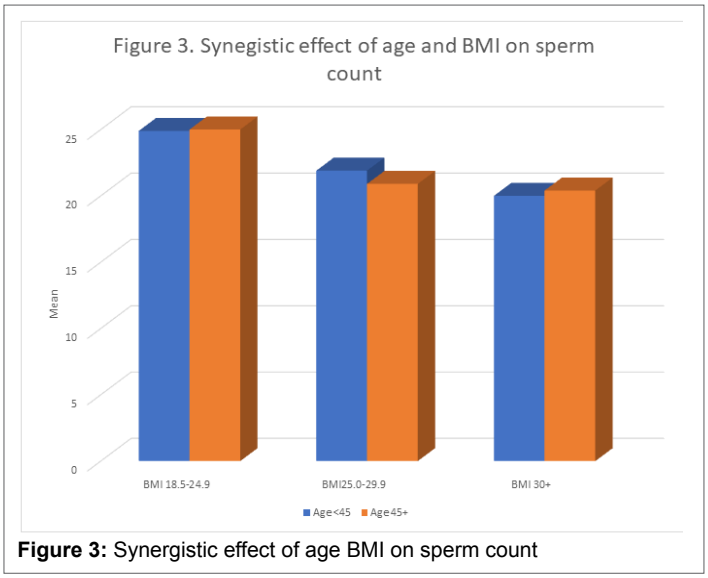

Figure 3: Synergistic effect of age BMI on sperm count

There was a noteworthy variation (t = -1.59, P-value=0.05) in the mean semen volume (ml.) of normal weight men (2.31 ml) compared with that of obese men (2.10 ml). Furthermore, significant difference was observed (t = -2.02, P-value = 0.02 respectively) when the mean sperm count (x10^6/ml.) of normal weight men (25.00) was compared that of overweight men (21.47) and to that of obese men (20.18). Also, mean sperm cells' progressive motility (%) of normal weight men (41.02) was significantly higher (t = -2.02, P-value = 0.02 respectively) than that of overweight men (37.84) and of obese men (34.66).

In addition, each age group was further classified into different BMI in which the means of semen volume, sperm count and progressive motility were calculated. Among those aged <45 years, no significant difference was observed in the mean semen volume (ml.) of normal weight men (2.43) compared to overweight (2.44) or obese (2.19) men. There was also no significant variation in the mean semen volume of normal (2.06), overweight (2.09) and obese (1.91) men aged ≥45 years. However, when compared to younger, normal weight men (2.43), the mean semen volume of older normal weight (2.06), older overweight (2.09) and older obese (1.91) men were significantly lower (t = 2.00, P-value = 0.02; t = 1.96, P-value = 0.03 and t = 3.04, P-value = 0.001). The mean sperm count (x 10^6/ml) of normal weight younger men (24.95) was significantly higher (t = 1.73, P-value = 0.04) than that of the overweight older men (20.86). In addition, the mean progressive motility of normal weight men aged <45 years

Table 1: Mean values of age, BMI, seminal fluid volume, sperm count and motility of patients.

Variable	Item	Total	Age		BMI		Volume (ml.)		Sperm count (x10^6)		Progressive Motility (%)	
			Mean	±sd	Mean	±sd	Mean	±sd	Mean (±sd)		Mean (±sd)	
Age (years)	All	907	42.67	7.11	-	-	2.26	1.47	22.26	23.08	38.18	21.51
	<45	567	38.23	4.00	-	-	2.28	1.40	22.50	23.43	38.83	21.57
	≥45	340	50.07	4.52	-	-	2.05	1.58	21.87	22.50	37.10	21.40
*t-test (P-value)	≥45 vs <45	-					3.37 (0.0004)		0.45 (0.33)		1.13 (0.13)	
BMI (Kg/m^2)	All	907	-	-	27.10	3.90	2.26	1.47	22.26	23.08	38.18	21.51
	18.5-24.9	268	-	-	23.16	1.37	2.31	1.50	25.00	23.20	41.02	19.90
	25.0-29.9	468	-	-	27.23	1.34	2.29	1.54	21.47	22.19	37.84	21.59
	≥30	171	-	-	32.90	3.88	2.10	1.24	20.18	24.97	34.66	23.23
*t-test (P-value)	≥ 25.0 vs ≥18.5	-					-0.17 (0.43)		-2.02 (0.02)		-2.02 (0.02)	
	≥30 vs ≥18.5	-					-1.59 (0.05)		-2.02 (0.02)		-2.95 (0.002)	

		Total (%)						
Age <45	BMI ≥18.5-24.9 (a)	180 (19.8)	2.43	1.55	24.95	23.55	41.1	19.8
	BMI 25.0-29.9 (b)	274 (30.2)	2.44	1.29	21.90	22.39	39.0	21.7
	BMI ≥ 30.0 (c)	113 (12.5)	2.19	1.35	20.05	25.49	34.7	23.6
t-test (P-value)	(a) vs (b)	-	-0.07 (0.47)		1.38 (0.08)		1.06 (0.14)	
	(a) vs (c)	-	1.40 (0.08)		1.65 (0.05)		2.40 (0.009)	
Age ≥ 45	BMI ≥18.5-24.9 (a1)	88 (9.7)	2.06	1.36	25.05	22.60	40.8	20.3
	BMI ≥ 25.0-29.9 (b1)	195 (21.5)	2.09	1.81	20.86	21.94	36.2	21.4
	BMI ≥ 30.0 (c1)	57 (6.3)	1.91	0.95	20.42	24.13	34.6	22.6
*t-test (P-value)	(a1) vs (b1)	-	-0.15 (0.44)		1.45 (0.07)		1.73 (0.04)	
	(a1) vs (c1)	-	0.78 (0.22)		1.16 (0.12)		1.67 (0.05)	
t-test (P-value)	(a) vs (a1)	-	2.00 (0.02)		-0.03 (0.49)		0.11 (0.45)	
	(b) vs (b1)	-	2.31 (0.01)		0.50 (0.31)		1.39 (0.08)	
	(c) vs (c1)	-	1.94 (0.03)		-0.09 (0.54)		0.03 (0.49)	

aged <45 years (41.1) was significantly higher (t = 2.30, P-value = 0.01 and t = 1.05, P-value = 0.03 respectively) than that of overweight older (36.2) and of obese older (34.6) men. Figure 2 indicates obvious synergistic effect of age and BMI on mean progressive motility of sperm showing a downward trend with increase in BMI in both age groups. This may reflect that BMI is more of a risk factor in sperm progressive motility regardless of age. There was no significant difference in sperm count as shown in Figure 3.

Using multivariate regression analysis to consider strength of correlation

Independently, age was responsible for a significant 2.16% variations observed in semen volume of the men (R^2=0.0216, F=20.03, P-value=0.00001), BMI was responsible for an insignificant 0.34% (R^2=0.0034, F=3.132, P-value=0.077) of the variation but the synergy of Age and BMI was responsible for a more significant 2.47% of the variation (R^2=0.0247, F=11.50, P-value=0.000001). Age was accountable for an irrelevant 0.02% of the variation observed in sperm count of the men (R^2=0.0002, F=0.16, P-value=0.690) while BMI alone was answerable for a significant 0.43% variation (R^2=0.0043, F=3.954, P-value=0.047) but the synergy of age and BMI could only explain an insignificant 0.45% of such variations (R^2=0.0045, F=2.042, P-value=0.130). Age provided a weak and insignificant 0.16% explanation of the differences observed in sperm progressive motility (R^2=0.0016, F=1.46, P-value=0.228), BMI gave a stronger and significant 1.32% explanation of such variations, but the synergy of age and BMI offered the strongest 1.47% description of the variations observed in sperm progressive motility among the men in the study (Table 2a).

These observations were corroborated by the correlation coefficients between age and BMI independently and synergistically as illustrated in Table 2b. There were significant but negative correlations between age and semen volume (coef. = -0.031, SE=0.007, t=-4.48, P-value=0.0001, 95% CI: -0.04, -0.02); between BMI and sperm count (coef. = -0.412, SE=0.207, t=-1.99, P-value=0.047, 95% CI: -0.82, -0.01) and between BMI and progressive motility (coef. = -0.672, SE=0.192, t=-3.49, P-value=0.001, 95% CI: -1.05, -0.29). In the observed synergy of age and BMI, age correlated more with semen volume (coef. = -0.030, SE=0.007, t=-4.45, P-value=0.00001, 95% CI: -0.04, -0.02) than BMI (coef. = -0.023, SE=0.013, t=-1.71, P-value=0.087, 95% CI: -0.05, 0.00); BMI correlated more with sperm count (coef. = -0.411, SE=0.207, t=-1.98, P-value=0.048, 95% CI: -0.82, -0.00) than age (coef. = -0.039, SE=0.107, t=-0.37, P-value=0.715, 95% CI: -0.25, 0.17). BMI also correlated more with progressive motility (coef. = -0.668, SE=0.192, t=-3.47, P-value=0.00001, 95% CI: -1.05, -0.29) than age (coef. = -0.115, SE=0.100, t=-1.16, P-value=0.248, 95% CI: -0.31, 0.08).

Discussion

Not only women but also men are becoming more conscious of the consequences of being overweight or obese and are engaged in various means such as regular exercise, watched diet and medication to keep within normal weight. Overweight and obesity in either male or female not only have negative impact on health such as diabetes but has been shown to affect male and female reproductive system. Age and ageing are also quintessential factors that are directly related to reproduction as it is well-established that for females, ability to produce viable eggs for fertilization wanes at about 45 years of age and older men produce lesser volume of seminal fluid compared to younger men. Separately, age and body mass index have been identified as culprits in reduced or abnormal sperm cell count, motility and morphology. This study, carried out among male Black sub-Sahara Africans, indicates negative impact of the synergistic effect of age and BMI on certain semen parameters.

This study has many major findings, one of which is that the mean sperm volume (ml.) of men aged 45 years and above was significantly lower than those have aged below 45 years. Different authors have reported similar findings in studies conducted in developed countries as documented in earlier works [10, 36], and later, that of Rolf et al., [37]. Studies have proposed to clarify how advancing male age may cause reduction in seminal fluid [19] among which is seminal vesicle inadequacy or prostate atrophy. Comparing two age groups (<45 years, n=567; ≥45 years, n=340), a significant difference was found in semen volume (2.28 ml.; 2.05 ml. respectively), a finding that correlates with what Eskenazi et al., [8], Hossain et al., [38], and Mukhopadhyay et al., [39] reported. However, an earlier study by Schwartz et al., [40] failed to detect a significant change in semen volume with age.

Another key finding in this study is that the mean sperm volume of obese men was significantly lesser than that of normal weight men. The means of sperm volume of normal weight men, overweight men and obese men 45 years and above were also significantly lower than that of younger men indicating that age is more significant than BMI in reduced production of seminal fluid. This finding contradicts what MacDonald et al., [5], Thomsen et al., [41], Aggerholm

Table 2a: Multivariate regression analysis with seminal fluid volume (ml.), sperm count($x10^6$) and progressive motility as dependent variable and age, BMI and synergistic age/BMI as independent variables.

Equation	Obs	Age			BMI			Age and BMI		
		R^2	F-statistics	P-value	R^2	F-statistics	P-value	R^2	F-statistics	P-value
Volume	907	0.0216	20.03	0.0001	0.0025	2.231	0.136	0.0223	10.31	0.000001
Sperm count		0.0002	0.16	0.690	0.0050	4.514	0.034	0.0051	2.31	0.100
Motility		0.0016	1.46	0.228	0.0125	11.460	0.001	0.0140	6.43	0.0017

Table 2b: Correlation coefficient, standard error and level of significance between dependent and independent variables in the study.

Variables		Coef.	SE	t	P-value	95% CI
Dependent	Independent					
Volume	Age	-0.031	0.007	-4.48	0.0001	-0.04, -0.02
Sperm count		-0.043	0.107	-0.40	0.690	-0.25, 0.17
Progressive motility		-0.121	0.100	-1.21	0.228	-0.32, 0.07
Volume	BMI	-0.021	0.013	-1.49	0.136	-0.05, 0.01
Sperm count		-0.447	0.210	-2.12	0.034	-0.86, -0.03
Progressive motility		-0.662	0.195	-3.39	0.001	-1.04, -0.28
Volume	Age	-0.029	0.007	-4.28	0.00001	-0.04, -0.02
	BMI	-0.019	0.013	-1.43	0.153	-0.05, 0.01
Sperm count	Age	-0.035	0.108	-0.32	0.746	-0.25, 0.17
	BMI	-0.446	0.211	-2.12	0.034	-0.86, -0.03
Progressive motility	Age	-0.118	0.100	-1.18	0.239	-0.31, 0.08
	BMI	-0.657	0.195	-3.36	0.001	-1.04, -0.27

et al., [42], Qin et al., [43] and Li et al., [44] reported. However, our finding of association between male overweight and obesity in association with reduced semen volume agrees with what Bakos et al., [45], Hakonene et al., [46], Jensen et al., [47] reported. The variance in findings might be due to the fact that our study took into consideration the synergy of age and BMI while most other studies concentrated on age or BMI in isolation.

A novel finding is that the mean number of pus cells was higher in overweight men aged 45 years and above compared to younger overweight men. Pus cells in the semen may startle infertile men who report at the clinic, but they may not be significant or, if more than 5 per high power field, may suggest recent infection such as gonorrhea, chlamydia, syphilis, along with other STDs which could be damaging to male reproductive system or result in testicular failure.

In addition, liquefaction time was longer in older than in younger overweight patient. Very few studies, especially in sub-Saharan Africa, have reported BMI-for-age disparity in liquefaction time. The observed longer duration of liquefaction time in older overweight men might be a factor for male sub fertility [48], especially in overweight people aged 45 years and above. A more intense study is needed to ascertain this finding.

Compared to their younger counterparts, normal weight, overweight and obese men aged 45 years and above were 1.58, 2.49 and 1.47 times more likely to produce seminal fluid <1.5 ml. a phenomenon that seemed to be driven by overweight men aged 45 years and older.

From the perspective of aging male, our findings resonate with what others reported: that male aging is related to the production of smaller sperm volume [8, 20, 38, 39] and concerning BMI our findings are in consonance with what Aggerholm et al., [42] and Qin et al., [43] reported about overweight men and the production of abnormally low sperm volume. One possible factor to explain this observation is that high concentration of spermidine and spermine in overweight, more than in obese men, may be the metabolites accountable for the lower sperm production in this group of men. Another possibility is that the production of lower sperm volume in overweight men maybe attributable to higher concentration of endocrine disruption substances than in obese men. Further studies are needed to elucidate this phenomenon.

An important finding in this study is that older normal weight and overweight men were respectively 1.02 and 1.06 times more likely to produce sperm count<$15x10^6$/ml. Many studies have reported on either age or BMI as a risk factor in the production of low sperm count. Findings from our study on synergistic effect of age and BMI support the claims in favor of age [2; 29] and in favor of BMI [14, 19, 49] simultaneously. A recent study suggested that metabolites alterations in seminal plasma may be the mediator of obesity and abnormal semen quality [50].

Earlier studies which argued that sperm count is affected little by age probably did not consider the BMI category of their study participants in each age group [40, 51-56]. For example, a study reported no significant correlation between BMI and the semen parameters measured with the exception of normal sperm morphology [57].

On the other hand, the report given by MacDonald et al., [5] of no evidence for a relationship between BMI and sperm count or total sperm count most likely did not take the age group of the study participants in each BMI category into consideration. In our study we found that, in some cases, age plays a primary role while BMI plays a secondary role in the alteration in sperm quantity/quality. At other circumstances, it is BMI that plays the major while age demonstrates a minor role to bring about the changes in semen quantity or quality. For example, the production of progressive motility of <32% in obese men was influenced more by BMI and less by age. Thus, aging takes its toll mostly on volume while increasing BMI is devastating to sperm count and progressive motility

There are some plausible explanations for the findings in this study. The combined assault of aging and increasing BMI on some sperm parameters is elucidated. Obesity and metabolic syndrome are known to have effects on

benign prostatic hyperplasia, male hypogonadism, male sexual function and infertility, and prostate cancer while age and BMI have been identified as risk factors for chronic prostatitis and chronic pelvic pain syndrome [58]. On the one hand, increasing BMI could influence quality and quantity of the semen and thereby trigger fertility challenges in the male. This mechanism probably occurs via "the hypothalamus-pituitary-gonadal axis dysfunction; abnormal levels of reproductive and related hormones (INH-B, FSH, LH, E2, PRL, leptin, T, SHBG, and AMH); dysfunction of male sexual accessory glands (neutral alpha-glucoside enzyme and seminal plasma fructose); and living and dietary habits (coffee intake volume) in overweight or obese patients" [58]. It is also possible that BMI affects fatty acid composition of spermatozoa through regulation of fatty acid metabolism in the testis [59]. On the other hand, there seems to be clear evidence that chromosomal breaks and fragments increase with age [26], that alteration in prostate protein and water content occur to decrease semen volume. An inverse relationship between increasing paternal age and decreasing fructose in semen volume, which brings about gradual decline in sperm motility, has been described [2, 29].The study of Alshahrani et al., [60] concludes that aging is a decisive risk-factor in sperm DNA fragmentation.

Conclusion and Recommendation

The result of this study has demonstrated that age and BMI, as a unit and in synergy, are associated with some undesirable effects on sperm quality and quantity. In this synergy, age, more than BMI, played a leading role in the reduction observed in volume of semen; both age and BMI functioned in tandem in the reduction observed in sperm count; and BMI more than age played the primary role in the reduced motility observed in the sperm count of infertile men who were examined at our clinic. A more penetrating research is required to evaluate the relationship between the synergy of male age and BMI in respect of sperm quality and quantity in the general population. Further studies in other sub-Sahara African countries are also recommended.

Study limitations

This study has some limitations that need to be highlighted and discussed. First, this study was clinic-based as participants were men who consulted because their wives were not getting pregnant after steady uninterrupted intercourse for at least 6 months. Therefore, the results may not reflect the situation among healthy fertile men in the community.

Secondly, the study was retrospective and data that were analyzed were as recorded by laboratory scientists. Information from patients concerning collection of sperm had to be taken as recorded by the patients themselves. Days of abstinence were recorded as reported by the patients themselves. There is the possibility, though remote, of memory loss on days of abstinence.

Confounding factors such as use of tobacco, smoking, alcohol consumption, caffeine intake, use of herbal or orthodox medication, previous or current genitourinary infection, systemic illnesses (e.g. hypertension, diabetes, coronary heart diseases etc.), current or previous occupational exposure (e.g. petrochemical, oil and gas, long distance drivers etc.) and past or present fatherhood details were not considered.

Lastly, almost all the patients were from average to high socio-economic status in low-lying geographical residential locations and the outcome of this study may not reflect the condition among people living on higher altitudes whose sperm parameters have not been analyzed.

Author contributions: ABA conceived of the study, participated in its design, and helped to draft the manuscript. BMA participated in its design, performed the statistical analysis, and drafted the manuscript. VDA, IO, OB, HA, AA, AS and OOS handled the recruitment of patients, sample collection, and supervised the clinical aspects of work. AA supervised all molecular laboratory work. All authors read and approved the final manuscript.

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