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Review Article

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Pathophysiology of Suicide: Risk Factors and Prevention Strategies

Elizaveta I Bon*, Maksimovich N.Ye, Gubarevich I.Ye, Malenovskaya M.Y and Krys V. A

Grodno State Medical University, Republic of Belarus, Grodno

***Corresponding Author**
Elizaveta I Bon, Grodno State Medical University, Republic of Belarus, Grodno.

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Abstract

Suicide represents a major global public health challenge, accounting for over 700,000 deaths annually worldwide [1]. This review synthesises current evidence on the pathophysiological mechanisms underlying suicidal behaviour and evaluates contemporary prevention strategies through a biopsychosocial framework. The neuro-immune-endocrine model posits that chronic stress and early life adversity induce epigenetic changes in hypothalamic-pituitary-adrenal (HPA) axis functioning, leading to chronic inflammation, neuroinflammation, and altered serotonergic and dopaminergic signaling [2-4]. Inflammatory markers including C-reactive protein, interleukin-6, and tumour necrosis factor-alpha have been consistently associated with increased suicide risk [5]. Emerging evidence implicates vascular dysregulation, including blood-brain barrier permeability and platelet activation, as contributing factors [6]. Risk factors span genetic, epigenetic, psychiatric, psychosocial, and demographic domains, with adverse childhood experiences, substance misuse, and sexual minority status conferring particularly elevated risk [7-9]. Prevention strategies demonstrate variable efficacy: means restriction has one of the strongest evidences bases among population-level suicide prevention strategies gatekeeper training enhances knowledge and self-efficacy dialectical behaviour therapy shows moderate evidence for reducing suicidal ideation in youth and synchronous remote-based interventions significantly reduce repeated suicide attempts [10-13]. The World Health Organization's LIVE LIFE initiative provides a comprehensive framework for national suicide prevention [1]. Effective prevention requires multilevel, integrated approaches addressing both population-level determinants and individual-level risk factors.

Keywords: Suicide, Suicidal Behavior, Suicide Risk Factors

1. Introduction

Suicide constitutes one of the most pressing yet preventable causes of premature death globally. According to the World Health Organization, more than 700,000 individuals die by suicide each year, with the majority of these deaths occurring in low- and middle-income countries [1]. Beyond mortality, suicidal behaviour encompasses a spectrum ranging from suicidal ideation through suicide attempts to death by suicide, each with distinct but overlapping pathophysiological correlates.

The conceptualisation of suicide has evolved considerably over recent decades. Once regarded primarily as a complication of psychiatric disorders—particularly major depressive disorder—contemporary research recognises suicide as a complex, multidetermined phenomenon with independent neurobiological, genetic, psychological, and social determinants [2,4]. This paradigmatic shift has profound implications for prevention, suggesting that effective strategies must address both the psychiatric context in which suicidality often emerges and the specific neurobiological vulnerabilities that confer risk independent of psychiatric diagnosis. This review synthesises current evidence on the pathophysiological mechanisms of suicidal behaviour and evaluates prevention strategies across multiple levels of intervention. We adopt a biopsychosocial framework that integrates findings from neurobiology, immunology, endocrinology, genetics, epidemiology, and intervention science. The review is structured as follows: first, we examine the neuro-immune-endocrine model of suicide pathophysiology; second, we review genetic and epigenetic contributions; third, we analyse major risk factor domains; fourth, we evaluate prevention strategies across

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population, community, and clinical levels; and finally, we discuss implications for research and practice.

1.1 Neurobiological and Pathophysiological Mechanisms

1.2. The Neuro-Immune-Endocrine Model

Contemporary understanding of suicide pathophysiology has moved beyond single-neurotransmitter models toward an integrative neuro-immune-endocrine framework. This approach recognises the bidirectional communication between peripheral physiological systems and the central nervous system through cytokines, hormones, and neurotransmitters. Under normal conditions, these humoral signals maintain physiological homeostasis, including mood regulation. However, chronic stress and early life adversity disrupt this equilibrium, elevating cortisol and proinflammatory cytokine levels while altering neurotransmitter balance, thereby increasing vulnerability to both psychiatric disorders and suicidal behavior [2].

The hypothalamic-pituitary-adrenal (HPA) axis occupies a central position in this model. HPA-axis dysregulation, including evidence of hyperactivity in some individuals, has been associated with suicidal behaviour [2,14]. Chronic stress activates the HPA axis, leading to sustained cortisol elevation that, over time, induces epigenetic changes in glucocorticoid receptor genes and alters immune system functioning [1]. These changes create a pro-inflammatory state that further destabilises neurotransmitter systems [2].

1.3. Inflammatory Mechanisms

A substantial body of evidence now supports the role of inflammation in the pathophysiology of suicidal behaviour. A systematic review examining the association between inflammatory markers and suicidality found that elevated levels of C-reactive protein, interleukin-6, and tumour necrosis factor-alpha were consistently associated with increased risk of suicidal behaviour across diverse populations [5]. The mechanisms linking inflammation to suicidality likely involve cytokine-mediated alterations in neurotransmitter systems, neuroplasticity, and stress response pathways [5,15]. The inflammatory pathway to suicidality operates through several interconnected mechanisms. Chronic inflammation may contribute to neuroinflammatory processes that are associated with suicidal behaviour. Inflammatory processes may affect serotonergic and dopaminergic signalling through alterations in tryptophan and related metabolic pathways [2,5,15]. Preliminary evidence suggests that inflammatory pathways may represent potential therapeutic targets, although robust clinical trials remain scarce. This represents a promising avenue for therapeutic development, particularly for patients whose suicidality is associated with elevated inflammatory markers [5,15].

1.4. Vascular Homeostasis and Suicidal Behaviour

Emerging evidence implicates vascular dysregulation as a contributing factor in suicide pathophysiology. A 2026 review synthesising clinical and preclinical studies explored how disruptions in vascular homeostasis—including endothelial integrity, blood-brain barrier permeability, platelet function, and microvascular flow—are associated with suicidal behaviour [6]. Epidemiological and genetic data highlight shared vulnerability between suicidal behaviour and cardiovascular or neurovascular conditions. Individuals with suicidal behaviour exhibit signs of increased blood-brain barrier permeability, platelet activation, nitric oxide dysregulation, altered kynurenine metabolism, elevated matrix metalloproteinase-9 activity, and white matter hyperintensities [6]. These vascular disturbances may promote a pro-inflammatory and oxidative environment that impairs neuroplasticity, thereby heightening vulnerability to suicidal behaviour through cognitive and emotional dysregulation [6,15]. Molecular indicators of vascular dysfunction—such as claudin-5, thrombospondins, platelet-derived growth factors, and components of the nitric oxide system—show potential for improving diagnosis and guiding therapeutic development. This vascular perspective complements the neuro-immune-endocrine model by identifying additional pathways through which systemic physiological dysregulation can influence brain function and behaviour. It also suggests novel biomarkers that may serve as dynamic indicators of both acute suicide risk and longer-term susceptibility [6,16].

1.5. Neurotransmitter Systems

The serotonergic system has historically received the most attention in suicide research. Numerous studies have demonstrated that hypofunction of the serotonin system in the ventral prefrontal cortex is associated with suicidal behaviour [3,4]. Decreased levels of the serotonin metabolite 5-hydroxyindoleacetic acid (5-HIAA) in cerebrospinal fluid, reduced serotonin uptake and transport, and alterations in serotonin receptor density have all been reported in in people who died by suicide and attempters. The serotonin transporter (SERT) appears to play a particularly critical role, with compelling clinical and genetic evidence supporting its involvement in suicide risk [3,4]. The dopaminergic system, while less consistently implicated than serotonin, has also been associated with suicidal behaviour. A model integrating serotonin and dopamine function proposes that these two monoamines interact in the regulation of aggression, which serves as a major risk factor for suicide. Evidence suggests that serotonergic and dopaminergic dysfunction may also be involved in depressed mood and impaired coping with imminent suicidality [3,4]. Noradrenergic system findings in suicide research have been generally inconsistent, though some studies suggest possible involvement [3,4]. The heterogeneity of findings across neurotransmitter systems likely reflects the pathophysiological heterogeneity of suicidal behaviour itself, with different neurochemical profiles characterising different subtypes of suicidality [3,4].

2. Genetic and Epigenetic Contributions

2.1. Genetic Vulnerability

Family and twin studies have consistently demonstrated that suicidal behaviour aggregates in families and has a heritable component [4,17]. Importantly, the familial transmission of suicide

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risk appears to be at least partially independent of the transmission of psychiatric disorders, suggesting that specific genetic factors confer vulnerability to suicidal behaviour itself rather than merely mediating risk through psychiatric illness [4,17].

Genetic polymorphisms in genes encoding components of the serotonergic system, particularly the serotonin transporter gene (SLC6A4), have been investigated in relation to suicidal behaviour [3,4,17]. Additional candidate genes include those involved in HPA axis regulation, neurotrophic signalling (notably brain-derived neurotrophic factor, BDNF), and inflammatory pathways [3,4,17]. However, findings across candidate gene studies have been inconsistent, reflecting the polygenic nature of suicidal behaviour and the limitations of single-gene approaches [4,17].

2.2. Epigenetic Mechanisms

Epigenetic modifications—changes in gene expression that do not involve alterations in DNA sequence—have emerged as important mediators of suicide risk. DNA methylation, particularly in genes related to HPA axis functioning, serotonergic neurotransmission, and neuroplasticity, has been associated with suicidal behaviour [14]. A 2026 review synthesising evidence on suicide biomarkers noted that epigenetic changes such as DNA methylation can affect gene expression and function, thereby increasing the risk of suicidal behaviour [16]. Early life adversity appears particularly potent in inducing lasting epigenetic changes. Exposure to childhood maltreatment has been associated with altered methylation patterns in glucocorticoid receptor genes, resulting in HPA axis dysregulation that persists into adulthood [2,14]. These epigenetic modifications may represent a biological mechanism through which early adverse experiences confer enduring vulnerability to suicidal behaviour [7,14]. The epigenetics of suicidality also intersects with immunology. A 2025 review described epigenetics and immunology as "under-recognised aspects of suicidality," suggesting that epigenetic regulation of immune function may contribute to the chronic inflammatory states associated with suicide risk [14]. This integration of epigenetic and immunological perspectives offers a more comprehensive understanding of how environmental exposures become biologically embedded to influence suicide risk across the lifespan [2,14].

3. Risk Factor Domains

3.1. Psychiatric Disorders

Psychiatric disorders are among the strongest and most consistent risk factors for suicidal behavior [2,4]. However, a psychiatric diagnosis is neither a necessary nor a sufficient condition for suicide: not all individuals with mental disorders experience suicidality, and not all suicidal individuals meet the criteria for a psychiatric disorder. This observation has driven research into transdiagnostic risk factors that may cut across diagnostic boundaries. A history of previous suicide attempt is among the strongest and most consistently replicated predictors of subsequent suicidal behaviour and suicide mortality [1]. The transition from suicidal ideation to attempt and from attempt to completion involves both stable vulnerability factors and acute precipitating circumstances, with the latter often including interpersonal crises, substance intoxication, and access to lethal means [8,10].

3.2. Adverse Childhood Experiences

Adverse childhood experiences (ACEs)—including physical, sexual, and emotional abuse, neglect, and household dysfunction—are consistently associated with increased risk of suicidal behaviour across the lifespan. A systematic review of meta-analyses found consistent associations between various forms of childhood maltreatment and self-injurious thoughts and behaviours across different populations [7].

The relationship between ACEs and suicidality may be influenced by the cumulative burden of adverse experiences, with exposure to multiple forms of childhood adversity potentially conferring greater vulnerability to suicidal behaviour [7]. These associations have been reported across different populations and age groups, highlighting childhood maltreatment as an important psychosocial risk factor for suicidal behaviour [7].

The pathophysiological mechanisms linking ACEs to suicide risk may involve the neuro-immune-endocrine pathways described above. Early life adversity may contribute to epigenetic alterations affecting HPA-axis and immune functioning, which may subsequently be associated with chronic inflammation, neuroinflammatory processes, and altered neurotransmitter signalling [2,14]. These biological changes may represent one pathway through which adverse childhood experiences contribute to enduring vulnerability to suicidal behaviour [7,14].

3.3. Substance Use

Substance use disorders represent a major modifiable risk factor for suicidal behaviour. A systematic review and meta-analysis examining the association between substance use and suicide mortality found that people who misuse substances are at 5.58 times higher risk for suicide compared to controls [8]. Alcohol use disorders were significantly associated with suicide risk, as were opioid and other drug use disorders [8]. The relationship between substance use and suicide is multifactorial. Acute intoxication impairs judgement and impulse control, increasing the likelihood that suicidal thoughts will be translated into action [8]. Chronic substance use may contribute to the neurobiological changes associated with suicide risk, including serotonergic dysfunction and HPA axis dysregulation [1,8]. Additionally, substance use disorders frequently co-occur with other psychiatric conditions and psychosocial stressors, creating a constellation of risk factors that collectively elevate suicide risk [8].

3.4. Sexual Minority Status

Sexual minority individuals experience elevated levels of suicidality, including suicidal ideation and suicide attempts, compared with heterosexual populations. The review found substantial variation in suicidality across sexual minority

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subgroups, with bisexual individuals showing particularly elevated risk in some analyses [9]. The review also identified elevated adverse mental health outcomes across the sexual minority subgroups examined [9]. These disparities are understood within a minority stress framework, which posits that stigma, discrimination, and internalised homophobia/transphobia create chronic stress that elevates risk for both mental health problems and suicidal behaviour [9].

3.5. Additional Risk Factors

Numerous additional factors contribute to suicide risk. Male sex is associated with higher rates of death by suicide, although females exhibit higher rates of suicide attempts [1]. Age-related patterns vary across regions, with suicide rates peaking in older adults in many high-income countries while young people constitute the highest-risk group in some settings [1,18]. Access to lethal means—particularly firearms—is a robust risk factor, with the case fatality rate of suicide attempts varying dramatically by method [10]. Social isolation, unemployment, financial strain, relationship breakdown, and bereavement are among the psychosocial stressors that may precipitate suicidal crises [2,18].

4. Prevention Strategies

4.1. Public Health Approaches: The WHO LIVE LIFE Initiative

The World Health Organization has developed comprehensive guidelines to support countries in implementing evidence-based suicide prevention strategies. These strategies focus on four key areas: restricting access to suicide means, promoting responsible media coverage of suicide, enhancing life skills in adolescents, and ensuring the early identification and management of suicidal behaviour [1]. The WHO's LIVE LIFE initiative provides a practical framework for countries to implement these evidence-based interventions [1].

The Western Pacific Region provides instructive examples of implementing the LIVE LIFE framework. In Cambodia, a landmark national consultation in 2025 convened over 230 participants from all 25 provinces, marking a crucial step toward the country's first national suicide prevention action plan [19]. Participants examined risk factors including intergenerational trauma, stigma, and access to lethal means, while also identifying strong religious and family networks as protective factors [19]. In Palau, the National Mental Health Promotion and Self-Harm Prevention Strategy 2025−2035 was launched under the theme "LIVE LIFE in Palau," emphasising multisectoral and community-driven approaches to reducing stigma and mobilising community assets [19].

These examples illustrate the importance of adapting global frameworks to local contexts, engaging diverse stakeholders, and addressing cultural factors that may either facilitate or impede suicide prevention efforts [1,19].

4.2. Means Restriction

Means restriction—limiting access to the methods commonly used in suicide—represents one of the most empirically supported population-level suicide prevention strategies. An umbrella review summarising international evidence found that most reviews concluded means restriction activities were successful in preventing suicide, leading the authors to describe it as "an empirically proven strategy that should be considered for the prevention of suicide" [10]. The evidence base for means restriction draws on natural experiments, such as changes in domestic gas composition that reduced suicide rates in the United Kingdom, and policy interventions, such as firearm legislation that has been associated with reduced suicide rates [10]. The principle underlying means restriction is that while many individuals may experience suicidal thoughts, the transition from ideation to action often occurs during acute crises that are time-limited [10]. By reducing access to highly lethal methods during these critical periods, means restriction can prevent deaths that might not otherwise occur [10].

Practical means restriction strategies include safe storage of firearms and medications, installation of barriers at jumping sites, restriction of access to pesticides in agricultural communities, and changes in medication packaging and prescribing practices [10]. The effectiveness of means restriction depends on the lethality of the method being restricted, the prevalence of that method in the population, and the availability of alternative methods [10].

4. 3. Gatekeeper Training

Gatekeeper training (GKT) aims to empower key community members—such as teachers, primary care physicians, clergy, and local leaders—to recognise warning signs, assess risk, and refer individuals to appropriate services. A systematic review and meta-analysis of randomised controlled trials found that GKT demonstrated effectiveness in enhancing knowledge and self-efficacy for suicide prevention, with moderate effect sizes [11]. The effects of GKT on actual intervention behaviour have been examined in a separate systematic review and meta-analysis, which found evidence for the effects of GKT on behavioural intention and intervention behaviour . However, the evidence base for GKT has limitations, including heterogeneity in training content, duration, and outcome measures [11,20]. The strongest evidence exists for improvements in knowledge and self-efficacy rather than for reductions in suicide rates or attempts, reflecting the practical and methodological challenges of evaluating training interventions at the population level [11]. Despite these limitations, gatekeeper training remains a widely implemented and potentially valuable component of comprehensive suicide prevention strategies, particularly when integrated with other interventions such as means restriction and crisis services [11,20].

4.4. Clinical Interventions: Psychotherapy and Medication

Clinical interventions for individuals at elevated suicide risk include both psychotherapeutic and pharmacological approaches. A systematic review of suicide interventions for youths found that

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dialectical behaviour therapy (DBT) showed moderate strength of evidence for reducing suicidal ideation [12]. Other categories of psychosocial treatments—including cognitive behavioural therapy, collaborative assessment and management of suicidality, and family-based interventions—showed insufficient to low strength of evidence for reducing suicidal outcomes [12].

The evidence base for pharmacological treatment of suicidality in youths was described as "largely nonexistent" in this systematic review, with medication, neurotherapeutics, and emerging therapies remaining unstudied in this population [12]. This represents a significant gap in the evidence base, given the high rates of suicide among young people and the widespread use of pharmacotherapy in youth mental health services [12].

For adults, the evidence base for pharmacological suicide prevention is stronger than in youth, although important limitations remain. Lithium has been associated with reduced odds of suicide in bipolar disorder and in mixed diagnostic samples, while clozapine has demonstrated protective effects against suicide in patients with psychotic disorders [1]. The Stanley-Brown Safety Planning Intervention represents a structured, collaborative approach to clinical suicide prevention [21]. The clinician works with the patient to identify warning signs, internal and external coping strategies, sources of professional support, and personal contacts, while also addressing access to lethal means [21].

4.5. Remote-Based Interventions

The COVID-19 pandemic accelerated the development and evaluation of remote-based interventions for suicide prevention, and these approaches have continued to evolve. A systematic review and meta-analysis of synchronous remote-based interventions found that such interventions were effective in preventing repeated suicide attempts at 1 month (RR 0.73, 95% CI 0.62–0.85), 6 months (RR 0.56, 95% CI 0.34–0.95), and 12 months (RR 0.68, 95% CI 0.49–0.96) [13]. Additionally, these interventions were associated with a reduction in suicide-related deaths at 18 months (Peto OR 0.18, 95% CI 0.08–0.44) [13]. Effects on suicidal ideation were not statistically significant at any time point, suggesting that remote-based interventions may be more effective at preventing suicidal behaviour than at reducing suicidal thoughts [13]. This finding is consistent with the understanding that different intervention approaches may target different aspects of the suicidal process [13].

The success of synchronous remote-based interventions—which include telephone, video, and text-based contact—suggests that active contact and follow-up with individuals who have attempted suicide can be effectively delivered through technology-mediated channels [4]. This has important implications for resource-limited settings and for populations that may face barriers to accessing traditional in-person services [13].

4.6. School-Based Prevention Programs

A 2025 systematic review of school-based suicide prevention interventions identified 14 interventions across 14 studies. No intervention had sufficient evidence to receive a high-level evidence rating, although Signs of Suicide was rated as having moderate evidence and improved outcomes were reported for several interventions [22]. However, the evidence base for school-based suicide prevention interventions has limitations. A systematic review assessing the level of evidence found that more research is needed to build the evidence base for school-based suicide prevention interventions that demonstrate positive impacts on suicide-related and mental health outcomes [22]. School-based programs show mixed results for improving help-seeking behaviours, and standardised, scalable interventions with rigorous evaluations are needed [22]. School-based suicide prevention programs evaluated in the literature have included screening for suicide risk and mental health problems, gatekeeper training for school personnel, curriculum-based education about mental health and help-seeking, and protocols for responding to students identified as being at risk [22]. The involvement of parents and community mental health services is also important for ensuring that students identified as at risk receive appropriate follow-up care [22].

4.7. Prevention in Specific Populations

Older Adults

Older adults have higher suicide rates than younger populations in many countries, and engage in more lethal suicide attempts [18]. A review of geriatric suicide using a socioecological framework identified risk factors at multiple levels, including individual factors (depression, physical illness, cognitive impairment), relationship factors (loss of spouse, social isolation), community factors (loss of meaningful roles, ageism), and societal factors (economic insecurity, inadequate healthcare) [18]. Prevention strategies discussed included early detection, comprehensive healthcare approaches, and legislative and policy solutions [18]. The interpersonal theory of suicide, which posits that suicidal desire emerges from the combination of perceived burdensomeness and thwarted belongingness, has been applied to understanding suicide risk in older adults [18]. Loss of social roles, declining health, and bereavement may contribute to both perceived burdensomeness and reduced belongingness, creating a psychological state conducive to suicidal desire [18].

4.9. Military Veterans

Military veterans represent another population at elevated suicide risk [23]. The review describes several multilevel prevention approaches for older military veterans, including screening, clinical management, and attention to social and environmental risk factors [23]. The prevention of suicide in older military veterans requires a multipronged approach that includes screening for suicidality, management of psychiatric and medical disorders, and attention to the specific psychosocial challenges faced by this population, including challenges related to social adjustment, mental and physical health, and access to lethal means [23].

5. Discussion

The evidence reviewed here supports several key conclusions

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regarding the pathophysiology and prevention of suicide. First, suicidal behaviour is a complex, multidetermined phenomenon that cannot be reduced to any single biological, psychological, or social cause [2,4]. The neuro-immune-endocrine model provides an integrative framework that accounts for the diverse findings across these domains, showing how chronic stress and early life adversity become biologically embedded through epigenetic changes that alter HPA axis functioning, immune regulation, and neurotransmitter metabolism [2,14]. Second, inflammation emerges as a central mechanism linking diverse risk factors to suicidal behaviour [5,15]. Elevated inflammatory markers are consistently associated with increased suicide risk, and the mechanisms through which inflammation influences suicidality—including altered neurotransmitter synthesis, neuroinflammation, and impaired neuroplasticity—provide plausible pathways from psychosocial adversity to suicidal behavior [5]. The potential for anti-inflammatory interventions to reduce suicidality, while not yet established through robust clinical trials, represents a promising avenue for therapeutic development [5,15].

Third, the vascular perspective on suicide pathophysiology offers novel insights and potential biomarkers [6]. The association between vascular dysfunction and suicidal behaviour, including increased blood-brain barrier permeability and platelet activation, suggests that systemic physiological dysregulation beyond the central nervous system may contribute to suicide risk [6]. This perspective also highlights the importance of considering cardiovascular and neurovascular health in suicide risk assessment and prevention [6,16].

Fourth, prevention strategies demonstrate variable but generally encouraging efficacy. Means restriction has one of the strongest evidence bases among population-level suicide prevention interventions, with consistent evidence across multiple systematic reviews [10]. Gatekeeper training improves knowledge and self-efficacy but has less consistent evidence for behavioural change and suicide reduction [11,20]. Dialectical behaviour therapy shows moderate evidence for reducing suicidal ideation in youth, while evidence for other psychosocial and pharmacological interventions in this population remains limited [12]. Synchronous remote-based interventions have been associated with reductions in repeated suicide attempts and suicide-related deaths, and may offer a scalable option for populations facing barriers to conventional in-person services [13].

Fifth, significant gaps remain in the evidence base. The lack of research on pharmacological and neurotherapeutic interventions for suicidal youth is particularly concerning given the high rates of suicide in this population [12]. School-based prevention programs show promise but require more rigorous evaluation and standardization [22]. Further research and implementation efforts are needed in low- and middle-income countries, where the majority of global suicide deaths occur [1,19].

6. Conclusion

Suicide is a preventable cause of death with complex and interacting pathophysiological, psychological, and social determinants [1,2]. The neuro-immune-endocrine model provides a framework for understanding how early life adversity and chronic stress become biologically embedded to increase vulnerability to suicidal behaviour, with inflammation and vascular dysfunction emerging as important areas of ongoing investigation [2,5,6]. Risk factors span psychiatric, genetic, epigenetic, psychosocial, and demographic domains, with adverse childhood experiences, substance misuse, and sexual minority status conferring substantial elevation in risk [7-9]. Prevention requires a multilevel approach that combines population-level strategies (means restriction, responsible media reporting, policy interventions), community-level interventions (gatekeeper training, school-based programs), and clinical interventions (psychotherapy, safety planning, remote-based follow-up) [10-13,21]. The World Health Organization's LIVE LIFE initiative provides a comprehensive framework for implementing these strategies, with the flexibility to adapt to local contexts and cultural factors [1].

Future research should prioritise longitudinal studies examining the temporal relationships between inflammatory markers, vascular dysfunction, and suicidal behavior [5,6,16]. Randomised controlled trials of anti-inflammatory and neurotherapeutic interventions are also needed [5,15]. Rigorous evaluation of school-based and community-based prevention programs remains necessary [11,22]. The development of reliable biomarkers for suicide risk would enable more precise identification of at-risk individuals and more targeted intervention [5,16]. Ultimately, reducing the global burden of suicide will require sustained commitment across multiple sectors and disciplines, guided by the growing evidence base on effective suicide prevention strategies [1,10,24].

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