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Acknowledgements

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Book:
Park K. Park's Textbook of Preventive and Social Medicine. 20th ed. Jabalpur, India: M/s Barnasidas Bhanot; 2009.

Book chapter:
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Original Articles

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Original Article

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Factors influencing male involvement in family planning in Sokoto metropolis, Nigeria

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ABSTRACT

Background: Lack of male involvement in family planning (FP) has been highlighted as one of the factors responsible for the low contraceptive prevalence rate in Nigeria. Male involvement in family planning can lead to contraceptive uptake and enhance the effective and continued use of contraceptive methods. **Aim:** This study aimed to assess male involvement in FP and determine the factors influencing male involvement in FP in Sokoto metropolis, Nigeria. **Materials and Methods:** It was a descriptive cross-sectional study done in Sokoto metropolis in November 2017 among 177 married men selected through a multi-stage sampling technique. A structured interviewer-administered questionnaire was used. Data were analyzed using SPSS version 23. **Results:** The mean age of the respondents was 39.4 ± 8.8 years, 84 (50.9%) had ever used a contraceptive method, only 54 (32.7%) were current users of a contraceptive method, and 83 (50.3%) were highly involved in family planning. The factors significantly associated with male involvement in family planning were the respondents and their wives' occupation and educational level, age of the respondents, social class, ever use, and current use of a contraceptive method. The predictors of male involvement in family planning were social class (aOR= 8.53, 95% CI= 1.82-39.90) and ever use of a contraceptive method (aOR= 20.68, 95% CI= 7.56-56.58). **Conclusion:** The level of male involvement in family planning established in this study is suboptimal; therefore, it is necessary to increase awareness of the need for more males to be involved in family planning.

Keywords: Family planning, contraceptive method, male involvement, Sokoto

INTRODUCTION

Nigeria has one of the fastest-growing populations in the world, making it the seventh most populous country worldwide.[1] This rapid and unprecedented increase in population is of major concern because of its potential to hinder the attainment of health and other developmental goals.[2] Unfortunately, the utilization of family planning (FP) methods has remained low in Nigeria despite its high fertility rate and decades of FP programmes.[1] The country's total fertility rate (TFR) has been declining slowly, and as of 2018, it was 5.3 births per woman.[1,3] The Northwestern part of the country has a TFR of 6.6, which is the highest in the country, and that of Sokoto State is 7.0.[3] The country's contraceptive prevalence rate (CPR) has remained low over the decades, currently 17% at the national level, 7% in the North-west zone and 2.1% in Sokoto State.[3] Lack of male involvement in FP has been highlighted as one of the factors responsible for the low CPR amongst other factors such as the desire to have more children, myths and misconceptions, and the fear of side effects.[1,4] Prevalence of joint decision-making by husbands and wives on contraceptive methods is very low in Sokoto, with just 8.7% reported in a rural community in Sokoto State, while in Enugu, it was 56.4%, and 74% in Sri Lanka.[5-7] In a survey carried out in Olorunda LGA, Osun State, the overall reported involvements among the respondents was found to be 4.8%.[4] Studies done in Bangladesh and New Delhi reported the level of male involvement in FP as 63.2%, and 72.5%, respectively.[8,9] Empirical evidence suggests that male involvement in FP can lead not only to contraceptive uptake but also to its effective use and continuation of use.[4] Unfortunately, for many decades, men have rarely been involved in FP programs until 1995, when the importance of men's involvement in reproductive health came to the limelight.[4]

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This was because it was realized that though women are the users of most contraceptive methods, men are the primary decision- makers and excluding them in FP was a losing strategy with serious consequences for not only the men but for their spouses and children.[4]

Male involvement in FP is broad and includes men's knowledge of FP, attitude about the use of contraception, communication with partners about FP, choices about appropriate contraceptive methods, giving emotional and behavioral support to their partners' contraceptive use.[9] Male involvement in FP encompasses all organizational activities aimed at men as a discrete group which have the objective of increasing the acceptability and practice of FP by both men and women.[10]

The current unmet need is 19% in Nigeria, the North West has an unmet need of 14.4%, and Sokoto State has 13%.[3] Nigeria has the highest maternal mortality ratio in sub-Saharan Africa and the second highest in the world,[5] with maternal deaths accounting for 31% of all deaths among women aged 15-49 years and the maternal mortality ratio was 512 maternal deaths per 100,000 live births.[3] Unsafe abortion, a common endpoint of unwanted pregnancy in Nigeria, contributes about 20-40% of the annual maternal deaths.[5] It has been shown that the rate of induced abortions is an indicator of the current state of family planning in any country, so the high rate of unsafe abortion in Nigeria may be attributed mainly to low CPR.[5] Most researches carried out on FP interviewed married women of reproductive age, and information about men were gathered by proxy from their wives.[11] Such information may be wrong, incomplete, or biased because many women are afraid to initiate a discussion on FP with their spouses, either for fear that their partners might respond violently or due to cultural or religious restraint.[11]

Regrettably, policies and programs based on such findings have not had the expected success in increasing CPR and at the same time reducing overall fertility.[12] Hence the need to study male involvement in FP in men from a different and more objective lens: men themselves. In Nigeria, data on male involvement in FP are generally scanty, and this is most especially so in the Northern part of the country. There is also a need to explore such concerns as the factors influencing male involvement in FP. This study was carried out to assess male involvement in FP and to determine the factors influencing male involvement in FP in Sokoto Metropolis, Nigeria.

MATERIALS AND METHODS

Study Design and Population

The study was cross-sectional in design, and it was carried out in Sokoto metropolis, Nigeria, in November 2017. Sokoto metropolis includes four Local Government Areas (LGAs): Sokoto North, Sokoto South, Dange-Shuni, and Wamakko. The study population consisted of married men whose wives were within the reproductive age group (15-49 years) and had been married for at least one year before the commencement of the study. In instances where a man had more than one wife, questions were asked about the most senior wife if she was within the reproductive age group. If the most senior wife is not within the reproductive age group, then the questions were asked about the second most senior wife if she was within the reproductive age group.

Sample Size Estimation and Sampling Technique

The sample size was estimated at 159 using the formula for proportion,[13] a CPR of 11.7% from a previous study,[14] and a precision level of 5%. One hundred and seventy-seven eligible study participants were enrolled in the study in anticipation of a 90% response rate and were selected by a multi-stage sampling technique. Stage 1 entailed selecting 2 LGAs, while in stage 2, two wards were selected from each of the selected LGA, and in stage 3, one settlement was selected from each of the 4 wards; all these were done through a simple random sampling technique by balloting. Proportionate allocation of participants was done as follows: 40, 59, 51, and 28 respectively to the four selected settlements. In stage 4, systematic random sampling was used to enroll households to obtain the study subjects after obtaining the sampling frame.

Data Collection

A 54-item structured interviewer-administered questionnaire was adapted from previous studies[2,4,15-17] and used to obtain information on the respondents' socio-demographic characteristics and male involvement in FP. The questionnaire's content validity was assessed after it was reviewed by researchers of the Community Health Department, Usmanu Danfodiyo University Sokoto, Nigeria. The questionnaire was pretested by the principal researcher and six research assistants in Sokoto North LGA (which was not one of the LGAs selected for the study) after the conclusion of the training of the research assistants who were medical students of Usmanu Danfodiyo University Sokoto.

Ever use and current use of any FP method was when either the wife or the husband had ever used or was using a FP method respectively. Respondents' involvement in FP was scored and graded on an 8- point scale of self-reported actions by married men. Each correct response was scored '1' while wrong, and no responses were scored '0'. These were converted into percentages and graded into ≥60% = high male involvement and <60% = low male involvement.[15] The social class of the couple was computed using the occupation and educational level of the respondents and their wives based on Oyedeji's method.[18]

Data were processed using IBM SPSS version 23. Quantitative variables were summarized using mean and standard deviations, while qualitative variables were summarized using frequencies and percentages. The Chi-square test was used for bivariate analysis, while binary logistic regression analysis was used to determine the predictors of male involvement in FP. All levels of statistical significance were set at $p < 0.05$.

Ethical Consideration

Ethical clearance for the study was obtained from the Research and Ethics review committee of the Sokoto state Ministry of Health; permission was obtained from the LGA and traditional ruler of each settlement, while written informed consent was obtained from the participants.

RESULTS

Socio-demographic characteristics of respondents

A total of 177 questionnaires were administered to the respondents; 165 were filled and valid for use after data cleaning (giving a response rate of 93%). The mean age of the respondents was 39.4 ± 8.8 years, with 63 (38.2%) being in 35-44-year age group. Sixty-nine were civil servants (41.8%), 88 had tertiary education (53.3%) and 87 had at most four children (52.7%). The majority were Hausa and Muslims (Table 1). The mean age of the wives was 28.3 ± 6.8 years with the majority being in 25-34-year age group. Most of the wives had only Qur'anic education 61 (37%) and were unemployed 102 (61.8%). Only 11 (6.7%) of the couple were in social class I (Table 2).

Male involvement in family planning

Eighty-four (50.9%) of the respondents or their wives had ever used a FP method and only 54 (32.7%) of the respondents or their wives were using a FP method at the time of the survey (Figure 1). Implants were the commonest FP methods being used by the couples (25, 46%).

Table 1: Socio-demographic characteristics of respondents

Variables	Frequency (%) n = 165
Age group (years)	
25-34	57 (34.5)
35-44	63 (38.2)
45-54	34 (20.6)
≥ 55	11 (6.7)
Tribe	
Hausa	149 (90.3)
Igbo	5 (3.0)
Yoruba	7 (4.2)
Other (e.g., Fulani, Egbira)	4 (2.4)
Religion	
Islam	158 (95.8)
Christianity	7 (4.2)
Educational level	
Quranic	30 (18.2)
Primary	12 (7.3)
Secondary	35 (21.2)
Tertiary	88 (53.3)
Occupation	
Trader	54 (32.7)
Farmer	12 (7.3)
Artisan	19 (11.5)
Student	2 (1.2)
Civil servant	69 (41.8)
Other (e.g., Gateman, Bike)	9 (5.5)
No of children	
≤ 4	87 (52.7)
> 4	78 (47.3)

Table 2: Socio-demographic characteristics of the respondents and their wives

Variables	Frequency (%) n = 165
Age group of wife (years)	
15-24	54 (32.7)
25-34	74 (44.8)
≥ 35	37 (22.4)
Wife's educational level	
Quranic	61 (37.0)
Primary	8 (4.8)
Secondary	53 (32.1)
Tertiary	43 (26.1
Wife's occupation	
Unemployed	102 (61.8)
Trader	32 (19.4)
Artisan	2 (1.2)
Student	3 (1.8)
Civil servant	24 (14.5)
Other (e.g., Nanny, Baker)	2 (1.2)
Social class of the couple	
SC I	11 (6.7)
SC II	26 (15.8)
SC III	45 (27.3
SC IV	49 (29.7)
SC V	34 (20.6)

The commonest reason for the current use of FP was to space birth (48, 88.9%) [Table 3)]. Less than half of the respondents (80, 48.5%) discussed FP with their wives in the preceding one year and 74 (44.8%) discussed on the desired number of children. Only 73 (44.2%) had ever

accompanied their wives to a FP clinic and 76 (46.1%) had ever provided money for FP services. The majority 117 (70.9%) of the respondents said they made the final decision on FP jointly with their wives and about half 83 (50.3%) of the respondents were highly involved in FP (Table 4).

Factors associated with male involvement in family planning

High male involvement in FP was associated with the respondents and their wife's occupation and educational level, age of the respondents, social class, ever use, and current use of a FP method. The proportion of respondents who were highly involved in FP was significantly higher among those in the upper social classes (91.9%) as compared to those in the middle social class (60.0%) and lower social classes (26.5%), those who had ever used a method of FP (85.7%) as compared to those who had never used a method of FP (13.6%) [Table 5].

In binary logistic regression analysis, upper social class (I & II) and ever use of a FP method were found to be predictors of high male involvement in FP. Those in the upper social class and those who had ever used a method of FP were about 15 times (aOR= 14.77, 95% CI= 3.24-67.45, p=0.001) and 40 times (aOR= 39.67, 95% CI= 16.08-97.87, p< 0.001) more likely to be highly involved in FP respectively (Table 6).

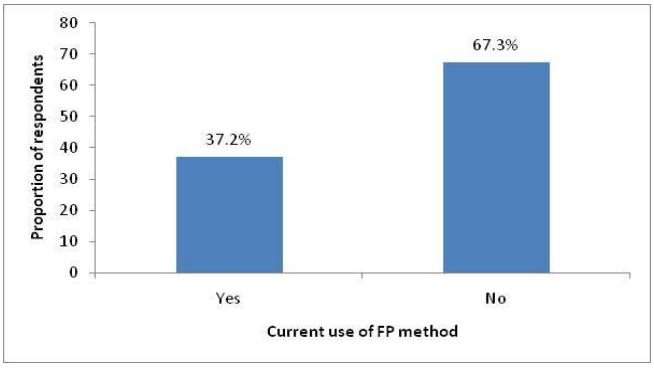

Figure 1: Current use of family planning methods by the respondents

DISCUSSION

This study assessed male involvement in FP and the factors influencing male involvement in FP in Sokoto Metropolis, Nigeria. Whereas about half of the respondents or their wives had ever used a method of FP, 32.7% were using a method of FP at the time of the survey which is in line with the studies done in Ogun, Uganda, and Tanzania[19-21] but differs from the findings of National Demographic and Health Survey of 2018 where the CPR was 17% nationally and 2.1% in Sokoto State.[3] The similarity with the former studies is likely because the respondents in those studies were men; and the dissimilarity with the later study likely because the respondents were women and the figures were for both the urban and rural areas. Although CPR in this study is encouraging, this is however not surprising as about half of the respondents had tertiary education and more than half of their wives had at least secondary education as an increase in educational attainment is positively associated with the use of a FP method.[3] Also, this study was done in urban areas where access to FP services may not be a problem.

Table 3: Pattern of family planning methods use among the respondents

Variables	Frequency (%) n = 54
Type of FP method used by the couples	
Male condom	6 (11.1)
Pills	4 (7.4)
Injectables	16 (30.0)
Implants	25 (46.0)
IUCD	3 (5.5)
Source of FP method	
PHC	9 (16.7)
Hospital	37 (68.5)
Drug store (chemist)	8 (14.8)
Purpose of using a FP method*	
Space birth	48 (88.9)
Achieve desired family size	26 (48.1)
Improves family's financial condition	16 (29.6)
Avoid unwanted pregnancy	12 (22.2)
Promote child health and improve quality of child care	12 (22.2)
Sexual fulfillment	4 (7.4)
Avert potential adverse effects of high fertility on the woman's health	1 (1.9)
Reasons for not using any FP method*	
No desire to use / not interested	72 (64.9)
Wife is currently pregnant	24 (21.6)
Religion / culture	19 (17.1)
Lack of awareness about FP	12 (10.8)
Delay in return of fertility	11 (9.9)
Side effects	8 (7.2)
Wife's refusal	9 (8.1)
Doesn't know where to get services	8 (7.2)
Encourage infidelity	4 (3.6)
Decrease in sexual urge of women	4 (3.6)
Desire for more children	31 (27.9)
Wife just delivered	1 (0.9)
Willingness to use FP in the future	
Yes	68 (61.3)
No	43 (38.7)

An analysis of the FP methods currently being used by the respondents and or their wives revealed implants to be the commonest method used. The fact that implant was the commonest method utilized in this study may be because 68.5% obtained their commodities in the hospital where the expertise for the insertion of implants

is available. Since implants are long-acting reversible contraceptives, and they are being utilized by the majority in this study, it is hopeful that couples would be able to meet their needs for spacing and limiting.

The commonest reason for the current use of FP was to space birth (88.9%) and a little less than half (48.1%) were using FP to achieve the desired family size. This may be explained by the fact that people in Northern Nigeria by their religion and tribe (Islam and Hausa) are more receptive to the idea of using FP for spacing births instead of limiting births as the latter is believed to be disallowed in the religion by some people.[14] Almost two-thirds of the respondents gave lack of interest as the reason they or their wives were not using a FP method as at the time of the survey. This underscores the need to enlighten the people by providing more information on the benefits of FP.

Only half of the respondents were highly involved in FP which is in tandem with the results recorded in studies done in Bangladesh and New Delhi[8,9] but different from the findings of a study done in Osun, Ogun, and Rwanda.[4,19,22] The outcome demonstrated in this study is encouraging but sub-optimal because as it is, the majority (74.5%) of the respondents had at least secondary education. However, level of education may not necessarily apply to their involvement in FP due to their religion and culture.

Less than half of the respondents had a discussion with their wives on FP in the preceding one year (48.5%). This is in consonance with the findings from the study done in Tanzania where 45.4% reported that they had a discussion with their wives in the preceding one year[20] but a study done in Sri Lanka recorded a higher figure (87.2%).[6] Though the outcome from this study is sub-optimal, it is hoped that with continuous enlightenment campaigns, discussion about FP by couples will be more frequent. Research has shown that communication between spouses is an important step before utilization and sustained use of FP.[4]

Regarding discussion with wife on the desired family size and on child spacing, 44.8% and 62.4% respectively indicated that they have ever done so in the past. The fact that a higher proportion of the respondents said they had a discussion on child spacing than child limiting was not surprising as 88.9% and 48.1% of the respondents currently using a FP method said it was to space birth and limit family size respectively, thus further buttressing the receptivity of child spacing more than child limiting in this part of the country.

Table 4: Involvement of the respondents in family planning

Variables	Frequency (%) n = 165
Discussed with your wife on FP in the preceding one year	
Yes	80 (48.5)
No	85 (51.5)
If yes, how many times?	
Range = 1-12 times	
Mean number of times = 3.9 ± 2.4	
Discussed with your wife the type of FP method to use	
Yes	95 (57.6)
No	70 (42.4)
Discussed with your wife the number of children to have	
Yes	74 (44.8)
No	91 (55.2)
Discussed with your wife on child spacing	
Yes	103 (62.4)
No	62 (37.6)
Provided money for FP services	
Yes	76 (46.1)
No	89 (53.9)
Accompanied your wife to the FP clinic	
Yes	73 (44.2)
No	92 (55.8)
Ever gone against the wish of your wife when it comes to FP issues	
Yes	24 (14.5)
No	141 (85.5)
Who made the final decision on FP in your home?	
Husband only	45 (27.3)
Wife only	3 (1.8)
Both husband and wife	117 (70.9)
Male involvement grade	
Low	82 (49.7)
High	83 (50.5)

A smaller proportion of the respondents had ever accompanied their wives to the FP clinics (44.2%) and provided money for FP services (46.1%) which were supported by a study done in Ogun State where 39.6% accompanied their wives to FP clinics.[19] However, the findings were contrasted by a study done in Osun State where 80.9% provided money for FP and 15.5% accompanied their wives to FP clinics.[4] The results in this study are encouraging, and it is anticipated that with increased enlightenment, more men will be involved in FP which may increase the CPR as research has shown that partner support is associated with the use of FP.[22]

Joint decision-making by couples about the use of FP is a key determinant of contraceptive use.[2] The majority of the respondents said they made the final decision on FP jointly with their wives, 27.3% said they made the decisions alone and 1.8% said only the wife decided with none admitting to decisions been made by the husband or wives' relatives.

These findings were similar to the study done in Rwanda[22] but in contrast to the findings of the study carried out in Kware in Sokoto State.[7] The high prevalence of joint decision-making by the couple as reported by men in this study as compared to other Nigerian studies may probably be an overestimate because three-fourth had a minimum of secondary education, and they do not want to be recognized as the prime decision-makers because they know that the right thing to do is to make a decision jointly.

Respondents in the upper social class and those who had ever used a method of FP were about 15 times and 40 times more likely to be highly involved in FP respectively. Social class was computed using the occupation and educational level of the husbands and wives. More than half of the respondents in this study had tertiary education and more than half of their wives had at least secondary education; this underscores the importance of high educational achievement in both spouses in male involvement in FP. Similarly, respondents who had ever used a method of FP were likely to have received some form of enlightenment on FP thus making their involvement in FP more likely.

Table 5: Factors associated with male involvement in FP among the respondents

Variables	Level of male involvement		Test of significance
	Low Frequency (%)	High Frequency (%)	
Age groups (years)			
< 40	52 (57.1)	39 (42.9)	χ^2= 4.500,
≥ 40	30 (40.5)	44 (59.5)	p = 0.034*
Occupation			
Informal sector	62 (66.0)	32 (34.0)	χ^2= 23.104,
Formal sector	20 (28.2)	51 (71.8)	p < 0.001*
Educational level			
Informal	23 (76.7)	7 (23.3)	χ^2= 10.668,
Formal	59 (43.7)	76 (58.3)	p = 0.001*
No of children			
≤ 4	46 (52.9)	41 (47.1)	χ^2= 0.743,
> 4	36 (46.2)	42 (53.8)	p = 0.389
Age of wife (years)			
≤ 4	70 (51.5)	66 (48.5)	χ^2= 0.974,
> 4	12 (41.4)	17 (58.6)	p = 0.324
Education level of wife			
Informal	46 (75.4)	15 (24.6)	χ^2= 25.595,
Formal	36 (34.6)	68 (65.4)	p < 0.001*
Occupation of wife			
Unemployed / Informal sector	79 (57.2)	59 (42.8)	χ^2= 19.227, p < 0.001*
Formal sector	3 (11.1)	24 (88.9)	
Social class			
Upper SC (I and 2)	3 (8.1)	34 (91.9)	χ^2= 46.094,
Middle SC (III)	18 (40.0)	27 (60.0)	p < 0.001*
Lower SC (IV and V)	61 (73.5)	22 (26.5)	
Ever use a FP method			
Yes	12 (14.3)	72 (86.7)	χ^2= 85.830,
No	70 (86.4)	11 (13.6)	p < 0.001*
Current use of a FP method			
Yes	5 (9.3)	49 (90.7)	χ^2= 52.505,
No	77 (69.4)	34 (30.6)	p < 0.001*

χ^2 = Pearson's Chi-square test; SC = Social class; *Significant ($p<0.05$)

Table 6: Predictors of male involvement in FP among the respondents

Variables	aOR	95% CI		p – value
		Lower	Upper	
Social class				
Upper versus Lower*	14.77	3.24	67.45	0.001**
Middle versus Lower*	1.95	0.68	5.56	0.214
Ever use of a FP method				
Yes versus No*	39.67	16.08	97.87	<0.001**

aOR = adjusted Odds Ratio; CI = Confidence Interval; *Reference group; **Significant (p<0.05)

CONCLUSION

The level of male involvement in FP established in this study is suboptimal; male involvement in FP was influenced by occupation and educational level of the respondents and their wives, social class of the couple, and ever use of a FP method. This underscores the need by the Sokoto State Government and the various non-governmental organizations like MSI, community-based organizations and religious bodies to increase the information on FP and the need for males to be involved through public enlightenment programs using all forms of media.

Limitations of the study

The male involvement actions were self-reported by the respondents and there is tendency for over-reporting of desirable actions and under-reporting of undesirable ones. An attempt was made to minimize this by assuring them of confidentiality and buttressing that the research is only for academic purposes.

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Nil.

Conflict of interest

None declared.

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Microbial studies in acute suppurative otitis media in children attending a tertiary health facility in North-western Nigeria

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ABSTRACT

Background: Acute suppurative otitis media (ASOM) is one of the most common otorhinolaryngological childhood infections globally, associated with prescription of antimicrobial agents even against a background of increasing bacterial resistance to antibiotics. **Aim**: This study is aimed at evaluating the microbial isolates of ASOM in children, attending Usmanu Danfodiyo University Teaching Hospital, Sokoto, North-western Nigeria. **Materials and Methods:** A cross-sectional study design was used to investigate 58 patients who met the inclusion criteria. Methods of data collection were interviewer administered questionnaire, clinical examination, and laboratory investigation. Quantitative variables were summarized using mean and standard deviations, while qualitative variables were summarized using frequencies and percentages. **Results**: The proportion of sterile cultures was 3.3%, while the remaining showed different species of aerobes (96.7%), anaerobes (1.6%) and fungi (4.9%). Ratio of gram-positive to gram-negative aerobic bacteria was 3.5: 1.The gram-positive aerobes isolated were Streptococcus pneumonia (37.7%), Streptococcus pyogenes (14.8%) and Staphylococcus aureus (23.0%); while Moraxella catarrhalis (11.5%) was the main gram-negative aerobe. Bacteroides fragilis (1.6%) was the only anaerobe, while Aspergillus niger (3.3%) was among the fungi isolated. Amoxicillin/clavulanic acid showed 100.0% sensitivity; followed directly by erythromycin (91.5%). **Conclusion**: This study showed that ASOM is more likely a mono-aerobic infection than polymicrobial, with high sensitivity to amoxicillin/clavulanic acid. Its treatment should include among others, early commencement of antibiotics with good gram-positive and gram-negative aerobic coverage.

Keywords: Acute suppurative otitis media, microbes, antimicrobials, sensitivity

INTRODUCTION

Acute suppurative otitis media (ASOM) is one of the most common otorhinolaryngological childhood infections throughout the world, and is associated with incessant prescription of antimicrobial agents even against a background of increasing bacterial resistance to antibiotics.[1-5] A recent worldwide systematic review estimated that there are 709 million new cases of acute otitis media annually, with greater than half in children under 5 years of age.[6] The incidence rates range from about 3.64 for Central Europe to as high as 43.36 for Sub-Saharan Africa.[6] Many local studies have also highlighted its high prevalence when compared to other otorhinolaryngological diseases like labyrinthitis, allergic rhinitis, epiglottitis, laryngitis, or even pharyngotonsillitis.[3,7,8]

This high prevalence of ASOM in developing countries of the world is probably because of poverty, ignorance, dearth of specialists and limited access to medical care.[9,10] Thus, when poorly managed and allowed to complicate, the disease can pose serious health-economic burden on the patient. ASOM is defined clinicopathologically as inflammation of the middle ear cleft of rapid onset and infective origin, associated with suppuration from the middle ear through a transient perforated tympanic membrane.[5] The condition usually starts as an acute otitis media with signs of inflammation, fullness and erythema, as well as symptoms associated with inflammation such as otalgia, irritability and fever. But this diagnosis is often missed in children especially in malaria endemic regions because

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the initial onset of fever is treated as plasmodiasis, and only recognized when the ear begins to suppurate.[11]

Pathophysiologically, the initial acute otitis media without suppuration can be referred to as either stage I (tubal occlusion) or stage II (pre-suppuration) of the disease, while ASOM proper is stage III (suppuration). After suppurating, the disease may either abate (stage IV) or progress into complications (stage V). Interestingly, early diagnosis of acute otitis media, including the quality, adequacy and timely institution of treatment in terms of proper antimicrobials is key to preventing progression through these stages. A combination of microbiological, environmental, and early childhood anatomical variations like the uniqueness of their Eustachian tube, well-endowed lymphoid follicles (adenoids) in their nasopharynx, and immaturity of their immune system, predispose children to developing the infection.[12]

Since the most common cause of ASOM is bacterial infection of the middle ear, emphasis has been on culture of middle ear effusion and not necessarily ear swabs from the external auditory canal (EAC) as they do not represent the actual aetiologic microbes in suppurative otitis media.[13,14] Majority of studies are biased towards identifying causative organisms in chronic suppurative otitis media(CSOM) than ASOM, probably because of the lack of consensus regarding the transition time from acute to chronic form of suppurative otitis media. However, the leading causes of bacterial ASOM in the order of prevalence are Streptococcus pneumoniae, non-typeable Haemophilus influenzae, Moraxella catarrhalis, and group A Streptococcus.[4,5,15] Less frequently reported are Streptococcus pyogenes and Staphylococcus aureus.[5,16] A study conducted on ASOM in Sokoto state, Nigeria isolated Staphylococcus aureus (46.2%), Escherichia coli (23.1%), Proteus and Pseudomonas species (12.8% each) and Klebsiella species (5.1%).[2] While in south-western Nigeria, Streptococcus pneumoniae (38.1%), Moraxella catarrhalis (19.0%) and Staphylococcus aureus (16.7%) were cultured as predominant bacteria in ASOM.[17] Another study on 272 patients with ASOM in Akwa Ibom state, Nigeria isolated Aspergillus niger as the predominant fungus, followed by Candida albicans (24.4%), Cryptococcus neoformans (20.5%), Candida species (13.5%) and Aspergillus flavus (9.0%).[18]

Many antimicrobial agents including penicillins, cephalosporins, vancomycin and azithromycin have been used for the treatment of ASOM. However, bacterial resistance to these antimicrobials has become an increasing source of concern globally, making treatment controversial and continuously changing.[5,19] Amoxicillin has been the first line antibiotic for treating ASOM, even with a high prevalence of drug-resistant Streptococcus pneumoniae, because resistance to beta-lactam antibiotics, such as amoxicillin, develops as a stepwise process.[5] Aminoglycosides especially gentamycin and the quinolones have remained sensitive and cost-effective over the years in the treatment of ASOM especially in poor resource countries.[2,20,21] Demonstrable variable percentages of sensitivities of middle ear fungal isolates from ASOM to fluconazole, voriconazole, ketoconazole and nystatin have been identified.[18]

Despite the global advancements in antimicrobial therapy and the many interesting transformative developments in laboratory and clinical management of infectious diseases, ASOM still suffers a dearth of knowledge in management especially in the suburbs and most primary and secondary level health care institutions. With poor or inadequate management, the disease can become persistent, recurrent, resistant or even progress to become CSOM with all its untoward complications. This study, therefore aimed to determine the microbiological isolates of ASOM in children, with their antimicrobial sensitivity pattern in UDUTH, North-western Nigeria. Findings from this study will direct physicians on the proper management of the condition.

MATERIALS AND METHODS

Study Area, Design, and Population

Sokoto state is located to the extreme Northwestern corner of Nigeria, within the Sudan savanna belt. Usmanu Danfodiyo University Teaching Hospital, the study center is situated in Wamakko LGA, within the Sokoto metropolis. It is a tertiary institution with 850 bed capacity, serving as referral centers to several hospitals within the North-western region. This was a cross-sectional hospital-based study conducted among children aged less than 18 years that attended the Ear, Nose and Throat (ENT), paediatric, and general outpatient clinics of UDUTH between December 2017 and June 2018. The inclusion criteria were new paediatric patients with a clinical diagnosis of ASOM and an active otorrhoea. Diagnosis of ASOM was based on the presence of a tympanic membrane perforation with otorrhoea of < 2 weeks, originating from the middle ear.[13,22] Patients with non-active ASOM, those who had received antimicrobial medication either ototopic or systemic 1 week before presentation, HIV/AIDS, malnourished children and patients whose

caregivers declined participating in the study were excluded. A total of 58 patients who met the inclusion criteria between December 2017 and June 2018 were recruited for the study.

Data Collection and Analysis

The methods of data collection employed include questionnaire survey by interview, clinical examination, and laboratory investigation. The procedure for collection of the middle ear discharge was innocuous and carried out by an Otorhinolaryngologist. Conchae were cleaned and sterilized with gauze soaked in 70% alcohol to remove contaminants. The EAC was also cleaned and sterilized using gauze-wig soaked and squeezed in 70% alcohol, and preliminary otoscopy done. Otomicroscopy was carried out to locate perforation on the tympanic membrane, and aid aspiration of the middle ear exudate using sterile disposable plastic Pasteur pipettes. Anaerobic samples were expressed immediately into tubes containing thioglycolate broth (transport medium) under an anaerobic chamber, while samples for aerobic and fungal culture were expressed onto a well labeled sterile swab stick (in Amies transport media) enclosed in airtight plastic tubing. Bilaterally discharging ears had their samples collected separately. All samples were sent within 2 hours to the Microbiology Department of UDUTH, Sokoto for microbiologic culture and sensitivity analysis.

For bacterial isolation, the middle ear discharges were inoculated on well-labeled dried Chocolate, MacConkey and 5% Sheep Blood agar plates at 37^0c for 18-24 hours aerobically and anaerobically, except for Chocolate agar that was incubated in a candle jar. Visual examination was done for bacterial growths after 18-24 hours, and plates with no growth were discarded, and labeled sterile for bacteria. But where there were growths, bacteria was identified by standard techniques based on morphological, cultural, and biochemical characteristics.[23-24] Antimicrobial sensitivities were carried out using the Kirby Bauer disk diffusion method.[25]

For fungal isolation, the swab sticks were streaked directly on the well labeled Sabouraud's Dextrose Agar (SDA) plates and incubated at room temperature aerobically for 3-7 days. The growths were identified based on their morphological and cultural characteristics, and microscopic examination done using lactophenol blue staining technique.[26]Antifungal sensitivities were carried out using standard protocols.[25] The Statistical Package for the Social Sciences (SPSS) version 23 software (IBM Corp, Armonk, NY, USA) was used for the data processing. Quantitative variables were summarized using mean and standard deviations, while qualitative variables were summarized using frequencies and percentages.

Ethical Consideration

Institutional ethical approval was sought and obtained. Assents were gotten from the parents and guardians to enroll their children/wards into the study.

RESULTS

Socio-demographic profile of study subjects

A total of 58 patients were studied, of which 61 middle ear discharges were collected from either the right, left or both ears. Their ages ranged from 5 months to 15 years, with a mean age of 4.5 years. Majority of the patients were males (60.4%), with a male to female ratio of 1.5:1. Close to half 27 (46.6%) of the patients, were yet to be enrolled into school (Table 1).

Table 1: Socio-demographic profile of study subjects

Variables	Frequency (%) n = 58
Age group (years)	
< 1	5 (8.6)
1-5	37 (63.8)
6-10	13 (22.4)
11-15	3 (5.2)
Sex	
Male	35 (60.4)
Female	23 (39.6)
Tribe	
Hausa	28 (48.3)
Fulani	16 (27.6)
Yoruba	9 (15.5)
Igbo	3 (5.2)
*Others	2 (3.4)
Religion	
Islam	53 (91.4)
Christianity	5 (8.6)
Educational level	
Yet to be enrolled	27 (46.6)
Day-care	4 (6.9)
Nursery	9 (15.5)
Primary	13 (22.4)
Secondary	5 (8.6)

*Others (Tiv, Ibibio, etc.)

Laterality of ASOM in study subjects

Acute suppurative otitis media (ASOM) was diagnosed in the right ear in a larger proportion of study subjects (46.4%), and both ears were affected in a few of them (15.5%) [Figure 1].

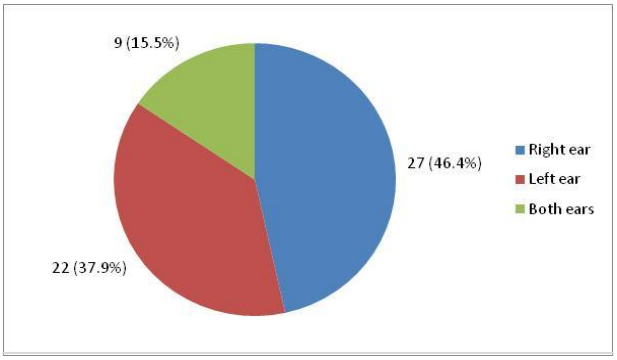

Figure 1: Laterality of ASOM in study subjects

Microbes isolated from aspirates

The microbes isolated in this study are shown in Table 2. Out of the 61 aspirates collected, 2 (3.3%) were sterile culturing neither bacteria nor fungi. The remaining 59 (96.7%) cultured different species of bacteria and fungi. The ratio of aerobes: anaerobes: fungi was 60.4: 1: 3.1, while the ratio of gram-positive: gram-negative aerobic bacteria was 3.5: 1. Streptococcus species (52.5%) was the most isolated gram-positive aerobe, followed by Staphylococcus aureus (23.0%), while Moraxella catarrhalis (11.5%) was the most isolated gram-negative aerobe. Only 1 (1.6%) species of anaerobe Bacteroides fragilis was isolated, while Aspergillus niger (3.3%) and Candida albicans (1.6%) were the fungal isolates. One patient (1.7%) displayed polymicrobial infection which comprised Staphylococcus aureus, Bacteroides fragilis, and Candida albicans.

Antibiotic sensitivity pattern of the isolated bacteria

The antibiotic sensitivity pattern of the isolated bacteria is shown in Table 3. Overall, amoxicillin/clavulanic acid (100.0%) showed the best sensitivity, followed by erythromycin (91.3%) and ceftriaxone (89.8%). The Bacteroides fragilis isolated was sensitive to many antibiotics including metronidazole and clindamycin.

Antifungal sensitivity pattern of the isolated fungi

All fungal isolates showed excellent susceptibility to all the antifungals tested (Table 4).

Table 2: Microbes isolated from aspirates

Variables	Frequency (%)	Percentage of total aspirates
A. Aerobes		
Gram-positive		
Streptococcus pneumonia	23 (37.7)	
Streptococcus pyogenes	9 (14.8)	75.4
Staphylococcus aureua	14 (23.0)	
Gram-negative		
Moraxella catarrhalis	7 (11.5)	
Escherichia coli	2 (3.3)	
Enterobacter species	1 (1.6)	
Citrobacter species	1 (1.6)	21.3
Proteus mirabilis	1 (1.6)	
Pseudomonas aeruginosa	1 (1.6)	
Total isolates	59 (96.7)	
B. Anaerobes		
Bacteroides fragilis	1 (1.6)	1.6
Total isolates	1 (1.6)	
C. Fungi		
Aspergillus niger	2 (3.3)	4.9
Candida albicans	1 (1.6)	
Total isolates	3 (4.9)	
D. Sterile aspirates	2 (3.3)	3.3
Total aspirates	**61 (100.0)**	

DISCUSSION

This study revealed a higher prevalence of ASOM among children aged 1 – 5 years (63.8%), which was almost three-times the value for those aged 6 – 10 years (22.4%). These findings were similar to those reported in France and Bangladesh, reiterating ASOM as a childhood disease.[28-29] The reasons for this high prevalence in this age group has been linked to immaturity of their immune system and the uniqueness of their Eustachian tube which is relatively shorter, wider, and straightened. Hence, infected materials from the nose, adenoids and sinuses readily pass along the Eustachian tube to the tympanic cavity; particularly during coughing, sneezing, vomiting, crying, and supine breastfeed or bottle feeding.[5,30]

Table 3: In vitro antibiotic sensitivity pattern of the isolated bacteria

Isolated aerobes (n)	Antibiotics, n (%)								
	Gent	Chl	Am/Clav	Ery	Cot	Oflx	Ceft	Met	Amx
Streptococcus pneumonia (23)	8 (34.8)	15 (65.2)	23 (100.0)	21 (82.6)	15 (65.2)	19 (82.6)	21 (82.6)	3 (13.0)	4 (17.4)
Streptococcus pyogenes (9)	3 (33.3)	7 (77.7)	9 (100.0)	8 (88.8)	7 (77.7)	6 (66.6)	8 (88.8)	1 (11.1)	1 (11.1)
Staphylococcus aureus (14)	11 (78.6)	13 (92.9)	14 (100.0)	14 (100.0)	10 (71.4)	12 (85.7)	13 (92.9)	5 (35.7)	3 (21.4)
Moraxella catarrhalis (7)	7 (100.0)	7 (100.0)	7 (100.0)	5 (71.4)	5 (71.4)	5 (71.4)	7 (100.0)	3 (42.9)	1 (14.3)
Escherichia coli (2)	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)	-	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)
Enterobacter species (1)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	-	1 (100.0)	-	1 (100.0)	1 (100.0)
Citrobacter species (1)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	-	1 (100.0)	-	1 (100.0)	-
Proteus mirabilis (1)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	-	1 (100.0)	1 (100.0)	1 (100.0)	-
Pseudomonas aeruginosa (1)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	-	1 (100.0)	1 (100.0)	1 (100.0)	-
Bacteroides fragilis (1)	-	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	-	1 (100.0)	1 (100.0)	-
Total (59)	35 (59.3)	49 (83.1)	59 (100.0)	54 (91.5)	38 (64.4)	23 (37.7)	53 (89.8)	19 (32.2)	12 (20.3)

Gent- Gentamycin (10µg); Chl- Chloramphenicol (10µg); Am/clav- Amoxicillin/clavulanic acid(30µg); Ery- Erythromycin (5µg); Cot- Cotrimoxazole (25µg); Oflx- Ofloxacin (30µg); Ceft- Ceftriaxone (30µg); Met- Metronidazole (5µg); Amx- Amoxicillin (25µg)

Table 4: In vitro antifungal sensitivity pattern of the isolated fungi

Fungal isolate (n)	Antifungals, n (%)					
	Clot	Nys	Flu	Gsf	Ket	ter
Aspergillus niger (2)	2 (100.0)	1 (50.0)	2 (100.0)	2 (100.0)	2 (100.0)	2 (100.0)
Candida albicans (1)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)	1 (100.0)
Total (3)	**3 (100.0)**	**2 (66.7)**	**3 (100.0)**	**3 (100.0)**	**3 (100.0)**	**3 (100.0)**

Nys- Nystatin (100U); Flu- Fluconazole (25µg); Gsf- Griseofulvin (2µg); Ket- Ketoconazole (10µg); Ter- Terbinafine (10µg)

The decline in the incidence of ASOM after this age is probably because the Eustachian tube matures by age of 7 years.[5] However, a study conducted in a semi urban community of Osun State, Southwestern part of Nigeria found the prevalence lowest in those <1 year, which is different from findings in this study, where their prevalence was third (8.6%) on the list.[10] The reason for this discrepancy might be that our study which is hospital-based, does not usually depict the true prevalence of a disease in a community.

A male to female ratio of 1.5: 1 was recorded from this study. This is in agreement with findings reported in Benin, Ibadan, and South Africa.[31-33] No rationale for this apparent disparity in sex prevalence has been identified. However, it may be socio-culturally related in this study, as the female child unlike their male counterparts have special dressings (hijab) that cover

their ears and thus reduces the stigma that is attributed to discharging ear. On the contrary, since the male child does not wear this covering, the parents might tend to seek more urgent medical attention to reduce this stigma. Others have attributed it to higher activity of the male children compared with the females, which exposes them to aural trauma and infectious conditions.[10] A similar study in Yemen, noted female predominance, although adults were part of their study population; while studies conducted in Benin and Kano noted an almost equal sex distribution.[19-21]

This study revealed a slightly increased unilateral right ASOM over the left in a ratio of 1.2:1 and a unilateral over bilateral disease (5.4:1), which is similar to findings in Yemen.[19] Left ear predominance, and even equal distribution of the disease between both ears have also been reported in Nigeria and South Africa.[17,33-35] This preponderance of the right ear over the left might just be an incidental finding. However, there is a possible association between bilateral infection and severity of disease.[17] Thus, it is only reasonable to consider bilateral ear involvement as a more severe disease requiring more attentive management protocol.

This study revealed a high prevalence of aerobic bacteria (96.7%) than fungi (4.9%) and anaerobes (1.6%). And the ratio of monomicrobial to polymicrobial infection was 13.9:1. These findings strongly suggest that ASOM is more likely a mono-aerobic infection than polymicrobial. A similar study in Abakaliki, a town in south-eastern Nigeria, cultured more mono-microbials (81.5%) than poly-microbials (6.2%).[35] Also in Lagos, south-western Nigeria, more aerobes (85.7%) were cultured than anaerobes (14.3%) from ASOM.[17] Anaerobes are usually associated with cholesteatoma and granulations especially in CSOM; thus the reason for its relatively low prevalence.

This study revealed a higher prevalence of Gram-positive aerobes when compared with the Gram-negative aerobes in a ratio of 3.5:1. This again strongly suggests that ASOM is more likely to be Gram-positive aerobic infection than Gram-negative. Predominant aerobic bacterial isolates from this study were Streptococcus pneumonia (37.7%), Staphylococcus aureus (23.0%), Streptococcus pyogenes (14.8%) and Moraxella catarrhalis (11.5%) and is similar to findings in Zaria, Abakaliki and Yemen.[8,19,35] An earlier study in Sokoto had isolated Staphylococcus aureus as the most common bacteria causing ASOM,but failed to isolate Streptococcus pneumonia, Streptococcus pyogenes, and Moraxella catarrhalis, which are aerobes documented worldwide to cause ASOM.[2,5] The reason for this difference might be due to the methodology employed in their study, in which ear swabs were taken from the EAC without any transport or preservative media (Amies media) employed. However, a study in Lagos, southwestern Nigeria that obtained middle ear exudates prospectively via aspiration using sterile disposable plastic pipettes and cultured them within 2 hours of collection, isolated Streptococcus pneumonia, Streptococcus pyogenes, and Moraxella catarrhalis for ASOM.[17]

The prevalence of fungi infection in this study was 4.9%. A study in Uyo, south-south Nigeria reported 45.6% of fungal isolates from patients with ASOM, even though their definition of ASOM wasn't clearly outlined.[18] However, studies in Benin and Abakaliki among children attending a tertiary health facilities, had fungal prevalence of 6.8% and 21.3% respectively[31,35] All these findings further reiterates the role of fungus in middle ear infections. Some have postulated that the prolonged use of topical broad spectrum antibiotics may lead to suppression of bacterial flora and subsequent emergence of opportunistic fungal flora in different areas of the body including the middle ear.[5] This occurs following entry of fungal spores from the external environment into the moist and alkaline medium of middle ear discharge, which finally leads to the development of mycotic otitis media causing intractable otorrhoea.[18]

Accelerated patterns of bacterial resistance have been reiterated, and invariably mandates an evidence-based approach to managing ASOM.[5] This study reported a 100.0% sensitivity with amoxicillin/clavulanic acid, followed directly by erythromycin (91.5%) and ceftriaxone (89.8%), similar to findings in Benin.[31] Contrarily, a study in Kano noted better sensitivities of gentamycin and chloramphenicol.[21] Amoxicillin /clavulanic acid enjoys good patronage in this study area especially among the ENT surgeons, being the most prescribed empirical antibiotic in ASOM. It can therefore be deduced from findings in this study, that amoxicillin/clavulanic acid and macrolides should be used as first-line drugs in children with ASOM. All these further reiterate that variations in the degree of susceptibility of bacteria to antibiotics occur, and they stress the need for local studies in this respect to guide the rational use of the existing antibiotics. The result from this study further suggests that should additional ototopic antibiotic therapy be considered in children with ASOM for better clinical outcome, ofloxacin which has none of the ototoxic risks of chloramphenicol can be used.

The possible side effects of quinolones on pre-pubertal children are eliminated when used as ototopics.

Only 4.9% of the aspirates in this study cultured fungi, of which 100.0% *in vitro* susceptibility to all the antifungals assessed was noted. The fungi isolated in this study might be contaminants, and further reiterates ASOM as a monoclonal aerobic infection. This contrasted with studies in Uyo, south-south Nigeria possibly because of the different sample collection techniques employed bybothstudies.[18] The cautious use of ototopical antifungals has been re-emphasized because of their ototoxic potentials.[5]

CONCLUSION

This study showed that, the pattern and types of microbial isolates identified to be implicated in ASOM in this study, is not different from those documented in other literatures, even though there are slight differences in their frequency. The disease is more likely a mono-aerobic infection than polymicrobial. Its treatment should include among others, early commencement of antibiotics with good gram-positive and gram-negative aerobic coverage, to eradicate the disease. The *in vitro* antibiotic sensitivity identified amoxicillin/clavulanic acid, followed by erythromycin as most adequate.

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Conflict of interest

None declared.

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Serum vitamin D levels and its relationship with asthma control and severity among asthmatic children in Usmanu Danfodiyo University Teaching Hospital (UDUTH), Sokoto, Nigeria

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ABSTRACT

Background: Asthma is a heterogeneous disease characterized by chronic airway inflammation with a rising prevalence globally, and its aetiology has been linked to vitamin D (VD) deficiency. **Aim**: This study aimed to determine the serum VD levels and its relationship with asthma control and severity among asthmatic children in UDUTH, Sokoto, Nigeria. **Materials and methods:** This was a cross-sectional study among 60 asthmatic children selected by systematic sampling technique. Data were collected with a proforma; anthropometric measurements, estimation of serum VD levels, and assessment of lung function were done. **Results:** The median age of the asthmatic children was 9.47 years (IQR = 3.98) and majority of them (58.3%) were males. The median serum VD level was 16.25 ng/ml (IQR = 13.38), and about two-thirds of the participants (63.3%) were VD deficient. A half of the participants 30 (50.0%) had well-controlled asthma, 21 (35.0%) had partly-controlled asthma, while 9 (15.0%) had uncontrolled asthma. There was no relationship ($p > 0.05$) between the serum VD levels and asthma control. Almost all the participants (98.3%) had mild to moderate asthma, and majority of them (66.7%) had intermittent or mild persistent asthma. There was no relationship ($p > 0.05$) between the serum VD levels and asthma severity. **Conclusion:** Although VD deficiency was very prevalent among the participants, there was no relationship between the serum VD levels and asthma control and severity. There is need to prevent and control VD deficiency in the study population through VD supplementation, food fortification and promotion of adequate exposure of children to sunlight by mothers.

Keywords: Serum vitamin D levels, asthma control, asthma severity, children

INTRODUCTION

Asthma is a chronic inflammatory condition of airways which gives rise to episodic airflow obstruction.[1] It is the most common chronic obstructive respiratory problem worldwide contributing to a major public health issue.[2] Vitamin D (VD) is a micro element with immunomodulatory and anti- inflammatory functions, and evidence suggests that VD has a role in the aetiopathogenesis of asthma.[3-5] *The major source of VD* is synthesis of cholesterol in the skin by UV irradiation (dependent on sun exposure).[6] Other sources are by means of diet and supplements. Vitamin D (VD) has long been identified as important in bone and calcium metabolism.[6] The detrimental effects of VD deficiency in paediatrics have become increasingly apparent and extend beyond skeletal health.[7] Additional important role of VD in extra skeletal health, particularly childhood asthma has been found.[7] Vitamin D has basic regulatory roles in immune function (immunomodulatory properties) of almost all cells especially on the airways of asthmatic children.[8] It affects Th1 and Th2 cytokines which contribute to the development of atopy (including asthma).[9] Moreover, VD has effects on epithelial, T and B lymphocytes, and antigen presenting cell functions.[10] In addition, by induction of regulatory T (T reg) cells to produce interleukin (IL) – 10, VD modulates inflammatory processes and could help to control asthma severity.[11] It acts as a paracrine factor modulating foetal lung maturation and smooth muscle cell proliferation thereby promoting lung development.[12] Studies suggest that there is a probable relationship between VD status and asthma-related symptoms presumably via the immune modulatory effects of VD.[13-16] Freishtat *et al*[16] in 2010 observed that a great majority of urban children in U.S.A with persistent asthma had

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VD deficiency and / or insufficiency. Uysalol *et al*[15] in 2013 studied VD deficiency in Italian asthmatic children and observed a causal relationship between them. A higher frequency of asthma attacks, more severe asthmatic episodes and greater difficulty in asthma control were observed in asthmatic children with low VD levels.

Reduced VD levels in adult and paediatric patients with asthma are associated with impaired lung function, increased airway hyperreactivity, and reduced corticosteroid response.[17] Also, children experiencing mild to moderate asthma with low VD concentration had more exacerbations.[18] However, some studies have reported contrasting effects of VD on asthma.[19,20] Nevertheless, there are uncertainties in defining the appropriate VD cutoffs and threshold/critical values for respiratory diseases and variables that may affect the utilization of VD in different populations.[21] This study was conducted to determine the serum VD levels among asthmatic children, and to also determine the relationship between serum VD and asthma control, severity and frequency of asthma exacerbation.

MATERIALS AND METHODS

Study Design, Population, Sample Size Estimation and Sampling Technique

This was a cross-sectional study among asthmatic children in Usmanu Danfodiyo University Teaching Hospital (UDUTH) Sokoto, Nigeria, from October 2019 to February 2021.

The minimum sample size required (n) was calculated as follows:[22]

$$n = \frac{Z_{1-\alpha/2}^2 \delta^2}{D^2}$$

Where:

$Z_{1-\alpha/2}$ = percentage point of the normal distribution corresponding to the required (two-sided) significance level (α) of 0.05 = 1.96.

δ= standard deviation of variable under study = 7.2 ng/mL (from a previous study).[23]

D = margin of error = 2 ng/mL

$$n = \frac{1.96^2 * 7.2^2}{2^2} = 50$$

The final sample size (n_f) after correcting for an anticipated 85% response rate =

$$n_f = \frac{n}{0.85} = \frac{50}{0.85} = 60$$

A total of 60 asthmatic children aged 5-15 years were enrolled by systematic sampling technique. Participants were enrolled from the Paediatric Pulmonology and Allergy Clinic, and the Emergency Paediatric Unit of the Department of Paediatric, UDUTH, Sokoto, Nigeria, with diagnosis made according to the GINA guideline.[24] Patients with chronic respiratory or cardiac diseases like pulmonary tuberculosis, congenital heart diseases, and those on VD supplement intake were excluded.

Data Collection

A proforma was used to obtain information on the participants' bio-data, disease history and results of anthropometric measurements, serum vitamin D estimation, and lung function assessment. Socio – economic class was classified as high-, middle- and lower-class based on the Oyedeji social class scheme.[25] Weight was measured to the nearest 0.1kg using a seca digital weighing machine, height was measured to the nearest 0.1cm using a seca stadiometer, and body mass index (BMI) was computed as = weight (kg) / height^2 (m^2).

Detailed spirometry was performed on all the participants to assess their lung function (LF) according to the American Thoracic Society guideline[26] using a BTL- 08 Spiro Pro portable spirometer under aseptic procedure which is an important part of the assessment of future risk exacerbation (asthma control). The spirometer was calibrated daily, and the procedure was done under ambient temperature, pressure and humidity. The procedure was explained and demonstrated to all the study participants. An incentive spirometer was used to encourage the participants while the subjects' seat on a chair and instructions were given. The subjects were allowed two to three practice trial blows and three test blows for 4 -6 seconds, and the personal best FVC, FEV_1, FEV_1/ FVC, PEFR- peak expiratory flow rates were recorded. Asthma severity was assessed using the NAEPP and GINA classifications.[27,24]

Based on the NAEPP classification, asthma severity was graded as intermittent, mild persistent, moderate persistent, and severe persistent, while it was graded based on the GINA classification as mild, moderate and severe. Asthma control was assessed using the GINA asthma control assessment as follows:

a. Asthma symptoms control: Well-controlled, partly-controlled, and poorly-controlled asthma.
b. b. Risk factors for poor asthma outcome: low FEV_1 (<60% predicted), ≥1 exacerbation in the previous year, socioeconomic problems, incorrect inhaler use, and co-morbidities.

Two milliliters of blood was collected from all the study participants in an aseptic procedure and analyzed for serum VD levels. The blood was centrifuged; serum was stored at -20^{0}C until the time for assay (i.e., 2 weeks). Serum levels of VD were quantified by ELISA kit immunodiagnostic systems. A 25-OH Vitamin D ELISA Assay kit, catalogue number: VID31-K1, was used for this study, it contains 96 wells and was meant for research use only (RUO), v.2.1 08.28.17 (packaged and produced by Eagle Biosciences, Inc, U.S.A). The VD ELISA kit is a complete kit for quantitative determination of serum levels of VD with sensitivity of 1.6ng/mL and uses newly monoclonal antibody which is specific for VD2 and VD3 at 100% specificity.

The values obtained and recorded for serum VD levels were categorized into four as follows:[28]

- VD levels < 20ng/mL were considered as deficient; VD levels from 20-30ng/mL were considered as insufficient; VD levels from >30-150ng/mL were considered as sufficient, and values greater than 150ng/mL were considered as hyper-vitaminosis D

Data Analysis

Data were analyzed using the IBM Statistical Package for the Social Sciences (SPSS) version 20.0. (Armonk, NK: IBM Corp, USA). Non- parametric tests were used after testing for normality with Shapiro-Wilk test. Descriptive statistical analysis such as median and inter-quartile range (IQR) were done for quantitative variables, Wilcoxon rank sum test and Kruskal Wallis H test were used to compare if differences exist in serum VD levels and asthma control, severity and frequency of asthma exacerbation between 2 or >2 groups respectively, while the Chi square test was used to determine if there is any relationship between categorized serum VD levels and childhood asthma control and severity. Spearman rho correlation was used to determine if there is any relationship between serum VD levels and frequency of exacerbation of asthma. All levels of statistical significance were set at $p < 0.05$.

Ethical Consideration

The study was approved by the Research Ethics Committee of UDUTH, Sokoto, Nigeria (UDUTH/HREC/2020/995/V1). All patients' parents/caregivers were required to sign a written informed consent form; parents/caregivers who could not sign made their thumbprints on the consent form. Assent was also obtained from children aged 7 years and above.

RESULTS

Socio-demographic characteristics of participants

Majority, 35 (58.3%) of the 60 participants were males, with a male to female ratio of 1.4: 1. The median age of the participants was 9.47 years (IQR = 3.98 years). Thirty-three (55.0%) were aged less than 10 years, and most of the participants (91.7%) reside in urban communities (Table 1).

Table 1: Socio-demographic characteristics of participants

Variables	Frequency (%) n = 60
Age group (years)	
5 - <10	33 (55.0)
10 – 15	27 (45.0)
Gender	
Male	35 (58.3)
Female	25 (41.7)
Domicile	
Urban	55 (91.7)
Rural	5 (8.3)

Anthropometric characteristics of participants

The median weight of the participants was 24.25 ± 14.25kg, majority of them (56.6%) had normal weight, about a third (36.7%) were underweight, while only a few of them were overweight (1.7%) and obese (5.0%) [Table 2].

Table 2: Anthropometric characteristics of participants

Variables	Frequency (%) n = 60
Nutritional status	
Underweight	22 (36.7)
Normal weight	34 (56.6)
Overweight	1 (1.7)
Obese	3 (5.0)
Anthropometric parameters	
Weight (kg): Median = 24.25; IQR = 14.25	
Height (m): Median = 131.00; IQR = 26.05	
BMI (kg/m^5): Median = 14.68; IQR = 2.60	

Participants' median serum VD levels

The median serum VD level among the study participants was 16.25 ± 13.38 ng/mL. There was no significant difference in the median serum VD levels of the male and female participants (w = - 0.712, p = 0.476). Likewise, there was no significant difference in the median VD levels of those that were aged < 10 years, and those that were aged 10-15 years (w = -0. 512, p = 0.572) [Table 3].

Table 3: Participants' median serum VD levels

Variables	VD levels (ng/mL)		Test of significance
	Median	IQR	
Sex			
Male	15.90	13.50	w = -0.712,
Female	16.00	14.05	p = 0.476
Age group (years)			
5 - <10	16.60	10.75	w = -0.512,
10 - 15	15.90	15.50	p = 0.572

IQR- Inter-quartile range; w – Wilcoxon rank sum test

Pattern of asthma symptoms control among the participants

A half of the participants 30 (50.0%) had well-controlled asthma, 21 (35.0%) had partly-controlled asthma, while 9 (15.0%) had uncontrolled asthma. Although, the proportion of participants with well-controlled asthma was higher among males (31.7%) as compared to females (18.3%), and among those that were aged < 10 years as compared to those that were aged 10-15 years, there was no significant difference ($p > 0.05$) in the distribution of asthma control by sex and age (Table 4).

Relationship between the serum VD levels and asthma symptoms control among the participants

Nineteen (63.3%), 13 (61.9%) and 6 (66.7%) of participants with well-controlled, partly-controlled and uncontrolled asthma respectively were VD deficient. There was no significant difference in the median VD levels of the asthma symptom control types ($r_s = 0.023$, $p = 0.702$). There was no relationship between the serum VD status and asthma symptoms control ($\chi^2 = 2.026$, $p = 0.731$) [Table 5].

Relationship between the serum VD levels and asthma severity among the participants

Almost all, 59 (98.3%) of the 60 participants had mild to moderate asthma by the GINA classification. There was no relationship between the serum VD levels and asthma severity ($H = 4.666$, $p = 0.097$). Also, majority of participants, 40 (66.7%) had either intermittent or mild persistent asthma by the NAEPP classification, and there was no relationship between the serum VD levels and asthma severity ($H = 7.110$, $p = 0.068$) [Table 6].

Relationship between the serum VD levels and frequency of asthma exacerbations among the participants

The median VD levels were not significantly different across the categories of the frequency of asthma exacerbations ($H = 0.665$, $p = 0.881$). There was no relationship between the frequency of asthma exacerbations and the serum VD levels ($r_s = -0.022$, $p = 0.867$) [Table 7].

Table 4: Pattern of asthma symptoms control among the participants

Variables	Asthma symptoms control status			Total	Test of significance
	Well-controlled Frequency (%)	Partly-controlled Frequency (%)	Uncontrolled Frequency (%)	Frequency (%)	
Sex					
Male	19 (31.7)	10 (16.7)	6 (10.0)	35 (58.3)	$\chi^2 = 3.451$,
Female	11 (18.3)	11 (18.3)	3 (5.0)	25 (41.7)	p = 0.457
Age group (years)					
5 - <10	19 (31.7)	10 (16.7)	4 (6.6)	33 (55.0)	$\chi^2 = 3.123$,
10 - 15	11 (18.3)	11 (18.3)	5 (8.3)	27 (45.0)	p = 0.425
Total	30 (50.0)	21 (35.0)	9 (15.0)	60 (100.0)	

χ^2 – Pearson's Chi-square test

Table 5: Relationship between the serum VD levels and asthma symptoms control among the participants

Asthma symptoms control status	Serum VD status			Median serum VD levels (ng/mL)
	Deficient Frequency (%)	Insufficient Frequency (%)	Sufficient Frequency (%)	
Well-controlled (n = 30)	19 (63.3)	9 (30.0)	2 (6.7)	14.50
Partly-controlled (n = 21)	13 (61.9)	5 (23.8)	3 (14.3)	18.61
Uncontrolled (n = 9)	6 (66.7)	3 (33.3)	0(0)	15.80
Test of significance	$\chi^2 = 2.026$, p = 0.731			$r_s = 0.023$, p = 0.702

χ^2 – Pearson's Chi-square test; r_s – Spearman rho correlation

Table 6: Relationship between the serum VD levels and asthma severity among the participants

Asthma severity status	Frequency (%)	Serum VD levels (ng/mL)		Test of significance
		Median	Inter-quartile range (IQR)	
GINA classification				
Mild asthma	45 (75.0)	18.60	13.30	H = 4.666, p = 0.097
Moderate asthma	14 (23.3)	11.25	9.61	
Severe asthma	1 (1.67)	9.60		
Total	**60 (100)**			
NAEPP classification				
Intermittent	16 (26.7)	20.50	13.68	H = 7.110, p = 0.068
Mild persistent	24 (40.0)	16.25	13.18	
Moderate persistent	11 (18.3)	18.61	2.50	
Severe persistent	9 (15.0)	9.90	5.90	
Total	**60 (100)**			

H - Kruskal Wallis test

Table 7: Relationship between the serum VD levels and frequency of asthma exacerbations in the previous year among the participants

Number of asthma attacks	Frequency (%)	Serum VD levels (ng/mL)		Test of significance
		Median	Inter-quartile range (IQR)	
0-3	43 (71.7)	16.25	13.30	r_s = -0.022, p = 0.867
4-7	13 (21.7)	14.50	13.80	
8-13	4 (6.7)	15.00	13.95	H = 0.665, p = 0.881
Total	**60 (100)**			

r_s – Spearman rho correlation; H - Kruskal Wallis test

DISCUSSION

This study assessed the serum VD levels among asthmatic children and also determined the relationship between the serum VD levels and asthma control, severity and frequency of asthma exacerbations. The median serum VD level among the participants in this study was 16.25ng/mL. Uysalol *et al*[15] and Freishtal *et al*[16] reported similar findings among Turkish and American children with serum VD levels of 16.6ng/mL and 18.5ng/mL respectively. The prevalence of VD deficiency among the participants in this study was 63.3%. Bener *et al*[29] in Qatar, made a similar observation with a VD deficiency prevalence of 68.0% among asthmatic children. This observation is also consistent with the findings in previous studies.[30-32]

Considering the fact that the study area is a tropical area with abundant sunshine, VD deficiency should supposedly be an uncommon finding in this study. The observed high prevalence of VD deficiency in this study despite availability of adequate sunshine in the study area could be due to the dark skin (melanin) complexion of the study participants which acts as a natural sunscreen, thus inhibiting absorption of VD from the sunlight. Furthermore, majority of the study participants were from a Muslim background who are known to cover their body due to their religious and cultural beliefs,[33,34] this style of dressing prevents the absorption of cutaneous VD from its main source; which is the sun. Moreover, this was a cross-sectional study that was done during the harmattan period in which there is usually little or no sunshine, and people tend to stay indoors to protect themselves against the dusty and cold weather;[34] and these in turn reduce the availability of VD for absorption. More than 90% of the participants live in urban areas, and urbanization comes with changes in lifestyle including spending more time indoors[35] which could prevent them from getting adequate exposure to sunlight for VD absorption.

However, on the contrary, Omole *et al*,[23] obtained high serum VD levels (with a mean of 47.2ng/mL) in a study among asthmatic children in Ile-Ife, Nigeria. The disparity between the latter study and this study could be

due to the good nutritional status of their study participants which gave them a better chance of having adequate/high serum VD levels. Whereas, more than a third (36.7%) of the participants in this study were underweight (which is in consonance with their low serum VD levels, and it also highlights VD deficiency as a common micronutrient deficiency in the study area),[36] only 7.8% of the participants in the latter study were underweight. Also, undernutrition causes a decrease in the VD binding protein in the blood, which decreases the ability of the body to conserve and store 25-hydroxyvitamin D.[36] In addition, differences in the methods of assay of serum VD (high performance liquid chromatogram UV method was used in the latter study[23] while ELISA kit was used in this study) could account for the discrepancy, due to their varied sensitivity and specificity to serum VD.[37] Complete body coverage was not a common finding in the culture of the Omole *et al* study population (i.e., South-western Nigeria), hence the study population had adequate exposure to sunlight with better absorption of cutaneous VD. In addition, the Omole *et al*[23] study area was semi-urban with fewer effects of urbanization, and with more time being spent outdoor (these expose their study population to adequate sunlight and increase availability of VD)[33,35] in contrast to the index study area which is urban.

This study reported no relationship between serum VD levels and asthma symptoms control, severity, and frequency of asthma exacerbations. This was previously reported by Omole *et al*[23] and Menon *et al*.[38] On the contrary, some studies[15,29] found direct relationship between the serum VD levels and asthma severity, control and frequency of exacerbations. With the finding of a high prevalence of VD deficiency in this study (which could also be a reflection of the global epidemic of VD deficiency),[39] one would expect to find a deterioration in asthma control, severity and worsening in the frequency of asthma exacerbations among the asthmatic children, but in fact the reverse is true as majority of them had well controlled asthma (50%), mild asthma severity (67%), and fewer episodes of asthma symptoms exacerbation (72%). Thus, despite the high prevalence of VD deficiency among study participants, asthma control, severity and frequency of asthma exacerbations were not affected by the low serum VD levels. Based on the absence of any relationship between low serum VD levels and asthma control among the participants in this study one may infer that serum VD does not play a significant role in the aetio-pathogenesis of asthma or/and even if it does, the serum VD level that may be detrimental enough to affect asthma may be lower than the median value reported in this study. Perhaps VD may have a threshold dose for effect, and in populations with generally low serum VD levels, the micronutrient may not be an important modifier of asthma disease. Interestingly Elnady *et al* [40] reported an inverse relationship between serum VD levels and asthma severity among Egyptian children. Also, the effects of VD supplementation on asthma severity and control have yielded conflicting results[19,20,] in which there were reports of either a direct relationship between serum VD levels and asthma control and severity, or no relationship. These observations call for a more careful review of the relationship between asthma and serum VD levels among children, and definition of the role of VD in asthma. Also, there is need to identify the optimal dose of serum VD in different groups based on cultural/religious practices, skin pigmentation, seasonality, nutritional status and asthmatic phenotypes, as all of these factors affect VD absorption and availability. If these issues are addressed, the results to be obtained in future reviews would be more conclusive and objective enough to provide a better insight as to whether serum VD is indeed the "light at the end of the tunnel" for asthmatic children.

CONCLUSION

Although VD deficiency was very prevalent among the participants, there was no relationship between serum VD levels and asthma control, severity and frequency of asthma exacerbations. There is need to prevent and control VD deficiency in the study population through VD supplementation, food fortification and promotion of adequate exposure to sunlight by mothers. Longitudinal studies on serum VD levels are recommended such that they span all seasons (heat, rainy and harmattan), and with a standard method of assay for a better interpretation and inference on serum VD levels among asthmatic children.

Limitation of the study

A cross-sectional study design which is not ideal for establishing temporal relationship / causality between the serum VD levels and asthma control, severity and frequency of asthma exacerbations was employed in this study.

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Conflict of interest

None declared.

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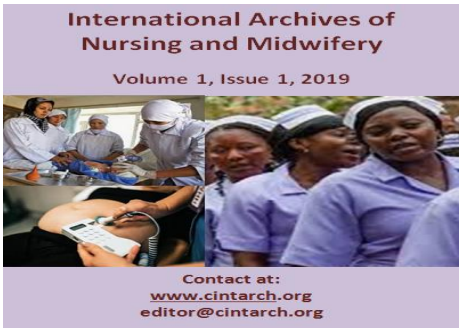

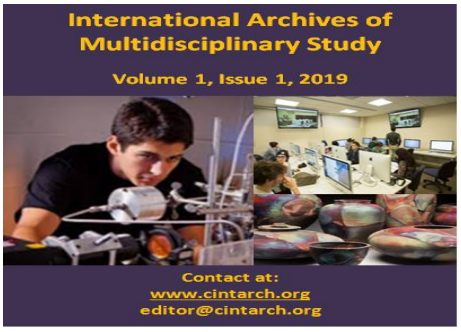

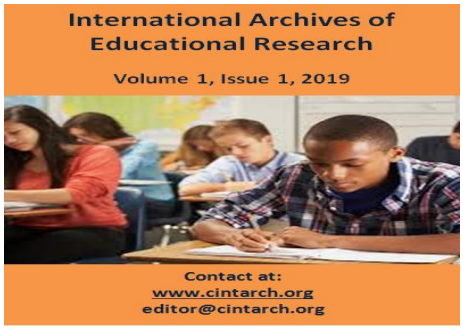

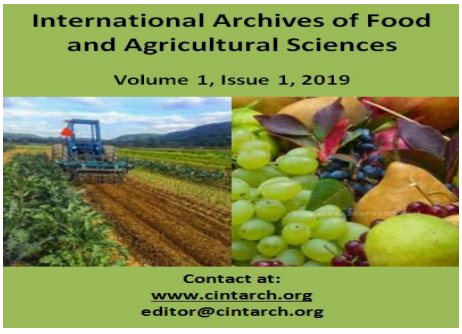

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