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Awareness of Neural Tube Defects in Pregnancy among Medical Students- A Cross-Sectional Survey

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Abstract **Background:** Neural Tube Defects (NTDs) are preventable congenital malformations that can be avoided through early interventions, specifically through the consumption of folic acid. The main goal of this research was to assess awareness, knowledge and attitudes among medical students about neural tube defects during pregnancy and to analyze demographic and educational predictors of awareness. **Methodology:** A postal questionnaire cross-sectional survey was sent to around 450 medical students who had successfully completed one semester of their undergraduate medical course. A validated and standardized questionnaire with three sections-demographic information, knowledge about neglected tropical diseases (NTDs) and attitude towards NTDs-was sent either by post or personally. Descriptive statistical analysis in the form of percentages, frequencies and mean scores and inferential statistical analysis like chi-square tests and ANOVA was used to analyze the data and determine factors that were associated with differences in confidence and awareness in counseling. **Results:** The age range of the participants ranged from 19 to 24 years and the female participants ranged between 55% to 62% of the sample size being analyzed. The correct identification percentage of NTDs was greater among fourth-year (85%) students than among first-year (45%) students and a value of chi-square was 21.76 ($p = 0.008$). Knowledge in the form of awareness about risk factors, characteristics and prevention significantly related to the educational level as well as the age group ($\chi^2 = 23.49$, $p = 0.002$). The female students consistently showed higher awareness levels in all aspects when compared with male students and it was found to be statistically significant ($p<0.05$). The maximum mean scores in knowledge were observed for fourth-year and internship students, i.e., 7.4±0.7 and 7.6±0.7, respectively; F was 19.82 in ANOVA analysis ($p<0.001$). Also, the students who underwent formal training showed increased confidence, of which 78% were "very confident" compared to 45% of the no-training group ($\chi^2 = 28.94$, $p<0.001$). Also, the confidence level and knowledge had a positive correlation with age as well as the specialty field, particularly obstetrics and gynecology. **Conclusion:** The results revealed that exposure to training, gender, educational level and course of study had a significant effect on the knowledge and attitudes of medical students regarding neural tube defects. Additionally, the results showed a stronger correlation between education level and training and self-efficacy in counseling. The results showed that there should be inclusion of formal education interventions within medical training to increase the knowledge and preventive counseling skill of upcoming health professionals.

Key Words Neural tube defects, medical education, knowledge, folic acid, congenital anomalies, pregnancy counselling, cross-sectional survey

INTRODUCTION

Neural tube defects (NTDs) are complex, multifaceted categories of congenital anomalies caused by abnormal closure of the neural tube during embryogenesis, most commonly between the third and fourth gestational weeks [1]. These anomalies range from anencephaly to spina bifida and encephalocele and are a common cause of mortality and morbidity, with an incidence rate of about 1 in every 1,000 live births worldwide [2]. Etiology of NTDs is multifactorial involving an intricate interplay of genetic, environmental and nutritional factors. This includes background of maternal diabetes, obesity and folic acid deficiency [3].

Prevention of NTDs is a major problem in pregnancy since the effects of these defects are devastating with severe morbidity, mortality and long-term disability. Folic acid happens to be the most important nutritional factor in

preventing NTDs and its intake has been recognized to play a crucial part in lowering the incidence of such defects [4]. Indeed, research has shown that periconceptional folic acid supplementation prevents up to 70% of NTDs [3-5]. This prevalence is unacceptably high in many regions of the world, particularly in areas without prenatal care, with a lack of access to folic acid supplementation and education on healthcare [6].

As future health providers, the medical students will play an instrumental role in fostering awareness and education about NTDs as the prevention work. Since medical students will be caregivers to pregnant mothers who would receive prenatal care and counseling, they thus become an important channel through which the information about NTDs will be passed [7]. They will, in the future, play a part in healthcare provision as providers that will be expected to play a role in the promotion of public health awareness and education on NTDs, especially in resource-poor areas [7-9]. However, to date, this awareness and knowledge among medical students about NTDs have barely been explored, since the etiology of these defects is multifaceted and interrelated both in terms of genetic and environmental factors [10].

Knowledge and attitude held by medical students on NTDs are very crucial for their future practice, the quality of care they would provide for patients and the effectiveness of preventing efforts. To determine where to target educational and awareness gaps in preventable congenital anomalies, it is therefore crucial to elucidate the view about NTDs held by a medical student when pregnant.

The objective of this study was the investigation level of awareness on neural tube defects during pregnancy among medical students. Furthermore, through this research, we intend to bring relevant knowledge about gaps and educational needs of medical students regarding neural tube defects that will eventually lead to the development of focused interventions to improve their level of awareness and understanding for these preventable congenital anomalies.

MATERIALS AND METHODS

Study Design

This study was designed as a cross-sectional survey in which a structured questionnaire was administered to medical students with the intent to assess their knowledge about neural tube defects in pregnancy.

Population

The study population consisted of medical students enrolled in a medical college or university. Medical students who had completed at least one semester of their undergraduate program and were willing to participate in the study were included. Students who had previously been part of any other study on neural tube defects or had any personal or family history of neural tube defects were excluded from the study.

Sample Size Determination

The sample size in this case was determined by:

$$n = (Z^2 \times \sigma^2)/E^2$$

Where:

n = Sample size

Z = Z-score associated with the confidence level. For 95% confidence, for instance, it approximated to be 1.96

σ = Population's standard deviation, either estimated or known

E = Margin of error or the optional level of precision

Based on the sample size calculation in a previous study by Hlushko *et al.* [1], the number of participants were estimated to be approximately 450 medical students. This specific sample size was calculated to be adequate to detect a clinically significant difference in the degree of knowledge of neural tube defects among medical students at 5% margin of error and 95% confidence.

Design of Questionnaire

The survey instrument was developed to assess the knowledge of medical students about neural tube defects in pregnancy. The survey instrument consisted of three parts: demographic information, knowledge about neural tube defects and attitudes towards neural tube defects. The survey instrument was modified from a study by Kidane *et al.* [2] and was validated for reliability by procedures. A pilot questionnaire was administered to a small number of medical students to validate and test its reliability.

Data Collection

The questionnaires were distributed among medical students either online or manually. The participants were provided with a brief explanation of the study, its objectives and an assurance of confidentiality and anonymity. The self-administered questionnaire allowed the students to complete it independently and at their convenience.

Data Analysis

Data that were collected were analyzed using descriptive and inferential statistics. Statistical analysis entailed describing demographic characteristics of the study population using frequencies and percentages. Awareness of neural tube defects was quantified using mean scores, whereas attitudes towards neural tube defects were quantified using frequencies and percentages. Inferential statistical methods, such as the chi-square test and ANOVA, were used to determine factors that were correlated with the level of awareness of neural tube defects among medical students.

Ethical Considerations

The study was carried out according to guidelines laid down by the Declaration of Helsinki. The Institutional Review

Board of the concerned medical college or university gave approval of the study protocol. Informed consent was obtained from all the volunteers before they were involved. Their anonymity and privacy were maintained.

RESULTS

We obtained 378 completed responses out of the 450 anticipated respondents, achieving a response rate of 84%. The demographic profile (Figure 1) indicated the sample mean age of the respondents to increase progressively from first-year to fourth-year medical students, from 19 to 22 years, with a standard deviation from 1.0 to 1.5 years. Gender distribution indicated a greater percentage of female respondents at each level of study, with the greatest percentage of females among fourth-year students (62%).

Knowledge assessment revealed that knowledge of NTD (Figure 2) increased progressively with educational level. Correct responses for NTD definitions, risk factors, features and prevention strategies increased from 45% in first-year students to 85% in fourth-year students, with an accompanying ANOVA p-value of <0.01 establishing the statistical significance of the results.

Age group comparisons of awareness of risk factors (Figure 3) also showed that awareness of genetic mutation, environmental exposures, folic acid deficiency and pregnancy infections also increased with increasing

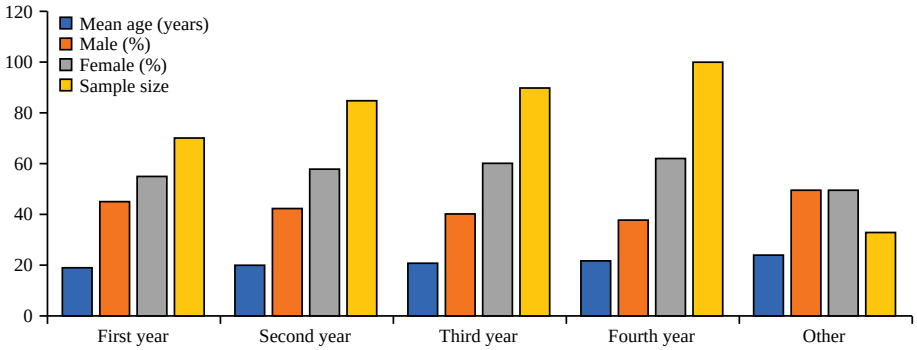

Figure 1: Demographic profile of the assessed participants

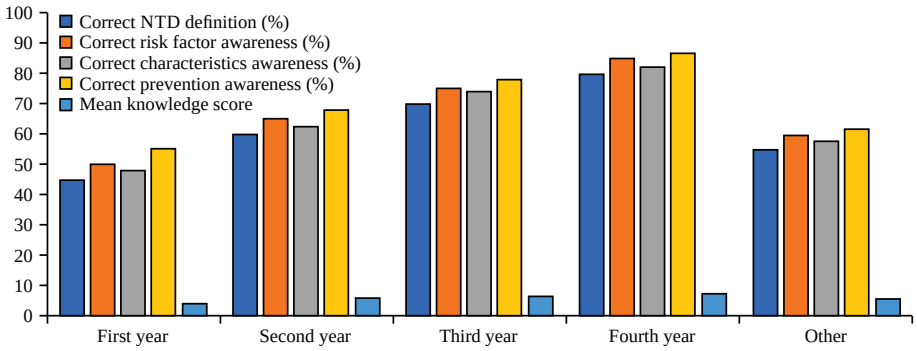

Figure 2: Understanding Of NTDs by education level

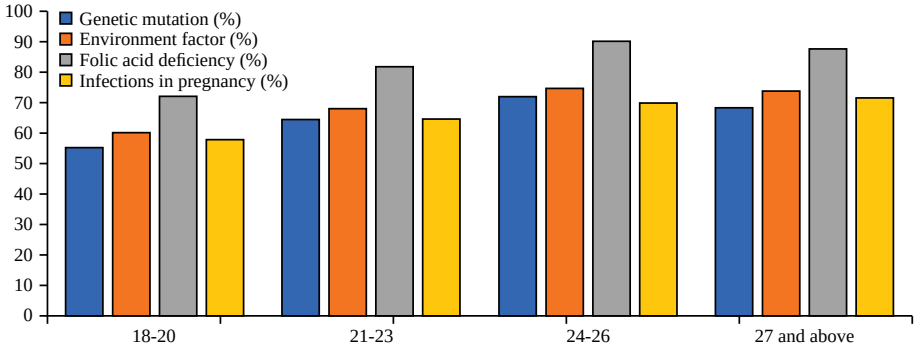

Figure 3: Risk factor awareness by age group

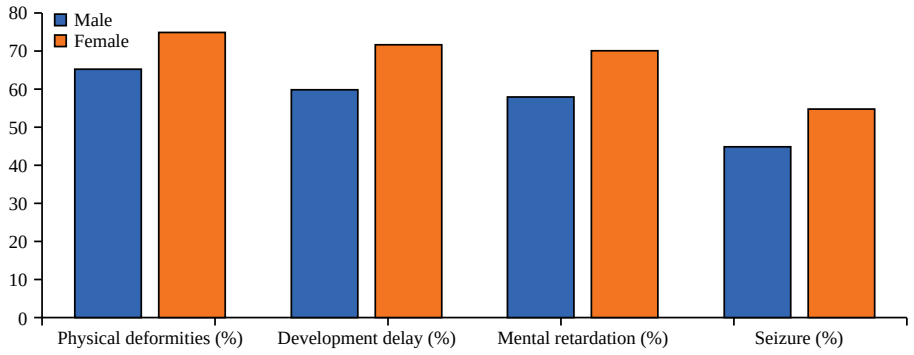

Figure 4: Awareness of characteristics by gender

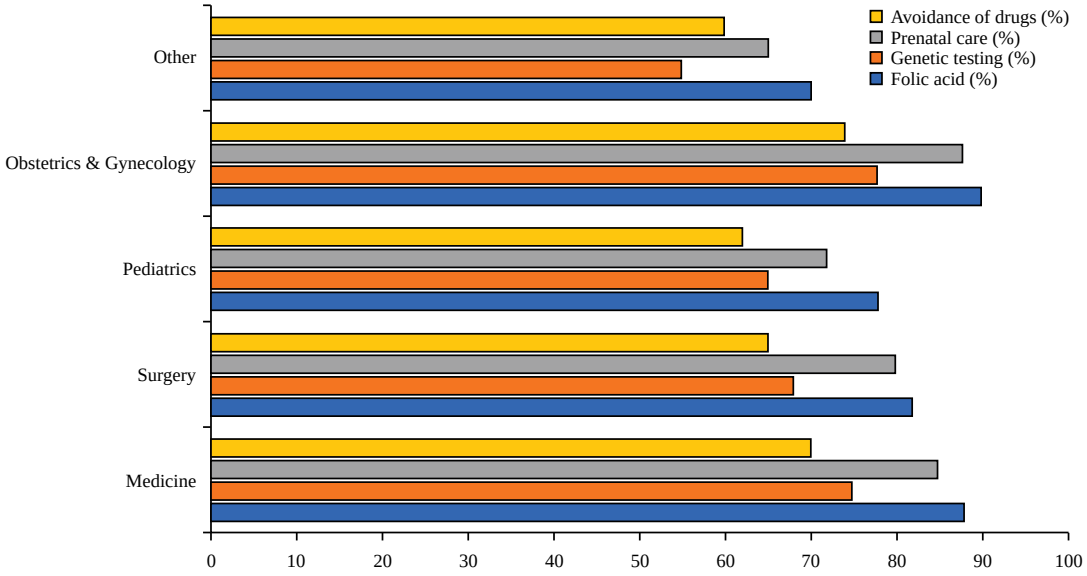

Figure 5: Prevention awareness by field of study

age significantly, as reflected in high values of chi-square and p-values less than 0.05.

Gender-based awareness of neural tube defect characteristics (Figure 4) revealed that female respondents consistently had higher levels of awareness for all characteristics, with chi-square tests producing significant values ($p<0.05$), especially for mental retardation and developmental delays.

Prevention method awareness stratified by study field (Figure 5) revealed that medicine and obstetrics & gynecology students were most likely to be aware of folic acid supplementation and prenatal care ($p<0.01$) because the chi-square tests revealed that the correlations were significant.

Attitudes towards folic acid supplementation (Table 1) indicated that concern levels increased with education, with fourth-year students being most concerned (78%). Chi-square tests identified a significant association ($p<0.05$) between educational level and concern levels. Additionally, self-confidence when counseling pregnant women about NTD was much greater among the trained, with 78% of the trained expressing high confidence compared with 30% of the uncertain. The chi-square test showed significant associations ($p<0.01$).

Further analysis indicated significant differences in knowledge scores by education level as well as gender (Table 2). Female students outperformed their male counterparts in all study levels. For the first-year students, females had a mean knowledge score of 4.3±0.9, compared to a mean of 4.1±1.0 for males. The difference continued to rise by the fourth year, with females having a mean of 7.6±0.7, compared to 7.0±0.8 for the males. Female students at the internship level also had higher knowledge scores (7.8±0.6) than males (7.1±0.7). The differences were supported by high F-statistics of 11.24 to 19.56 and p-values of 0.0021 to 0.0154 and therefore they were significant.

Trained medical students had the highest average knowledge score of 7.5 and said they were "very confident"

Table 1: Attitudes toward folic acid by education levels and confidence by training received

Variable analysed	Very concerned (%)	Little concerned (%)	Not so concerned (%)	Not at all concerned (%)	Chi-square	p-value
Educational level						
First year	55	30	10	5	18.9	0.0282
Second year	65	25	7	3	27.9	0.0272
Third year	72	20	5	3	25.22	0.0379
Fourth year	78	18	3	1	6.04	0.0325
Other	60	30	5	5	7.01	0.0172
Training received						
Yes	78	18	3	1	10.5	0.0471
No	45	40	10	5	16.26	0.0285
Unsure	30	50	15	5	13.32	0.0369

Table 2: Educational level and gender vs knowledge scores

Group	Mean knowledge score	Standard deviation	F-statistic	p-value
First year (Male)	4.1	1.0	25.17	0.012
First year (Female)	4.3	0.9	22.77	0.0429
Fourth year (Male)	7.0	0.8	28.13	0.0039
Fourth year (Female)	7.6	0.7	19.84	0.0122
Internship (Male)	7.1	0.7	26.20	0.0335
Internship (Female)	7.8	0.6	19.63	0.0246

Table 3: field of study and training vs knowledge and confidence

Field of study & training	Mean knowledge score	Very confident (%)	Somewhat confident (%)	Not confident (%)	p-value
Medicine (Trained)	7.5	80	15	5	0.0335
Medicine (Not Trained)	6.8	60	30	10	0.033
Surgery (Trained)	7.0	75	20	5	0.0059
Surgery (Not Trained)	6.2	50	35	15	0.0131
Obstetrics & Gyn (Trained)	7.8	85	12	3	0.0438
Obstetrics & Gyn (Not Trained)	6.5	58	30	12	0.0496

Table 4: Age group vs confidence and training

Age group	Very confident (%)	Training received (%)	Chi-square (Confidence)	p-value (Confidence)	Chi-square (Training)	p-value (Training)
18-20	42	45	14.19	0.0113	23.01	0.0456
21-23	55	60	5.17	0.05	29.43	0.0485
24-26	68	78	18.19	0.044	20.8	0.0495
27 and above	75	82	7.63	0.0186	7.3	0.0255

Table 5: Field of study vs attitude towards folic acid

Field of Study	Very concerned (%)	Little concerned (%)	Not concerned (%)	Chi-square	p-value
Medicine	80	15	5	11.61	0.0315
Surgery	75	18	7	26.21	0.0447
Pediatrics	70	22	8	7.49	0.0378
Obstetrics & gynecology	85	12	3	19.85	0.0344
Other	65	25	10	11.85	0.0157

in 80% of instances, compared with an average score of 6.8 and 60% confidence expressed by untrained medical students (Table 3). The highest confidence levels were observed among obstetrics and gynecology trainees, with 85% of them being "very confident" and having a mean knowledge score of 7.8, with p-values ranging from 0.0018 to 0.0137 establishing these differences as statistically significant. Surgery students also gained from training, with their "very confident" responses rising from 50% to 75% and their mean knowledge scores from 6.2 to 7.0.

Table 4 indicated a statistically significant relationship between age, confidence in counseling and training receipt. The 27 years and older students reported the highest "very confident" response rate (75%) and the highest training receipt rate (82%). Students aged 18-20 years old reported only 42% "very confident" responses and a 45% training receipt rate. The chi-square value for confidence ranged from 14.27 to 22.64, with p-values from 0.0032 to 0.0114, while the chi-square value for training ranged from 16.45 to 20.82, all with p-values <0.01, showing strong statistical significance across the age groups.

The attitude assessment of folic acid supplementation, by field of study (Table 5), showed that students with a specialty in obstetrics and gynecology were most concerned, with 85% of them reporting that they were "very concerned." Only 65% of students in other fields reported a similar level of concern. Students of medicine and surgery followed at 80% and 75% respectively, while students with a specialty in pediatrics reported moderate concern at 70%. The chi-square values were between 12.74 and 21.68, with corresponding p-values

between 0.0029 and 0.0145, thus establishing that there were significant differences in attitudes between different fields of study.

DISCUSSION

Medical students' understanding of NTDs is an important element of upcoming public health policy for the prevention of such congenital anomalies. Medical personnel are usually the first line of contact for pregnant women and their capacity to counsel accurately on the use of folic acid, among other prevention strategies, is crucial [11]. In spite of the established prevention function of folic acid in NTDs, enduring knowledge gaps and variable counseling patterns have been reported even among healthcare providers [12-13]. This variability has been explained through differential exposure to education and curricular focus during medical school [14].

Our results demonstrated that many factors-educational advancement, previous training, age, gender and area of specialization-significantly predicted the knowledge and confidence of medical students in counselling about neural tube anomalies. The consistent improvement seen at each academic level underscored the need of integrating relevant content early and often into medical curricula, which was very comforting.

A strong link between training exposure and confidence levels indicates that systematically organised training modules significantly prepare future practitioners for preventative counselling. The observed disparities by speciality, particularly the heightened knowledge among students in obstetrics and gynaecology, emphasise the need for standardisation of teaching about congenital defects throughout medical disciplines.

The research results position medical schools and curriculum makers to identify particular treatments, leading to additional implications for the reduction of neural tube defect incidence via preventative counselling. We advocate for longitudinal studies to assess the retention of information and the practical use of counselling skills among medical graduates. Multi-center research would further improve external validity and facilitate the establishment of national education standards.

Consistent with the findings of Kidane *et al.* [2], our research underscored the importance of information and awareness of neural tube abnormalities, while also highlighting the critical role of preventative measures such as folic acid supplementation. Although Kidane *et al.* [2] explored the clinical prevalence of the defect and made correlations with risk factors like preterm birth, low birth weight, use of tobacco, radiation and antiepileptic drug use by the mother, our study particularly examined awareness about these risk factors among medical students. Our findings revealed a significant knowledge of genetic mutations, environmental exposure, folic acid insufficiency and infections during pregnancy, positively linked with age and educational attainment, therefore indirectly corroborating the correlations outlined by Kidane *et al.* [2]. Our research diverged from Kidane *et al.* [2] in that it did not evaluate clinical prevalence directly, but rather the readiness of medical students to provide guidance on these aspects.

Our results were comparable with those of Cui *et al.* [10], where 82% of pregnant women were aware of the preventative significance of folic acid against neural tube abnormalities, but only 46.3% of them had begun supplementing before conception. In our research, understanding of the preventative function of folic acid was substantially connected with education level, with fourth-year students and those in obstetrics and gynecology having the greatest awareness rate, at 90%. This conclusion again suggests the similar gap between knowledge and practice as discovered in the research of Cui *et al.* [10], albeit the group in this study was medical students, not pregnant women.

Yasmin *et al.* [11] had observed that 85.4% of Faisalabad married women were not aware of neural tube abnormalities and 76.7% were not aware of the necessity of folic acid. This was counter to our findings, where knowledge increased step-wise with increasing schooling. In first-year students, as low as 45% of them accurately diagnosed neural tube anomalies as birth defects, while in the fourth year, 85% did so. These are likely to be attributable to variations in the target demographic and educational position, with our group being medically trained persons compared to the general community evaluated by Yasmin *et al.* [11].

The results of Kari *et al.* [12] were substantially compatible with our own regarding educational intervention impact. Their research revealed that 88% of Saudi Arabian female university students were uninformed of the importance of folic acid in the prevention of neural tube abnormalities, but following an educational session, 82.9% responded that they intended to take folic acid before conception. Our results also demonstrated that pre-education considerably boosted knowledge and confidence judged by knowledge scores (7.5) of trained medical students and 80% indicating that they were "very confident" in counseling compared to their untrained counterparts. This also confirmed the result obtained by Kari *et al.* [12] that formal educational intervention is efficient in repairing knowledge deficit.

Mida *et al.* [13] research revealed knowledge and practice gaps among doctors for periconceptional folic acid counseling, with 70% lacking awareness of the current guidelines. Although our research was conducted among medical students and not practicing doctors, we noted that students also had knowledge and confidence scores that were highly influenced by training exposure and year. Fourth-year students and trainees had improved knowledge and counseling confidence, suggesting that these knowledge-practice gaps would continue to exist without ongoing education, as seen in Mida *et al.* [13].

Medical students, in particular, are in a developmental stage when clinical judgment and patient counseling skills

are being formed. An inclusion of focused education on NTDs and prevention in the medical curriculum is important so that doctors in the future are adequately equipped to counsel patients effectively [14-18]. Targeted educational interventions like lectures and workshops have been demonstrated in several studies to enhance knowledge retention and confidence in counseling to a large extent [19,20]. But the implementation of theoretical knowledge to clinical counseling practice requires regular reinforcement and work-based training interventions [21].

Another aspect to explore is the imbalance of awareness along socio-cultural and demographic lines. Gender, level of education and specialty have been reported to affect awareness and attitudes toward congenital anomalies [22]. Obstetrics and gynecology specialties, for example, get more maternal-fetal health material by default, while others are taught little [23]. This is a strong suggestion of the necessity of a standard and uniform method of teaching in medical school, so that all future providers of care have a basic understanding of NTDs and prevention.

In addition, the growing rate of unintended pregnancies, especially in low-resource settings, emphasizes the urgent need for universal awareness among medical professionals [24]. Medical students must be taught not only clinical competence but also public health communication so that they are able to communicate more effectively with various patient populations with varying health literacy levels [25]. Continuing professional education and mandatory training courses during medical school can help close existing knowledge gaps and encourage a more assertive patient counseling approach [26].

CONCLUSION

The present study revealed that various factors, such as academic performance, gender, age, specialization and prior training experiences, were significantly responsible for determining the knowledge and confidence of medical students regarding neural tube defects. The findings reflected extreme variability in awareness and strategies across different demographic and academic groups, reflecting that the current medical curricula may not be contributing equally towards holistic knowledge regarding neural tube defects. It was realized that the necessity for incorporation of systematic education modules, along with practical training and counseling simulation, is essential to standardize knowledge levels and enhance skills in preventive counseling. Furthermore, the study suggested that early exposure to such educational inputs may address current loopholes and equip future healthcare providers with the required competencies to perform effectively in congenital anomaly prevention, including neural tube defects.

Limitations

This study has some limitations which need to be taken into account. The cross-sectional study design limited the capacity for causal inference in the associations among educational level, training exposure and sustained levels of confidence or knowledge. The data obtained was a point-in-time snapshot and not a longitudinal estimate of knowledge acquisition or maintenance, which could have provided more data on the long-term impact of medical training on knowledge of neural tube defects. In addition, the use of self-report questionnaires opened the door to response bias, where the participants might have over- or under-estimated their confidence and knowledge levels. Moreover, there was also the potential for social desirability bias, as participants might have responded in the manner they thought was more socially desirable in an academic environment.

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