



Linguistic and paralinguistic predictors of suicidal behaviour among military personnel and veterans: A review of the literature

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◆ **Abstract.** The problem of suicide among military personnel and veterans has become particularly acute in the context of military operations in Ukraine. Prolonged deployment in the combat zone, loss of comrades, and a combination of physical and psychological trauma significantly increase the risk of developing depression and suicidal intentions. Traditional methods of psychological diagnosis often do not provide adequate sensitivity, as military personnel often hide their problems due to fear of stigmatisation or unwillingness to seek help. This highlights the need to find innovative approaches, among which the analysis of linguistic and prosodic characteristics as potential predictors of suicide plays a leading role. The aim of the study was to review current scientific approaches to identifying the risk of suicidal behaviour in the military environment by systematising linguistic and prosodic indicators and determining their diagnostic and prognostic value for the development of early suicide warning systems. The work was carried out in the format of a systematic review of scientific literature using methods of analysis, synthesis, induction and generalisation. Publications in psychology, psychiatry, neurobiology, linguistics and related disciplines were reviewed. Particular attention was paid to studies that examined linguistic and vocal markers of depressive and suicidal states in the context of military service and post-service adaptation. It was found that the speech of military personnel at increased risk of suicide is characterised by a number of features: frequent use of categorical statements, preference for first-person singular pronouns, reduced syntactic complexity, a tendency to use negative constructions, and a predominance of negatively coloured vocabulary. Prosodic analysis revealed monotony of voice, reduced volume, slowed tempo, and uniformity of intonation patterns. Combining these indicators with machine learning data can significantly improve the accuracy of risk prediction and create multimodal systems for assessing psycho-emotional state. The results obtained have applied significance for improving approaches to the prevention of suicidal behaviour in the military environment. The use of automated systems for analysing textual and acoustic speech parameters creates the conditions for timely monitoring of the mental state of military personnel and veterans, early detection of crisis trends, and implementation of preventive measures in conditions of limited access to psychological assistance

◆ **Keywords:** linguistic markers; early suicide warning; mental health; post-traumatic stress disorder; thought processes

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♦ Introduction

The problem of suicide among military personnel and veterans is particularly relevant because it has not only an individual but also a social dimension, affecting the moral and psychological state of military communities and the overall level of security of the state. Suicide is one of the leading causes of death worldwide, and the prevention of suicidal behaviour is one of the priorities of global mental health policy (Sierra *et al.*, 2021). According to the findings of Y. Sokol *et al.* (2021), military personnel and veterans are a particularly vulnerable group, with suicide risks exceeding the average for the civilian population. According to T. Khraban (2022), the most common precursors include post-traumatic stress disorder, depression, alcohol and substance abuse, chronic pain, family conflicts, and feelings of hopelessness. An additional danger is the availability of lethal means, primarily firearms, which in the case of military personnel significantly increases the likelihood of completed suicide. This problem is particularly significant in the context of the full-scale war in Ukraine, which has been ongoing since 2022. Combat operations, mass destruction, the death of comrades, the forced displacement of civilians, and prolonged stays on the front lines create a critical level of psychological stress for military personnel (Khraban, 2024). Based on the experience of world wars, R. Randles *et al.* (2025) and A. Finnegan *et al.* (2025) identified a combination of combat stress, prolonged separation from family, and feelings of social isolation as factors that increase the risk of suicidal thoughts and actions. In the case of Ukraine, these factors are exacerbated by the scale and duration of the war, as well as the uncertainty of its end. As emphasised by K.M. Schafer *et al.* (2024), after demobilisation or rotation, veterans often face difficulties in social adaptation, family relationship breakdowns, economic problems and a sense of loss of meaning.

J.A. Naifeh *et al.* (2025) identified post-traumatic stress disorder, depression, and comorbid mental states as some of the key determinants of suicidal behaviour in the military. In the Ukrainian context, this phenomenon is complicated by the impact of collective trauma on society, which is reflected in the psychological state of veterans and military personnel. The risk of suicide among military personnel increases due to a number of specific factors. First, military service is associated with increased disciplinary responsibility, where failures or misconduct can be perceived as a serious burden and lead to feelings of guilt. Second, there is a culture of courage and endurance in the army, which often prevents open access to psychological help. Third, the social stigma surrounding mental disorders reduces the willingness of military personnel and veterans to acknowledge their own problems, making early intervention difficult (Schafer *et al.*, 2024). M. Silvestrini & J.A. Chen (2023) noted that military personnel are more likely than civilians to choose more lethal methods of suicide, such as firearms, which significantly increases the rate of completed cases. In the context of the war in Ukraine, this factor is particularly significant, as military

personnel's direct access to weapons and experience in using them increase the likelihood of lethal means being used in crisis situations, necessitating early risk detection and timely intervention. The search for new tools capable of detecting indirect markers of psycho-emotional states is of particular importance. This is where linguistics opens up new horizons for research and practice. Since language reflects a person's inner world, their thoughts, emotions and values, the analysis of linguistic features can be a sensitive indicator of mental state. As noted by K. Sun *et al.* (2020), language patterns are a kind of "mirror" of the psyche that allows us to detect changes in the emotional sphere. In this context, the use of sentiment analysis, machine learning and natural language processing methods opens up prospects for the creation of innovative tools for identifying suicide risks. Analysis of texts created by military personnel or veterans on social networks, in chat rooms, diaries, or during private conversations can reveal specific linguistic markers of risk. A significant breakthrough in this area has been the application of machine learning algorithms and deep text analysis. An analysis by X. Du & Y. Sun (2022) showed that combining traditional linguistic characteristics with mood and emotion polarity analysis significantly improves the accuracy of text classification based on psychological state. In the case of military personnel and veterans, this approach can provide more effective monitoring of their mental health, especially in environments where direct contact with a psychologist is not possible. According to C. Lao *et al.* (2022), social media provides researchers with a unique opportunity to analyse users' sincere expressions of their inner experiences. The anonymity guaranteed by some platforms encourages more open expression of emotions and thoughts, including suicidal ones. The use of such data in combination with natural language processing algorithms allows the creation of early warning systems that can signal the need for intervention before a fatal step is taken. Thus, the war in Ukraine has brought to the fore the problem of suicidal behaviour among military personnel and veterans, while at the same time creating the conditions for the introduction of innovative approaches to its monitoring and prevention. Linguistic methods, combined with artificial intelligence technologies, can play a key role in the development of such approaches. The linguistic characteristics of texts can reveal hidden patterns of risk, and their analysis contributes to the creation of more accurate and sensitive diagnostic tools. This is particularly important in the context of a protracted military conflict, when the psychological resources of military personnel and veterans are under maximum strain and society must provide effective support mechanisms. The aim of the article was to analyse current scientific approaches to identifying suicide risks among military personnel and veterans through a systematic review of linguistic and prosodic speech markers, to summarise their diagnostic potential, and to outline the prospects for integrating these indicators into multimodal early warning systems for suicidal behaviour.

◆ Literature Review

Contemporary literature has seen the emergence of several interdisciplinary approaches that take different approaches to identifying suicidal tendencies through linguistic and related markers:

1. Cognitive-psychological research. The first conceptual models explaining the link between thought processes and suicidal behaviour appeared in the mid-20th century, when the idea of a negative cognitive triad was formulated, encompassing distorted perceptions of oneself, the world and the future (Beck *et al.*, 1999). Further research expanded this concept by describing dysfunctional thought patterns, including catastrophising, all-or-nothing thinking, and overgeneralisation, which are often found in the speech of individuals with depressive symptoms (Wenzel & Jager-Hyman, 2012). Studies by L.L. Fazakas-DeHoog *et al.* (2017), S. Jager-Hyman *et al.* (2014), and S.K. Satyander (2024) aimed to systematise cognitive distortions, with a particular focus on the role of absolutist thinking and cognitive rigidity in the formation of suicidal risks. M. Al-Mosaiwi & T. Johnstone (2018) and K. Kim *et al.* (2019) have shown that absolutist vocabulary (“always,” “never,” “everything”) occurs significantly more often in the speech of individuals with depressive and suicidal tendencies, and excessive focus on one’s own experiences is manifested in the high frequency of use of first-person singular pronouns. The current stage of research was characterised by the integration of cognitive-psychological ideas with natural language processing and machine learning methods, which allows speech patterns to be identified as reflections of internal cognitive processes and used as early indicators of suicidal risk (Sun *et al.*, 2020).

2. Neurobiological and neuroimaging studies. The first works that attempted to explain suicidal behaviour from the perspective of neurobiology appeared at the end of the 20th century, when the role of serotonin dysfunction in the development of impulsivity and depressive states directly related to suicide risk was proposed (Mann *et al.*, 1999). Studies conducted between 2010 and 2020 began to use neuroimaging methods to identify structural and functional differences in the brains of individuals with suicidal tendencies. J.J. Mann (2013) and N. Tsujii *et al.* (2017) demonstrated that patients who have attempted suicide exhibit abnormalities in the prefrontal cortex, which is responsible for regulating emotions and controlling behaviour, as well as changes in the serotonin system that affect decision-making and stress resistance. In the 2020s, the focus shifted to studying how cognitive and emotional states are reflected in the brain and how they correlate with verbal manifestations. Traditional approaches to assessing suicide risk are based on clinical examinations, psychodiagnostic techniques, and self-assessment questionnaires, such as the Columbia Suicide Severity Rating Scale (C-SSRS) or the Patient Health Questionnaire (Lao *et al.*, 2022). However, according to K. Hawton *et al.* (2022), the effectiveness of these tools is limited by a number of factors: first, not all military personnel and veterans are willing to openly

report their thoughts or problems; second, access to qualified assistance in the combat zone or after demobilisation is often difficult. In this context, there has been growing interest in neurocognitive and linguistic approaches that can more objectively reflect internal mental states. Functional magnetic resonance imaging data have shown that representations of mental states are relatively stable regardless of the type of stimulus – visual or linguistic – which has led to talk of the “supramodality” of mental processes (Weaverdyck *et al.*, 2021). This conclusion confirmed that speech patterns can be reliable indicators of internal emotional states and reflect the same neural mechanisms that are revealed in visual experiments. The current stage was characterised by the active integration of neuroimaging and linguistic approaches. Thus, studies have begun to appear in which the results of brain activity analysis are compared with machine learning algorithms that process linguistic data. According to R. Huang *et al.* (2024), this opens up opportunities for creating complex models capable of taking into account both biological and linguistic risk markers. Z. Ceja *et al.* (2025) determined that suicidal behaviour among military personnel is multidimensional and cannot be explained by a single factor. Its occurrence is determined by a combination of psychological, social, economic, and biological determinants. This interdisciplinary approach forms the basis for more accurate suicide early warning systems, particularly in high-stress groups such as military personnel and veterans.

3. Linguistic-computational research (machine learning (ML) and natural language processing (NLP)). The first works on natural language processing in the field of mental health appeared in the 2000s and used statistical methods and dictionaries such as LIWC, which made it possible to analyse language patterns and link them to psycho-emotional states (Tausczik & Pennebaker, 2009). In the study by J. Pestian *et al.* (2020), NLP was applied to the analysis of children’s narratives, demonstrating the potential for automatic detection of suicidal texts. After 2010, there was a shift towards machine-learning methods: support vector machines (SVM), Random Forest, and LSTM began to be used for classifying messages from social networks such as Reddit and Twitter (Ramírez-Cifuentes *et al.*, 2020). This stage confirmed that automated models can achieve high accuracy in recognising suicidal expressions. The contemporary stage was characterised by the widespread application of deep learning and transformer-based models (BERT, GPT). The works of X. Du & Y. Sun (2022) and R. Huang *et al.* (2024) showed that integrating linguistic features with sentiment polarity increases predictive accuracy, while the use of multimodal models combining textual and behavioural data provides even greater predictive power.

4. Prosodic research. The first studies demonstrated that voice monotony and reduced speech tempo correlate with depressive states (Darby *et al.*, 1984). In the 2000s, methods for automatic voice analysis developed actively, with particular attention to frequency characteristics as potential markers of mental state (France *et al.*, 2000). In

the 2010s, the implementation of machine-learning methods made it possible to predict depressive states based on prosodic parameters (Low *et al.*, 2011). Findings from the study by A. Belouali *et al.* (2021) showed that combining prosodic and linguistic features in the analysis of veterans' audio-narratives increases the accuracy of predicting the risk of suicidal behaviour.

5. Socio-communicative research on online communities. Analyses of online forums by D. Baker & S. Fortune (2008) and K.M. Harris *et al.* (2009) demonstrated that users regularly express suicidal thoughts within virtual communities. Contemporary studies, including those by C. Lao *et al.* (2022) and L. Bojanić *et al.* (2025), focus on anonymous platforms such as Reddit, where users tend to express their thoughts more openly and sincerely. Data from such resources have proved particularly valuable for the early detection of suicidal behaviour risk among military personnel and veterans. Moreover, it has been shown that language patterns in online communication may be more authentic compared with information obtained during clinical interviews.

6. Clinical research on assessment and prevention methods. Throughout the 1970s–2000s, the main tools for assessing suicide risk remained clinical interviews and standardised psychodiagnostic scales, such as the Columbia Suicide Severity Rating Scale (C-SSRS) and the Patient Health Questionnaire-9 (PHQ-9) (Kroenke & Spitzer, 2002). However, their sensitivity for detecting potential risk was limited. Further developments in suicidology highlighted the necessity for more specialised screening tools. In contemporary clinical practice, validated, scientifically grounded questionnaires that have proven effective in medical and primary-care settings are widely used. These include the Ask Suicide-Screening Questions (ASQ) and the Suicide Behavior Questionnaire-Revised (SBQ-R). Adapted versions of previously established methods are also in demand – the Columbia Suicide Severity Rating Scale – Triage Version (C-SSRS), the Patient Health Questionnaire-9 Adolescent Version (PHQ-9A), and the Patient Safety Screener – 3 (PSS-3) (Wright-Berryman *et al.*, 2023). Studies by T.H. McCoy *et al.* (2016) and J. Pestian *et al.* (2020) showed that automatic analysis of electronic medical records can reveal hidden risk patterns that are inaccessible to traditional methods. Combined models integrating linguistic, behavioural, and clinical data into a single system of early warning of suicidal risks have also demonstrated their effectiveness (Lauderdale *et al.*, 2025). The evolution of scientific approaches – from the cognitive-psychological concepts of the 1960s to contemporary multimodal models based on NLP, prosodic analysis, and neuroimaging in the 2020s – illustrates a gradual shift from general descriptions to high-precision tools for identifying suicidal risks. However, it is multimodal approaches that combine the analysis of language, voice, and behavioural data that can form the basis for early-warning systems, which are particularly vital in the context of the ongoing war in Ukraine.

◆ Materials and Methods

In current study, a systematic literature review was employed, which allowed for the consolidation of contemporary scientific approaches to identifying suicide risk among military personnel and veterans based on linguistic and prosodic speech characteristics. This approach enabled the integration of findings from both theoretical and empirical studies, as well as the identification of promising directions for the development of multimodal systems for assessing psycho-emotional states. The methodological basis of the study was based on the application of general scientific methods, in particular analysis, synthesis, induction, deduction and generalisation, which ensured the systematic and comprehensive processing of scientific sources. The source array consisted of articles reviewed in leading psychological, medical, and interdisciplinary publications, which examined the cognitive-psychological, neurobiological, linguistic-computational, prosodic, socio-behavioural, and clinical aspects of the study of suicidal behaviour. Particular emphasis was placed on publications that analysed linguistic and prosodic markers of depressive and suicidal states in the military environment and demonstrated the possibilities of integrating these data with machine learning methods and clinical indicators. The literature search was conducted in July-August 2025 using the PubMed, Scopus, Web of Science, and Google Scholar scientific databases. Keywords in Ukrainian and English were used: “linguistic markers of suicidal risk,” “prosodic analysis,” “military personnel,” and “veterans.” The selection was made based on the criteria of peer review, scientific significance, relevance, and direct relevance to the topic. The chosen methodology made it possible to identify both the main problem areas (insufficient sensitivity of traditional tools, limited adaptability of methods to the military context) and promising areas for development (creation of multimodal early warning systems, integration of linguistic and prosodic analysis, application of artificial intelligence algorithms to monitor the mental state of military personnel and veterans). The source data was processed using content analysis, comparative analysis and generalisation methods, which ensured the methodological integrity and internal logical consistency of the conclusions.

◆ Results and Discussion

A systematic review revealed a number of characteristic linguistic and prosodic patterns that correlate with an increased risk of suicidal behaviour among military personnel and veterans. Analysis of scientific sources has shown that changes in lexical, pronominal, syntactic, and prosodic characteristics of speech reflect deep cognitive-affective processes associated with depressive and crisis states. For clarity and systematisation of the results obtained, the summarised data are presented in Table 1, which outlines the main groups of markers, their typical manifestations and psycho-emotional interpretation in the context of suicide risk.

Table 1. *Linguistic and prosodic predictors of suicidal behaviour among military personnel and veterans*

Group of markers	Examples	Psycho-emotional interpretation/connection with suicidal risk
1. Lexical (Vocabulary) Patterns	[Absolutist adverb] + [assessment of a state/situation] – “always bad”, “never works out”, “completely pointless”; [Quantifier of generality] + [negative verb] – “no one will help”, “nothing can be changed”, “there is no peace anywhere”; [Emotional assessment] + [totality] – “everything is in vain”, “complete hopelessness”, “absolute emptiness”	Cognitive polarisation (“all or nothing”); decreased tolerance for uncertainty; impaired cognitive flexibility; emotional fixation on negativity, which reinforces suicidal thinking patterns
1.1. Self-blame/ internal helplessness	“I always ruined everything”; “I cannot change anything”; “I was never strong enough”	Absolutist adverbs (“always”, “never”, “nothing”) indicate rigid thinking, fixation on failures
1.2. Pessimistic overgeneralisation	“It is all over”; “life no longer has any meaning”; “there is nothing left”	Generalisation through the words “everything” and “nothing” demonstrates a reduction of the complexity of thinking to polarised assessments
1.3. Dysfunctional generalisation of social experience	“No one can be trusted”; “everyone has turned away”; “no one understands”	Absolutist quantifiers (no one, everyone) signal a loss of trust and social support
1.4. Hopelessness/lack of perspective	“It will never get better”; “it will always be this bad”; “there is no chance”	Categorical predictions (“never”, “always”, “none”) reflect cognitive fixation on hopelessness
1.5. Emotional self-discreditation	“I am completely broken”; “absolutely hopeless situation”; “I am worthless”	Hyperbolic intensification (“completely”, “absolutely”) reflects internal devaluation of the “I-image”
2. Pronominal Patterns	[I/me/myself] + [emotionally charged verb] – “I can not take it anymore”, “it hurts me”, “it is destroying me”; [We/ours] + [denial or devaluation of meaning] – “nobody needs us”, “our efforts are futile”; [I] + [opposition to the group or society] – “I am not like everyone else”, “I can not go back to living among people”	Shift in cognitive focus from external (social) to internal (intrapersonal) space; increased levels of self-reflection and self-blame, typical of depressive thinking; emotional detachment and impaired social integration
2.1. Self-centred perception of the situation	“I can not live like this anymore”; “no one understands me”; “I do not care what happens next”	Emphasis on “I” signals a focus on one’s own pain, emotional isolation, and loss of external reference points
2.2. Loss of team identity	“We are no longer a team”; “we have been forgotten”; “our sacrifices are worthless”	Decreased use of “we” or its negative connotation indicates a breakdown of social ties and disintegration of group support
2.3. Social alienation/distancing	“I am not like them”; “their lives go on, but I am stuck there”; “I have no one to talk to”	The emphasised opposition between “I” and “they” indicates a loss of belonging to the social community
2.4. Self-isolation and feelings of estrangement	“It is easier for me alone”; “I do not want to see anyone”; “I do not care what they think”	First-person pronouns are combined with lexemes of loneliness (“alone”, “by myself”, “nobody”), which reinforces the effect of alienation
3. Syntactic Patterns	[Negation] + [nominal construction/short sentence] – “There is no point”, “It is not worth it”, “I can not take it anymore”; [Separate fragments instead of complex sentences] – “I wanted to talk. Then I changed my mind. It is pointless anyway”; [Repetitions with a rhythmic pause] – “There was life. There was. Now – nothing”	Reduction in syntactic complexity, signalling a decline in cognitive productivity; Fragmentary speech associated with the disorganisation of thought processes; Frequent use of negation, which structures speech around themes of hopelessness, loss of control or meaning; Reduced variety of grammatical connections, reflecting internal closedness and difficulties with integrating experience
3.1. Reduction of syntactic complexity	“I do not know. I have no strength. It is just over”	Short, isolated sentences without connections – an indicator of reduced cognitive control and affective exhaustion
3.2. Fragmentary expression of thought	“I wanted to say... it did not work out... it does not matter anymore.”	Incomplete sentences, ellipsis, self-interruption – evidence of speech disorganisation characteristic of a depressive state
3.3. Dominance of negation	“I do not want anything. There is no one. There is no point”	Syntactic construction around negation (“no”, “not”, “there is no”) forms a completely negative semantic field
3.4. Shortened complex subordinate constructions	“I would like to go back, but I can not”	The use of minimal grammatical connections instead of detailed explanations demonstrates cognitive economy
3.5. Fragmentary reflections	“We were brothers. Now – silence. Just silence”	Short, rhythmic phrases with repetitions and pauses convey a state of emotional “freezing”
4. Prosodic (Acoustic) Patterns	[Low volume] + [slow tempo] + [monotonous intonation] – reflects “emotional exhaustion” (“I do not know... nothing makes sense...”); [Sharp drops in tone at the end of sentences] – a symptom of loss of energy and psychological “sliding” into hopelessness; [Mechanical repetition of phrases or sounds] – reflects fixation on internal conflict, monotonous “chewing over” of thoughts	A decrease in intonational dynamics signals emotional flatness and suppression of affect; A slowdown in speech tempo reflects cognitive inertia and loss of motivational tone; A decrease in volume and timbral expressiveness indicates energy depletion and apathy; Repetitive intonations are an indicator of rigidity of thinking and a decrease in the ability to regulate emotions
4.1. Monotony of voice	Statements are pronounced in an even, emotionless tone; intonation boundaries are almost imperceptible	Reflects a decrease in affective reactivity, emotional “freezing”
4.2. Reduced loudness	The voice becomes quiet, muffled, sometimes trembling; the interlocutor can barely distinguish the words	Indicates energy depletion, apathy, and internal fatigue

Table 1. Continued

Group of markers	Examples	Psycho-emotional interpretation/connection with suicidal risk
4.3. Slowed tempo	Pauses between words are prolonged, statements lose coherence	Indicates psychomotor retardation and cognitive overload
4.4. Repetition of intonational contours	Speech is rhythmically monotonous, with repeated intonations in phrases: "yes... I do not know... yes..."	A sign of emotional rigidity, limited emotional range
4.5. Disturbances of timbre and breathing	Periodic lowering of the voice at the end of phrases, shallow or uneven breathing	Indicates physiological tension or stress-related anxiety

Source: developed by the authors

At the lexical level, there is a predominance of absolutist and generalising constructions, which signal cognitive rigidity, dichotomous thinking and a tendency to globalise negative experiences. Pronoun patterns reveal a shift in focus to one's own experiences, increased self-reflection and emotional alienation, which may be an indicator of loss of social identity after combat experience. The syntactic level is characterised by reduced complexity, fragmentation, and a predominance of negation, reflecting weakened cognitive control, emotional exhaustion, and disorganised thinking. Prosodic indicators, including slow tempo, reduced volume, monotony, and repetitive intonations, correlate with states of apathy, psychomotor inhibition, and internal tension. Together, these patterns form an integrated linguistic and behavioural profile of suicidal vulnerability, which can serve as the basis for automated early diagnosis systems based on speech analysis. Speech is a unique tool that reflects a person's internal cognitive and emotional processes. Changes in speech, such as word choice, syntactic constructions, or prosodic characteristics, can signal transformations in mental state and an increased risk of suicidal intent (Homan *et al.*, 2022). In this context, linguistic analysis becomes not only a reflection of subjective experiences, but also a valuable source of predictors that can complement clinical assessment and monitoring methods. In contemporary scientific approaches to suicidal behaviour, integrative theoretical models are becoming increasingly important, in particular the interpersonal theory of suicide (ITS), the three-stage theory (3ST) and the integrated motivational-volitional model (IMV). They explain the development of suicidal intentions through a combination of interpersonal, cognitive, and motivational factors (O'Connor & Kirtley, 2018). The key elements are feelings of social isolation, perceived burden on others, as well as feelings of hopelessness and being "stuck" in one's own problems. These factors not only shape the internal readiness for suicide, but are also directly reflected in language patterns. The relevance of using linguistic analysis to identify suicidal states among military personnel and veterans is due to the specific circumstances in which this group finds itself. Full-scale war in Ukraine is accompanied by excessive stress, combat losses, and constant exposure to traumatic events, which significantly increases the risk of developing depressive and suicidal tendencies (Nock *et al.*, 2013). In this context, language can serve as a sensitive indicator of mental states, allowing risks to be identified even before critical symptoms appear. Linguistic analysis has made it possible to identify specific language patterns

that correlate with suicidal thoughts and behaviour. One of the most persistent signs is the use of absolutist vocabulary, which reflects a rigid style of thinking. Frequent use of words such as "always," "never," and "completely" indicates a dichotomous perception of reality and reduced cognitive flexibility (Al-Mosaiwi & Johnstone, 2018). A similar linguistic tendency has been identified in the texts of individuals with depression and suicidal intentions, making it an important predictor of psycho-emotional state. The use of personal pronouns is no less indicative. An increased frequency of first-person singular pronouns ("I") signals an egocentric focus, self-absorption, and social isolation (Kim *et al.*, 2019; Huang *et al.*, 2024). Conversely, reduced use of first-person plural pronouns ("we") reflects a loss of sense of belonging to a group and may indicate a breakdown in social ties (Sloan, 2005). In a military context, this is a particularly alarming signal, as cohesion and team identity are traditionally a resource for psychological resilience. Analysis of emotional vocabulary showed a predominance of negative words, particularly those associated with death, despair and hopelessness. The works of B. Desmet & V. Hoste (2018), R.A. Fahey *et al.* (2020), and B. O'Dea *et al.* (2021) confirm that such words occur much more frequently in the speech of individuals with suicidal ideation. At the same time, positive vocabulary in these texts is usually minimal. However, as noted by C. Herbert *et al.* (2019), it is important to consider the phenomenon of a temporary increase in the frequency of positive words immediately before suicide, which may mask the real emotional state.

In addition to lexical features, syntactic characteristics are also important. According to L. Pearl (2023), the syntactic organisation of utterances is an important source of information about the cognitive processes and psycho-emotional state of the speaker. In the case of military personnel and veterans who are depressed or exhibit suicidal tendencies, speech is characterised by simplified syntactic structures, shorter sentences and reduced variety of grammatical constructions. Such tendencies reflect a decrease in cognitive resources and difficulties with organising thoughts, which often accompany depressive disorders. The syntactic complexity index, which takes into account the number of subordinate clauses, the use of conjunctions and pronouns, is significantly lower in depressive texts than in control samples, indicating a limited ability to cognitively plan and structure speech (Homan *et al.*, 2022). In a military context, a decrease in syntactic complexity may be associated with fatigue and post-traumatic stress disorder, as well as with a sense of hopelessness, which

manifests itself in simplified speech patterns. It is also important to analyse the information structure of a sentence. H. Delage & U.H. Frauenfelder (2019) emphasised that in the texts of individuals with depressive or suicidal states, there is a decrease in the ability to highlight key information elements, which leads to fragmentary statements and a loss of communicative clarity. Syntactic simplicity is often combined with an increased number of negative constructions. Studies by M.M. Tadesse *et al.* (2020) and B. O'Dea *et al.* (2021) have shown that the speech of individuals with suicidal intentions more often contains negative statements ("I can not," "there is nothing") that reinforce feelings of helplessness and hopelessness. Such patterns are particularly evident in the texts of military personnel who have experienced the loss of comrades in battle or post-war isolation. Thus, syntactic features – shorter sentences, reduced complexity, fragmented statements, and frequent use of negation – are important linguistic markers of suicidal states. Their analysis, combined with other linguistic characteristics, allows the creation of comprehensive risk assessment models capable of detecting dangerous psycho-emotional states in military personnel and veterans at an early stage.

Prosodic speech parameters are an important source of information about a person's psycho-emotional state and are increasingly seen as reliable indicators of suicidal risk among military personnel and veterans. The main markers of suicidal risk include: monotony of voice – lack of intonation fluctuations, indicating emotional "freezing" and decreased sensitivity to external stimuli; decreased volume – a quiet, muffled voice, which may reflect apathy and inner fatigue; slowed speech rate – prolonged pauses and slow articulation, often associated with cognitive overload or low psychomotor activity; mechanical, repetitive intonation patterns – rhythmic repetition of the same intonation patterns, which may be a manifestation of rigidity of thinking or emotional suppression (Homan *et al.*, 2022). According to D.J. France *et al.* (2000), such changes not only reduce emotional expressiveness but also reflect deep affective and cognitive disorders characteristic of depressive and crisis states. However, L.S. Low *et al.* (2011) noted that prosodic features are dynamic: they change depending on emotional state, physical condition, and social context, making them a valuable source of information for monitoring the mental health of military personnel. The integration of prosodic characteristics with linguistic markers – such as vocabulary, syntax, and sentence structure – demonstrates high predictive value. For example, a study of veterans by A. Belouali *et al.* (2021) showed that combining intonation parameters with vocabulary analysis can significantly improve the accuracy of machine learning algorithms in detecting suicidal intent. Modern technologies open up new opportunities for the practical use of this data. Automated voice analysis systems, including mobile applications for real-time monitoring, allow for the assessment of the psycho-emotional state of military personnel and veterans and the timely signalling of potential crisis situations. The use of modern audio signal processing methods and artificial intelligence algorithms allows even

subtle changes in the voice to be detected, which are difficult to notice with traditional expert assessment (Iyer & Meyer, 2022; Dhelim *et al.*, 2023). Thus, prosodic characteristics of the voice, considered in conjunction with linguistic markers, constitute a valuable analytical resource for detecting suicidal tendencies among military personnel and veterans. Their integration into multimodal early warning systems could become one of the key areas of suicide prevention in the military environment, ensuring timely detection of crisis situations and increasing the effectiveness of interventions.

◆ Conclusions

The study demonstrated that language is a unique tool that reflects a person's internal cognitive and emotional processes. Changes in speech, including word choice, syntactic structures, and prosodic characteristics, can signal an increased risk of suicidal intent among military personnel and veterans. Linguistic analysis in this context is an important complement to traditional clinical methods of mental health assessment and monitoring. The identification of specific speech patterns, such as absolutist vocabulary, frequent use of first-person singular pronouns, simplified syntactic constructions, and negations, provides additional predictors of psycho-emotional state. Prosodic characteristics of speech – monotone voice, reduced volume, slow tempo, and repetitive intonation patterns – reflect affective and cognitive impairments and can serve as early indicators of suicidal risk. Their dynamic nature allows for real-time tracking of changes in mental state. Timely detection of suicidal risks is particularly important in environments where access to qualified psychological care professionals is limited. Linguistic analysis allows crisis states to be identified even before obvious symptoms appear, which is critically important for military units and veterans, especially in the context of the war in Ukraine. It has been determined that the integration of linguistic and prosodic parameters into multimodal early warning systems opens up prospects for timely response, increased effectiveness of preventive measures and psychological intervention. Automated technologies, including mobile applications and artificial intelligence algorithms, allow tracking subtle changes in speech and quickly assessing the mental state of military personnel and veterans. Thus, linguistic analysis combined with the assessment of prosodic characteristics of the voice is a valuable analytical resource for identifying suicidal tendencies and can become a key element of early warning systems in the military environment. Further research into linguistic and prosodic markers of suicidal risk among military personnel and veterans could significantly improve the effectiveness of early detection of crisis situations. One priority area is research into the dynamics of speech patterns over time, which allows for the timely identification of critical points of increased risk. In addition, the development of artificial intelligence technologies and automated platforms for voice and text analysis opens up prospects for continuous monitoring of the mental state of military personnel and veterans. Combining these approaches with clinical

methods can increase the effectiveness of preventive measures and psychological intervention.

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◆ References

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Мовні та паралінгвістичні предиктори суїцидальної поведінки військовослужбовців та ветеранів: огляд літератури

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✦ **Анотація.** Проблема суїцидів серед військових та ветеранів набула особливої гостроти в умовах воєнних дій в Україні. Тривале перебування у зоні бойових дій, втрати серед побратимів, поєднання фізичних і психологічних травм суттєво підвищують ризик розвитку депресивних станів та формування суїцидальних намірів. Традиційні методи психологічної діагностики часто не забезпечують належної чутливості, оскільки військовослужбовці нерідко приховують власні проблеми через страх стигматизації або небажання звертатися по допомогу. Це актуалізує необхідність пошуку інноваційних підходів, серед яких провідне місце посідає аналіз мовних і просодичних характеристик як потенційних предикторів суїцидів. Метою дослідження був огляд сучасних наукових підходів до ідентифікації ризику суїцидальної поведінки у військовому середовищі шляхом систематизації лінгвістичних і просодичних показників та визначення їх діагностичної й прогностичної цінності для розроблення систем раннього попередження суїцидів. Робота виконана у форматі систематичного огляду наукової літератури з використанням методів аналізу, синтезу, індукції та узагальнення. Опрацьовано публікації з психології, психіатрії, нейробіології, лінгвістики та суміжних дисциплін. Особлива увага приділялася дослідженням, у яких вивчалися мовні та голосові маркери депресивних і суїцидальних станів у контексті військової служби та адаптації після неї. Встановлено, що мовлення військовослужбовців із підвищеним ризиком самогубства характеризується низкою особливостей: частим використанням категоричних висловлювань, перевагою займенників першої особи однини, зниженням синтаксичної складності, схильністю до заперечних конструкцій і переважанням негативно забарвленої лексики. Просодичний аналіз виявив монотонність голосу, зниження гучності, уповільнення темпу та одноманітність інтонаційних моделей. Поєднання цих показників із даними машинного навчання дозволяє значно підвищити точність прогнозування ризиків і створювати мультимодальні системи оцінки психоемоційного стану. Отримані результати мають прикладне значення для вдосконалення підходів до профілактики суїцидальної поведінки у військовому середовищі. Використання автоматизованих систем аналізу текстових та акустичних параметрів мовлення створює передумови для своєчасного моніторингу психічного стану військовослужбовців і ветеранів, раннього виявлення кризових тенденцій та реалізації превентивних заходів в умовах обмеженого доступу до психологічної допомоги

✦ **Ключові слова:** лінгвістичні маркери; раннє попередження суїцидів; психічне здоров'я; посттравматичний стресовий розлад; мисленнєві процеси