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Multinomial Logistic Regression (MLR) Analysis: Predictive Model of Risk Factors for the Incidence of Period Pain (Primary Dysmenorrhea) in Adolescent Girls

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A B S T R A C T

World epidemiological data states that primary dysmenorrhea occurs most frequently in women aged 17-24 years. Multinomial Logistic Regression (MLR) is suitable for producing predictive models with a dependent variable (menstrual pain) that has four categories. This study analyzes the predictive model of risk factors for the incidence of menstrual pain (primary dysmenorrhea) in adolescent girls in Pekalongan City. The research design was an analytic survey with a cross-sectional design. A total of 100 samples were collected using multistage random sampling at four school sites. The questionnaires used included NRS, PSS-10, and anthropometric measurements. Of the fourteen variables studied, three variables, family history of menstrual pain, sleep duration, and exercise habits, proved to significantly affect the incidence of menstrual pain in adolescent girls (p-value <0.05). The Multinomial Logistic Regression model produced three logit equations. The independent variables, consisting of age, age of menarche, Body Mass Index (BMI), duration of menstruation, menstrual cycle, family history of menstrual pain, meal skipping, night sleep time, morning wake-up time, sleep duration, exercise habits, cigarette smoke exposure, alcohol consumption, and stress level, could influence menstrual pain by 61.2%. Meanwhile, the other 39.8% was influenced by variables not studied. The accuracy of the classification table, with a prediction truth rate of 80.9%, explained that respondents with a family history of menstrual pain were 98.319 times more likely to have moderate menstrual pain compared to those without a family history of menstrual pain. The predictive modeling has good accuracy.

INTRODUCTION

The issue of adolescent health is currently a serious concern in the global arena, not least about adolescent reproductive health. There are various changes and reproductive health risks during adolescence. Adolescent girls generally have health problems related to adolescent reproduction, including menstrual disorders. Menstruation is a natural periodic bleeding from the uterus in women, including adolescent girls. Adolescent girls often experience pain during menstruation. Pain during menstruation is a menstrual disorder (Kusyanti & Fay, 2023). According to the World Health Organization (WHO), dysmenorrhea is a painful condition that occurs during or before menstruation and is a common complaint experienced by women, including adolescent girls. Its classification consists of primary and secondary dysmenorrhea.

World epidemiological data stated that primary dysmenorrhea occurs most frequently in women aged 17-24 years, averaging around 50% of women in each country, with an increasing trend (De Sanctis et al., 2016). The results of research by Hasan *et al.* (2023) and Badri *et al.* (2024) on the prevalence of menstrual pain showed that 25% occurred in older women and 75% occurred at a young age. The

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incidence of menstrual pain in several countries was quite diverse, namely 62.5% in Bangladesh, 34% in Egypt, 94% in Oman, and Korea by 0.9%. Menstrual pain decreases with age. So far, there is no mortality data due to menstrual pain, but menstrual pain is associated with significant morbidity. Research estimated that 40% of individuals with menstrual pain had significant symptoms. In addition, 16-29% of women who experience menstrual pain had a significant impact on decreased quality of life. Menstrual pain can also reduce productivity through increased absenteeism and lost school days (Francavilla et al., 2023; Kusyanti & Fay, 2023; Zeba et al., 2024).

A review article interpreted that the risk factors for menstrual pain included Body Mass Index (BMI) < 20, age of menarche < 12 years, long menstrual intervals, family history of dysmenorrhea, irregular bleeding, unhealthy lifestyles, stress, and depression (Zeba et al., 2024). Research by Angelia, Sitorus, and Etrawati (2017) also found that several factors contribute to primary dysmenorrhea among students at one high school in Palembang, including stress, timing of sleep, timing of waking in the morning, sleep duration, family history of dysmenorrhea, and menstruation duration. In addition, a prior study by Munir *et al.* (2023) found that menstrual duration, nutritional status, and family history correlated with menstrual pain, using a sample of 62 students from one of the Midwifery Academies in Bogor.

The development of statistics is very important for solving problems across various scientific fields, particularly in public health. Therefore, a researcher needs a rational basis for selecting the most appropriate statistical test for their analysis (Ramadani et al., 2023). Based on Indriyani *et al.* (2024) and Sobari *et al.* (2024), Multinomial Logistic Regression (MLR) is a set of logistic regressions that assume the dependent variable (Y) has a polycotomous or multinomial scale, i.e., more than two categories. The advantages of Multinomial Logistic Regression are that it can handle dependent variables with a multinomial scale, enabling more complex analyses than binary logistic regression. According to Putri *et al.* (2022), the flexibility of this model enables researchers to model the relationships between independent variables and multiple dependent categories, providing deeper insight into the factors that influence these categories. Thus, Multinomial Logistic Regression modeling can be used to predict future data on risk factors for the incidence of menstrual pain. This study analyzes the predictive model of risk factors for the incidence of menstrual pain (primary dysmenorrhea) in adolescent girls in Pekalongan City.

METHOD

The research design was an analytic survey with a cross-sectional design. Multistage random sampling was chosen as the sampling technique. Pekalongan city has four sub-districts: West Pekalongan, East Pekalongan, South Pekalongan, and North Pekalongan. Each sub-district will randomly select one Senior High School (SMA or SMK) using the Wheel of Names. 4 school loci were selected: SMA N 1

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Pekalongan (East Pekalongan District), SMA N 2 Pekalongan (North Pekalongan District), SMK N 3 Pekalongan (West Pekalongan District), and SMK N 4 Pekalongan (South Pekalongan District), with each school taking a sample of 25 students, so that the sample amounted to 100. Data collection used questionnaire interviews with adolescents in each locus. In addition, anthropometric measurement methods include body weight and height of adolescent girls to determine their Body Mass Index. The instruments were questionnaires, scales, and height-measuring instruments. The questionnaires included the Numeric Rating Scale (NRS) questionnaire, the Perceived Stress Scale (PSS-10) questionnaire, and a questionnaire containing the research variables. Data analysis used Multinomial Logistic Regression test using SPSS 26.0 software. The stages of data analysis include simultaneous testing to determine which independent variables affect the dependent variable, partial testing to examine the p-values of each parameter βjk, and fit testing (model fitting) to assess the model's fit to both the independent and dependent variables.

RESULT

MLR analysis produces several statistical values, including pseudo R-Square. The statistical value was the percentage of the 14 independent variables studied that could explain 1 dependent variable. This table includes 3 models: Cox and Snell, Nagelkerke, and McFadden. The Nagelkerke model obtained 0.612, indicating that the independent variables consisting of age (X_1), age of menarche (X_2), Body Mass Index (BMI) (X_3), duration of menstruation (X_4), menstrual cycle (X_5), family history of menstrual pain (X_6), meal skipping (X_7), night sleep time (X_8), morning wake-up time (X_9), sleep duration (X_{10}), exercise habits (X_{11}), cigarette smoke exposure (X_{12}), alcohol consumption (X_{13}) and stress level (X_{14}) could influence the dependent variable, namely menstrual pain (Y) by 61.2%. Meanwhile, the other 39.8% was influenced by variables not studied (Table 1).

Table 1. Pseudo R-Square

Pseudo R-Square	
Cox and Snell	0,555
Nagelkerke	0,612
McFadden	0,340

Furthermore, Likelihood Ratio Tests indicated which of the 14 independent variables can affect the dependent variable. If the p-value is <0.05, then the interpretation is that the independent variables partially influence the dependent variable. The partial test showed that family history of dysmenorrhea (p = 0.001), sleep duration (p = 0.013), and exercise habits (p = 0.031) influenced the incidence of menstrual pain among adolescent girls in Pekalongan City (Table 2).

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Table 2. Likelihood Ratio Tests

Effect	Model Fitting Criteria -2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	156,058[a]	0,000	0	.
Age (X_1)	160,598	4,540	3	0,209
Age of menarche (X_2)	161,570	5,511	6	0,480
Body Mass Index (BMI) (X_3)	172,843	16,785	12	0,158
Duration of menstruation (X_4)	158,295	2,237	3	0,525
Menstrual cycle (X_5)	162,174	6,116	6	0,410
Family history of menstrual pain (X_6)	173,767	17,709	3	0,001
Meal skipping (X_7)	159,390	3,332	3	0,343
Night sleep time (X_8)	158,870	2,812	3	0,422
Morning wake-up time (X_9)	156,780	0,722	3	0,868
Amount of sleep time (X_{10})	166,859	10,801	3	0,013
Exercise habits (X_{11})	164,917	8,859	3	0,031
Cigarette smoke exposure (X_{12})	160,975	4,917	3	0,178
Alcohol consumption (X_{13})	158,416	2,358	3	0,502
Stress level (X_{14})	162,909	6,851	6	0,335

Table 3 describes model fit information. It compares the values from an MLR model with those from a model with only an intercept and determines which is the better fit. If the -2 Log Likelihood value from Intercept Only to Final decreases, the Multinomial Logistic Regression model performs much better. The results showed that the -2 Log Likelihood values decreased from Intercept to Final, from 237.121 to 156.058. The magnitude of the Chi-Square value was 81.083, and the *p*-value was 0.036 ($p<0.05$). Thus, it indicated that the Multinomial Logistic Regression model with 14 independent variables could show better accuracy to predict risk factors for the incidence of menstrual pain (dysmenorrhea) in adolescent girls in Pekalongan City (Table 3).

Table 3. Model Fitting Information

Model	Model Fitting Criteria			Likelihood Ratio Tests		
	AIC	BIC	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	243,121	250,937	237,121			
Final	282,058	446,184	156,058	81,083	60	0,036

The Goodness-of-fit showed a *p*-value of 0.998 ($p > 0.05$), indicating that the Multinomial Logistic Regression model fit the observed data (Table 4). In addition, the parameter estimation table in the multinomial logistic regression displays the estimated regression coefficients for each category of the dependent variable, excluding the reference category, along with *p*-values indicating the significance of each independent variable's effect on the odds of each category relative to the reference category.

Table 4**.** Goodness of Fit

	Chi-Square	df	Sig.
Pearson	175,189	231	0,998
Deviance	154,672	231	1,000

As a result of the Parameter Estimate analysis, three simultaneous logit function equations of Multinomial Logistic Regressions were obtained as follows:

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i. $\ln\left(\frac{p\ (y=2)}{p\ (y=1)}\right)=\left(\frac{\text{mild menstrual pain}}{\text{no menstrual pain}}\right)=\ \alpha+\ \beta_1X_1+\beta_6X_{6(1)}=\ 24{,}492-1{,}626\ \text{age}+3{,}610$ there are women in family who have a history dysmenorrhea

ii. $\ln\left(\frac{p\ (y=3)}{p\ (y=1)}\right)=\left(\frac{\text{moderate menstrual pain}}{\text{no menstrual pain}}\right)=\ \alpha+\beta_6X_{6(1)}=\ 33{,}381+4{,}588$ there are women in the family who have a history of dysmenorrhea

iii. $\ln\left(\frac{p\ (y=4)}{p\ (y=1)}\right)=\left(\frac{\text{severe menstrual pain}}{\text{no menstrual pain}}\right)=\ \alpha+\beta_6X_{6(1)}=\ 8{,}341+6{,}202$ there are women in the family who have a history of dysmenorrhea

The usefulness of the Odds Ratio (OR) is to facilitate the interpretation of the logistic regression model. Based on the interpretation results of the *p*-value on the parameters partially, we can continue to interpret the OR value in this study as follows:

1. The Odds Ratio or Exp(B) value of variable X_1 (age) was 0.197, indicating that if there was an increase in age, it was estimated that there was a 0.197 times greater chance of having mild menstrual pain.
2. The Odds Ratio or Exp(B) value of variable $X_{6(1)}$ (history of dysmenorrhea) was 36.960, indicating that respondents with a family history of dysmenorrhea were 36.960 times more likely to have mild menstrual pain compared to those without a family history of dysmenorrhea.
3. The Odds Ratio or Exp(B) value of variable $X_{6(1)}$ (history of dysmenorrhea) was 98.319, indicating that respondents with a family history of dysmenorrhea were 98.319 times more likely to have moderate menstrual pain compared to those without a family history of dysmenorrhea.
4. The Odds Ratio or Exp(B) value of variable $X_{6(1)}$ (no history of dysmenorrhea) was 493.804, indicating that respondents with a family history of dysmenorrhea were 493.804 times more likely to have severe menstrual pain compared to those without a family history of dysmenorrhea.

Table 5. Classification

Observed	Predicted				
	No menstrual pain	Mild menstrual pain	Moderate menstrual pain	Severe menstrual pain	Percent Correct (%)
No menstrual pain	6	2	3	0	54,5
Mild menstrual pain	2	14	13	3	43,8
Moderate menstrual pain	1	8	38	0	80,9
Severe menstrual pain	0	3	3	4	40
Overall Percentage (%)	9	27	57	7	62

A classification table is used to determine classification accuracy. Of the 11 respondents with no menstrual pain, 2 were predicted to experience mild menstrual pain, and 3 would experience moderate menstrual pain, with a prediction accuracy rate of 54.5%. In addition, 32 respondents with mild menstrual pain, 2 were predicted to have no menstrual pain, 13 were predicted to experience moderate menstrual pain, and 3 were predicted to experience severe menstrual pain, with a prediction accuracy rate 43.8%. Of 47 respondents with moderate menstrual pain, 1 was predicted to have no menstrual pain, 8 were predicted to have mild menstrual pain, and none were predicted to have severe menstrual pain, with a prediction accuracy rate of 80.9%. Of the 10 respondents who experienced severe menstrual pain, none (0) were predicted to have no menstrual pain, 3 were predicted to experience mild menstrual pain, and 3 were predicted to experience moderate menstrual pain, with a prediction correctness rate of 40%. The

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overall percentages for 100 respondents were: 11 with no menstrual pain, 32 with mild menstrual pain, 47 with moderate menstrual pain, and 10 with severe menstrual pain, with the model's accuracy at 62%.

DISCUSSION

It is in line with prior studies by Tsamara *et al.* (2020) and Zeba *et al.* (2024), finding that the incidence of menstrual pain (primary dysmenorrhea) peaks at the transition between the late adolescent group and the young adult group, namely around the age of 17-24 years or 15-25 years. However, menstrual pain levels between individuals vary from one to another, ranging from those who do not experience pain, experience mild pain, moderate pain, to severe pain (Nasution et al., 2022).

The findings showed that most respondents experienced moderate menstrual pain. Without realizing it, menstrual pain has a considerable impact on female students. mentioned that. So far, there is no mortality data due to menstrual pain, but menstrual pain is associated with significant morbidity (Kusyanti & Fay, 2023). Dysmenorrhea in school students can reduce concentration and even motivation to learn in class, more seriously even not going to class because of complaints of menstrual pain that is quite serious. Menstrual pain or dysmenorrhea is synonymous with symptoms of endometriosis. It is quite worrying because every teenager with complaints of menstrual pain has the opportunity to have infertility complaints (Silaen, Ani, and Putri, 2019).

Rosyida (2020) mentions that young women with BMI in the category of less than normal weight and overweight are much more likely to experience menstrual pain complaints compared to young women who have BMI in the normal category. It is because young women with BMI in the less-than-normal-weight category tend to have poor endurance when experiencing complaints of menstrual pain or dysmenorrhea, especially if the menstrual pain is severe. Meanwhile, adolescent girls who have a BMI in the overweight category have the potential to store quite a lot of fat in their bodies. It disrupts the reproductive system through hormonal imbalance and results in pain.

It is in accordance with a study by Zeba *et al.* (2024), which found that a family history of dysmenorrhea is one of the risk factors for the incidence of menstrual pain. Based on the theory of HL. Blum (1974) explains that genetic factors are among the determinants of health status. The families of women who have a history of menstrual pain include genetics and heredity (De Sanctis et al., 2016). According to the Ministry of Health, adolescents aged 12-18 years ideally sleep around 8-9 hours/day. Getting enough sleep will affect overall body health. The high social activity during adolescence is a factor that contributes to poor sleep quality among adolescents (Nasution et al., 2022).

Exercise is an investment in future health for adolescent girls. Prostaglandin hormone secretion can decrease with regular exercise. However, if young women are reluctant to exercise regularly, the blood

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vessels of the reproductive organs will undergo vasoconstriction, reducing the oxygen supply. As a result, young women have complaints of dysmenorrhea (Purwati et al., 2020).

Nicotine has properties that obstruct blood flow to the endometrium. This kind of mechanism in the body can trigger complaints of pain during menstruation (Rosyida, 2020). Adolescents with significant levels of stress trigger estrogen and progesterone levels in the body to drop. In addition, prostaglandin synthesis increases. These two things that do not synergize cause uterine muscle contractions so that adolescent girls feel menstrual pain (Mayangsari & Ayubi, 2024; Purwati et al., 2020).

Partial test showed that three variables, history of dysmenorrhea, amount of sleep time, and exercise, influenced the incidence of menstrual pain in adolescent girls in Pekalongan City, with *p*-value <0.05 (Table 2). The results of the study have similarities with the research of Angelia *et al.* (2017), showing that several factors cause primary dysmenorrhea in students of one of the high schools in Palembang, including stress, sleep time at night, time when getting up early, sleep duration, female families who have a history of dysmenorrhea, and menstruation duration. A study by Munir *et al.* (2023) found that family history factors were associated with menstrual pain (p = 0.013). In addition, research by Hasan *et al.* (2023) found that lifestyle factors were influential in the incidence of dysmenorrhea. Moreover, research on adolescent girls in Pekalongan City indicated that sleep duration and exercise habits affected menstrual pain. These studies support each other, indicating that sleep time and exercise habits are lifestyle factors that can affect the quality of life of adolescent girls during menstruation.

However, this study did not find a significant effect on 11 other variables: age, menarche age, BMI, duration of menstruation, menstrual cycle, meal skipping, bedtime, wake-up time, cigarette exposure, alcohol consumption, and stress level. It is not in line with the research by Nasution *et al.* (2022), which showed that physical activity, nutritional status, and stress levels were associated with the incidence of dysmenorrhea. In contrast, another study stated that the age of menarche was not associated with menstrual pain. However, there was a relationship between the menstrual cycle, length of menstruation, nutritional status, and family history of dysmenorrhea with the incidence of dysmenorrhea in students in Bogor (Munir et al., 2023).

Thus, the Multinomial Logistic Regression model fit the observed data and can be interpreted with a fairly good level of accuracy in this investigation (Table 4). This study also produced three logit equations. It aligns with a study showing that the global model's accuracy in predicting the incidence of menstrual pain among adolescent girls in Pekalongan City was fairly high (Arofah & Sofro, 2022; Sobari et al., 2024).

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CONCLUSION

Multinomial Logistic Regression analysis proves statistically to produce a global model accuracy in correctly predicting the incidence of menstrual pain among adolescent girls in Pekalongan City. Family history of menstrual pain, sleep duration, and exercise habits partially influence the incidence of menstrual pain. Family history of menstrual pain is the most dominant risk factor.

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