

VALEOLOGICAL ASPECTS OF EMOTIONAL REGULATION AND PRACTICES FOR GETTING OUT OF KARPMAN'S "TRIANGLE OF SUFFERING"

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<https://doi.org/10.35339/ic.2025.12.2.ssn>

ABSTRACT

Background. Karpman's "Triangle of Suffering" is a model of social interaction of people who are in "toxic", conflict relationships in the roles of mainly the Victim, Persecutor and Rescuer, experience negative emotions (fear, resentment, guilt, anger, aggression) and generate such emotions in other participants in Karpmanian relationships. These negative emotions can cause mental disorders, social maladjustment and psychosomatic pathology; therefore, when teaching valeological disciplines, it is necessary to show how to find a way out from Karpman's triangle through the self-regulation of emotions. There is a lack of empirical research that proves the success of such training.

Aim. Studying the practices of coming out of Karpman's "Triangle of Suffering" and efficiency of emotional self-regulation in non-medical students when learning valeological disciplines.

Materials and Methods. The study was carried out using the method of system analysis, sociological and bibliosemantic methods (97 literary sources were analyzed). The study included a sample of 124 students, equally divided by gender (62 males and 62 females), with an average age of 20.4 years. Participants were divided into control (n=17) and main groups according to the criteria for their participation in the Karpman's triangle, the chosen strategies for exiting the triangle and the implementation of the exit intention. We proposed two strategies to exit the Karpman triangle, namely defensive (termination of communication with so called "Karpman's team members") and Emotional-Energy Transformation (EET, reaching a new energy level in a triangle with a change of roles and transformation of emotions). Emotional interaction was assessed using the Difficulties in Emotion Regulation Scale twice with an interval of at least 1 month between surveys. Statistical analysis included descriptive statistics (M±SD), comparative analysis (t-test), correlation studies, and calculation of effect magnitude (Cohen's d). The study was approved by the ethics committees of two scientific institutions.

Results and Conclusions. Among the 124 participants in the study, 24 students chose the EET strategy, of which 16 people fully implemented it. EET produced the best emotional regulation scores (average DERS reduction of [42.5±4.7] points at 87.5%). The defensive strategy chosen by 5 participants (of whom only 1 person implemented) showed an average decrease in DERS of only [19.8±3.2] points.

Keywords: *strategies for getting out of toxic relationships, Victim, Rescuer, Persecutor, transformation of emotions.*

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Introduction

The Karpman's Drama Triangle, or "Triangle of Suffering" – a model of social interaction introduced by psychiatrist Stephen Karpman in 1968 [1]. It describes three destructive roles that people often fall into in toxic, conflict relationships: the

Victim, Rescuer, and Persecutor. All participants in these relationships suffer, experience negative emotions, and generate negative emotions in other participants of "Karpman's team members".

In his subsequent research [2], Karpman S. developed his theory of "triangular" relationship models into the "Compassion Triangle", where instead of the roles of Victim, Rescuer, and Persecutor, the roles of openness, honesty, and responsibility are at play. The author focuses on personal growth, the awareness of one's behavioral scripts, and the ability to establish healthy boundaries in interaction with others. This approach aims to develop emotional maturity and build authentic, fulfilling relationships. However, this positive triangular model has been less popular with other researchers, psychologists, psychiatrists and educators who study ways to overcome conflicts and negative emotions, carry out behavior correction or provide psychological assistance.

To provide a comparison, the following *Table 1* outlines the key differences between the Drama Triangle and the Compassion Triangle.

In the study of the Triangle of Suffering, Karpman S. (1968) [1] shows how the roles of the Victim, Rescuer, and Persecutor arise and change in family conflicts. The Victim believes that their problems are caused by external circumstances,

the Rescuer tries to control the situation through excessive caregiving, and the Persecutor blames others for their failures. This creates a vicious cycle where each person exacerbates the negative emotions of the others. All the three roles are destructive, undesirable, associated with such negative emotions as pity, resentment, anger, guilt, and lead to aggression.

The author also analyzes the connection between the roles in the triangle and anxiety disorders, noting that people who frequently fall into the Victim role are prone to depression, whereas Rescuers often suffer from emotional burnout [3], which is also confirmed in the works by other authors [4–6]. Thus, studies by Bianchi R. et al. (2018) and Koutsimani P. et al. (2019) demonstrate links between burnout and depression, which is important in the context of the negative impact of prolonged participation in the "Triangle of Suffering", in which one and the same person can take turns playing different roles. And the study by Trifiletti E. et al. (2017) examines burnout and impaired anxiety defenses among nurses who are constantly trying to help others, that is are in the role of the Rescuer.

The theory of "Triangle of Suffering" has been developed both in classical psychology and in its alternative teachings (in particular, in Neuro Lin-

Table 1. Comparison of Stephen Karpman's "triangular" models, the Triangle of Suffering and the Triangle of Compassion

Characteristic	Drama (Suffering) Triangle	Compassion Triangle
Author	Stephen Karpman, 1968	Stephen Karpman, 2014
Model type	Destructive, reactive	Constructive, conscious
Main roles and actions	Victim – Feeling helpless, looking for salvation	Creator – takes control of his/her life, rather than passively waiting to be rescued
	Rescuer – helps from a position of superiority, even without asking	Coach – provides resources and motivates without rescuing
	Persecutor – criticizes, punishes, controls	Challenger – honestly points out problems, but without aggression
Goal	Sustaining emotional drama, reinforcing dependent patterns	Building authentic, healthy relationships
Interaction style	Reactive, emotionally manipulative	Conscious, responsible, respectful of self and others
Psychological impact	Conflict, emotional exhaustion, codependency	Emotional maturity, autonomy, mature empathy
Popularity in practice	Very high, a classical model in transactional analysis	Limited spread, less known even among professionals
Core principles	Avoidance of responsibility, manipulation, emotional reactivity	Openness, honesty, personal responsibility

guistic Programming, NLP). In cognitive-behavioral therapy, as described in Beck's foundational work "Cognitive Therapy and the Emotional Disorders" [7], the triangle concept is used to analyze dysfunctional thought patterns, particularly in the chapters on interpersonal relationships. Beck shows how the roles of Persecutor, Rescuer, and Victim create specific cognitive distortions that sustain depressive and anxious conditions.

In modern psychotherapeutic practice, particularly within the transactional analysis, the Karpman's model has been further developed in T.A. Harris's classic work "I'm OK – You're OK" [8]. In the chapter "Transactional Analysis in Therapy", the author thoroughly examines how the Karpman's triangle manifests in therapeutic relationships and everyday communication, offering specific strategies for breaking out of dysfunctional games. Specifically, he emphasizes awareness of one's roles and transitioning to an autonomous lifestyle, where individuals take responsibility for their feelings and actions without resorting to passivity or aggression. Harris T.A. pays special attention to the "script rewriting" technique, when individuals consciously change their habitual responses, for example, instead of automatically rescuing others, learning to say: "I believe you can handle this yourself". An alternative to the Rescuer's self-destructive behavior may be the attitude "it's not my responsibility".

The triangle theory has gained particular relevance in organizational psychology, as illustrated in Berne's work "Games People Play" [9]. In the chapter "Psychological Games in Organizations" (pp. 89–117), the author demonstrates how the roles of Karpman's triangle emerge within corporate structures, influencing teamwork effectiveness and leadership dynamics. The author gives examples when a Persecutor-boss constantly criticizes employees, a Rescuer-manager takes on excessive responsibilities, and a Victim-employee avoids accountability. The author particularly emphasizes that such dynamics reduces team productivity, as energy is spent not on work processes but on maintaining dysfunctional roles. Berne E. suggests a "game exit" strategy through awareness of these patterns and conscious change of communication behavior.

The latest research keeps on developing these ideas, as illustrated in Widdowson's book "Transactional Analysis: 100 Key Points and Techniques" [10], which investigates practical methods for working with the Karpman S. triangle in therapy and coaching. Ukrainian NLP trainer Litvinov R.M. writes (2019) [11; 12] that each role of the Karpman's triangle has its own emotions and patterns of behavior, namely "The Victim – pity (for him/herself) and feeling of guilt, the Rescuer – pity (for the Victim), and then Resentment (for the fact that his/her help was not appreciated), the Persecutor – anger and aggression". The author describes several energy levels at which the "Triangle of Suffering" can exist. Depending on these levels, roles can change: The Victim (at level –1) becomes a Hero at level +1, and a Winner at level +2; The Persecutor (at level –1) becomes a Philosopher at level +1, and a Contemplator at level +2; The Rescuer (at level –1) becomes a Motivator-Provocateur at level +1, and a Strategist at level +2. The change of roles determines the change of predominant emotions. The vector of this change lies in the direction: negative emotions → neutral emotions → positive emotions → rejection of emotions (at Sage level +3, contemplation without judgment) (Fig. 1).

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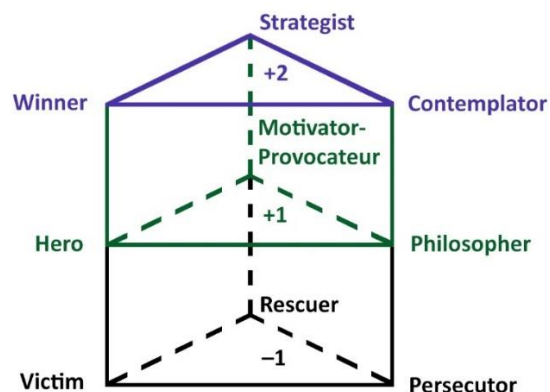


Fig. 1. Changing roles of the Karpman triangle depending on the "energy level".

According to BPDFamily.com (2020–2021) [13] and Lawson A. (2024) [14], Karpman's scenario of the entire "Triangle of Suffering" occurs in the vast majority of family conflicts. According to Litvinov R.M. (2019) [12], 3 out of 4 people in the world are constantly in Karpman's relationships. In the conditions of constant stress of war, the negative emotions generated by Karpman's triangle can lead to a breakdown in compensation with the occurrence of mental disorders and psychosomatic pathology [15].

Thus, Karpman's relationships are widespread; they are associated with generation of negative emotions that can cause mental and psychosomatic disorders, interfere with adherence to heal-

thy lifestyle models [16; 17], which makes them the subject of valeological research. The issues of managing negative emotions are insufficiently studied according to modern valeological literature [18–20]. Thus, in a systematic review of 15 studies of group interventions on emotion regulation, performed by Moore R. et al. (2022), the authors note the lack of methodological objectivity, the weak theoretical basis of most of them, and the lack of standardization, especially for use in health-saving programs. These facts were the reason for doing our research.

The **aim** of the research was to study the practices of getting out of Karpman's "Triangle of Suffering" and success of emotional self-regulation in non-medical students during the study of valeological disciplines.

Materials and Methods

The study was carried out as part of a pedagogical experiment using system analysis, sociological and bibliosemantic methods. As part of the pedagogical experiment, the results of the participation of 124 Ukrainian and German non-medical students who studied at National Technical University "Kharkiv Polytechnic Institute" (NTU "KhPI") and Ukrainian Engineering Pedagogics Academy (UEPA) during 2016–2023 were studied (see *Table 2*). The average age of students was $[21.7 \pm 2.6]$ years, with a median of 20.4 years. Students of NTU "KhPI" were trained within the valeological discipline "Fundamentals of Medical Knowledge and Health-Saving", developed by the Kharkiv Regional Institute of Public Health Problems (2004–2025). UEPA students were trained within the valeological discipline "Health Pedagogy" developed by UEPA (2019–2024). The purpose of studying these valeological disciplines is to form students' valeological competence [21–24], an important part of which is the ability to restore psychological balance and control one's own emotions.

Distance learning for UEPA students in 2020–2023 was used forcibly due to the COVID-19 pandemic and the war. Distance learning has made it impossible to conduct full-fledged psychological workshops [25]. Nevertheless, this fact did not become an obstacle to the study, because the students needed control of emotions during the exit from Karpman's relationships, which are formed mostly at home and in work teams. The student population was divided into two groups of equal size based on gender: 62 men and 62 women. The inclusion criterion in the study was the successful acquisition of theoretical information on the topic "Mental and psychological health of the individual. Professional burnout of teachers" based on the results of testing and successful formation of the cognitive component of valeological competence ("knowledge"), as well as passing two consecutive questionnaires with an interval of at least one month. The criteria for exclusion from the study were the formation of the cognitive component of valeological competence with a theme at the level of less than 60% and the student's refusal to participate in the study.

The pedagogical experiment was conducted in compliance with confidentiality, according to the principles described in the scientific publication [26], namely only the teacher had data on the answers about the health of students and their family members, they were subject to medical secrecy. All study participants signed an informed consent to participate. The overall design of the study was approved by the ethics committee of the Kharkiv Regional Institute of Public Health Services (Protocol No.2 of January 20, 2016; and Protocol No.3 of January 12, 2020). The verification of psychological assessment methods was carried out in accordance with the principles described in the publication [27] and in compliance with Difficulties in Emotion Regulation Scale, DERS, according to which it is possible to conduct an individual and

Table 2. Characteristics of non-medical students trained in the transformation of emotions and way out of Karpman's "Triangle of Suffering" within valeological disciplines in two Kharkiv universities in 2016–2023

Higher education institution	Years of study	Countries of students' origin	Form of study	Number of students, abs.	including:	
					males, abs. (%)	females, abs. (%)
NTU "KhPI"	2016–2019	Ukraine	classroom	58	30	28
UEPA	2020–2023	Ukraine, Germany	remote	66	32	34
Total				124	62 (50.0)	62 (50.0)

group assessment of 6 key aspects of emotional dysregulation: inability to accept emotions (rejection of negative experiences), difficulties in controlling impulsive actions under the influence of emotions, limited regulation strategies, insufficient awareness of emotions, difficulties in achieving goals due to emotional loading, lack of clarity of emotions [28]. The test lasts 5–10 minutes; in a group context it helps to assess the effectiveness of emotion regulation training. The questionnaire contains 36 items. Each answer is evaluated on a 5-point Likert scale (from "almost never" (1 point) to "almost always" (5 points)). The subscale of rejection of emotions made it possible to get 6–30 points, where 6 is complete acceptance, 30 is a sharp rejection of one's experiences. The scoring of the other subscales was as follows: difficulties in achieving goals – [5–25] points (where 5 – ease of work under the influence of emotions, 25 – complete disorganization of activity), impulsivity – [6–30] points (where 6 – complete control, 30 – frequent uncontrolled actions), insufficient awareness – [6–30] points (where 6 – clear understanding, 30 – complete lack of reflection), limited strategies – [8–40] points (where 8 – a rich arsenal of methods, 40 – a feeling of helplessness), fuzziness of emotions – [5–25] points (where 5 – clarity, 25 – complete confusion). The overall score can be 36–180 (where 36 is good regulation, 180 is pronounced maladaptation), and a value of more than 115 indicates serious difficulties.

Within the framework of the sociological method of research, 2 surveys of students were conducted, with an interval of at least a month, which was required to analyze own Karpmanian relationships, the emotions they cause, the development of a strategy for getting out of such relationships and reflection on emotions and other consequences of such actions. According to the results of self-analysis, 17 students (13.7%) reported the absence of Karpmanian relationships in their lives. They made up the Control Group (CG). CG students also underwent a second questionnaire on the DERS at least a month after the first questionnaire. CG students remained in CG provided that there was no deviation of the indicators of the second questionnaire compared to the first one by more than 10% according to the overall assessment, and by more than 5% for each of the separate categories. The validity of choosing the stability of the DERS test within 10% is confirmed by the study of Danasasmitha F.S. et al. (2024) [29],

which had good internal coherence ($\alpha \approx [0.89–0.91]$) and validity.

In the theoretical aspect, for forming the cognitive component of valeological competence on the theme, students were explained that in Karpman's triangle of suffering, the intensity of negative emotions is distributed by roles in the following sequence (from the strongest to the weakest): anger (Persecutor), anxiety (Victim), irritation (Rescuer), guilt (Persecutor), helplessness (Persecutor), hidden aggression (Rescuer), illusory control (Rescuer). This gradation reflects the emotional dynamics between the participants in dysfunctional relationships, where the Persecutor expresses the most intense negative emotions, and the Rescuer expresses relatively smaller, but more hidden.

The second important theoretical aspect is the methods for getting out of Karpman's triangle:

1. Protective (refuse to communicate with "Karpman's team members": create one's own family, change the group in which the student studies, change the place of work);
2. Emotional-Energy Transformation (EET) (move to new energy levels with a change of roles and transformation of emotions).

The ways of possible exit from the Karpman's "Triangle of Suffering", or mitigation of the destructive effect of the negative emotions caused by it, are shown in Figure 2.

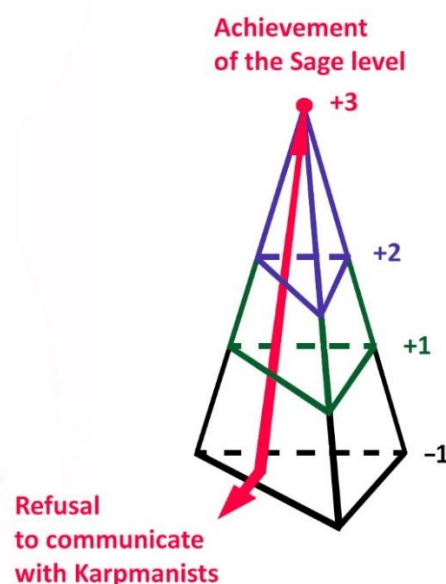


Fig. 2. Ways out of Karpman's "Triangle of Suffering".

In addition to regulating emotions, students were asked to answer a number of questions:

1. how immersed they are in Karpmanian relationships;

2. where exactly Karpmanian relationships arose: in the family, in the team where the student studies, or in the team where he/she works;

3. what kind of negative emotions does the student show in him/herself and other participants in Karpmanian relationships (fear, anger, aggression, resentment, guilt, pity – from strongest to weakest);

4. how destructive negative emotions are for the student due to the existing Karpmanian relationships (cause constant anxiety and discomfort, cause fear and exhaustion, cause suicidal thoughts, cause outbursts of anger and aggression, cause somatic diseases);

5. what strategy for exiting Karpmanian relationships (defensive or EET) did the student choose;

6. whether the student has implemented the chosen strategy for exiting Karpmanian relationships between the first and second questionnaires.

Depending on the attitude to being in Karpmanian relationships (intentions to get out of them) and depending on the implementation of such intentions based on the results of the repeated survey of students, they were divided into the following groups:

- Main Group I (MG I) – recognize participation in Karpman's relations, but have not chosen a strategy for exiting them;

- Main Group II (MG II) – recognize participation in Karpmanian relationships, have chosen a defensive strategy, but did not implement it during the study;

- Main Group III (MG III) – recognize participation in Karpmanian relationships, have chosen a defensive strategy, and implemented it during the study;

- Main Group IV (MG IV) – recognize participation in Karpmanian relationships, have chosen

the EET strategy, but did not implement it during the study;

- Main Group V (MG V) – recognize participation in Karpmanian relationships, have chosen an EET strategy, and implemented it during the study.

The number of students in these groups will be shown in the next section of the article.

When studying the theory, students were asked to understand the emotions that the participants in Karpmanian relationships experienced themselves and that generated in other participants of the "Triangle of Suffering" (see Table 3), as well as strategies for transforming emotions:

- pity must be turned into mercy, and then – into help;

- resentment must be realized, then discussed so that it does not turn into revenge;

- aggression needs to be released, and anger should be discharged in a way that is safe for others (through meditation, physical exhaustion, screaming in a place where no one can hear, etc.).

- guilt must be acknowledged, and the situation that caused it – "smoothed out" (rebalanced) [12].

The search for literature sources within the bibliosemantic method used in the study was carried out on PubMed and Google Scholar using the keywords "Karpman's triangle", "transformation of emotions", "destructive emotions of conflicts", "emotional self-regulation in valeology". A total of 97 sources were analyzed, of which 61 sources were discarded on the criteria of vague research design and low evidence [30].

Results and Discussion

The obtained result of the absence of Karpmanian relationships in the lives of 17 out of 124 students (13.7%) and the formation of the control group requires explanation. Student statements were checked by us in accordance with the description of their relationships, when conflicts arise on indirect signs of the duration and strength of negative emotions after conflicts at home, at work or at the place of study. The check was ne-

Table 3. Emotions that the participants in Karpman's "Triangle of Suffering" feel, and which they evoke in other participants in Karpmanian relationships.

Role in the triangle	Emotions that are experienced	Emotions that arise from other participants
Victim	fear, resentment, guilt	pity
Rescuer	fear, resentment	guilt
Persecutor	fear, anger, aggression	fear, guilt

cessary because Lac A. & Donaldson C.D. (2022) [31] clearly showed that participants in the triangle of suffering tend to underestimate or deny participation in "negative" roles, especially in the role of the Persecutor. Reluctance to admit negative behavior can reach [20–50]% of respondents [32].

The age of the students who received the training is important. Modern neuropsychological research emphasizes that the period of early adulthood (18–25 years), which corresponds to the median of the age of the surveyed students (20.4 years), is critical for forming effective strategies of regulation of emotional reactions [33; 34], which is crucial for getting out of dysfunctional interaction patterns, in particular Karpman's triangle.

Karpman's triangle as a psychological model demonstrates how maladaptive emotional patterns maintain cyclical dynamics between three roles. The Victim is stuck in states of helplessness and fear, the Rescuer is stuck in hidden aggression and the illusion of control, the Persecutor is in open anger and accusations. It is important to realize that it is these emotional states that are the main "fuel" for maintaining a toxic relationship system. Students of early adulthood, despite the ability to identify basic emotions, often demonstrate limited opportunities for their transformation. A typical scenario is when the person, once in the role of the Victim, has difficulty reformulating the feeling of helplessness into a more constructive state. Gender characteristics also play a significant role – men are more likely to suppress emotions of fear or confusion due to social stereotypes, which can exacerbate their suspension as the Persecutor. This was the reason for the customization of the sample by sex, which was not significantly impaired by the formation of CG.

The process of getting out of Karpman's triangle requires consistent work with emotional states. The first stage involves a deep awareness of the emotional "hooks" typical of each role. For example, for the Victim it can be an automatic reaction of fear to conflict situations, for the Rescuer it can be a sense of duty to solve the problems of others. Valeological practices are aimed at developing students' ability to instantly recognize these emotional patterns [35; 36].

The next critical step is mastering techniques for transferring intense negative emotions into a neutral state. Studies have proved the effectiveness of mindful breathing [37; 38], cognitive distancing [39; 40], and mental observation techniques [41]. When an emotion loses its captivating

power, it becomes possible to analyze it from the observer's perspective, which is key to further transformation.

The final stage involves rethinking neutralized emotions in a constructive way. For example, the fear of the Victim can be turned into awareness of one's own boundaries, and the anger of the Persecutor can be turned into energy to establish a healthy distance. Cognitive reframing methods are particularly effective, which can change the perspective of perception of the situation [42]. The duration of these phases was due to the minimum interval between the two surveys of students.

Regular practice of such exercises contributes to the formation of new neural connections in the prefrontal cortex, which is responsible for self-control and decision-making [43]. This creates a physiological basis for more mature forms of emotional response, which is the key to getting out of the Karpman's triangle. An important aspect is the integration of these practices into valeological programs, which allows students to master the tools of emotional self-regulation in a safe learning environment [44; 45].

According to the results of the first and second surveys, students were divided into 6 groups (see *Table 4*). The protective strategy of exiting Karpmanian relationships, which requires more decisive actions (breaking off burdensome toxic relationships), was chosen by 4 students (3.2% of the total number of students), but only one of them (25.0%) managed to implement that strategy. That student already lived separately from the family in which Karpmanian relationships developed. He stopped communicating with conflict relatives. A more time-consuming EET strategy was chosen by 54 students (43.5% of the total number of students), but only 9 students (16.7% of them) managed to implement it. For these 9 students, on average, the transition to +1 energy level of communication took 1 month and 13 days. At the level of +2 and +3, the transition did not take place. The results of the DERS survey are shown in *Table 5* and *Figure 3*.

The results of the study clearly demonstrate the significant influence of Karpmanian relationships on the emotional regulation of students. The CG that was not in such relationships performed best on the DERS scale, with an average overall score of 60.5–62.3. These students had the lowest scores across all subscales: rejection of emotions (7.9–8.2), difficulty achieving goals (11.8–12.4), impulsivity (13.2–14.0), lack of awareness (9.5–10.1), limited strategies (15.9–16.6), and fuzziness

Table 4. Division of students into groups based on the results of two questionnaires depending on the presence of Karpmanian relationships in their lives, intentions to get out of them and the implementation of such intentions.

Groups		MG I	MG II	MG III	MG IV	MG V	CG	Total
Number of students	abs.	50	3	1	45	9	17	124
	%	40.3	2.4	0.8	36.3	7.3	13.7	100.0

Table 5. Results of two DERS surveys

Group	Survey	Total Score (M \pm SD)	Nonacceptance	Goals Difficulty	Impulsivity	Awareness Deficits	Strategies Limited	Clarity Deficits
CG (n=17)	1	62.3 \pm 8.1	8.2 \pm 2.1	12.4 \pm 3.0	14.0 \pm 3.5	10.1 \pm 2.4	16.6 \pm 4.2	11.0 \pm 2.9
	2	60.5 \pm 7.8	7.9 \pm 1.9	11.8 \pm 2.8	13.2 \pm 3.1	9.5 \pm 2.1	15.9 \pm 3.9	10.2 \pm 2.7
MG I (n=50)	1	98.7 \pm 12.4	18.5 \pm 4.3	20.1 \pm 4.7	22.3 \pm 5.1	16.8 \pm 3.9	28.4 \pm 6.5	17.6 \pm 4.2
	2	97.2 \pm 11.9	18.1 \pm 4.1	19.7 \pm 4.5	21.8 \pm 4.9	16.3 \pm 3.7	27.9 \pm 6.2	17.2 \pm 4.0
MG II (n=3)	1	112.4 \pm 14.6	22.6 \pm 5.0	23.9 \pm 5.4	26.1 \pm 6.0	19.4 \pm 4.5	32.8 \pm 7.5	21.6 \pm 5.1
	2	110.8 \pm 14.2	22.0 \pm 4.8	23.3 \pm 5.2	25.4 \pm 5.8	18.9 \pm 4.3	32.1 \pm 7.2	21.1 \pm 4.9
MG III (n=1)	1	124.7 \pm 16.2	26.8 \pm 6.2	27.5 \pm 6.5	29.4 \pm 7.1	22.1 \pm 5.3	37.2 \pm 8.9	25.7 \pm 6.3
	2	105.3 \pm 12.8*	18.9 \pm 4.4*	20.4 \pm 4.8*	22.0 \pm 5.2*	16.7 \pm 3.9*	28.3 \pm 6.7*	17.0 \pm 4.1*
MG IV (n=45)	1	108.9 \pm 13.8	21.3 \pm 4.9	22.7 \pm 5.3	24.8 \pm 5.9	18.6 \pm 4.4	31.5 \pm 7.3	20.8 \pm 5.0
	2	107.5 \pm 13.4	20.8 \pm 4.7	22.1 \pm 5.1	24.1 \pm 5.7	18.1 \pm 4.2	30.8 \pm 7.0	20.3 \pm 4.8
MG V (n=9)	1	119.6 \pm 15.4	25.1 \pm 5.8	26.3 \pm 6.2	28.2 \pm 6.8	21.0 \pm 5.0	35.6 \pm 8.4	24.4 \pm 6.0
	2	92.4 \pm 11.2*	15.7 \pm 3.7*	17.2 \pm 4.1*	18.9 \pm 4.6*	14.2 \pm 3.4*	24.8 \pm 5.9*	15.6 \pm 3.8*

Notes: CG – control group; MG – main group; (M \pm SD) – (Mean \pm Standard Deviation);

* – significant difference between surveys.

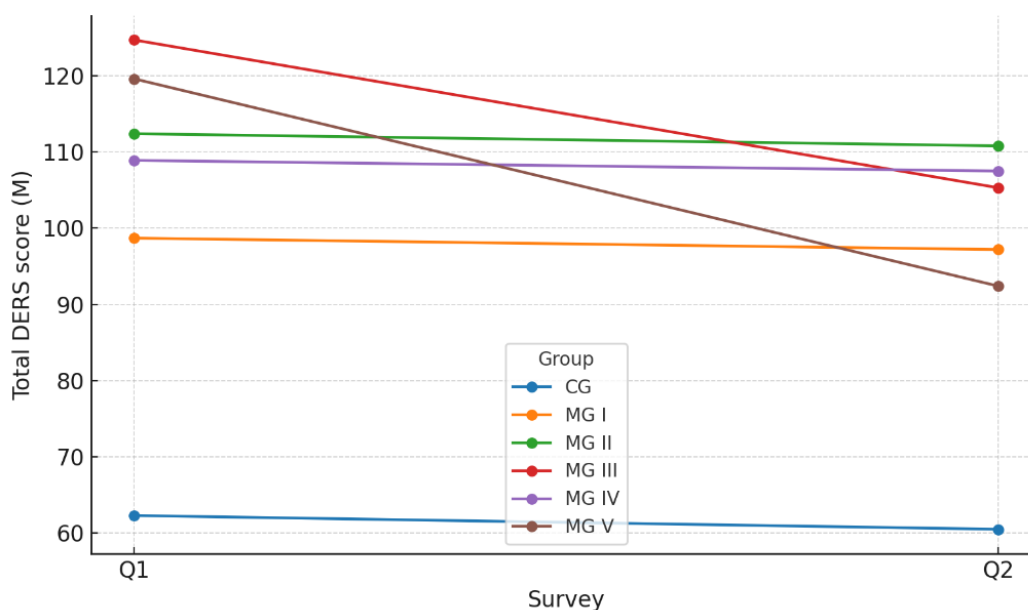


Fig. 3. Dynamics of the total DERS score in groups.

Notes: Q1 – first Questioning; Q2 – second Questioning; M – Mean.

of emotions (10.2–11.0). Such results indicate stable emotional regulation and confirm that the absence of Karpmanian relationships contribute to psychological well-being.

In contrast, students from MG I who acknowledged their involvement in Karpmanian relationships but had no intention of changing them performed significantly worse. Their average overall DERS score was 97.2–98.7, approaching the critical level (>115.0 points). Impulsivity (21.8–22.3) and limited regulatory strategies (27.9–28.4) were particularly high. This indicates that it is the fact of being in Karpmanian relationships without trying to change the situation that significantly impairs emotional regulation.

The results of groups that chose exit strategies but did not implement them (MG II and MG IV) indicate insufficient emotional regulation. MG II students who chose a defensive strategy but did not take action had high rates of dysregulation ([110.8–112.4] points total). Similarly, MG IV students (who chose the EET strategy without implementation) showed only a slight improvement: the decrease was about 1–2 points). This confirms that the very fact of realizing the problem and intentions to solve it without real action does not lead to a significant improvement in the emotional state.

The most illustrative were the results of groups that not only realized the problem, but also actively acted to solve it. The MG III (Defensive Strategy with Implementation) showed a dramatic improvement, with the overall DERS score dropping by 19.4 points (from 124.7 to 105.3). Even more impressive were the results of MG V (EET-strategy with implementation), where there was a drop in score by 27.2 points (from 119.6 to 92.4). These data clearly show that it is active actions to change the situation, especially using structured approaches like EET, that lead to the greatest improvement in emotional regulation.

The DERS scores of CG students in this study not only became a benchmark for comparison, but also clearly demonstrated that the absence of Karpmanian relationships correlates with significantly better emotional regulation. The stability of the results in CG students between the two surveys (no significant changes) confirms that it is the Karpmanian relationship that is the key factor in emotional dysregulation in other groups.

Thus, Karpmanian relationships significantly worsen the emotional regulation of students; at those only active actions to change the situation (and not just awareness of the problem or intentions) lead to significant improvements. The EET strategy turned out to be the most effective, which confirms the importance of structured approaches to solving the problem. The results obtained emphasize the need to develop special psychological programs for students who are in Karpmanian relationships, with an emphasis on practical tools for getting out of such relationships.

The study revealed significant gender differences in overcoming Karpmanian relationships (see *Table 6*). Among 62 males, 42 persons (67.7%) successfully implemented exit strategies, while among 62 females there were only 32 (51.6%). This difference of 16.1% indicates that males are more effective in overcoming toxic relationships.

Emotional regulation has also been shown to be more effective in males. Their average overall DERS score was 89.2 ± 10.4 , which is 13.5 points lower than that of females (102.7 ± 12.1). The most noticeable differences were observed in the area of emotion rejection ($[15.3 \pm 3.8]$ in females vs. $[20.1 \pm 4.5]$ in males) and impulsivity ($[18.7 \pm 4.2]$ vs. $[22.4 \pm 5.1]$, respectively).

Relapses after leaving relationships were significantly less common among males – only 6 cases (9.7%) compared to 13 (21.0%) in females. These data confirm that males were not only more

Table 6. Comparative indicators of overcoming Karpmanian relationships by gender

Indicator		Males (n=62)	Females (n=62)
Successful exit	abs. (%)	42 (67.7%)	32 (51.6%)
Average score DERS	M \pm SD	89.2 ± 10.4	102.7 ± 12.1
Rejection of emotions		15.3 ± 3.8	20.1 ± 4.5
Impulsivity		18.7 ± 4.2	22.4 ± 5.1
Relapses	abs. (%)	6 (9.7%)	13 (21.0%)

Notes: DERS – Difficulties in Emotion Regulation Scale; (M \pm SD) – (Mean \pm Standard Deviation).

likely to successfully exit Karpmanian relationships, but also showed more stable results after stopping them.

The results of our study on gender differences coincide with a number of other results. So, the results of the study by Graham K. et al. (2011), conducted among 24,778 participants from 18 countries, showed that males were statistically significantly less likely to remain in destructive relationships related to substance abuse compared to females. In particular, only 38.2% of males continued such relationships, while among males this figure was 52.7%, which shows a significant difference of 14.5% ($p < 0.001$). This pattern was particularly evident among heavy alcohol consumers, where the difference between sexes reached 21.6%. A multivariate analysis confirmed that even after taking into account factors such as age, education, and country of residence, males had a 32.0% lower risk of remaining in destructive relationships ($OR = 0.68$; 95% CI: 0.61–0.75). The authors attribute these differences to a combination of social, economic, and psychological factors, including male's greater social support, less economic dependence, and more effective stress coping strategies. These data show a general trend of males having a greater ability to get out of toxic relationships.

Research by McRae K. et al. (2008) [46] using functional magnetic resonance imaging revealed significant gender differences in the mechanisms of emotional regulation. In the experiment involving 28 healthy adults (14 males and 14 females), it was found that males were significantly more effective in using cognitive reappraisal to reduce negative emotional responses. When viewing emotionally negative images, males showed 23.0% more activity in the dorsolateral prefrontal cortex ($p < 0.01$), a key area of cognitive control, which correlated with their ability to reduce subjective feelings of negativity more quickly (the Self-Assessment Manikin (SAM) score was 18.0% lower than that of females) [47]. Females, in turn, were more likely to involve the limbic system, which led to a longer emotional response. The authors explain these differences both by biological factors (different levels of activation of the prefrontal cortex) and by socialization influences, which is confirmed by the correlation between the results of tomography and data of psychometric tests on emotion regulation strategies.

Gender differences in the tendency to relapse of returning to toxic relationships are demonstrated by a study by Vennum A. et al. (2014) [48],

which showed that females were 25% more likely to return to their former partners, ($OR = 1.25$, 95% CI 1.01–1.54).

Conclusions

We consider the goal of the study to be achieved, namely the data obtained clearly proved that the proposed strategies allow to effectively get out of dysfunctional relationships. Among the 124 participants in the study, 24 students chose the EET strategy, of which 16 people fully implemented it. The analysis showed that Emotional-Energy Transformation (EET) gives the best results in the implementation of the strategy for exiting the Karpman's triangle: 87.5% of participants who applied it showed a significant improvement in emotional regulation (average decrease in DERS by $[42.5 \pm 4.7]$ points) and a change in behavioral patterns. Cases of complete remission were especially impressive: 9 students (37.5% of OG V participants who chose and implemented the EET strategy) achieved zero indicators in the key DERS subscales. The defensive strategy chosen by 5 participants (of which only 1 implemented) showed significantly more modest results – an average decrease in DERS only $[19.8 \pm 3.2]$ points.

Gender analysis revealed significant differences in the effectiveness of interventions. In the second survey, males demonstrated higher academic performance (94.1% vs 71.4% for females with average DERS $[67.3 \pm 5.1]$ points vs $[67.3 \pm 5.1]$ points for females).

The results obtained indicate the need for a differentiated approach to psychological assistance. For males, clear strategies of action turned out to be more effective, while females needed more attention to aspects of emotional regulation and relapse prevention. Comprehensive work with emotional transformation can be a powerful tool not only for getting out of dysfunctional relationships, but also for the formation of sustainable psychological maturity.

The prospects for further research are the development of differentiated approaches to the transformation of emotions and the way out of Karpman's "Triangle of Suffering", taking into account individual characteristics (strength of character, temperament, the presence or absence of depressive or anxiety disorders, signs of emotional burnout).

DECLARATIONS:

Disclosure Statement

The author has no potential conflicts of interest to disclosure, including specific financial in-

terests, relationships, and/or affiliations relevant to the subject matter or materials included.

Statement of Ethics

The author has no ethical conflicts to disclose.

Data Transparency

The data can be requested from the author. FAIR data is prepared for publication and contains

anonymous data from surveyed students. Student questionnaires are linked to data from the same students surveyed on other issues (confidential survey mode).

Funding Sources

There are no external sources of funding.

Consent for publication

The author gives her consent to publication.

References

1. Karpman S. Fairy tales and script drama analysis. *Transactional Analysis Bulletin*. 1968;7(26):39-43. Available at: https://karpmandramatriangle.com/dt_article_only.html
2. Karpman S. *A Game Free Life: The New Transactional Analysis of Intimacy, Openness, and Happiness*. San Francisco: Drama Triangle Publications; 2014. 300 p.
3. Karpman SB. The New Drama Triangles. USATAA/ITAA conference lecture (11 Aug 2007). Karpman Drama Triangle [Internet]. Available at: <https://karpmandramatriangle.com/pdf/thenewdramatriangles.pdf> [accessed 10 May 2025].
4. Koutsimani P, Montgomery A, Georganta K. The Relationship Between Burnout, Depression, and Anxiety: A Systematic Review and Meta-Analysis. *Front Psychol*. 2019;10:284. DOI: 10.3389/fpsyg.2019.00284. PMID: 30918490.
5. Trifiletti E, Pedrazza M, Berlanda S, Pyszczyński T. Burnout Disrupts Anxiety Buffer Functioning Among Nurses: A Three-Way Interaction Model. *Front Psychol*. 2017;8:1362. DOI: 10.3389/fpsyg.2017.01362. PMID: 28848476.
6. Bianchi R, Verkuilen J, Schonfeld IS, Laurent E, Brisson R. Burnout-depression overlap: Nomological network examination and factor-analytic approach. *Scand J Psychol*. 2018;59(5):532-8. DOI: 10.1111/sjop.12460. PMID: 29958322.
7. Beck AT. *Cognitive Therapy and the Emotional Disorders*. New York: International Universities Press; 1976. 356 p. Available at: <https://archive.org/details/cognitivetherapy0000beck>
8. Harris TA. *I'm OK – You're OK*. New York: Harper & Row; 1969. 309 p. Available at: <https://drthomasharris.com/im-ok-youre-ok-book-thomas-harris>
9. Berne E. *Games People Play: The Psychology of Human Relationships*. New York: Grove Press; 1964. 192 p. Available at: <https://surli.cc/hpeaah>
10. Widdowson M. *Transactional Analysis: 100 Key Points and Techniques*. 2nd ed. London: Routledge; 2019. 302 p. Part 1. Available at: <https://surl.lu/ecmxbg>
11. Lytvynov RM. Code of human relations-1 (part 1: the triangle is suffering, how to recognize yourself in it and get out of it). *Bull KhRIPHS*. 2019;5(91):3-10. DOI: 10.5281/zenodo.3553041.
12. Lytvynov RM. Human relations code-1 (Part 2: New roles of the Karpman's triangle at other energy levels). *Bull KhRIPHS*. 2019;6(92):30-6. DOI: 10.5281/zenodo.3587894.
13. Karpman Drama Triangle – An Overview. BPDFamily.com, 03 Jan 2020, last modified 04 Jan 2021 [Internet]. Available at: <https://www.bpdfamily.com/content/karpman-drama-triangle> [accessed 11 May 2025].
14. Lawson A. Caught in the Drama Triangle. *Psychology Today*, 9 Apr 2024 [Internet]. Available at: <https://www.psychologytoday.com/us/blog/beyond-mental-health/202409/caught-in-the-drama-triangle> [accessed 11 May 2025]
15. Organization for Security and Co-operation in Europe (OSCE). *Theory and Practice of Psychological Assistance and Rehabilitation: A Handbook for the National Guard of Ukraine*. Kyiv: OSCE; 2020. 320 p. Available at: <https://www.osce.org/files/f/documents/9/6/471033.pdf> [in Ukrainian].
16. Garnefski N, van Rood Y, de Roos C, Kraaij V. Relationships between traumatic life events, cognitive emotion regulation strategies, and somatic complaints. *J Clin Psychol Med Settings*. 2017;24(2):144-51. DOI: 10.1007/s10880-017-9494-y. PMID: 28508141.

-
-
17. Ciuluvica C, Amerio P, Grossu IV. Emotional Dysregulation Mechanisms in Psychosomatic Chronic Diseases Revealed by the Instability Coefficient. *Brain Sci.* 2020;10(10):673. DOI: 10.3390/brainsci10100673. PMID: 32992986.
 18. Easdale-Cheele T, Parlatini V, Cortese S, Bellato A. A narrative review of the efficacy of interventions for emotional dysregulation, and underlying bio-psycho-social factors. *Brain Sci.* 2024;14(5):453. DOI: 10.3390/brainsci14050453.
 19. Moore R, Gillanders D, Stuart S. The Impact of Group Emotion Regulation Interventions on Emotion Regulation Ability: A Systematic Review. *J Clin Med.* 2022;11(9):2519. DOI: 10.3390/jcm11092519. PMID: 35566645.
 20. Shevchenko A. Qualimetric criteria for formation of valeological competence in the adaptive education system. *Electronic scientific journal "Adaptive management: theory and practice". "Pedagogy" series.* 2022;13(25):28 p. DOI: 10.33296/2707-0255-13(25)-06.
 21. Shevchenko AS, Shtefan LV. Formation of valeological competence in non-medical students. *Engineering and Educational Technologies.* 2021;9(4):8-23. DOI: 10.30929/2307-9770.2021.09.04.01.
 22. Shevchenko AS. Methodology of valeological competence forming in non-medical students using cloud technologies. *Problems of Engineering and Pedagogical Education.* 2023;78:39-48. DOI: 10.32820/2074-8922-2023-78-39-48.
 23. Shtefan LV, Shevchenko AS. Materials of academic discipline "Health Pedagogy": lectures, guidelines for practical classes, extracurricular activities, presentations; for applicants for higher education degree "master" full-time and part-time educational forms for the specialty 011 "Educational, pedagogical sciences". Kharkiv: Ukrainian Engineering Pedagogics Academy, 2021. 5 vol. [In Ukrainian].
 24. Shtefan LV, Shevchenko AS. Materials of academic discipline "Health Pedagogy": lectures, guidelines for practical classes, extracurricular activities, curriculum, diagnostic tools, syllabus, exam tickets; for applicants for higher education degree "bachelor" full-time and part-time educational forms for the specialty 011 "Educational, pedagogical sciences". Kharkiv: Ukrainian Engineering Pedagogics Academy, 2019. 171 p. [In Ukrainian].
 25. Shevchenko A, Kucherenko S, Komyshan A, Shevchenko V, Kucherenko N. Formation of valeological competence in conditions of classroom and distance learning. *Scientific notes of the pedagogical department.* 2022;50(1):137-47. DOI: 10.26565/2074-8167-2022-50-14.
 26. Shevchenko A. On the Observance of Confidentiality in the Process of Teaching Valeological Disciplines to Students of Electrical and Power Engineering Specialties. *Proceedings of the 2022 IEEE 4th International Conference on Modern Electrical and Energy System (MEES), Kremenichuk, Ukraine, 20–23 Oct 2022.* USA, Washington, D.C.: Institute of Electrical and Electronics Engineers Xplore, 2023. P. 49-53. DOI: 10.1109/MEES58014.2022.10005730.
 27. Shevchenko AS, Tolstaia TYu, Shtefan LV, Shevchenko VV, Kucherenko SM, Kucherenko NS. The use of psychological and psychiatric methods in determining valeological competence formation in non-medical students of Ukraine. *Inter Collegas.* 2023;10(2):52-7. DOI: 10.35339/ic.10.2.sts.
 28. Gratz KL, Roemer L. Multidimensional assessment of emotion regulation and dysregulation: Development, factor structure, and initial validation of the Difficulties in Emotion Regulation Scale. *J Psychopathol Behav Assess.* 2004;26(1):41-54. DOI: 10.1023/B:JOBA.0000007455.08539.94.
 29. Danasasmita FS, Pandia V, Fitriana E, Afriandi I, Purba FD, Ichsan A, et al. Validity and reliability of the Difficulties in Emotion Regulation Scale Short Form in Indonesian non-clinical population. *Front Psychiatry.* 2024;15:1380354. DOI: 10.3389/fpsy.2024.1380354. PMID:38590788.
 30. Shevchenko AS, Brown GW. What evidence-based medicine can oppose to falsifications in science. *Bull KhRIPHS.* 2020;96(4):24-35. DOI: 10.5281/zenodo.5076629. [In Ukrainian].
 31. Lac A, Donaldson CD. Development and Validation of the Drama Triangle Scale: Are You a Victim, Rescuer, or Persecutor? *J Interpers Violence.* 2022;37(7-8):NP4057-81. DOI: 10.1177/0886260520957696. PMID: 32917106.
 32. Krumpal I. Determinants of social desirability bias in sensitive surveys: a literature review. *Qual Quant.* 2013;47(4):2025-47. DOI: 10.1007/s11135-011-9640-9.
 33. Arain M, Haque M, Johal L, Mathur P, Nel W, Rais A, et al. Maturation of the adolescent brain. *Neuropsychiatr Dis Treat.* 2013;9:449-61. DOI: 10.2147/NDT.S39776. PMID: 23579318.
-
-

34. Hochberg ZE, Konner M. Emerging Adulthood, a Pre-adult Life-History Stage. *Front Endocrinol (Lausanne)*. 2020;10:918. DOI: 10.3389/fendo.2019.00918. PMID: 31993019.
35. Shtefan LV, Shevchenko AS. The formation of a healthy lifestyle of engineers-pedagogues in the process of studying valeological disciplines. *Proceedings of the IV International Scientific and Practical Conference "Current Trends in Education, Science and Technology"* (Ukraine, Bakhmut, 27 May 2020). P. 8-11. DOI: 10.5281/zenodo.3880794.
36. Lane RD, Smith R. Levels of Emotional Awareness: Theory and Measurement of a Socio-Emotional Skill. *J Intell*. 2021;9(3):42. DOI: 10.3390/jintelligence9030042. PMID: 34449662.
37. Chin P, Gorman F, Beck F, Russell BR, Stephan KE, Harrison OK. A systematic review of brief respiratory, embodiment, cognitive, and mindfulness interventions to reduce state anxiety. *Front Psychol*. 2024;15:1412928. DOI: 10.3389/fpsyg.2024.1412928. PMID: 38933581.
38. Cho H, Ryu S, Noh J, Lee J. The Effectiveness of Daily Mindful Breathing Practices on Test Anxiety of Students. *PLoS One*. 2016;11(10):e0164822. DOI: 10.1371/journal.pone.0164822. PMID: 27764151.
39. Maglio SJ, Trope Y, Liberman N. Distance from a distance: psychological distance reduces sensitivity to any further psychological distance. *J Exp Psychol Gen*. 2013;142(3):644-57. DOI: 10.1037/a0030258. PMID: 23025560.
40. Kross E, Grossmann I. Boosting wisdom: distance from the self enhances wise reasoning, attitudes, and behavior. *J Exp Psychol Gen*. 2012;141(1):43-8. DOI: 10.1037/a0024158. PMID: 21728454.
41. Freudenthaler L, Turba JD, Tran US. Emotion Regulation Mediates the Associations of Mindfulness on Symptoms of Depression and Anxiety in the General Population. *Mindfulness (NY)*. 2017;8(5):1339-44. DOI: 10.1007/s12671-017-0709-y. PMID: 28989550.
42. Mauss IB, Cook CL, Cheng JY, Gross JJ. Individual differences in cognitive reappraisal: experiential and physiological responses to an anger provocation. *Int J Psychophysiol*. 2007;66(2):116-24. DOI: 10.1016/j.ijpsycho.2007.03.017. PMID: 17543404.
43. Calderone A, Latella D, Impellizzeri F, de Pasquale P, Fama F, Quartarone A, Calabrò RS. Neurobiological Changes Induced by Mindfulness and Meditation: A Systematic Review. *Biomedicines*. 2024;12(11):2613. DOI: 10.3390/biomedicines12112613. PMID: 39595177
44. Shevchenko AS, Shevchenko VV, Pomogaybo KG, Danylchenko SI, Brown GW, Shumskyi OL, et al. The system of risk factors for diseases in valeological disciplines. *Inter Collegas*. 2025;12(1):48-65. DOI: 10.35339/ic.2025.12.1.ssp.
45. Shevchenko A, Zhoga R. Individual educational trajectory in modern Ukrainian higher education as a tool for adaptability to its environment. *Adaptive Management: Theory and Practice. Series Pedagogics*. 2023;16(31):15. DOI: 10.33296/2707-0255-16(31)-16.
46. McRae K, Ochsner KN, Mauss IB, Gabrieli JJD, Gross JJ. Gender Differences in Emotion Regulation: An fMRI Study of Cognitive Reappraisal. *Group Process Intergroup Relat*. 2008;11(2):143-62. DOI: 10.1177/1368430207088035. PMID: 29743808.
47. Lang PJ. Behavioral treatment and bio-behavioral assessment: Computer applications. In: Sidowski JB, Johnson JH, Williams TA, eds. *Technology in Mental Health Care Delivery Systems*. Norwood (NJ): Ablex Publishing; 1980. P. 119-37.
48. Vennum A, Monk JK, Adams R. "It's complicated": The continuity and correlates of cycling in cohabiting and marital relationships. *J SocPersRelat*. 2014;31(3):410-30. DOI: 10.1177/0265407513501987.

Received: 05 May 2025

Accepted: 26 Jun 2025

Published: 30 Jun 2025

Cite in Vancouver style as: Shevchenko AS, Shumskyi OL, Nesterenko VG, Burbyha VA, Kucherenko SM, Kucherenko NS, Shayda VP, Gavrylov EV. Valeological aspects of emotional regulation and practices for getting out of Karpman's "Triangle of Suffering". *Inter Collegas*. 2025;12(2):109-21. <https://doi.org/10.35339/ic.2025.12.2.ssn>

Archived: <https://doi.org/10.5281/zenodo.17055940>

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