



## Perception of Dysmenorrhea and Its Relationship to School Activities among Senior Secondary School Students in Nnewi, Nigeria

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### Authors' contributions

This work was carried out in collaboration between all authors. Authors UCO and NBE designed the study, wrote the protocol and wrote the first draft of the manuscript. Author UEE managed the literature searches. Authors POUA and CCE did analyses and write up of the study. All authors read and approved the final manuscript.

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### ABSTRACT

**Introduction:** Dysmenorrhea is one of the commonest disorders of menstruation afflicting women of reproductive age. It is a cause of lost time from school and work among such women.

**Objectives:** This study was carried out to determine the perception of dysmenorrhea and its effect on school activities among senior secondary school students in Nnewi-North Local Government Area, Anambra State.

**Methodology:** This was a descriptive cross-sectional study in which information was elicited from 215 senior secondary school students selected by multi-stage sampling technique.

**Results:** The predominant age group of respondents was 15-19 years. Among the 215 students,

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203 had attained menarche but only 143(70.4%) experienced dysmenorrhea. Also 143 perceived menarche as a normal pain that came with menstruation while 60 regarded it as a sign of some abnormality in the body. Menstrual pain led to impaired concentration in class among 56 (39.2%) of student, missing school/classes by 10(7%) students, and not participating in games by 12 (8.4%) student. However, 25(17.5%) of respondents saw a doctor for their pain, while the rest resorted to self-medication and other non-pharmacological means of pain relief.

**Conclusion:** The prevalence of dysmenorrhea was high among the students and it affected several school activities adversely. However, several wrong practices have been adopted by majority of the students to tackle their condition.

**Recommendation:** A proper orientation on dysmenorrhea should be given to parents and teachers of students at the Parents Teachers Association (PTA) meeting to enable them address properly, all matters related to this condition.

*Keywords: Dysmenorrhea; perception; relationship; school activities; secondary school students.*

## 1. INTRODUCTION

Dysmenorrhea to the lay man means painful menstrual period. According to American College of Obstetrics and Gynecology (ACOG), it is defined as a medical condition of pain during menstruation that interferes with daily activities [1]. Dysmenorrhea is the commonest gynecological problem affecting women of reproductive age [1]. It is also the leading cause of lost time from school work among the age group; the pain ranges from dull, aching to burning, shooting and it may be associated with nausea, headache, dizziness, vomiting. Dysmenorrhea is experienced by 45-95% of women of reproductive age. It has been shown to improve after pregnancy or childbirth and with increasing age [2].

There are three types of dysmenorrhea: [3] Primary dysmenorrhea otherwise called spasmodic dysmenorrhea. This is a chronic cyclical pain associated with menstruation in the absence of identifiable pathological condition. It usually starts soon after menarche once ovulation is established and improves with age [4]. It is also most severe among virgins and almost absent among parous women. There is no particular etiological agent associated with it but some risk factors [5] identified in relation to the condition include: Early age at menarche, nulliparity, menorrhagia, smoking, obesity, family history etc, some also include psychological and emotional factors. Secondary dysmenorrhea is found in the presence of a pelvic pathology. It is seen in older women [3]. Various causes [5] of secondary dysmenorrhea include endometriosis, pelvic inflammatory disease, ovarian cyst and tumors, adenomyosis, fibroids, uterine polyps, congenital malformation (eg bicornuate uterus/subseptate uterus), intrauterine

contraceptive device/IUCD, transverse vaginal septum, pelvic congestion syndrome, Allentasters syndrome (pelvic pain from old broad ligament lacerations following delivery). Membranous dysmenorrhea is usually seen in younger people. It is pain following passage of a uterine cast. It is the least common type. Endometritis has been suggested as the etiology.

Dysmenorrhea is the leading cause of lost time from school and work among women/girls of reproductive age group [6]. A research by Titilayo et al. [7] observed a very wrong perception about the way out of dysmenorrhea among undergraduate students. Some of the respondents in the stated study think of engaging in frequent pre-marital sex or even getting pregnant and giving birth to a child. Another study also found that dysmenorrhea is a common health problem, having negative effects on the health-related quality of life among university female students [8]. All these point to the fact that dysmenorrhea is a serious public health issue affecting women of reproductive age (including adolescent girls in schools) worldwide with great impact on their quality of life. Therefore, attention needs to be drawn to this so as to improve quality of life and academic performance of our secondary school girls, the leaders of tomorrow. A number of studies have been carried out on menstruation but just a few were focused on perception of dysmenorrhea among senior school students. This study will hopefully solicit to incorporate culture-specific education regarding menstrual disorders into the school curriculum. It may also encourage the use of appropriate medication to relieve symptoms. This study also serves as an avenue for creating awareness on the side of school health attendance. Moreover, it will sensitize

public health physicians to always seek out for and treat these adolescent girls who have misconceptions about menstruation.

The objective of this study therefore is to ascertain the perception of dysmenorrhea and its effect on school activities among senior secondary students in Nnewi, Nigeria.

## 2. METHODOLOGY

### 2.1 Study Area

The study was conducted in Nnewi-North Local government Area, Anambra State. Nnewi is the second largest city in Anambra State. It has 2 Local Governments; Nnewi-North and Nnewi-South. Nnewi has a population of 391,227 based on 2006 census and land span of 1,076.9 square metres (2,789 km<sup>2</sup>) [9]. Nnewi has many registered primary, secondary schools and a higher institution of learning and a federal teaching hospital which predominantly serves Anambra and neighbouring states.

#### 2.1.1 Study population

The study was done among female senior secondary school students in Nnewi-North LGA. Both co-educational and girls-only secondary schools were included in the study.

#### 2.1.2 Study design

This was a descriptive cross-sectional study.

#### 2.1.3 Sample size determination

The sample size was worked out using Cochran formulae for determining minimum sample size;  $n = (Z^2pq)/d^2$ , where n= minimum sample size, Z=standard normal deviate at 95% confidence interval which is 1.96, p=proportion of persons in the population who experience dysmenorrhea which is 85.1% [6], Q=1-p, d=degree of precision (0.05)5%.  $n = (Z^2pq)/d^2 = (1.96 \times 1.96 \times 0.85 \times 0.15) / (0.05 \times 0.05) = 0.49 / 0.0025 = 195$ .

The minimum sample size was 195.

To make up for expected attrition of about 10% during the study, sample size= minimum sample size + expected attrition=195 + (10/100 x 195)= 195+19.5=214.5. Sample size=215.

#### 2.1.4 Sampling technique

A multi-stage sampling technique was used. According to records from Nnewi-North Local

Government Post-primary Education Section, there are 51 registered secondary schools in the LGA, 8 public secondary schools and 43 private secondary schools. In stage 1, the schools were segregated into public and private schools. The ratio of public to private schools was used to obtain the number of schools to be used for the study. Total number of schools used= sum of ratio of public (pu): private (pr) schools.

Pu: pr =8:43=1:5.4. Therefore, a ratio of 1 public to 5 private schools was used for this study to select the schools. The schools were: Maria Regina model comprehensive secondary school, Dr. Alutu's college of excellence, Immaculata girls model secondary school, The Lord's foundation secondary school, Christ the Way secondary school, New Era model secondary school. In stage 2- each of the schools selected was further segregated into classes to select members to be recruited into the study. Thirty-six respondents were selected from each school and further divided into 3. In each of the 3 subdivisions, 12 respondents were further selected. In stage 3, the students from each class were selected from the class registers. Simple random sampling method was applied in each of the above described stages.

#### 2.1.5 Inclusion criteria

The study included female senior secondary school students in each selected school.

#### 2.1.6 Ethical consideration

Consent was sought from the school authorities and the sampled students themselves before the study. Permission was taken from the school Principal and class Teachers. Also, assent was obtained from the students' parents and guardians before the study was carried out. The aim of the study was explained to the sampled population. Absolute secrecy and confidentiality were ensured.

#### 2.1.7 Data collection

This was done using a semi-structured, self-administered questionnaire which was earlier pre-tested among secondary school girls in another local government area to ensure validity and reliability. The questionnaire elicited responses on the socio- demographics of the study population, presence and perception of dysmenorrhea, perceived effect of dysmenorrhea on school activities and academic

performance and what the students do when they have dysmenorrhea.

### 3. RESULTS

A total of 215 questionnaires were distributed, 214 were retrieved.

The study revealed that 15-19 years constitute the majority age group of respondents at 153 (71.5%), as shown in Table 1. Also secondary school was the highest educational levels attained by the majority of subjects' fathers 120 (56.1%) and mothers 103 (48.1%).

In Table 2, it was shown that out of the 214 students interviewed, 203 (94.9%) had experienced menarche, while the most frequently occurring age at menarche was 12 years at 81 (39.9%). Of the 203 that had experienced menarche, 143 (70.4%) reported having dysmenorrhea.

Table 3 depicted the comparison of perception of menstrual pain between the students who experienced it and those who had not experienced it. There was a statistically significant difference in the sources of knowledge of dysmenorrhea between those who experienced painful menstruation and those who did not ( $X^2=16.75$ ,  $p<0.01$ ). In all other areas of knowledge and perception of dysmenorrhea, the responses of the two groups were basically similar.

Fig. 1 depicted that 116 respondents have had menstrual pain during school examinations while 76 have had their concentration in class impaired by dysmenorrhea. Thirty-two were prevented from participating in school games while 20 missed school/ classes entirely.

In Table 4, majority of the respondents 64(44.7%) took drugs when they had menstrual pain, 27(18.9%) consulted a doctor while 24(16.8%) resorted to taking hot tea. However, 9(6.3) did nothing about the problem. The table also showed that among those who took drugs, paracetamol was the most frequently used drug and is taken by 45(70.3%) of them.

### 4. DISCUSSION

About 18.7% of respondents were within age range of 10-14years, 81.3% were within 15-19 years range and the mean age of the students was 15.3 years. This is within the official

secondary school age (12-17 years) for students in Nigeria [10].

**Table 1. Socio-demographic status of the respondents**

Variables	Frequency (n=214)	Percent (%)
<b>Age group (years)</b>		
10-14	50	23.4
15-19	153	71.5
≥20	11	5.1
Total	214	100
<b>Class</b>		
Senior secondary 1	70	32.8
Senior secondary 2	72	33.6
Senior secondary 3	72	33.6
Total	214	100
<b>Father's highest education</b>		
No formal education	5	2.3
Primary education	49	22.9
Secondary education	120	56.1
Tertiary education	40	18.7
Total	214	100
<b>Mother's highest education</b>		
No formal education	3	1.4
Primary education	14	6.5
Secondary education	103	48.1
Tertiary education	94	43.9
Total	214	100

Among the 214 respondents, 203 (94.9%) had attained menarche. Of the 203 respondents who were menstruating, 70.4% experienced menstrual pain. This corresponds with outcome of study done among secondary school students in Onitsha, Anambra state which showed the proportion of subjects with dysmenorrhea to be 66.2% [11]. However, it contrasts with the result of another study done among undergraduate students of Bahar Dar University which reported a proportion of 85.1% [6]. The discrepancies observed in the two studies may be attributed to age [12] and racial differences [13] which were associated with menstrual pain in females of reproductive age group.

The major source of knowledge about dysmenorrhea among the students who had menstrual pain was personal experience. This perhaps largely contributed to the significant difference observed in this parameter when respondents with dysmenorrhea were compared with those who did not have dysmenorrhea. Personal pain experience was evidently the main driving force that made the students seek

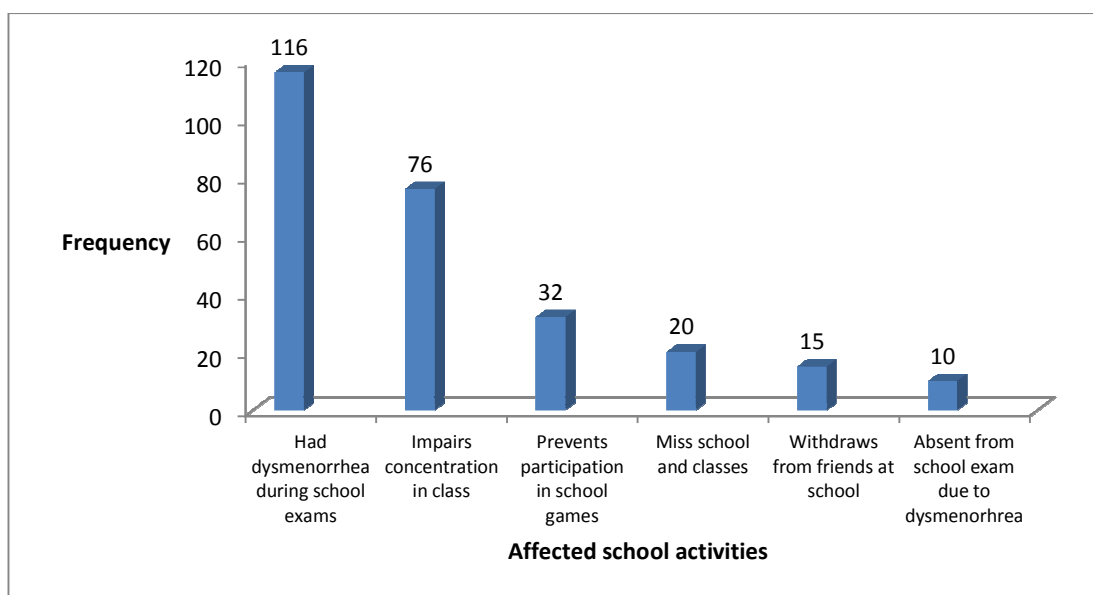
knowledge, educate themselves about the condition and quickly sought self-medication to ameliorate the condition. This is in line with result of another study in an unnamed urban community which found that pain intensity was a strong predictor of use of self-treatment methods among adolescents [14].

The respondents had various perceptions of the causes of menstrual pain. Among the 203 students who experienced dysmenorrhea, 70.4% (143) thought it was a normal pain that came with menses, 14.3% [29] thought it was a sign of infection among other misconceptions. This portrayal of arrays of wrong perception of dysmenorrhea was perhaps a reflection of poor access to appropriate sexuality education by these students [15]. Appropriate sexuality information would have enabled many of the respondents to understand that though menstrual pain may be present in a normal individual in the absence of other pathologies; several diseases can also cause the problem [16]. This finding of wrong perception about dysmenorrhea is however in agreement with result of a Maylasian study among rural and urban girls which showed that majority of the girls perceived menstrual pain as normal and so relied on self-care method [17]. Also among the respondents with dysmenorrhea, 9.8% perceived pain as mild, 47.6% as moderate and 34.2% as severe. This corresponds with the outcome of a

Turkish study done among undergraduate students which showed 19.8% of respondents as having mild pain, 49.8% as moderate and 30.4% as severe pain respectively [18]. This indicates that dysmenorrhea is predominantly perceived as moderate or severe by sufferers.

**Table 2. Respondent's experience with menstruation**

Menstrual experience	Frequency (n=214)	Percent (%)
Have experienced menarche	203	94.9
Have not yet experienced menarche	11	5.1
Total	214	100
<b>Age at menarche (years)</b>		
11	18	8.9
12	81	39.8
13	64	31.5
14	20	9.9
15	20	9.9
Total	203	100
Experience dysmenorrhea	143	70.4
Do not experience dysmenorrhea	60	29.6
Total	203	100



**Fig. 1. Effect of menstrual pain on school activities of respondents**

**Table 3. Comparative analysis of respondents' knowledge and perception of menstrual pain**

Perception	Have dysmenorrhea [%] (n=143)	Don't have dysmenorrhea (%) (n=71)	X <sup>2</sup> , p-value
<b>Source of knowledge of dysmenorrhea</b>			
Personal experience	43 [30]	0[0]	*X <sup>2</sup> =16.75, P<0.01 (significant)
Mother	32[22.4]	17[23.9]	
Friends	23[16.1]	18[25.4]	
Doctor	19[13.3]	11[15.5]	
Class teacher	26[18.2]	25[35.2]	
<b>Knowledge of duration of menstrual pain</b>			
Some days before menses	17[11.9]	6[8.5]	X <sup>2</sup> =5.56, P>0.1
1	20[14]	18[25.4]	
2	34[23.8]	13[18.3]	
3	43[30]	19[26.7]	
4	17[11.9]	7[9.8]	
5	12[8.4]	8[11.3]	
<b>Perception of pain severity</b>			
Mild	14[9.8]	10[14.1]	X <sup>2</sup> =7.48, p>0.05
Moderate	68[47.6]	42[59.2]	
Severe	49[34.2]	12[16.9]	
Very severe	12[8.4]	7[9.8]	
<b>Perception of origin of pain</b>			
Normal pain that comes with menses	91[63.6]	32[45.1]	*X <sup>2</sup> = 7.21 p>0.1
Sign of infection	30[21]	26[36.6]	
Sign of an abnormality in the body	10[7]	8[11.3]	
Sign that someone has not conceived before	10[7]	5[7]	
Others	2[1.4]	0[0]	
<b>Perception of character of pain</b>			
Aching	20[14]	15[21.1]	X <sup>2</sup> =8.73 p>0.1
Biting	36[25.2]	8[11.3]	
Burning	15[10.5]	10[14.1]	
Shooting	9[6.3]	6[8.4]	
Lasts a whole day	48[33.5]	18[25.4]	
Intermittent	8[5.6]	8[11.3]	
Others	7[4.9]	6[8.4]	

In this study, dysmenorrhea was found to adversely affect school activities of concerned students. Among respondents whose school activities were affected by dysmenorrhea, 39.2% had impaired concentration in class due to menstrual pain, 8.4% could not participate in school games, 7% missed classes/school, 3.5% withdrew from friends in school because of menstrual pain. This disagrees with the result of a study done in Port-Harcourt, Rivers state, Nigeria which showed that dysmenorrhea caused impaired concentration in class among 58.3% of respondents, 18.3% school absenteeism [19]. Similarly, the result did not agree with an Italian study among young women which showed 31.9% school absenteeism

among respondents with menstrual pain [20]. These differences in reaction to school program may be due to differences in pain perception, sick role and illness behavior which are largely culturally determined [21].

Among the respondents who experienced menstrual pain, only 6.3% did not need any intervention to relieve their pain while the rest did one thing or the other to relieve the pain. This is at variance with a study among secondary school students in Port-Harcourt in which 25% of respondents with dysmenorrhea did nothing to relieve their menstrual pain [19]. Majority (44.7%) of the affected students in this study took drugs, while 11.9% took hot water bath, 16.8% took hot

tea and 1.4% took herbal medication. This is in agreement with the pattern of interventions found among the students in the Port Harcourt study in which 1.67% took herbal medication, 16.67% took tea, and 43.3% took drugs [19]. However the findings are at variance with result of a Turkish study which showed that 30.4% of respondents relieved their pain by taking analgesics and 19.8% did nothing for their pain [22]. The differences in pattern of response to dysmenorrhea may have arisen as a result of cultural differences.

**Table 4. Most frequent action taken by students when they experience dysmenorrheal**

Interventions	Frequency (n=143)	Percent (%)
See a doctor	27	18.9
Take drugs	64	44.7
Hot water bath	17	11.9
Hot tea	24	16.8
Herbal medication	2	1.4
Do nothing	9	6.3
Total	143	100
<b>Drugs taken</b>	<b>n=(64)</b>	
Paracetamol	45	70.3
Ibuprofen	3	4.7
Aspirin	2	3.1
Buscopan	7	10.9
Diclofenac	3	4.7
Felvin	4	6.3
Total	64	100

## 5. CONCLUSION

The proportion of those students who experienced dysmenorrhea was high in this study. It has also been demonstrated to affect school activity of a large number of the students by impairing their concentration in class. Moreover, dysmenorrhea prevented some of the students from writing their exams.

This study also demonstrated several wrong practices by the students to relieve their pain. It showed that majority of the dysmenorrhoeic students resorted to self-medication instead of visiting a doctor for evaluation of the cause of their dysmenorrhea.

## 6. RECOMMENDATION

Based on findings from this study, it is hereby recommended that regular sexuality education be given to the girls, their parents and teachers.

Consequently, health workers should embark on health awareness creation concerning dysmenorrhea especially during the parents teachers association (PTA) meetings. This will sufficiently equip the parents and teachers with knowledge to appropriately educate their young girls on matters related to dysmenorrhea.

Also, workshops should be organized for health correspondents of media houses on appropriate dissemination of information on causes and perception of menstrual pain.

Finally, school health services should be commenced in schools to give students correct perspective on menstruation, its related problems and where to seek solution.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Onur O, Kaygusuz I, Gumus I, Derbent A, Simvali S, Urun E. Impact of home based exercise in people with primary dysmenorrhea. *South African Journal of Obstetrics and Gynecology*. 2012; 18(1):528.
2. Bewley S, Cheong Y, Creighton S, Dobbs S, Gebbie A, Gupta J, et al. *Gynecology by ten teachers*. 19<sup>th</sup> edition. Published by Bookpower Edition of Nineteen Edition, India, 2011;40-42.
3. Agboola A. *Textbook of obstetrics and gynecology for medical students*, 2nd edition. Heinemann Educational Books plc, Ibadan, Nigeria. 2006;119-121.
4. Reddish S. Dysmenorrhea. *Australia Family Physician*. 2006;35(11):842-859.
5. Calis KA, Popat V, Danj DK, Cassey FE, Kalantaridu SN, Ergol M. Dysmenorrhea. Available from Medscape. (Last updated Dec 1, 2014, Cited on Dec 3, 2014)
6. Shferaw MT, Wubshet M, Tegabu M. Menstrual problems and associated factors among students of Bahar Dar University, Amhara National Regional State, Ethiopia. *Pain African Medical Journal*. 2014;17(246):1.
7. Titilayo A, Agunbiade OM, Banjo O, Lawani A. Menstrual discomfort and its influence on daily academic activities and psychological relationship among

- undergraduate female students in Nigeria. *Tanzanian Journal of Health Research*. 2009;11(4):181-88.
8. Unsal A, Iyranci U, Tozun M, Calik E. Prevalence of dysmenorrhea and its effect on quality of life among a group of female university students. *Ups J Med Sci*. 2010;115(2):138–145. (Published online 2010 Apr 7)  
DOI: 10.3109/03009730903457218  
PMCID: PMC2853792
  9. Wikipedia atom feed, Nnewi. Updated; 2014.  
Available:<http://www.na.cuk.org/factfile.htm> (Cited Dec 4th, 2014)
  10. Nigerian demographic and health survey; 2003.  
Available:<http://www.dhsprogram.com/pubs/pdf/FR148/FR148.pdf> (Accessed in January 2016)
  11. Adinma ED, Adinma JB. Perception and practices on menstruation among Nigerian secondary school girls. *African Journal of Reproductive Health*. 2008;12(1):74-83.
  12. Wandner LD, Scipio CD, Hirsh AT, Torres CA, Robinson ME. The perception of pain in others: How gender, race and age influence pain expectations in others: How gender, race and age influence pain expectations. *J Pain*. 2012;13(3):220–227.
  13. Sheffield D, Biles PL, Orom H, Maixner W, Sheps DS. Race and sex differences in cutaneous pain perception. *Psychosom Med*. 2000;62(4):517-23.
  14. Fouladbakhsh JM, Vallerand AH, Jenuwine ES. Self-treatment of pain among adolescents in an urban community. *Pain Manag. Nurs*. 2012;13(2):80-93.
  15. POU Adogu, OS Nwafulume. Knowledge, attitude and willingness to teach sexuality education among secondary school teachers in Nnewi, Nigeria. *British Journal of Education, Society & Behavioral Science (BJESBS)*. 2015;7(3):184-193. Article no. 2015.082. ISSN: 2278-0998 Available:[www.sciencedomain.org](http://www.sciencedomain.org) (BJESBS).
  16. Dawood YM. *Global library of women's medicine*; 2008. ISSN: 1756-2228 DOI: 10.3843/GLOWM.10009
  17. Wong LP. Premenstrual syndrome and dysmenorrhea: Urban-Rural and multiethnic differences in perception impact and treatment seeking. *Journal of Pediatric Adolescent Gynecology*. 2011;24(5):272-273.
  18. Potur DC, Bilgin NC, Komurcu N. Prevalence of dysmenorrhea in university students in Turkey: Effect on daily activities and evaluation of different pain management methods. *Pain Manag. Nurs*. 2014;15(4):768-77. DOI: 10.1016/j.pmn.2013.07.012 (Epub 2013 Nov 11)
  19. Buowari OY. Effect of dysmenorrhea on quality of life among secondary school girls in Port Harcourt, Nigeria. *African Journal Online (AJOL)*. 2014;3(2):1.
  20. Grandi G, Ferrari S, Xholli A, Cannoletta M, Palma F, Romani C, et al. Prevalence of Menstrual pain in young women: What is dysmenorrhea? *Journal of Pain Research*. 2012;5:169-74.
  21. Loyd DM, Findlay G, Roberts N, Nurmikko T. Illness behavior in patients with chronic low back pain and activation of the affective circuitry of the brain. *Psychosomatic Medicine*. 2014;76:0033-3174/14/7606.
  22. Adesola A, Ogunfowoken OAB. Management of primary dysmenorrhea by school adolescent in Ile-Ife, Nigeria. *Journal of School Nursing*. 2010;26(2):131-136.

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