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RESEARCH ARTICLE

ASSESSING THE RELATIONSHIP BETWEEN LOW BODY MASS INDEX, SPERMCONCENTRATIONS AND SOME SEMINAL ELECTROLYTES AMONGSTYOUNG ADULTS

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ABSTRACT

The development of male infertility is increasing rapidly worldwide with numerous causative agents and idiopathic causes. Infertility conundrum coincides with the epidemic of abnormal body weight which holds sway to countless pathological conditions. This study was therefore designed to evaluate the relationship between low body mass index (BMI), sperm counts and seminal electrolyte concentrations in young adults. A total of one hundred (100) students of the Niger Delta University constituted the study subjects. The age bracket was pegged between 18-35 years. The study was stratified into two categories; normal BMI (20-25) and underweight (< 19). The BMI, electrolytes and sperm concentrations were analyzed using WHO approved standards and procedures. Data generated from the mathematical and empirical analysis were analysed using student *t*-test and Pearson correlation obtained using SPPS version 18-20 packages. The result showed a significant decrease ($p<0.05$) in seminal sodium and bicarbonate in the underweight when compared to normal BMI, whereas seminal potassium was on the contrary. Correlation between BMI and sperm count revealed non-significant relationship with Pearson coefficient (r) = - 0.077; p – value = 0.778. In conclusion, the distorted electrolytes observed in the study are a plausible predisposition of underweight to infertility.

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INTRODUCTION

Body Mass Index (BMI) is a person's weight in kilograms divided by the square of height in meters. It usually correlates with total body fat. This means that as the BMI score increases, so does a person's total body fat. The WHO defines an adult who has a BMI between 25 and 29.9 as overweight, 30 or higher considered as obese, BMI below 18.5 as underweight, and between 18.5 to 24.9 a healthy weight(WHO, 1995). Sperm count, or sperm concentration measures the concentration of sperm in a man's ejaculate. Over 15 million sperm per milliliter is considered normal, according to recent WHO report (WHO, 2010). Electrolytes are charged ions found in body fluids essential to a lot of metabolic processes. The role electrolytes play is similar across both intracellular and extracellular fluids. Electrolytes play a vital role in maintaining homeostasis in the body; regulate fluid balance, oxygen delivery, and acid–base balance. Electrolyte disturbances are involved in many disease processes, and are an important part of patient management in medicine (Alfarouk*et al.,* 2020; Balcı*et al.,* 2013). Body mass index has been implicated in several disease conditions. However, the role of BMI with respect to sperm count is still being debated though with different perspectives. It has been reported that serum testosterone, sex hormone-binding globulin (SHBG), and inhibin B are decreased with increasing body mass index (BMI), whereas estradiol increased with increasing BMI (Jensen *et al.,* 2004; MacDonald *et al.,* 2010). However, several reports have implicated obesity in adult men as link to low sperm quality(Aggerholm*et al.,* 2008; Koloszar*et al.,* 2005; martini *et al.,* 2010). Also obese men are 3 times more likely to exhibit a reduction in semen quality than men of a normal weight, (Sharma *et al.,* 2013) and overweight and obesity has been associated with an increased prevalence of azoospermia or oligozoospermia (Sermondede*et al.,* 2013).

A recent study investigating the relationship between male BMI and semen parameters have demonstrated that there was a clear association between obesity and sperm production (volume, concentration, and total sperm count) (Belloc *et al.,* 2014). Evidence has been shown that obesity is linked to male fertility because of lifestyle changes, internal hormonal environmental alterations, and sperm genetic factors. However, some studies that show no significant correlation between BMI and semen parameters (concentration, semen volume, and total sperm motility) (Duits *et al.,* 2010; Eskandar *et al.,* 2012; Relwani *et al.,* 2011). A meta-analysis from MacDonald *et al.*(2010) found no evidence of a relationship between BMI and sperm concentration or total sperm count, but there was a negative relationship between testosterone, SHBG, and free testosterone with an increased BMI. The role of seminal electrolytes on spermatogenesis and healthy seminal environment are not in doubt as most metabolic processes are electrolytes driven. Nag and Chaudhuri (1978) finding ventilate the indispensible roles of electrolytes in semen quality. Similarly, Colagar *et al.* (2009) posited that some seminal electrolytes are major determinant of sperm quality and infertility. All these point to the integral role of seminal electrolytes. However, there is a gap on the effect of low BMI on seminal electrolytes which is crucial indicator of semen quality and infertility. As the osmotic equilibration and acid-base balance established by seminal electrolytes are not exploited in the discourse of low BMI and infertility. Therefore, this study is designed to critically evaluate the relationship between low BMI and seminal electrolytes with the view of establishing empirical stances on sperm count and semen quality.

MATERIALS AND METHODS

Study population: This study was carried out at the Niger Delta University, Wilberforce Island, in Southern Ijaw Local Government Area of Bayelsa State. Bayelsa State is a multicultural state in the southern part of Nigeria in the core Niger Delta region. Geographically, Bayelsa State is located within Latitude: 04° 15' North, 05° 23' South and Longitude: 05º 22' West and 06º 45' East. It shares boundaries with Delta State on the North, Rivers State on the East and Atlantic Ocean on the West and South and is populated by different ethnic groups across the country. The subjects consist of 100 male students from age range of 18 and 35 years of the Niger Delta University, Wilberforce Island, Bayelsa State. All the subjects provided written informed consent and signed a standardized consent form. Research approval for this study was given by the Ethics Committee of the Niger Delta University, Wilberforce Island, Bayelsa State, Nigeria.

Selection Criteria: All the participants completed a questionnaire administered by an interviewer after the sperm was collected. The questionnaire covered personal information including background, ethnicity, period of abstinence, lifestyle factors, occupational exposure, genetic risk factors, and reproductive conditions. Information was obtained on their alcohol and smoking intake in the previous week before completing the questionnaire. Students involved in taking alcohol, cigarettes or into habits with direct bearing on sperm biosynthesis were excluded using the questionnaire. In addition, subjects that have sex within 7 days were also excluded from the study.

Physical examination: The weight and height of the volunteers were recorded, and BMI was calculated using the standard formula [BMI equals to weight in kilogram/height^2 in meters (kg/m^2)]. According to BMI, subjects were categorized into obese (BMI: ≥30 kg/m^2), overweight (BMI: 25–29.9 kg/ m^2), normal weight (BMI: 18.5–24.9 kg/m^2) and underweight (BMI: <18.5 kg/m^2). Those with obese, and overweight BMI were excluded from the study.

Semen Collection: Sterile sample containers were given to the participants for semen samples collection**.** The semen samples were collected by masturbation in sterile containers after sexual abstinence of 7 days and analyzed within 1 hour of collection. The reference values were used for definitions of normal and abnormal values of semen parameters. The remainder of the sample was centrifuged, and the seminal plasma analysed immediately without storage for seminal electrolytes.

Laboratory Analysis: An ion-selective electrode (ISE) (Analyzer ISE 4000, France) was used for the measurement of seminal electrolytes. Seminal electrolytes measured include sodium, potassium, chloride bicarbonate and calcium. The sperm count was performed with the aid of microscope by a certified Medical Laboratory Scientist.

Statistical analysis: All data are reported as means ± Standard Deviation. Student *t*-test was used for the group comparisons, whereas Pearson correlation for establishing a possible relationship. All data were analyzed by Statistical Package for Social Sciences program v.18-21 (SPSS Inc., Chicago, IL).

RESULTS

Samples from voluntary subjects were collected and classified based on the BMI (Under weighted and Normal weighted) and sperm count qualities (< 1 million cells/ml, <15 million cells/ml and ≥ 15 million cells/ml). Table 1 shows a significant increase in values of BMI and seminal sodium and bicarbonate concentrations in the normal weight when compared to underweight, whereas seminal potassium was on the contrary. Figure 1 was an expression of correlation between BMI and sperm count which showed a no significant correlation ($p \geq 0.05$).

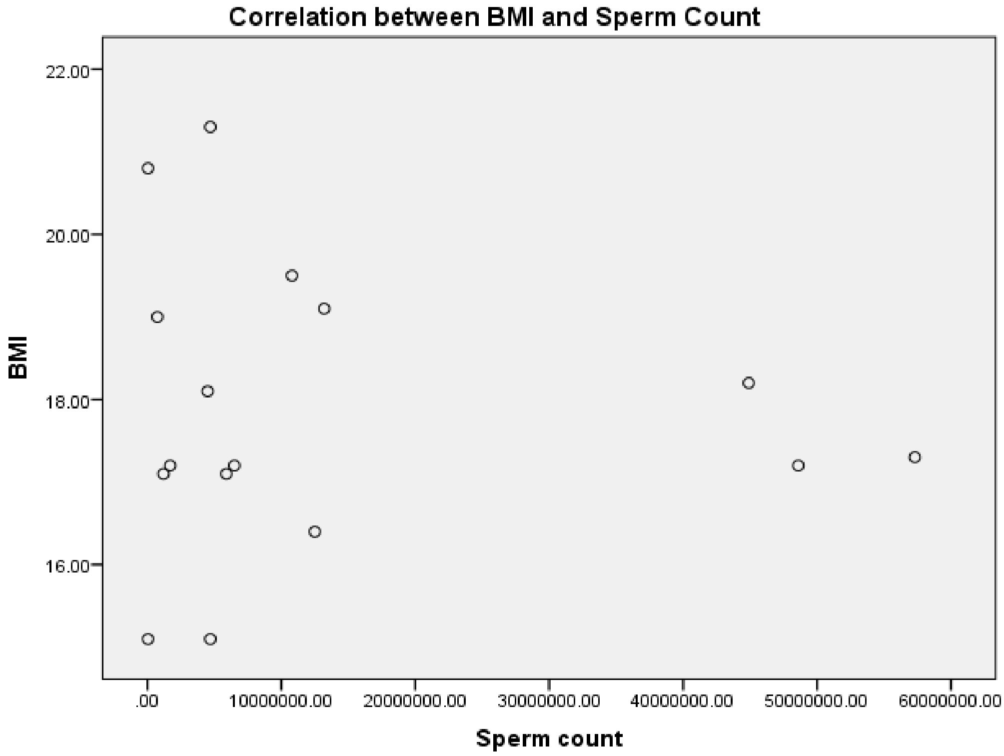
DISCUSSION

The statistical results showed that seminal sodium (Na^+) and bicarbonate (HCO_3^-) were significantly decreased in underweight group ($p \leq 0.005$) when compared with the normal weight, whereas seminal potassium (K^+) took the contrary (table 1). Similarly, Pearson analysis between sperm count and studied BMI established no significant correlation (figure 1). The stance of this study with respect to establishing relationship between sperm count and underweight was statistically non-significant. This finding was in accordance with the narrative of MacDonald et al, (2010). Underweight is characterized by low BMI which is attributable to a lot of disorders and disease conditions. Irrespective of the non-correlationship observed, BMI play significant role in ensuing healthy metabolic processes which is pivotal to normal cell growth and development. Studies have implicated abnormal body weight to elevate the risk of oligozoospermia or azoospermia (Sermondade et al, 2013).

Table 4.1 Comparison of seminal electrolytes between normal and underweighted subjects

PARAMETERS	NORMAL WEIGHTED MEAN±S.D	UNDER WEIGHTED MEAN±S.D	t- value	p-value
BMI (Kg/m^2)	21.050±0.353	17.400±1.326	-8.413	0.000
Na^+(mmol/L)	361.966±0.807	275.160±72.347	-4.487	0.001
K^{+}(mmol/L)	15.038±1.917	24.098±10.585	2.888	0.014
Cl^-(mmol/L)	60.312±0.169	80.586±54.693	1.389	0.189
HCO_3(mmol/L)	290±49	205±60	2.76	0.03

Legend MEAN±S.D = Mean ± Standard deviation, Na (Sodium), K (Potassium), Cl (Chloride) HCO_3 (Bicarbonate). Not significant level (P≥ *0.05*) Significant level (P≤ *0.05*)



Legend: Pearson correlation (r) = - 0.077 P- Value = 0.778

Figure 1. A correlational relationship between BMI and Sperm Count

Seminal HCO_3^- acts as a key capacitating agent and its importance in mediating changes in spermatozoa has been demonstrated in multiple studies in mice and humans. This result is in accordance with Gangwar, (2015). Seminal bicarbonate plays essential function in spermatozoa maturation and buffering of the environment for optimal activities. Acid-base balance is one the major roles of bicarbonate in sustaining a healthy systemic environment. The decrease in concentration of seminal bicarbonate in the underweight group is a pointer to vulnerability to infertility. This is based on the premise of unsustainable maintenance of acid-base and osmotic balance resulting from insufficiency in bicarbonate concentration. Acidotic or alkalotic environment will hinder the biosynthesis of health sperm cells and other ancillary molecules essential for fertilization. The role of seminal sodium in creating osmotic balance and a conducive environment for spermatogenesis is a known fact. The decrease in concentration of seminal sodium in the underweight group further affirms predisposition to infertility and difficulty in manufacturing a healthy sperm cells. The posture of this study is in line with the positions of handful of authors who enunciated that seminal sodium is very important for sperm metabolism, function, survival, and transport in the female genital tract. Cations such as Na, K, Ca, and P in the seminal plasma establish osmotic balance (Barrier *et al.,* 2002; Massanyi *et al.,* 2004a, Massanyi *et al.,* 2004b).The increase in seminal potassium in the underweight group as compared to the normal is controversial. Sodium and potassium actively participate in creating osmotic balance that sustains healthy spermatogenesis. Furthermore, the role in acrosomal reactions has also been attributed to seminal sodium and potassium (Vickram *et al.,* 2012). Though, the contributory osmotic balance equation favours seminal sodium based on its high concentration and osmoticallyactive index, seminal potassium is also important. The increase observed for seminal potassium in the underweight needs a further probe to validate the scientific bases which could be great insight in the study of infertility. The finding with respect to seminal potassium contradicted to stance of Hamad *et al*. (2014).

CONCLUSION

The causes of infertility are on the increase with a lot of instances of idiopathic causes. Knowing the cause of infertility is crucial for effective management and treatment. The observed fall in seminal sodium and bicarbonate amongst the under weights affirm possible predisposition to infertility. The roles of these molecules in creating osmotic balance and pH friendly environment are crucial to healthy spermatogenesis and semen transportation. Hence, these indices established in this study should be considered in infertility management. Also, a call for a further study on this topic is apt and pertinent.

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