ORIGINAL ARTICLE

Prevalence of Stress and Depression by ST-5, PHQ2, and PHQ9, and a Preliminary Study of Their Association with Neutrophil-to-Lymphocyte Ratio in Ubon Ratchathani, Thailand

Siriwoot Butsri, PhD[1], Sureewan Bumrungthai, PhD[1], Sureewan Duangjit, PhD[2], Janpen Bamrungthai, MD[3], Mayuree Wongpratate, PhD[4,5]

[1] Division of Biopharmacy, Faculty of Pharmaceutical Sciences, Ubon Ratchathani University, Ubon Ratchathani, Thailand; [2] Division of Pharmaceutical Chemistry and Technology, Faculty of Pharmaceutical Sciences, Ubon Ratchathani University, Ubon Ratchathani, Thailand; [3] Department of Ear, Nose, and Throat, Sunpasitthiprasong Hospital, Ubon Ratchathani, Thailand; [4] Faculty of Medicine, Mahasarakham University, Mahasarakham, Thailand; [5] Chulabhorn Royal Academy, Bangkok, Thailand

Objective: To evaluate the prevalence of stress and depression by ST-5, PHQ2, and PHQ9 among individuals in Ubon Ratchathani Province, Thailand, and to examine the association between neutrophil-to-lymphocyte ratio (NLR) and stress and depression risk.

Materials and Methods: A cross-sectional study comprised 280 participants. The Thai-versions of ST-5, PHQ2, and PHQ9 were used to evaluate stress and depression risk. Blood samples were collected to measure complete blood count (CBC). The association between NLR and the risk of stress or depression was analyzed using univariate logistic regression. The strength of association was assessed using odds ratios with 95% confidence intervals. A p-value of less than 0.05 was considered statistically significant.

Results: The prevalence of stress, at risk of depression and depression exhibited were 10.71%, 15.36%, and 5.00% of all participants, respectively. Moreover, participants who had severe to very severe stress, and moderate to severe depression were found only among females when compared with males. However, no significant association was found between NLR and the risk of stress and depression.

Conclusion: Prevalence of stress exhibited 10.71%, at risk of depression showed 15.36%, and depression was found 5% of all participants. The authors suggest that the community-based program for stress management should be provided and early detection of depression by specialist may be useful for reducing incidence and severity of depression, especially in females. To prove the association between NLR and stress and depression risk, further research in depressed patients may be required.

Keywords: Prevalence; Risk; Stress; Depression; Neutrophil-to-lymphocyte ratio

Received 4 April 2025 | Revised 4 July 2025 | Accepted 8 July 2025

J Med Assoc Thai 2025;108(9):763-9

Website: http://www.jmatonline.com

Depression is a common mental health problem worldwide[1]. It affects not only mental health but also overall well-being, with symptoms including depressed mood, social isolation, loss of energy or interest, feelings of worthlessness, overthinking, sleep problems, weight problems, and more[2]. Moreover, these symptoms may lead individuals experiencing them to suicidal thoughts or attempted suicide[2-4].

Stress is considered a major contributing factor to depression, particularly when individuals are unable to cope with the problems or threats, leading to chronic stress and development of depression[5,6]. In addition, inflammation has been suggested to play a key role in the etiology of depression[7,8]. Although the exact relationship between depression and inflammation remains unclear, bacterial lipopolysaccharide (LPS) can activate astrocytes and induce neuroinflammation[8]. Previous studies have reported that elevated inflammatory marker such as the neutrophil-to-lymphocyte ratio (NLR) are associated with depressive symptoms, for instance, elevated NLR has been linked to depression in Japanese men[9]. Furthermore, a meta-analysis in China found significantly higher NLR levels in depressed patients compared to controls[10]. These

Correspondence to:

Wongpratate M.
Chulabhorn Loyal Academy, Bangkok 10210, Thailand.
Phone: +66-2-5766000 ext. 7284
Email: mayuree.won@cra.ac.th, numerous.living@gmail.com

How to cite this article:

Butsri S, Bumrungthai S, Duangjit S, Bamrungthai J, Wongpratate M. Prevalence of Stress and Depression by ST-5, PHQ2, and PHQ9, and a Preliminary Study of Their Association with Neutrophil-to-Lymphocyte Ratio in Ubon Ratchathani, Thailand. J Med Assoc Thai 2025;108:763-9.
DOI: 10.35755/jmedassocthai.2025.9.763-769-03019

findings suggest that NLR may serve as a potential biomarker for depression.

In Thailand, the prevalence of stress and depression was 15.40% to 48.80% and 7.00% to 39.10%, respectively. Most studies focus on undergraduate students and hill tribes[4,11-15]. However, there is limited data among the general population who lives in Ubon Ratchathani, Thailand. Furthermore, the association between NLR and stress or depression risk has not yet been explored in Thai population. Therefore, the present study aimed to evaluate the prevalence of stress and depression by ST-5, PHQ2, and PHQ9 testing among individuals residing in Ubon Ratchathani province, Thailand, and to examine the association between NLR and the risk of stress and depression for the purpose of creating an early mental health management in the country.

Materials and Methods

Study population

The present study is designed as a cross-sectional study. The study population comprised of 280 participants, aged between 18 and 89 years. This study was conducted in Ubon Ratchathani province, Thailand, between August 2022 and May 2023. All subjects were community volunteers with no history of, or diagnosed with, psychological disorders, as determined by self-reported questionnaire data focusing on prevention of depression. The sample size was calculated using the Cochran's formula[16], $n = (p(1–p)Z^2)/e^2$, where n=sample size, p=population proportion (p=0.2), Z=Z value (e.g., 1.96 for a 95% confidence level), and e=acceptable sampling error (e=0.05). The sample size from the Cochran's formula was 246 subjects, then the random sampling method was applied. All of participants were informed of the objectives, methodology, and any associated risks or benefits of the research and signed an informed consent form. The authors asserted that all procedures contributing to the present work complied with the Ethical Standards of the relevant National and Institutional Committees on Human Experimentation and with the Helsinki Declaration of 1975, as revised in 2013. All procedures involving human subjects/patients were approved by the Research Ethics Committee of the University of Phayao (approval No. UP-HEC 1.3/013/65), Thailand.

Mental health questionnaires

The study used the Thai version of mental health questionnaires, which are valid and reliable methods from the Department of Mental Health, Ministry of Public Health, Thailand[17], for screening stress and depression risk. The tests included the ST-5, PHQ2, and PHQ9.

The ST-5 is a stress test questionnaire consisting of five questions, with a maximum score of 15. Scores are categorized into four levels, mild stress with 0 to 4, moderate stress with 5 to 7, severe stress with 8 to 9, and very severe stress with 10 to 15.

The PHQ2 is a patient health questionnaire-2, used to screen depressive symptoms over the past two weeks. The total score ranges from 0 to 2, with the interpretation levels including normal with 0 and at risk of depression with a 1 to 2.

The PHQ9 is a patient health questionnaire-9 used to assess the severity of depression, with a total score ranging from 0 to 27. Scores are interpreted as no depressive symptoms with 0 to 6, mild depression with 7 to 12, moderate depression with 13 to 18, and severe depression with 19 to 27.

Blood sampling and hemogram measurement

Two milliliters of blood were collected from the subjects' peripheral veins and stored in ethylenediaminetetraacetic acid (EDTA) tubes. Complete blood count parameters were subsequently analyzed in the laboratory of the N Health clinic, Ubon Ratchathani, Thailand. The NLR was categorized as either normal or abnormal range. The normal range was defined as 0.8 to 2.2, while values of 0.1 to 0.7 and 2.3 or more were considered abnormal[18].

Statistical analysis

Statistical analysis was performed using Stata, version 14 (StataCorp LP, College Station, TX, USA) and Microsoft Excel. The participants' demographic data and categorical variables were expressed in frequencies, ratios, and mean ± standard deviation. The associations between NLR and the risk of stress and depression were assessed using univariate logistic regression. The strength of association was measured using odds ratios (ORs) with 95% confidence intervals (CIs). A p-value of less than 0.05 was considered statistically significant.

Results

The present study was conducted on 280 participants in Ubon Ratchathani province, Thailand. Of these, 251 participants (89.64%) completed blood sampling. Twenty-nine participants (10.36%) refused to have their blood drawn. The demographic data are summarized in Table 1. Among the participants, 22.5% were males and 77.5% were females. The

Table 1. Demographic data

Characteristics	Total; n (%)	Men; n (%)	Women; n (%)
Gender	280 (100)	63 (22.50)	217 (77.50)
Age (years)			
Min		34	18
Max		84	89
Mean±SD		60.75±10.43	56.94±14.78
Status			
Not married	29 (10.36)	7 (11.11)	22 (10.14)
Married	250 (89.28)	56 (88.89)	194 (89.40)
Widow	1 (0.36)	0 (0.00)	1 (0.46)
ST-5 (score)			
Mild stress (0 to 4)	250 (89.29)	58 (92.06)	192 (88.48)
Moderate stress (5 to 7)	24 (8.57)	5 (7.94)	19 (8.76)
Severe stress (8 to 9)	3 (1.07)	0 (0.00)	3 (1.38)
Very severe stress (10 to 15)	3 (1.07)	0 (0.00)	3 (1.38)
PHQ2			
Normal	237 (84.64)	55 (87.30)	182 (83.87)
At risk	43 (15.36)	8 (12.70)	35 (16.13)
PHQ9 (score)			
No depressive symptoms (0 to 6)	266 (95.00)	62 (98.41)	204 (94.01)
Mild depression (7 to 12)	12 (4.28)	1 (1.59)	11 (5.07)
Moderate depression (13 to 18)	1 (0.36)	0 (0.00)	1 (0.46)
Severe depression (≥19)	1 (0.36)	0 (0.00)	1 (0.46)

SD=standard deviation

Table 2. Complete blood count (CBC) parameters of the study population

CBC	Total	Men	Women
Gender; n (%)	251 (100)	47 (18.73)	204 (81.27)
WBC ($\times 10^3/mm^3$); mean±SD		7.56±1.81	7.22±1.76
RBC ($\times 10^6/mm^3$); mean±SD		4.77±0.50	4.65±0.58
Neutrophils (%); mean±SD		51.5±8.9	52.2±8.9
Lymphocytes (%); mean±SD		36.0±8.4	36.4±7.5
NLR; mean±SD		1.6±0.7	1.5±0.6
NLR value; n (%)			
Normal range (0.8 to 2.2)	217 (86.45)	37 (14.74)	180 (71.71)
Abnormal range (0.1 to 0.7 and >2.2)	34 (13.55)	10 (3.98)	24 (9.56)
• High NLR (>2.2)	26 (10.36)	7 (2.79)	19 (7.57)
• Low NLR (0.1 to 0.7)	8 (3.19)	3 (1.20)	5 (1.99)

SD=standard deviation; WBC=white blood cell; RBC=red blood cell; NLR=neutrophil-to-lymphocyte ratio

average age was 60.75 years among males and 56.94 years among females. The majority of participants were married (89.29%).

The prevalence of stress, at risk of depression and depression was assessed using the ST-5, PHQ2, and PHQ9 questionnaires, respectively. The finding revealed that 10.71% of participants experienced stress, 15.36% were at risk of depression, and 5% had depression. Notably, the present study results showed that participants who had severe to very severe stress and those with moderate to severe depression were found exclusively among females when compared with male participants (Table 1).

The complete blood counts were used to assess inflammatory marker, NLR. The mean neutrophil and lymphocyte values were 51.5±8.9% and 36.0±8.4% among males and 52.2±8.9% and 36.4±7.5% among females, respectively. The mean NLR was within the normal range, between 0.8 and 2.2, in the study population, 1.6±0.7 in males and 1.5±0.6 in females, respectively. The abnormal NLR ranges, which are 0.1 to 0.7 and more than 2.2[18], were found in 13.55% of participants, with elevated NLR in 10.36% and decreased NLR in 3.19% (Table 2).

Table 3. Association between the NLR and the risk of stress (ST-5) in the study population

Related factors	ST-5 score		OR [95% CI]	p-value
	0 to 4 (low stress) (n=222)	5 to 15 (moderate to very severe stress) (n=29)		
NLR; mean±SD	1.5±0.60	1.6±0.66		0.405
NLR value; n (%)				
Normal (0.8 to 2.2)	192 (86.49)	25 (86.21)	1	
Abnormal (0.1 to 0.7 and >2.2)	30 (13.51)	4 (13.79)	1.02 [0.24 to 3.27]	0.967

SD=standard deviation; OR=odds ratio; CI=confidence interval; NLR=neutrophil-to-lymphocyte ratio
p<0.05, statistical significance

Table 4. Association between the NLR and the risk of depression (PHQ2) and level of depression (PHQ9) in the study population

Related factors	PHQ2 score		OR [95% CI]	p-value
	0 (normal) (n=212)	1 to 2 (at risk) (n=39)		
NLR; mean±SD	1.5±0.59	1.6±0.68		0.343
NLR value; n (%)				
Normal (0.8 to 2.2)	182 (85.85)	35 (89.74)	1	
Abnormal (0.1 to 0.7 and >2.2)	30 (14.15)	4 (10.26)	0.69 [0.17 to 2.15]	0.513
	PHQ9 score			
	0 to 6 (no depressive symptoms) (n=237)	7 to 27 (mild to severe depression) (n=14)		
NLR; mean±SD	1.5±0.58	1.8±0.87		0.070
NLR value; n (%)				
Normal (0.8 to 2.2)	206 (86.92)	11 (78.57)	1	
Abnormal (0.1 to 0.7 and >2.2)	31 (13.08)	3 (21.43)	1.81 [0.31 to 7.37]	0.375

SD=standard deviation; OR=odds ratio; CI=confidence interval; NLR=neutrophil-to-lymphocyte ratio
p<0.05, statistical significance

Table 5. Association between the NLR and the risk of depression (PHQ2) among women and men

NLR	PHQ2 score		OR [95% CI]	p-value
	0 (normal)	1 to 2 (at risk)		
Men	(n=42)	(n=5)		
Normal (0.8 to 2.2)	34 (80.95)	3 (60.00)	1	
Abnormal (0.1 to 0.7 and >2.2)	8 (19.05)	2 (40.00)	2.83 [0.20 to 28.62]	0.279
Women	(n=170)	(n=34)		
Normal (0.8 to 2.2)	148 (87.06)	32 (94.12)	1	
Abnormal (0.1 to 0.7 and >2.2)	22 (12.94)	2 (5.88)	0.42 [0.05 to 1.86]	0.243

OR=odds ratio; CI=confidence interval; NLR=neutrophil-to-lymphocyte ratio
p<0.05, statistical significance

When examining the association between NLR and stress and depression risk, no statistically significant associations were found in the present study (Table 3-5).

Discussion

In the present study, the authors examined the prevalence of stress and depression among the general population in Ubon Ratchathani province, Thailand. The results demonstrated that the prevalence of stress was 10.71% in the study population, which is lower than previous studies among undergraduate student in Thailand that was at 15.40%[15]. Furthermore, Siripongpan et al., reported a notably higher prevalence of 48.80% among first-year university students. These findings may suggest that the general population in Ubon Ratchathani experiences lower levels of stress compared to the undergraduate students. Academic problems and life's adjustment in the university may contribute to the elevated level of stress observed in the student population[14].

Prevalence of depression was found to be only 5.00% of all participants based on PHQ9 results. In contrast, 15.36% of participants were at risk of depression using PHQ2 questionnaires in the present study. The previous findings reported higher

prevalence rates. For instance, 29.20% of volunteers suffer from depression among general population aged over 45 years[11]. Furthermore, Srisopa et al., and Pitanupong et al. reported the prevalence rates of 20.70% and 27.40%, respectively, among undergraduate students[4,15]. Similarly, Kinoshita et al. found a prevalence of 19.7% of volunteers in Japanese population[9]. Additionally, Singkhorn et al. showed that 39.10% of participants had depression among hill tribe age 40 years or over in Thailand[13]. The variation in prevalence rates may be influenced by factors including study populations, sample sizes, assessment tools, age groups, cultures, and social norms. Furthermore, the present study found that participants who had severe to very severe stress, and moderate to severe depression were exclusively females. This finding is consistent with the previous studies conducted in Thailand. For instance, Siripongpan et al., found that the prevalence of depression and pathological stress were higher among female undergraduate student compared to other gender groups[14]. Similarly, being females was found to be associated with depression among hill tribe adults aged 30 years and older[12,13]. The higher depression rate observed in females may be attributed to contributing factors, including influence of sex hormones, response of hypothalamic-pituitary-adrenal axis to stress, high tendency for body shame and lower self-esteem, as well as experiences of violence or childhood sexual abuse. These factors increase the risk of depression in females more than males[19]. The present study would suggest that the community-based program for stress management and early detection of depression by specialist, especially in females may be necessary to reduce incidence and severity of stress and depression in the country. Furthermore, health education focuses on stress management and the promotion of healthy lifestyles behaviors, such as adequate exercise, enough sleep, emotional self-awareness, emotional regulation, and relaxation techniques, which may help prevent the development of depressive disorders, particularly among Thai females[20].

When the authors investigated the association between NLR and the risk of stress, risk of depression, and level of depression, the results showed non-significant trend towards associations in the present study. Previous studies in Thailand have reported that elevated NLR is associated with certain types of cancer, including nasopharyngeal and breast cancer patients[21,22]. Additionally, NLR values greater than 2.3 have been used as a primary diagnostic marker of cholangiocarcinoma[23]. Elevated NLR levels have also been observed in patients with mental disorders such as schizophrenia, neurodegenerative diseases, Alzheimer, and depression[9,10,24-29]. Moreover, a higher NLR has been linked to the severity of depression, with mean values reported as mild at 1.38±0.53, moderate at 1.47±0.53, severe at 1.64±0.48, and very severe at 2.02±0.95, with a statistically significant difference ($p<0.001$)[25]. The general population without depressive disorders might have less inflammation than clinical populations. Therefore, no statistically significant association was found in the present study. Recently, the NLR has been recognized as a biomarker of systemic inflammation and neuroinflammation[30,31]. An increase in pro-inflammatory cytokines, such as TNF-α, IL-1β, and IL-6 are a key factor leading to neutrophil activation and elevated NLR levels. Activated neutrophils produce reactive oxygen species, reduce levels of tissue inhibitors of metalloproteinase-1, and upregulate matrix metalloproteinase-9, which collectively contributes to an increased permeability of the blood-brain barrier and disruption of tight junctions. This cascade promotes neuroinflammation[32]. This is one of an interesting mechanism involving depression to explore. However, limitations of the present study are 1) the lack of patients diagnosed with depression and a small sample size. NLR as a biomarker in mental health screening requires future research such as examining association between NLR and patients diagnosed with depression across many dimensions and increasing the sample size. This may find compelling evidence for a new biomarker to precisely detect depressive disorder. 2) Gender imbalance observed in the present study may be attributed to the fact that the average female population in the community is higher than male population.

Conclusion

The prevalence of stress accounted for 10.71%, at risk of depression showed 15.36%, and depression was found in 5% of all participants. The authors suggest that a community-based program for stress management should be provided and early detection of depression by specialist may be useful for reducing incidence and severity of depression, especially in females. No associations were found between NLR and the risk of stress and depression in the present study. Further research into depressive patients may be required.

What is already known about this topic?

Prevalence of depression is quite high among undergraduate student and hill tribes aged 40 years or over in Thailand, reports rates between 20.70% and 39.10%. Prevention and early detection of depression may reduce incidence and severity of depression in Thailand.

What does this study add?

This study reported the prevalence of stress and depression in Ubon Ratchathani and was the first study to assess an association between NLR and the risk of stress and depression in Thailand.

Acknowledgement

This research project was financially supported by Faculty of Medicine Mahasarakham University and Faculty of Pharmaceutical Sciences, Ubon Ratchathani University (grant no. 0604.11 6/2567).

Conflicts of interest

The authors declare that there are no conflicts of interest.

References

1. World Health Organization. Depressive disorder (depression) [Internet]. 2023 [cited 2024 Sep 10]. Available from: https://www.who.int/news-room/fact-sheets/detail/depression.
2. Herrman H, Patel V, Kieling C, Berk M, Buchweitz C, Cuijpers P, et al. Time for united action on depression: a Lancet-World Psychiatric Association Commission. Lancet 2022;399:957-1022.
3. Rachchaiya K, Phanasathit M. Prevalence and factors associated with suicidality in patients with major depressive disorders in Charoenkrung Pracharak hospital. J Psychiatr Assoc Thai 2023;68:380-393.
4. Pitanupong J, Sa IA, Sathaporn K, Jiraphan A, Ittasakul P, Karawekpanyawong N. The personality traits with depression and suicidal ideation among Thai medical students: a university-based multiregional study. BMC Psychol 2024;12:223. doi: 10.1186/s40359-024-01707-8.
5. Tafet GE, Nemeroff CB. The links between stress and depression: Psychoneuroendocrinological, genetic, and environmental interactions. J Neuropsychiatry Clin Neurosci 2016;28:77-88.
6. Khan S, Khan RA. Chronic stress leads to anxiety and depression. Ann Psychiatry Ment Health [Internet] 2017 [cited 2024 Sep 10];5:1091. Available from: https://www.jscimedcentral.com/public/assets/articles/psychiatry-5-1091.pdf.
7. Cui L, Li S, Wang S, Wu X, Liu Y, Yu W, et al. Major depressive disorder: hypothesis, mechanism, prevention and treatment. Signal Transduct Target Ther 2024;9:30. doi: 10.1038/s41392-024-01738-y.
8. Beurel E, Toups M, Nemeroff CB. The bidirectional relationship of depression and inflammation: Double trouble. Neuron 2020;107:234-56.
9. Kinoshita H, Takekawa D, Kudo T, Sawada K, Mikami T, Hirota K. Higher neutrophil-lymphocyte ratio is associated with depressive symptoms in Japanese general male population. Sci Rep 2022;12:9268. doi: 10.1038/s41598-022-13562-x.
10. Cheng Y, Wang Y, Wang X, Jiang Z, Zhu L, Fang S. Neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio, and monocyte-to-lymphocyte ratio in depression: An updated systematic review and meta-analysis. Front Psychiatry 2022;13:893097. doi: 10.3389/fpsyt.2022.893097.
11. Wangtongkum S, Sucharitakul P, Wongjaroen S, Maneechompoo S. Prevalence of depression among a population aged over 45 years in Chiang Mai, Thailand. J Med Assoc Thai 2008;91:1812-6.
12. Chomchoei C, Apidechkul T, Keawdounglek V, Wongfu C, Khunthason S, Kullawong N, et al. Prevalence of and factors associated with depression among hill tribe individuals aged 30 years and over in Thailand. Heliyon 2020;6:e04273.
13. Singkhorn O, Apidechkul T, Pitchalard K, Moonpanane K, Hamtanon P, Sunsern R, et al. Prevalence of and factors associated with depression in the hill tribe population aged 40 years and older in northern Thailand. Int J Ment Health Syst 2021;15:62. doi: 10.1186/s13033-021-00487-7.
14. Siripongpan A, Phattaramarut K, Namvichaisirikul N, Poochaya S, Horkaew P. Prevalence of depression and stress among the first year students in Suranaree University of Technology, Thailand. Health Psychol Res 2022;10:35464. doi: 10.52965/001c.35464.
15. Srisopa P, Moungkum S, Hengudomsub P. Factors predicting depression, anxiety, and stress of undergraduate students in the Eastern region of Thailand. Nurs Sci J Thai 2023;41:109-22.
16. Uakarn C, Chaokromthong K, Sintao N. Sample size estimation using Yamane and Cochran and Krejcie and Morgan and Green formulas and Cohen statistical power analysis by G*Power and comparisons. Apheit Int J 2021;10:76-88.
17. Department of Mental Health, Ministry of Public Health. Mental health check-in [Internet]. 2016 [cite 2024 Nov 18]. Available from: https://dmh.go.th/test/.
18. Zahorec R. Neutrophil-to-lymphocyte ratio, past, present and future perspectives. Bratisl Lek Listy 2021;122:474-88.
19. Riecher-Rössler A. Sex and gender differences in mental disorders. Lancet Psychiatry 2017;4:8-9.
20. Ghafori SS, Yousefi Z, Bakhtiari E, Mohammadi Mahdiabadi Hasani MH, Hassanzadeh G. Neutrophil-to-lymphocyte ratio as a predictive biomarker for early diagnosis of depression: A narrative review. Brain Behav Immun Health 2024;36:100734. doi: 10.1016/j.

bbih.2024.100734.
21. Muangwong P, Homkham N, Narueban W, Tadadoltip C, Jongjumnien C, Taenawakun N, et al. Longitudinal measurements of neutrophil-to-lymphocyte ratio in nasopharyngeal cancer treated with concurrent chemoradiotherapy. PLoS One 2023;18:e0292591.
22. Ondee S, Boonmak K, Buaklang P, Jedpiyawongse A. Utility of neutrophil-to-lymphocyte ratio and platelet-to-lymphocyte ratio as prognostic factors in pretreatment breast-cancer patients. Thai Cancer J 2020;40:142-53.
23. Chalermwat C, Silsirivanit A, Saentaweesuk W, Bhudisawasdi W, Pairojkul C, Khahmahpahte S, et al. Neutrophil-to lymphocyte ratio: a systemic inflammatory index for primary diagnosis and prognosis of cholangiocarcinoma. Biomed J Sci Tech Res 2019;13:9857-64.
24. Demir S, Atli A, Bulut M, İbiloğlu AO, Güneş M, Kaya MC, et al. Neutrophil-lymphocyte ratio in patients with major depressive disorder undergoing no pharmacological therapy. Neuropsychiatr Dis Treat 2015;11:2253-8.
25. Aydin Sunbul E, Sunbul M, Yanartas O, Cengiz F, Bozbay M, Sari I, et al. Increased neutrophil/lymphocyte ratio in patients with depression is correlated with the severity of depression and cardiovascular risk factors. Psychiatry Investig 2016;13:121-6.
26. Kulaksizoglu B, Kulaksizoglu S. Relationship between neutrophil/lymphocyte ratio with oxidative stress and psychopathology in patients with schizophrenia. Neuropsychiatr Dis Treat 2016;12:1999-2005.
27. Jacobs T, Jacobson SR, Fortea J, Berger JS, Vedvyas A, Marsh K, et al. The neutrophil to lymphocyte ratio associates with markers of Alzheimer's disease pathology in cognitively unimpaired elderly people. Immun Ageing 2024;21:32. doi: 10.1186/s12979-024-00435-2.
28. Cervellati C, Pedrini D, Pirro P, Guindani P, Renzini C, Brombo G, et al. Neutrophil-lymphocytes ratio as potential early marker for Alzheimer's disease. Mediators Inflamm 2024;2024:6640130. doi: 10.1155/2024/6640130.
29. Mohammadi A, Mohammadi M, Almasi-Dooghaee M, Mirmosayyeb O. Neutrophil to lymphocyte ratio in Alzheimer's disease: A systematic review and meta-analysis. PLoS One 2024;19:e0305322.
30. Kotani K, Sakane N. White blood cells, neutrophils, and reactive oxygen metabolites among asymptomatic subjects. Int J Prev Med 2012;3:428-31.
31. Kara SP, Altunan B, Unal A. Investigation of the peripheral inflammation (neutrophil-lymphocyte ratio) in two neurodegenerative diseases of the central nervous system. Neurol Sci 2022;43:1799-807.
32. Sayed A, Bahbah EI, Kamel S, Barreto GE, Ashraf GM, Elfil M. The neutrophil-to-lymphocyte ratio in Alzheimer's disease: Current understanding and potential applications. J Neuroimmunol 2020;349:577398. doi: 10.1016/j.jneuroim.2020.577398.