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Prediction of emotional intelligence level of medical students based on multiple regression analysis

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Прогнозування рівня емоційного інтелекту студентів-медиків на основі багатофакторного регресійного аналізу

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Introduction

Emotional intelligence (EI) is a crucial component of professional competence in future physicians, influencing academic performance, the quality of patient care, communication effectiveness, teamwork, and resilience in stressful situations [1; 2; 3]. Defined as the ability to perceive, understand, regulate, and effectively utilize emotions, EI has become an integral part of contemporary medical education and clinical practice [4; 5].

Evidence indicates that higher levels of EI are associated with improved physician–patient relationships, enhanced accuracy of clinical decision-making in complex emotional situations, and reduced risk of burnout, anxiety, and depression among medical students [6; 7; 8]. In patient-centered models of care, the ability to understand others' emotions and demonstrate empathy is essential for building trust and promoting adherence to treatment [9]. Assessment of EI at different stages of medical education provides multiple benefits. It facilitates formative feedback, enhances self-awareness, and allows monitoring of students' emotional development over time. Furthermore, such assessments can be used to evaluate the effectiveness of programs and interventions designed to develop EI [10; 11]. Medical institutions may integrate EI measures into formative assessments, Objective Structured Clinical Examinations (OSCEs), or even admissions processes, while ensuring ethical use of results and providing appropriate resources to support competence development.

The effectiveness of educational interventions targeting EI and resilience is exemplified by the study of Versel et al. (2023) [12]. The authors implemented an elective course for second-year medical students designed to cultivate emotional intelligence skills and resilience strategies, including positive thinking, cognitive reframing, gratitude, and reflection. The results demonstrated a significant increase in overall EI scores and all subscales, including components of stress management and general well-being. Additionally, the course received high evaluations from students, indicating its acceptability and potential for integration at the preclinical stage of medical education [13]. These findings underscore the importance of targeted educational programs in fostering emotional competence and resilience in future physicians [14].

The aim of this study was to develop a predictive model for the level of emotional intelligence (EI) among medical students using the Wong and Law Emotional Intelligence Scale (WLEIS), based on multivariate regression analysis.

Object, materials and research methods

In this study, the level of emotional intelligence (EI) among 4th-, 5th-, and 6th-year students of the Medical Faculty at Ternopil National Medical University was assessed using the Wong and Law Emotional Intelligence Scale (WLEIS). WLEIS is a validated self-report instrument based on both ability and trait theories of emotional intelligence. It evaluates four key components: Self-Emotion Appraisal (SEA), Others' Emotion Appraisal (OEA), Use of Emotion (UOE), and Regulation of Emotion (ROE).

The study employed a cross-sectional design conducted over the course of the academic year, during which students completed the WLEIS questionnaire. Assessing EI at different stages of education enables the provision of formative feedback, promotes self-awareness, and tracks the dynamics of students' emotional development. Furthermore, these data can be used to evaluate the effectiveness of educational interventions aimed at enhancing EI.

To analyze the factors influencing EI levels, multivariate regression analysis was applied. Although the response rate was low, the sample size of respondents provided sufficient statistical power (0.78) to explain even

small proportions of variance in WLEIS scores ($R^2 = 0.05$) at a significance level of 0.05.

The results allowed the identification of an imbalance in the development of emotional competencies: students demonstrated relatively high skills in Others' Emotion Appraisal (OEA), whereas Regulation of Emotion (ROE) and Use of Emotion (UOE) remained comparatively weak. This suggests potential difficulties in controlling one's own emotions and in utilizing emotional awareness as a tool for motivation and behavioral decision-making.

Emotional intelligence (EI) in medical education is considered a key prerequisite for effective communication, teamwork, and clinical competence, directly influencing students' well-being and the quality of future medical practice. Recent reviews and empirical studies demonstrate consistent associations between EI and academic performance, psychological well-being, stress-coping skills, and clinical outcomes, although the strength of these associations varies depending on context and measurement methodology. In particular, meta-analyses in MD programs confirm a statistically significant but moderate-to-weak correlation between EI and academic achievement, highlighting the need for more precise models of its determinants across different educational settings [10].

The Wong and Law Emotional Intelligence Scale (WLEIS) is widely used as a standardized measurement instrument, with its validity and reliability confirmed across various cultural contexts (including Korea, Latin America, and Peru), ensuring the feasibility of accurate cross-sample comparisons and the development of predictive models [15; 16].

The state of research on emotional intelligence (EI) among medical students from 2019 to 2025 is characterized by a shift from descriptive studies to analytical approaches employing multivariate regression models to identify predictors of EI levels. Evidence suggests that age, academic semester, prior leadership or professional experience, as well as other sociodemographic and academic variables, may serve as significant predictors of higher EI among medical students [17].

In samples of healthcare and nursing students, the application of multiple linear regression has made it possible to identify significant predictors of EI and determine their contribution to the variability of EI scores [18].

Several cross-sectional studies among medical students have also constructed multivariate models to identify the determinants of EI, confirming the relevance of this approach for educational analytics [19].

At the same time, other studies demonstrate that higher EI is associated with greater clinical competence, happiness, and better stress-coping abilities, which indirectly indicates the practical value of predicting EI levels for targeting educational interventions [20; 21; 22].

Given the above, the development of a multivariate regression model for predicting EI levels among medical students using the WLEIS is highly relevant. Such a model, grounded in a validated measurement tool and modern statistical approaches, would enable: (1) quantitative assessment of the contribution of demographic, academic, and psychosocial factors to EI formation; (2) identification of at-risk groups for targeted educational interventions; and (3) strengthening of the evidence base for integrating EI development training into medical school curricula. Ultimately, this would enhance graduates' clinical readiness and improve the quality of patient interaction in the context of increasing demands for emotional and communicative competence among future physicians [15–18].

Approaches for developing multivariable regression models for prediction in medicine have been discussed in the following studies [23–25].

Research results

To construct the multivariate regression model for predicting the level of emotional intelligence (EI), 19 factors were included (see Table 1).

To assess the significance of the predictor variables' impact, a stepwise multiple regression analysis was performed using Statistica 12.0 software. The results, identifying significant predictors of emotional intelligence (EI) level, obtained from the multiple regression analysis, are presented in Figure 1.

Since the factors X2, X5, X6, X7, X9, X10, X12, X14, and X17 demonstrated a significance level of $p > 0.05$, they were excluded from further analysis, and a multiple regression analysis was repeated. After constructing the revised regression model, all remaining factors were found to be acceptable and were included in the development of the mathematical model (Fig. 2).

The absence of multicollinear predictors of emotional intelligence (EI) provides grounds for constructing a regression model based on 10 factors:

X1 – Nationality;

X3 – Gender;

X4 – Self-Emotional Appraisal (SEA) (the ability to understand one's own emotions): I have a good understanding of why I feel certain feelings most of the time;

X8 – Others' Emotional Appraisal (OEA) (the ability to perceive and understand others' emotions): I always know my friends' emotions from their behavior;

X11 – Others' Emotional Appraisal (OEA): I have a good understanding of the emotions of people around me;

X13 – Use of Emotions (UOE) (the ability to use emotions to facilitate performance): I always tell myself I am a competent person;

X15 – Use of Emotions (UOE): I always encourage myself to make every effort;

X16 – Regulation of Emotions (ROE) (the ability to regulate one's own emotions): I am able to control my anger so as to handle difficulties rationally;

X18 – Regulation of Emotions (ROE): I am always able to calm down quickly when I am very angry;

X19 – Regulation of Emotions (ROE): I have good control over my own emotions.

The significant predictors of emotional intelligence (EI) are presented in Table 1.

Table 1

Factors predicting the level of emotional intelligence (ei)

No.	Notation of Factors in the Predictive Mathematical Model	Full Title (Detailed Research Question)
1	X1	Nationality
2	X2	Age
3	X3	Gender
4	X4	Self-Emotion Appraisal (SEA) — the ability to understand one's own emotions. I have a good sense of why I have certain feelings most of the time.
5	X5	I have a good understanding of my own emotions.
6	X6	I really understand what I feel.
7	X7	I always know whether or not I am happy.
8	X8	Others' Emotion Appraisal (OEA), (the ability to perceive and understand the emotions of others) I always know my friends' emotions from their behavior.
9	X9	I am a good observer of others' emotions.
10	X10	I am sensitive to the feelings and emotions of others.
11	X11	I have a good understanding of the emotions of people around me.
12	X12	Use of Emotion (UOE), (the ability to use emotions to facilitate performance). I always set goals for myself and then try my best to achieve them.
13	X13	I always tell myself I am a competent person.
14	X14	I am a self-motivated person.
15	X15	I would always encourage myself to try my best.
16	X16	Regulation of Emotion (ROE), (the ability to regulate one's own emotions.) I am able to control my temper so that I can handle difficulties rationally.
17	X17	I am quite capable of controlling my own emotions.
18	X18	I can always calm down quickly when I am very angry.
19	X19	I have good control of my own emotions.

Regression Summary for Dependent Variable: KEI (1 in EI)
R= ,89792253 R?= ,80626487 Adjusted R?= ,79815701
F(19,454)=99,442 p<0,0000 Std.Error of estimate: ,27456

N=474	b*	Std.Err. of b*	b	Std.Err. of b	t(454)	p-value
Intercept			-0,275728	0,205099	-1,34437	0,179500
X1	0,077023	0,037548	0,094414	0,046026	2,05133	0,040808
X2	-0,042568	0,034794	-0,013234	0,010817	-1,22343	0,221802
X3	0,114478	0,023119	0,170061	0,034345	4,95158	0,000001
X4	0,153383	0,045520	0,066086	0,019612	3,36957	0,000817
X5	0,048368	0,050946	0,020266	0,021345	0,94941	0,342917
X6	-0,000322	0,051267	-0,000137	0,021793	-0,00628	0,994990
X7	0,040950	0,034626	0,013811	0,011678	1,18266	0,237562
X8	0,087008	0,036685	0,040193	0,016947	2,37173	0,018121
X9	-0,017606	0,039659	-0,007668	0,017273	-0,44394	0,657298
X10	-0,018043	0,034557	-0,005848	0,011200	-0,52212	0,601841
X11	0,132083	0,043561	0,062297	0,020546	3,03212	0,002567
X12	-0,058589	0,035668	-0,023135	0,014084	-1,64260	0,101157
X13	0,119177	0,040709	0,046215	0,015786	2,92756	0,003588
X14	0,046499	0,050553	0,017580	0,019113	0,91981	0,358162
X15	0,164294	0,054854	0,059407	0,019835	2,99510	0,002894
X16	0,108986	0,044361	0,042769	0,017408	2,45680	0,014391
X17	0,044577	0,058395	0,017238	0,022582	0,76337	0,445640
X18	0,131138	0,036665	0,047977	0,013414	3,57668	0,000385
X19	0,212313	0,054306	0,084203	0,021538	3,90955	0,000107

Fig. 1. Results of identifying significant predictors of emotional intelligence level through multiple regression analysis using Statistica 12.0

N=474	b*	Std.Err. of b*	b	Std.Err. of b	t(463)	p-value
			Regression Summary for Dependent Variable: KEI (1 in EI) R= ,89502328 R?= ,80106667 Adjusted R?= ,79677005 F(10,463)=186,44 p<0,0000 Std.Error of estimate: ,27551			
Intercept			-0,510716	0,094048	-5,43035	0,000000
X1	0,053407	0,022721	0,065466	0,027852	2,35055	0,019164
X3	0,109265	0,021819	0,162318	0,032413	5,00780	0,000001
X4	0,198634	0,030683	0,085582	0,013220	6,47374	0,000000
X8	0,069761	0,031780	0,032226	0,014681	2,19508	0,028653
X11	0,117389	0,034004	0,055367	0,016038	3,45222	0,000607
X13	0,095229	0,034478	0,036928	0,013370	2,76200	0,005973
X15	0,196789	0,039514	0,071157	0,014288	4,98023	0,000001
X16	0,137056	0,033657	0,053784	0,013208	4,07218	0,000055
X18	0,135890	0,034661	0,049716	0,012681	3,92050	0,000102
X19	0,239689	0,039021	0,095060	0,015476	6,14250	0,000000

Fig. 2. Results of identifying significant factors for predicting the level of emotional intelligence (EI) using multiple regression analysis in Statistica 12.0 after excluding factors X2, X5, X6, X7, X9, X10, X12, X14, X17
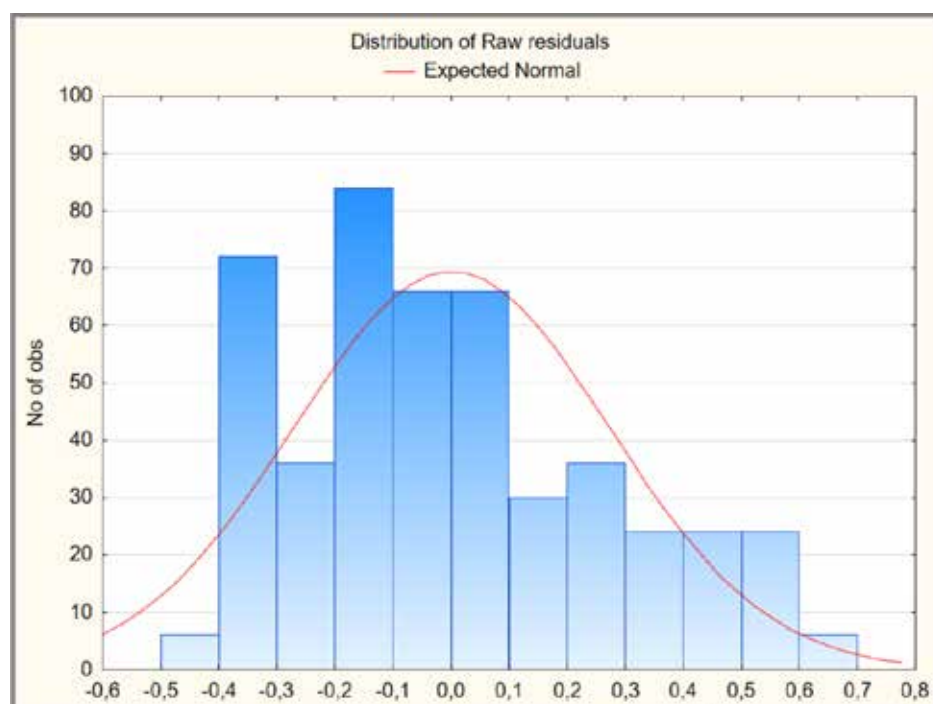
The next step involved calculating the regression coefficients «b» (Beta), which represent the relative contribution of each selected factor to the EI level among the surveyed students.

Based on the results presented in Figure 2, a mathematical model was constructed to determine the Emotional Intelligence Coefficient (Emotional Quotient) (EQ) or (KEI):
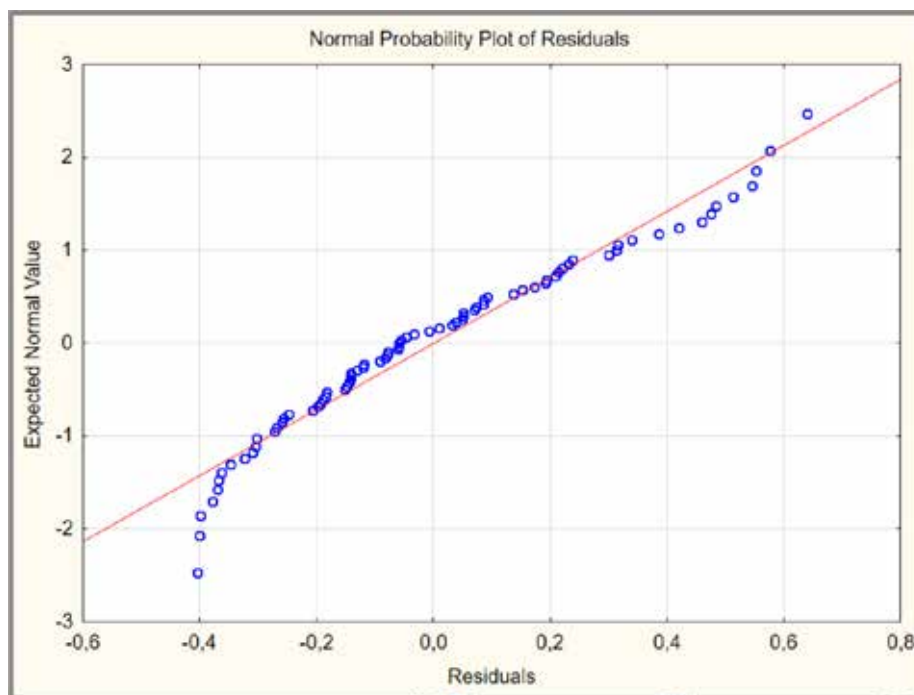
$$KEI = 0{,}065466 * X1 + 0{,}162318 * X3 + 0{,}085582 * X4 + 0{,}032226 * X8 + 0{,}055367 * X11 + 0{,}036928 * X13 + 0{,}071157 * X15 - 0{,}053784 * X16 + 0{,}049716 * X18 - 0{,}095060 * X19 - 0{,}510716.$$

To evaluate the quality of the regression model, residual deviations were analyzed, including the construction of a histogram (Fig. 3). As shown in the histogram, the residuals are symmetrically distributed and approximate the normal distribution curve. Therefore, the statistical hypothesis regarding their conformity to a normal distribution is not rejected. Based on the histogram results, it can be concluded that the residuals are symmetrically distributed and closely follow the normal distribution curve, supporting the assumption of normality.

To further confirm the normality of the residuals, a normal probability (Q-Q) plot was constructed (Fig. 4).

Fig. 3. Histogram of residuals from the multiple regression model predicting emotional intelligence (EI) levels

Fig. 4. Normal probability (Q-Q) plot of residuals from the multiple regression model predicting emotional intelligence (EI) levels

Analysis of the plot indicates the absence of systematic deviations from the normal probability line. This supports the conclusion that the residuals are normally distributed.

To assess the overall adequacy of the model, an **ANOVA analysis** was performed (Fig. 5). The results indicate a high level of model acceptability for predicting emotional intelligence (EI) levels, as the significance level was p < 0.001. This suggests that the model performs better than a simple prediction based on mean values.

To further evaluate the quality of the mathematical Emotional Intelligence Coefficient (EIC) model, Nagelkerke's coefficient of determination (R²) was analyzed. This coefficient indicates the proportion of variance explained by the included predictors and is considered a universal measure of the relationship between one dependent variable and others. The coefficient of determination ranges from 0 to 1. The closer the value of R² is to 1, the higher the quality of the multivariate regression model. In the proposed mathematical EIC model, the coefficient of determination is R² = 0.8 (Statistica 12.0: R² = 0.80106667; Fig. 2). Thus, in this case, 80.1% of the variance is explained by the predictors included in the model for predicting EI levels. The coefficient of determination indicates the extent to which the observed data support the mathematical model.

	Analysis of Variance; DV: KEI (1 in EI)				
Effect	Sums of Squares	df	Mean Squares	F	p-value
Regress.	141,5150	10	14,15150	186,4413	0,00
Residual	35,1432	463	0,07590		
Total	176,6582				

Fig. 5. Results of the ANOVA analysis

Discussion of research results

The constructed multivariate regression model included 10 predictors that demonstrated a statistically significant contribution to the variance in emotional intelligence (EI) levels among medical students. The model explains 80.1% of the variance (R² = 0.801), indicating its high predictive power.

The β coefficients indicated that the variables X3 (β = 0.162) and X1 (β = 0.065) made the greatest positive contributions to EI levels, reflecting key sociodemographic and academic characteristics of the students. Significant predictors also included X15 and X18, which represent students' educational and extracurricular activities. Negative effects on EI levels were observed for variables X16 and X19, potentially indicating certain behavioral or psycho-emotional traits that may limit the development of emotional competence.

The assessment of model adequacy confirmed the normality of residuals (as indicated by the histogram and normal probability plot), the absence of multicollinearity among variables, and the high overall statistical significance of the model (ANOVA, p < 0.001). This supports the use of the model for practical prediction of EI levels and the identification of at-risk groups among medical students.

Prospects for further research

The results highlight the necessity of integrating structured emotional intelligence (EI) training into the medical curriculum at Ternopil National Medical University named after I.Ya. Horbachevsky, Ministry of Health of Ukraine. Future studies should examine

the dynamics of EI development throughout medical education and evaluate the impact of targeted interventions on academic and clinical outcomes. Such research is crucial for the development of evidence-based educational programs designed to foster emotionally competent, empathetic, and effective healthcare professionals.

Conclusions

The developed multivariate regression model identified 10 key predictors of emotional intelligence (EI) levels among medical students, accounting for over 80% of the variance in EI scores. The most significant positive predictors were academic performance and socio-communicative activity, while certain behavioral factors had a negative impact. The proposed model can serve as an analytical tool for the early identification of at-risk groups and the development of targeted educational interventions. The practical implementation of the model may enhance medical students' emotional competence, stress resilience, empathy, and the effectiveness of their future clinical practice.

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Емоційний інтелект є однією з провідних компетентностей сучасних медичних працівників, визначаючи їхню академічну результативність, ефективність професійної комунікації та здатність долати стрес у клінічних умовах. Сучасні теоретичні та практичні дослідження підтверджують наявність тісних взаємозв'язків між рівнем емоційного інтелекту й академічною успішністю, психологічним благополуччям, умінням студентів справлятися зі стресовими ситуаціями та успішністю професійної діяльності. Водночас інтенсивність цих зв'язків варіює залежно від умов дослідження та методів оцінювання.

Мета. Метою дослідження було створення математичної моделі прогнозування рівня емоційного інтелекту для студентів 4–6-х курсів Тернопільського національного медичного університету з використанням шкали Вонга і Ло (WLEIS) і багатофакторного регресійного аналізу.

Матеріали та методи. Дослідження проводилося за поперечним дизайном; студенти заповнювали анкету WLEIS протягом навчального року. Зібрані дані були статистично опрацьовані та проаналізовані для визначення впливу різних факторів на рівень емоційного інтелекту й побудови регресійної моделі. Застосовували дисперсійний аналіз (ANOVA) для дослідження впливу однієї або кількох якісних змінних (факторів) на одну залежну кількісну змінну.

Результати. Результати дослідження показали, що здатність розпізнавати й розуміти емоції інших студентів була відносно високою, тоді як регуляція власних емоцій та ефективне їх використання демонстрували нижчі показники.

Побудована багатофакторна регресійна модель має 10 факторів прогнозування, які продемонстрували статистично значичний внесок до варіативності рівнів емоційного інтелекту (EI) серед студентів-медиків. Модель пояснює 80,1 % варіативності ($R^2 = 0{,}801$), що показує її високі прогностичні можливості.

Коефіцієнти β показали, що варіативності X3 ($β = 0{,}162$) та X1 ($β = 0{,}065$) становили найбільший позитивний внесок до рівнів EI, відображаючи ключові соціо-демографічні й академічні характеристики студентів. X15 і X18 також охоплюють важливі фактори прогнозування, які репрезентують навчальну та повсякденну діяльність. Негативний вплив на рівень EI спостерігався для варіативностей X16 і X19, потенційно вказуючи на певні поведінкові та психо-емоційні риси, що можуть обмежувати розвиток емоційної компетентності.

Оцінка адекватності моделі підтвердила нормальність залишків (як показали гістограма та графік нормальної вірогідності), відсутність мультіколінеарності серед студентів, а також високе загальне статистичне значення моделі (ANOVA, $p < 0{,}001$). Це свідчить про підтримку використання моделі для практичного прогнозування рівнів EI та визначення груп ризику серед студентів медиків.

Висновки. Розроблено математичну модель, яка дає змогу прогнозувати рівень емоційного інтелекту у студентів-медиків і може бути використана для створення цільових освітніх програм та інтервенцій, спрямованих на підвищення емоційної компетентності. Реалізація таких стратегій сприятиме покращенню комунікації, командної роботи й емоційної стійкості майбутніх медичних фахівців. Запропонована модель може слугувати аналітичним інструментом для раннього виявлення груп ризику та розроблення цільових освітніх заходів.

Ключові слова: емоційний інтелект, шкала емоційного інтелекту Вонга і Ло (WLEIS), студенти-медики, регресійний аналіз, багатофакторна регресійна модель прогнозування.

Emotional intelligence (EI) is a key competency for future medical professionals that influences academic performance, communication effectiveness, and stress resilience in clinical settings. Recent reviews and empirical studies demonstrate consistent associations between EI and academic performance, psychological well-being, stress-coping skills, and clinical outcomes, although the strength of these associations varies depending on context and measurement methodology.

Purpose. The aim of this study was to develop a mathematical model for predicting the level of EI among 4th–6th-year students of Ternopil National Medical University using the Wong and Law Emotional Intelligence Scale (WLEIS) based on multivariate regression analysis.

Materials and methods. The study was conducted using a cross-sectional design. A total of 474 students (from the 4th, 5th, and 6th years) completed the WLEIS questionnaire throughout the academic year. No analysis was performed based on the year of study. The collected data were analyzed using medical-statistical methods, including multivariate regression analysis and analysis of variance (ANOVA), to assess the impact of one or more categorical variables (factors) on a single dependent continuous variable. Additionally, a bibliosemantic method was employed to analyze the scientific literature, and a structural-logical analysis was used to build the predictive model of emotional intelligence.

Results. The results indicated that the ability to recognize and understand others' emotions was relatively high, whereas the regulation and effective use of one's own emotions demonstrated lower scores.

Conclusions. The developed mathematical model enables the prediction of EI levels among students and can be applied to design targeted educational programs and interventions aimed at enhancing emotional competence. The implementation of such strategies will contribute to improved communication, teamwork, and emotional resilience among future medical professionals. The proposed model can serve as an analytical tool for the early identification of at-risk groups concerning students' emotional well-being and the development of targeted educational interventions.

Key words: emotional intelligence, Wong and Law Emotional Intelligence Scale (WLEIS), medical students, regression analysis, multivariate regression prediction model.

ABBREVIATIONS
EI — emotional intelligence
WLEIS — Wong and Law Emotional Intelligence Scale

OSCE — Objective Structured Clinical Examination
SEA — Self-Emotion Appraisal
OEA — Others' Emotion Appraisal
ROE — Regulation of Emotion
UOE — Use of Emotion
EIC — Emotional Intelligence Coefficient
ANOVA — Analysis of Variance
MD — *Doctor of Medicine*

Conflict of interest: absent.
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