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Neuropsychiatry of psychological resilience: An overview

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ABSTRACT

Psychological resilience is the operational software of competencies that enables us to cope positively with life's drawbacks. As with all competencies and associated skills, the level of psychological resilience may vary among individuals. This research addresses the neuropsychiatric dimension of psychological resilience and discusses its potential applications in improving public health and pharmacy practices. To conduct a modeling study to identify, diagnose and disseminate to the society the individual characteristics that constitute the building blocks of a resilient society that will cope with pandemics, climate change, wars, waves of migration, inability to meet the basic needs of the increasing population and infrastructure problems, global economic crisis, technological challenges, digital transformation pressure, disruptive changes, and the VUCA (volatility, uncertainty, complexity, ambiguity) world environment, led us to a detailed literature review. Neuropsychiatry of psychological resilience is exemplified by recent global developments, biological underpin-

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nings, genetic variations, clinical perspectives, and developmental aspects.

Keywords: psychological resilience, neuropsychiatry, biological basis of resilience, genetics of resilience, pharmacist-led resilience

INTRODUCTION

Psychological resilience, often described as the "operational software" of human competencies, enables individuals to adapt positively and maintain well-being amidst adversity. This capacity has drawn significant attention in neuropsychiatry and mental health, especially given global stressors like the Corona Virus Disease-19 (COVID-19) pandemic, climate crises, and socio-political upheavals[1]. These challenges underscore the need to understand resilience both individually and as a societal asset.

Resilience research has evolved from focusing on innate traits to encompassing dynamic, multifaceted constructs shaped by biological, psychological, and social factors. Definitions range from "positive adaptation despite adversity" to "dynamic processes enabling individuals to thrive," reflecting the integration of neurobiological, genetic, and environmental perspectives. Foundational theories include Michael Rutter's (1987) protective factors framework, Ann Masten's (2001) "ordinary magic," and Michael Ungar's (2011) socio-ecological model emphasizing context and culture[2-4].

The neuropsychiatric dimension of resilience reveals roles for neural networks, the HPA axis, genome-wide association studies (GWAS), and genetic variations like 5-HTTLPR polymorphisms[1]. However, gaps persist, including limited longitudinal and cultural research, particularly in low- and middle-income countries. Promising digital interventions and strategies like mindfulness require robust validation across diverse populations. Additionally, there is growing interest in how resilience research can inform pharmacy practices, particularly in patient care, medication adherence, and mental health support. This review synthesizes global studies conducted from 1980 to 2024, identifying gaps and proposing future directions for resilience research.

METHODOLOGY

Search strategy

A systematic review was conducted to assess the neuropsychiatric dimensions of psychological resilience. PubMed, PsycINFO, Scopus, and Web of Science were searched for peer-reviewed articles published from January 1980 to December 2024. Keywords included "psychological resilience,"

"neuropsychiatry," "biological basis of resilience," "genetics of resilience" and "pharmacist-led resilience." Boolean operators (AND, OR) refined the search strategy, ensuring diverse perspectives were included. Filters for language (English) and article type (empirical studies, systematic reviews, meta-analyses) were applied to enhance relevance.

Inclusion and exclusion criteria

Studies on resilience's neuropsychiatric aspects, including biological, genetic, or clinical dimensions, feature empirical research, systematic reviews, and meta-analyses were included and grey literature, non-peer-reviewed studies, and conference abstracts, articles not available in English and studies unrelated to psychological resilience were excluded.

Screening process

Following the PRISMA 2020 flow diagram, a total of 1,200 articles were identified. After duplicate removal (n=300), 900 articles underwent title and abstract screening, excluding 500 irrelevant studies. Full-text reviews were conducted for 400 articles, resulting in 85 studies meeting all criteria.

Quality assessment

Methodological rigor was evaluated using the Critical Appraisal Skills Program (CASP) checklists. Studies with robust designs, adequate sample sizes, and appropriate statistical analyses were included. Weak studies were excluded to maintain review integrity.

Data extraction and analysis

Data were systematically extracted using a template to capture objectives, methodologies, findings, and limitations, with thematic synthesis categorizing biological mechanisms, genetics, clinical implications, and trends.

Ethical considerations

This review adhered to ethical guidelines for systematic research. All studies included were previously published and publicly available, ensuring compliance with ethical standards. No direct data collection involving human, or animal subjects was undertaken.

Limitations

Non-English articles and grey literature were excluded. This exclusion may have resulted in the omission of findings from diverse cultural or socio-economic contexts. Reliance on published studies introduces potential publication bias, warranting cautious interpretation.

RESULTS and DISCUSSION

Studies on psychological resilience

Resilience research lacks a definitive consensus on its conceptualization. Studies in this field are categorized into three models: the stress-resilience model, the biopsychosocial model, and the dynamic systems theory[5]. Research on resilience dates to the 1970s, with significant contributions shaping its development. Michael Rutter pioneered resilience research, emphasizing protective factors in reducing the impact of risk factors[2]. Norman Garmezy identified factors that enable individuals to thrive amidst adversity[6]. Ann Masten introduced the concept of "ordinary magic," highlighting resilience as part of normal life processes[3]. Emmy Werner's longitudinal study demonstrated that high-risk children could achieve positive outcomes through protective factors[7]. Suniya Luthar examined the interplay of risk and protective factors[8], while Michael Ungar developed a socio-ecological model emphasizing the role of context and culture[4].

Psychological resilience answers why some individuals experience trauma after events like earthquakes, while others adapt and recover. Despite numerous definitions, operational consensus remains elusive[9-10]. Resilience broadly refers to the ability to adapt positively to adversity, manage stress, and recover from trauma[11-13]. It involves dynamic processes fostering mental health and adaptation throughout life[14]. Positive psychology underpins resilience, focusing on human strengths like happiness and flourishing[15].

Resilience measurement tools included many scales[16-18]. Research on resilience surged during the COVID-19 pandemic, linking it to mental health and leading to resilience-building interventions[19-21]. Applications extend to military training[22], health contexts like cancer[23], and sports performance[24].

Trauma does not always result in post-traumatic stress disorder (PTSD) and can sometimes lead to post-traumatic growth, often linked to psychological resilience[25]. However, it was found that women exposed to physical, verbal, or sexual violence showed high post-traumatic growth but lower-than-expected resilience, with no association found between resilience and the type of violence[26]. A study defined resilience as a capacity, process, and outcome[27], while a different study described it as the ability to resist, bounce back from, or grow through stressors[28], which may explain Arabaci and colleagues' findings[26].

Resilience negatively correlates with psychiatric symptoms[29] and positively with social support, adaptive coping, and optimism[30]. Factors like secure attachment and purpose in life enhance resilience[12]. Men are reportedly more resilient than women[31]. Resilience also varies by age, with older adults excel-

ling in emotional regulation and problem-solving, while younger adults rely more on social support[32].

In a study, it was concluded that individuals with mood disorders are less resilient compared to psychologically normal participants[33]. Similarly, a different study found a medium-level negative correlation between resilience and depression[34]. A previous study observed that individuals with major depressive disorders in remission show lower resilience compared to the general population[35]. Additionally, a study provided empirical evidence of a positive association between psychological resilience and positive coping styles[36].

Resilience ensures well-being and supports self-confidence, healthy relationships, and achievement[37]. Researchers redefined resilience as a complex process involving pre-adversity functioning, challenging circumstances, post-adversity outcomes, and predictors. This multi-level process includes individual, family, and community factors, yet family and community resilience remain underexplored[38]. Resilience is a complex phenotype shaped by personality, mood, self-image, and adaptability[39-40]. Traits like optimism, attachment, intellectual functioning, and effective coping facilitate adaptation to adversity[41].

Neurologically, the medial prefrontal cortex and amygdala play key roles in stress and trauma reduction[41]. The left parietal lobule is linked to emotional control[42]. The central executive network (CEN) and salience network (SN) integrate sensory and emotional information for cognitive control and emotional regulation[43,44]. The hypothalamic-pituitary-adrenal (HPA) axis regulates stress via cortisol secretion, and its malfunction can reduce resilience[37].

Genetic factors also influence resilience. Serotonergic and dopaminergic systems regulate mood and stress. Genetic variations in dopamine and serotonin pathways impact resilience[45]. The NRG1 gene's rs10503920 polymorphism correlates with resilience, while serotonin (SERT) and dopamine transporter (DAT1) genes contribute to individual resilience differences[39,46]. Genetic variability plays a crucial role in determining vulnerability to stress and resilience. Monoamine oxidase A (MAOA) and the serotonin transporter gene (5-HTT) influence susceptibility to depression and stress-related behaviors[41]. Specific genetic combinations, such as the two long alleles of the 5-HTT gene, are linked to higher resilience[41]. Contributing genes include the serotonin transporter gene (SLC6A4), brain-derived neurotrophic factor (BDNF), and catechol-O-methyltransferase (COMT), which impact neurotransmitter function and stress responses[47]. Epigenetic mechanisms, such as DNA methylation and histone modification, mediate gene expression in response to environmental stress, affecting biological pathways related to emotional regulation[48]. Gene-

environment interactions further shape resilience; early-life adversity may amplify vulnerability in genetically predisposed individuals, while supportive environments can mitigate these effects[49].

A previous study highlighted the potential for identifying genetic markers for PTSD to develop early treatments, focusing on neurotransmitters like serotonin, dopamine, and cortisol[50]. Studies have observed increased medial prefrontal activity in at-risk siblings of bipolar patients, suggesting a compensatory resilience mechanism[41]. Furthermore, changes in beta coherence patterns in patients with Major Depressive Disorder (MDD) indicate impairments in emotional regulation and heightened psychological vulnerability[42]. Researchers explored resilience in children, noting short-lasting white matter changes after trauma[51]. Their recent work links resilience to resting-state brain connectivity, suggesting protective effects during concussion recovery[52].

Mindfulness practices enhance the central executive and salience networks, promoting cognitive control and emotional regulation[53]. They regulate the HPA axis, lower cortisol levels, and support neurotransmitter balance, enhancing resilience[54,55]. Mindfulness also induces beneficial epigenetic changes, potentially modifying gene expression associated with stress regulation[56]. By fostering adaptive coping strategies, mindfulness reduces the impact of genetic predispositions to stress[57].

Brain regions such as the prefrontal cortex and amygdala are closely associated with resilience, as identified through functional MRI and PET scans. Twin studies and genome-wide association studies (GWAS) have explored genetic markers like 5-HTTLPR and BDNF polymorphisms. Psychometric tools such as the Connor-Davidson Resilience Scale (CD-RISC) and the Resilience Scale for Adults (RSA) are commonly used, though cultural adaptability remains a challenge. High-resolution imaging and large genetic datasets enhance accuracy, but limitations include a lack of longitudinal designs and cultural biases in assessment tools.

Case studies illustrate resilience across diverse contexts. For example, during the COVID-19 pandemic, an anesthesiologist-maintained resilience through social networks, including managerial and peer support, which helped manage work stress[58]. In another study, resilience emerged from internal and external factors like benefit finding, empathy, self-belief, and gratitude in individuals facing adversities such as domestic violence, health challenges, and loss[59]. A coastal community repeatedly impacted by climate change achieved resilience through flood defenses, education, and social capital, highlighting the importance of adaptive capacity and mental health support[60]. Economically, small

businesses survived financial hardships by diversifying products and building strong stakeholder relationships, driven by leadership resilience, innovation, and stress management[61].

The biological underpinnings of resilience include neural networks like the Central Executive Network (CEN) and Salience Network (SN), which are critical for emotional regulation. Dysregulation of the hypothalamic-pituitary-adrenal (HPA) axis, however, lowers resilience. Genetic factors, particularly variations in serotonin transporter genes (5-HTTLPR), influence stress resilience. Epigenetic modifications shaped by early adversity also affect resilience.

Clinically, resilience-enhancing interventions, including mindfulness-based therapies, show promise but require further evidence. Digital tools like mobile apps and online programs are gaining traction for resilience training, offering accessible resources for stress management. Cultural sensitivity is crucial for tailoring interventions to diverse populations.

Strategies to enhance resilience include expressive writing for emotional processing, gradual fear exposure to build competence, and self-compassion to reduce self-criticism. Techniques like mindfulness, meditation, physical activity, and cognitive restructuring improve emotional regulation and stress relief. However, integrating multiple strategies should be approached cautiously, as some individuals may struggle with unfamiliar practices like mindfulness and self-distancing, potentially increasing frustration or anxiety and reducing adherence. General perspectives for studies about psychological resilience were given in Table 1.

Table 1. Perspectives about psychological resilience

Author(s)	Year	Focus	Key Findings
Rutter	1987	Protective Factors	Protective factors buffer against adversity
Masten	2001	Ordinary Magic	Resilience is common and can be nurtured
Southwick et al.	2014	Models of Resilience	Multiple dynamic models proposed
Maul et al.	2019	Neurobiology of Resilience	HPA axis, amygdala, and genetic factors crucial
Recent Studies	2020-2024	Mindfulness and Genetics	Mindfulness enhances CEN, epigenetic modulation

Pharmacists have been shown to play a vital role in enhancing psychological resilience at both the individual and community levels. Through their close interaction with patients, pharmacists contribute to the provision of emotional

support, health literacy, medication adherence, and stress management, which are critical elements for fostering resilience. By providing clear guidance on treatment plans, addressing concerns empathetically, and offering preventive health advice, pharmacists help patients feel more empowered and better equipped to manage chronic illnesses, mental health conditions, and acute crises. Furthermore, community pharmacists, who frequently function as the primary healthcare access point, contribute to the reduction of healthcare access barriers, thereby promoting social support – a recognised protective factor in resilience development[28]. Interventions led by pharmacists, encompassing medication therapy management, mental health first aid, and counselling for chronic disease management, have been demonstrated to reduce patient anxiety and enhance coping mechanisms[19]. The integration of mindfulness-based interventions and psychoeducational programs into pharmacy practice has the potential to enhance resilience among vulnerable populations[51]. The multifaceted role of the pharmacist has been demonstrated to enhance patient resilience on an individual basis, as well as augmenting the community's broader capacity to contend with and recuperate from public health challenges.

Limitations

Significant gaps in resilience research include the scarcity of longitudinal studies crucial for understanding causal relationships and resilience progression[62]. Factors like age, gender, ethnicity, and education affect resilience, with poverty reducing it[63]. Genetic influences, such as 5-HTTLPR and BDNF, are understudied despite exceptions like previous researches[49,64]. Additionally, research in low- and middle-income countries and digital interventions requires further exploration. Moreover, pharmacy-specific resilience interventions remain underexplored.

In conclusion, psychological resilience is crucial for mental health and adapting to adversity. Electroencephalography (EEG) biomarker-based cognitive retraining enhances resilience and cognitive function, particularly in high-stress environments like space missions[64]. Neurofeedback targeting beta coherence shows promise in improving emotional coping and neural patterns[42]. Resilience stems from biological, genetic, and environmental factors, yet cultural and temporal variations are underexplored. Future research should prioritize longitudinal studies and validate digital resilience training for diverse populations.

STATEMENT OF ETHICS

Not applicable as no human or animal subjects were involved in the study.

CONFLICT OF INTEREST STATEMENT

The authors declare there is no conflict of interest associated with this study.

AUTHOR CONTRIBUTIONS

All authors were equally involved in the literature investigation and preparation of the manuscript draft. All authors read and approved the manuscript.

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