RESEARCH PAPER

Digital Warfare Surveillance Stress and PTSD: A Neuropharmacological Review of Trauma Pathways and Therapeutic Interventions

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ABSTRACT

Contemporary warfare has increasingly shifted from physically bounded battlefields to technologically mediated spaces shaped by drone monitoring, satellite intelligence, biometric tracking, algorithmic targeting, and cyber-surveillance. While earlier studies of war trauma primarily focused on bodily injury, shell shock, and post-traumatic stress disorder arising from direct combat exposure, the present review examines digital surveillance as a chronic psychological stressor with significant neurobiological and therapeutic implications. Continuous monitoring, uncertain threat perception, loss of privacy, and anticipatory fear may activate prolonged stress responses, particularly through the hypothalamic-pituitary-adrenal axis, leading to cortisol dysregulation, hypervigilance, sleep disturbance, anxiety, depressive symptoms, and PTSD-like manifestations. The paper adopts a review-based analytical approach by integrating literature from trauma studies, military psychology, neuropharmacology, psychopharmacology, and digital warfare studies. It examines how surveillance-induced stress may alter emotional regulation, memory processing, autonomic arousal, and behavioural responses among affected populations, including civilians, soldiers, drone operators, refugees, and conflict-zone communities. Further, the study discusses existing therapeutic approaches, including selective serotonin reuptake inhibitors, serotonin-norepinephrine reuptake inhibitors, anxiolytics, beta-blockers, sleep-modulating agents, trauma-focused cognitive behavioural therapy, eye movement desensitization and reprocessing, and community-based psychosocial interventions. The paper argues that surveillance-related trauma should be understood not merely as a cultural or psychological phenomenon but also as a clinically relevant stress condition requiring pharmacological and non-pharmacological management. By repositioning digital warfare trauma within the framework of neuropharmacology and therapeutic care, the study contributes to emerging discussions on mental health, trauma treatment, and public health preparedness in technologically mediated conflict environments.

Keywords: Digital warfare PTSD neuropharmacology surveillance stress trauma therapy anxiety disorders psychopharmacology cortisol neuroinflammation therapeutic intervention.

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1. INTRODUCTION

1.1 Background of the Study

The nature of warfare has undergone a significant transformation with the increasing use of drones, satellites, biometric identification, cyber operations, artificial intelligence, and algorithmic surveillance systems. Modern conflict is no longer limited to physical battlefields; rather, it operates through digital infrastructures that continuously monitor, classify, predict, and target human behaviour. This technological transformation has created new forms of psychological vulnerability. Individuals living under constant surveillance may experience persistent fear, uncertainty, self-regulation, hypervigilance, sleep disturbance, and emotional exhaustion even in the absence of direct physical violence. Such conditions indicate that digital surveillance may function as a chronic psychological stressor capable of producing trauma-like symptoms.

From a neurobiological perspective, prolonged exposure to surveillance-based insecurity may activate the body's stress response system, particularly the hypothalamic-pituitary-adrenal axis. Repeated activation of this system may disturb cortisol regulation, alter emotional processing, and increase the risk of anxiety, depression, and post-traumatic stress disorder. The experience of being continuously watched or potentially targeted may therefore produce not only cultural and social consequences but also measurable psychological and pharmacological concerns. This makes the study of digital warfare relevant to neuropharmacology, psychopharmacology, and therapeutic intervention.

The present paper examines surveillance-induced trauma in the context of contemporary warfare by integrating insights from trauma theory, military psychology, neurobiology, pharmacology, and therapeutic studies. It argues that the psychological effects of digital surveillance should be examined not merely as literary or theoretical representations but also as clinically relevant stress responses. The paper further explores the possible role of

pharmacological and non-pharmacological interventions in managing PTSD, anxiety, sleep disturbance, and stress-related symptoms arising from technologically mediated warfare.

1.2 Problem Statement

Traditional studies on war trauma have largely focused on physical injury, battlefield violence, and post-traumatic stress disorder arising from direct exposure to conflict. However, contemporary warfare increasingly operates through digital surveillance, drone monitoring, biometric tracking, satellite intelligence, and algorithmic targeting. These technologies create a prolonged state of psychological insecurity, where individuals experience fear, hypervigilance, sleep disturbance, anxiety, and loss of autonomy even without direct physical injury. Such conditions may contribute to chronic stress responses and PTSD-like symptoms. Therefore, this paper examines digital surveillance-induced trauma from a neuropsychopharmacological perspective, focusing on its psychological, biological, and therapeutic implications. The study further explores how pharmacological and non-pharmacological interventions may assist in managing trauma-related mental health consequences in populations exposed to digital warfare.

1.3 Research Questions

1. To examine digital surveillance in modern warfare as a source of chronic psychological stress.
2. To analyse the neurobiological relationship between surveillance-induced fear, anxiety, and PTSD.
3. To study the role of cortisol imbalance, hypervigilance, sleep disturbance, and trauma-related symptoms in affected populations.
4. To assess the relevance of pharmacological and therapeutic interventions in managing surveillance-induced trauma.
5. To reposition digital warfare trauma within the broader framework of neuropharmacology and mental health care.

1.4 Objectives of the Study

- To examine digital surveillance in contemporary warfare as a source of chronic psychological stress.
- To analyse the relationship between surveillance-induced fear, anxiety, hypervigilance, sleep disturbance, and PTSD-like symptoms.
- To study the neurobiological role of the hypothalamic-pituitary-adrenal axis, cortisol dysregulation, autonomic arousal, and emotional memory in trauma formation.
- To assess the pharmacological relevance of antidepressants, anxiolytics, beta-blockers, sleep-modulating agents, and other therapeutic approaches in managing trauma-related symptoms.
- To evaluate the role of non-pharmacological interventions such as trauma-focused cognitive behavioural therapy, eye movement desensitization and reprocessing, mindfulness-based therapy, and community mental health support.
- To reposition the study of digital warfare trauma within the broader framework of neuropharmacology, psychopharmacology, and public health.

2. THEORETICAL FRAMEWORK

2.1 Panopticism and Surveillance

Michel, Foucault's, Panopticon and, Disciplinary Power; Biopolitics and Governmentality; Post-Panoptic Societies and Digital Control Systems, Michel Foucault's concept, of the Panopticon, derived from, Jeremy Bentham's architectural model, serves as a foundational metaphor for understanding modern systems of surveillance and control. Foucault, argues, that the Panopticon functions not merely as a physical structure, but, as a mechanism, of power that, induces, a state of conscious and, permanent, visibility. In such a, system, individuals internalize the, gaze, of authority and, begin to regulate their own, behavior, thereby rendering overt, coercion unnecessary. This form of disciplinary power operates, through subtle techniques of, observation, normalization, and examination, shaping individuals into compliant subjects. Building on this framework, Foucault introduces the concept, of biopolitics, which shifts the, focus of, power from, disciplining individual bodies to managing entire populations. Biopolitics involves, the, regulation of life processes such, as, birth, health, mortality and, productivity, positioning, the population as a central concern of, governance. Through statistical analysis, surveillance systems and institutional practices, states, exercise control over biological existence itself. Closely related is, the, notion, of governmentality, which, refers, to, the, art, of governing, beyond traditional political, structures. It, encompasses, a wide range of practices and, rationalities through which individuals are guided to, govern themselves in accordance, with, state, objectives. In, this, sense, power becomes decentralized and diffused, operating through, everyday practices rather than solely through top-down, authority.

2.2 Surveillance Capitalism

Shoshana Zuboff's concept, of *surveillance, capitalism*, as articulated in, *The, Age, of Surveillance, Capitalism*, provides a, critical framework for understanding how data-driven systems, operate as mechanisms of power in contemporary society, including, in, the context, of, warfare. Zuboff defines surveillance capitalism as, an, economic logic that centers, on the, extraction, of, behavioral data from, individuals, which, is then analyzed, commodified and, used, to predict and, shape future actions. While, her analysis, primarily focuses on, corporate, digital platforms, its, implications extend significantly into military and security domains, where, similar techniques of data extraction and behavioural prediction are deployed for strategic purposes. In war contexts, data extraction operates through an, extensive network, of digital infrastructures, including drones, satellites, biometric systems and communication networks. These technologies collect, vast, amounts of information about, individuals and populations,

ranging, from movement, patterns and communication habits to biometric identifiers and social connections. This, continuous harvesting, of data transforms human activity into what, Zuboff terms "behavioural surplus," a resource that can be, processed to generate, actionable intelligence. In military applications, such, data is, not, only used, for surveillance but, also for identifying, potential, threats, mapping social networks and predicting, patterns of behaviour that may indicate, insurgent, oropposite, activity.

2.3 Trauma Theory

Cathy Caruth conceptualizes trauma, as a, form of *belated experience*, emphasizing that, traumatic events are, not, fully grasped, at the moment, of their occurrence but, are, instead, understood retrospectively through delayed psychological, responses. In, her influential work *Unclaimed Experience*, Caruth argues that, trauma resists immediate representation because it overwhelms, the, subject's capacity to process, it in real time. As a result, the traumatic event, returns later in the form of intrusive memories, flashbacks and repetitive, reenactments.

This notion, of belatedness highlights the, temporal disjunction at the, core of trauma: the experience is not, simply located in, the past, but persists, in, the present, shaping perception and, subjectivity. Caruth further suggests that trauma is characterized by its incomprehensibility, as, it remains "unclaimed" by consciousness at the, moment it, occurs. This, framework is, particularly useful for analyzing contemporary forms of trauma, where the impact of events, especially those mediated by technology and distance—may emerge, gradually rather than, immediately. Judith Herman outlines a foundational framework for understanding trauma recovery in, her seminal work *Trauma and Recovery*, where she identifies, three key stages: safety, remembrance, and, mourning and reconnection. The, first stage, safety, involves, establishing a sense, of physical and psychological stability, which is essential for any further healing. The second, stage, remembrance and, mourning, requires the, individual to process and, articulate the traumatic, experience, often through narrative, reconstruction. The, final stage, reconnection, emphasizes the restoration of relationships, and a, renewed engagement with, everyday life. Herman's, model underscores that recovery is not linear but requires, sustained effort within supportive social and institutional contexts.

2.4 Algorithmic Violence

Algorithmic violence, refers to the, use, of automated and data-driven systems in the, identification, selection and, execution, of targets in, contemporary warfare. Unlike, conventional forms of violence that rely on, human, judgment, and direct engagement, algorithmic systems operate, through, computational, processes that analyze, vast datasets to, produce, actionable decisions. These, systems, draw on inputs from surveillance technologies such as drones, satellites and digital, communication networks, transforming raw data into strategic, outputs. In, this, context, violence is increasingly mediated by algorithms that function as both tools and agents of decision-making, raising, critical questions about accountability and control.

One of the, central aspects of algorithmic violence is the, automation of targeting systems. Modern military infrastructures, employ machine, learning, models and predictive, analytics to identify potential, threats based on, patterns of behaviour, movement and association.

Individuals, may be, flagged as targets not because of confirmed hostile actions but due to, correlations within data sets, such as frequent contact with known, suspects or presence in certain This process, often described as "signature strikes," exemplifies a shift from evidence-based, targeting to, probability-based decision-making. While proponents argue, that such, systems, enhance, precision, and, efficiency, critics, highlight the of errors, misidentification, and, the, reinforcement of, biased datasets, which can, disproportionately affect already vulnerable populations. Drone, decision-making further illustrates the ethical complexities of AI-based warfare. Unmanned, systems, increasingly incorporate semi-autonomous or fully autonomous capabilities, allowing, them, to track, select and, potentially engage targets with minimal, human intervention. Although, human, operators are, often, described as, remaining "in the loop," the, scale of algorithmic, processing, can limit, meaningful oversight. This raises concerns about the, erosion of moral, responsibility, as decisions once, made by human agents are, delegated to, machines. The, distance between operator and target both physical and psychological also contributes to what some scholars describe as a, "dehumanization" of warfare, where targets are, reduced, to data points rather than recognized as individuals.

3. LITERATURE REVIEW

Existing literature on war trauma has traditionally focused on physical injury, shell shock, PTSD, combat exposure, and the psychological effects of direct violence. Early trauma studies examined how soldiers and civilians respond to battlefield injury, displacement, loss, and memory fragmentation. However, the rise of digital warfare has expanded the meaning of trauma by introducing forms of harm that are invisible, prolonged, and technologically mediated. Drone warfare, biometric tracking, satellite surveillance, cyber operations, and algorithmic targeting generate psychological pressure through anticipation, uncertainty, and permanent visibility.

Scholars of surveillance studies have shown that constant observation can produce self-regulation, fear, and loss of autonomy. Trauma theorists have explained that psychological injury does not always arise from a single event but may also emerge from prolonged exposure to insecurity. Military psychology further demonstrates that soldiers, civilians, and remote warfare operators may suffer from anxiety, guilt, moral injury, insomnia, and PTSD-like symptoms as a result of technologically mediated conflict. However, much of this scholarship remains limited to theoretical, political, or literary analysis. There is a need to connect these discussions with neuropharmacology and

therapeutic science. Chronic surveillance stress may influence the hypothalamic-pituitary-adrenal axis, cortisol levels, autonomic arousal, emotional regulation, and sleep patterns. These biological pathways are directly relevant to anxiety disorders, PTSD, depression, and trauma-related mental health conditions. Existing clinical literature on PTSD treatment highlights the role of antidepressants, anxiolytics, beta-blockers, sleep-regulating drugs, and psychotherapy. However, specific attention to surveillance-induced trauma remains limited. Therefore, this paper attempts to bridge the gap between digital warfare studies and pharmacological trauma research. It argues that surveillance stress should be studied not only as a cultural or political condition but also as a clinically relevant mental health concern. By integrating psychological, neurobiological, and pharmacological perspectives, the study contributes to a broader understanding of trauma in the age of digital warfare.

3.1 Post-9/11 War Literature

Post-9/11 war literature marks, a significant shift in the, representation of conflict, reflecting, the changing nature of warfare in the aftermath, of the, September 11 attacks. Unlike earlier war narratives centered on, direct battlefield, encounters, contemporary texts, increasingly engage, with technologically mediated violence, particularly drone, warfare and the, prolonged conflicts in Iraq and Afghanistan. These, works foreground not, only physical, danger but also moral ambiguity and psychological dislocation experienced by both soldiers and civilians. Drone, warfare, memoirs provide, a compelling insight into, the, ethical and emotional complexities of remote combat. For instance, Brandon Bryant's memoir *The Predator* recounts his experience as a drone operator involved, in targeted, killings from thousands of miles away. Bryant, describes the strain, of, watching targets for extended periods, forming, a visual familiarity with them and then participating in their destruction at the, push of a button. This, paradox of intimacy and, distance produces a, unique form, of trauma, where, operators are physically safe yet, psychologically affected by their actions. Similarly, Matt, J. Martin's, *Predator: The Secret Origins of the Drone, Revolution* highlights, the strategic and, emotional, burdens placed, on, those engaged in remote, warfare.

In parallel, fiction emerging from the, Iraq and Afghanistan wars, explores the fragmented and eventually disorienting realities of soldiers, and civilians. Phil, Klay's, *Redeployment* offers, a series of interconnected stories that, depict, the mental strain, moral conflict, and, reintegration struggles faced by returning soldiers. The, narrative, captures how violence extends beyond the, battlefield, shaping identity and memory long after deployment. Likewise, Kevin, Powers's, *The Yellow, Birds* provides a haunting portrayal of the Iraq War, emphasizing the, fragility of, human life and the, lingering psychological scars of combat. These, literary works, also engage, with the experience, of civilians living, in, conflict, zones. Novels and testimonies often depict, the, pervasive presence of surveillance technologies, the, unpredictability of, drone strikes and, the, erosion of, everyday safety. The, blending, of fiction and, lived experience in these narratives underscores the enough impact of post-9/11 wars, where, trauma is not confined to, soldiers but, extends, across entire populations.

3.2 Digital Warfare Narratives

Digital warfare narratives represent a significant evolution in contemporary war literature shifting attention from physical battlefields to virtual arenas where conflict is conducted through code networks and information systems. These narratives explore the implications of cyber warfare hacking and digital surveillance foregrounding forms of violence that are often invisible yet deeply consequential. Unlike traditional war stories which emphasize physical confrontation digital warfare texts highlight disruption infiltration and control within interconnected technological environments. Cyber warfare fiction plays a crucial role in imagining the possibilities and dangers of digitally mediated conflict. Novels such as Ghost Fleet by P. W. Singer and August Cole depict future war scenarios in which cyber-attacks disable military systems satellites and communication networks leading to widespread chaos and vulnerability. The novel draws on real-world military strategies and technological developments illustrating how cyber operations can precede or even replace conventional combat. Similarly works like Daemon by Daniel Suarez envision autonomous digital systems that manipulate financial markets infrastructure and social behaviour blurring the line, between fiction and expected reality. These texts underscore the growing significance of cyberspace as a domain of warfare where control over information can translate into strategic dominance.

In parallel hacker memoirs and whistleblower accounts provide firsthand insights into the practices and ethics of digital conflict. The revelations of Edward Snowden documented in his memoir Permanent Record expose the scope of global surveillance programs and the extent to which governments collect and analyze personal data. Snowden's disclosures demonstrate how digital infrastructures can be weaponized not only against external adversaries but also against civilian populations raising critical questions about privacy liberty and state power. His case highlights the blurred distance between national security and mass surveillance a recurring theme in digital warfare narratives.

3.3 Gap in Existing Scholarship

Despite the growing body of research on surveillance technologies and trauma studies there remains a significant gap in scholarship that integrates these two domains into a cohesive theoretical framework. Existing literature tends to treat surveillance and trauma as distinct phenomena: surveillance is often examined through the lens of power governance and data extraction while trauma is approached from psychological medical or narrative perspectives. This separation limits the ability to fully understand the type of psychological injury produced by continuous digital monitoring in contemporary conflict zones. Scholars such

as Michel Foucault have provided foundational insights into surveillance as a mechanism of disciplinary power, emphasizing how constant visibility induces self-regulation and internalized control. Similarly, Shoshana Zuboff has examined how data extraction and behavioural prediction shape subjectivity within digital economies. On the other hand, trauma theorists like Cathy Caruth and Judith Herman focus on the temporal and psychological dimensions of trauma including delayed experience memory fragmentation and recovery processes. While each of these frameworks is robust in its own right few studies bring them together to analyze how surveillance itself can function as a source of trauma.

Real-world cases highlight the urgency of such an integrated approach. For instance, investigations into drone warfare in regions such as Waziristan reveal that civilians living under constant aerial surveillance experience persistent anxiety sleep disturbances and behavioural changes even in the absence of direct strikes. Reports by organizations like Amnesty International document how the continuous presence of drones creates an atmosphere of fear and unpredictability disrupting daily life an social interaction. These findings suggest that surveillance itself independent of physical violence can produce lasting psychological harm. Similarly, the disclosures by Edward Snowden exposed the scale of global digital monitoring demonstrating how entire populations are subjected to data collection and analysis. While much of the scholarship on these revelations focuses on privacy and civil liberties less attention has been paid to their psychological impact. The knowledge or suspicion of being constantly observed can lead to self-censorshipand a diminished sense of autonomy effects that resonate with trauma-related symptoms but are rarely conceptualized as such.

4. RESEARCH METHODOLOGY

This study adopts a review-based analytical research design to examine the neuropsychopharmacological implications of digital surveillance-induced trauma in contemporary warfare. The research is interdisciplinary in nature and draws upon literature from neuropharmacology psychopharmacology trauma studies military psychology public health digital warfare studies and therapeutic sciences. Instead of treating surveillance only as a literary or theoretical concept the study examines it as a chronic stress-producing condition with possible clinical biological and pharmacological consequences. The study relies on secondary sources including scholarly articles books clinical studies review papers reports on drone warfare and surveillance literature on PTSD and research on pharmacological treatment of trauma-related disorders. The analysis focuses on identifying the relationship between continuous surveillance exposure and symptoms such as anxiety hypervigilance insomnia emotional dysregulation intrusive fear social withdrawal and PTSD-like conditions. Special attention is given to the role of stress pathways particularly the hypothalamic-pituitary-adrenal axis cortisol dysregulation sympathetic nervous system activation and neurochemical changes associated with chronic fear and traumatic stress.

The paper also reviews pharmacological and non-pharmacological approaches used in the management of trauma-related mental health conditions. These include selective serotonin reuptake inhibitors serotonin-norepinephrine reuptake inhibitors anxiolytics beta-blockers sleep-regulating agents' trauma-focused cognitive behavioural therapy eye movement desensitization and reprocessing and psychosocial support models. The study is descriptive and analytical in nature and does not involve primary clinical trials or experimental data. Its purpose is to build a conceptual and therapeutic framework for understanding surveillance-induced trauma within the scope of neuropharmacology and mental health care.

5. ANALYTICAL SECTIONS

5.1 Digital Surveillance as a Chronic Psychological Stressor

Digital surveillance in contemporary warfare produces a form of stress that differs from conventional battlefield trauma. Traditional trauma often results from direct exposure to violence such as injury attack displacement or witnessing death. In contrast surveillance-induced trauma may develop through continuous exposure to uncertainty and perceived threat. The affected individual may not experience immediate physical harm but the persistent awareness of being monitored can produce psychological distress.

This condition is especially visible in drone-affected conflict zones where populations live under the constant sound and presence of unmanned aerial vehicles. The drone may or may not attack but its presence creates a permanent state of anticipation. Similarly biometric surveillance and algorithmic tracking can create fear among refugees and conflict-affected communities because personal data may be used for identification exclusion detention or targeting. This transforms everyday life into a condition of psychological insecurity. From a pharmacological perspective such chronic fear may activate stress pathways and increase the risk of trauma-related disorders. Continuous surveillance can maintain the body in a state of alertness causing hyperarousal insomnia irritability and anxiety. Over time these symptoms may develop into PTSD-like conditions. Therefore, digital surveillance should be understood as a chronic psychological stressor with direct relevance to neuropharmacology and mental health treatment.

5.2 The Psychology of Being Watched

The Psychology of Being Watched: Surveillance Trauma and the Fragmented Self

The experience of being watched has long occupied a central place in philosophical psychological and cultural analyses of power. In contemporary contexts however this experience has intensified and expanded through the proliferation of digital surveillance technologies. The psychology of being watched is no longer limited to specific institutional settings such as prisons or military zones but has become a pervasive condition shaping everyday life particularly in regions affected by technologically mediated

warfare. This chapter examines how continuous surveillance produces psychological effects such as hypervigilance paranoia anticipatory trauma self-surveillance and memory fragmentation ultimately contributing to what can be conceptualized as a form of invisible and enduring injury.

At the core of this psychological condition lies hypervigilance a heightened state of sensory awareness and alertness typically associated with trauma. Individuals under constant observation whether through drones biometric systems or digital tracking develop an acute sensitivity to their surroundings. This heightened awareness is not merely a response to immediate danger but a sustained condition in which the possibility of threat is ever-present. As Judith Herman explains trauma disrupts the individual's sense of safety leading to persistent states of arousal and vigilance. In surveillance contexts however hypervigilance is not only a symptom of past trauma but also a rational adaptation to ongoing conditions of monitoring. The individual becomes attuned to subtle cues constantly scanning both physical and digital environments for signs of observation or intervention. Closely related to hypervigilance is the emergence of paranoia which in this context should not be understood merely as a pathological condition but as a socially and technologically induced state. When surveillance systems operate invisibly and unpredictably individuals may struggle to determine when and how they are being watched. This uncertainty fosters a sense of mistrust and suspicion not only toward institutions but also toward one's own perceptions. Michel Foucault's analysis of the Panopticon provides a useful framework for understanding this dynamic. In a panoptic system the possibility of constant observation leads individuals to internalize the gaze of authority regulating their behaviour even in the absence of direct supervision. In digital environments this logic is amplified by the scale and opacity of surveillance technologies which operate across networks that are largely inaccessible to those being observed.

5.3 Algorithmic Targeting and Dehumanization

Predictive Policing, AI-Mediated Violence and the Narrative Representation of Remote Killing

The emergence of predictive policing in war zones marks a significant transformation in the logic of contemporary conflict where decisions are increasingly guided by data analytics rather than direct human judgment. Predictive policing refers to the use of algorithms and statistical models to forecast potential threats based on patterns of behaviour movement and association. While initially developed in civilian law enforcement contexts these techniques have been adapted for military use particularly in counterinsurgency operations. In war zones predictive systems analyze vast datasets drawn from surveillance technologies communication intercepts and biometric records to identify individuals or groups deemed suspicious. This approach shifts the focus from reactive measures to preemptive action where intervention occurs not in response to confirmed acts but in anticipation of possible future behaviour.

The implications of predictive policing in conflict settings are profound. Individuals may be categorized as threats based on probabilistic assessments rather than concrete evidence raising serious concerns about accuracy bias and accountability. Scholars such as Shoshana Zuboff have highlighted how data extraction and behavioural prediction function as mechanisms of control shaping not only what is known about individuals but also how they are governed. In military contexts this predictive logic can result in targeting decisions that are detached from traditional standards of verification thereby redefining the boundaries of legitimacy in warfare. The use of "pattern of life" analysis for example allows military actors to infer intent based on routine activities effectively transforming everyday behaviour into potential evidence of hostility. Closely related to predictive policing is the rise of AI-mediated violence in which artificial intelligence systems play a central role in the identification and execution of targets. These systems range from decision-support tools that assist human operators to semi-autonomous platforms capable of selecting and engaging targets with minimal intervention. Grégoire Chamayou argues that such technologies contribute to the development of "riskless warfare," where one side minimizes its exposure to danger while exerting lethal force at a distance. This asymmetry not only alters the strategic dynamics of conflict but also has significant ethical implications.

One of the most pressing concerns surrounding AI-mediated violence is the phenomenon of moral displacement. As decision-making processes become increasingly automated responsibility for violent outcomes becomes diffused across a network of actors including programmers engineers military commanders and machine systems themselves. This diffusion complicates traditional notions of accountability making it difficult to determine who is responsible when errors occur. Hannah Arendt's concept of the "banality of evil" provides a useful lens for understanding this dynamic as it highlights how ordinary individuals can participate in harmful systems without fully confronting the moral implications of their actions. In the context of AI-driven warfare violence is often mediated through interfaces and algorithms creating a distance that can obscure its constant consequences.

5.4 Gendered and Civilian Dimensions of Surveillance Trauma

Surveillance Gender and Marginalization in Conflict Zones: Biometric Control Digital Profiling and the Politics of Visibility

The expansion of digital surveillance technologies in contemporary conflict zones has introduced new dimensions to the governance of populations particularly affecting already marginalized groups. Among these women refugees and ethnic minorities occupy especially vulnerable positions within systems of monitoring and control. Surveillance in such contexts is not merely a neutral or technical process but is deeply embedded in existing social hierarchies and power relations. This chapter examines how the surveillance of women the use of biometric data in

refugee management digital profiling and ethnic targeting intersect to produce layered forms of marginalization and vulnerability. The surveillance of women in conflict zones reflects both the gendered dynamics of war and the specific ways in which digital technologies amplify existing inequalities. Women are often positioned as both subjects of protection and objects of suspicion within military and humanitarian frameworks. Surveillance systems deployed in conflict zones such as checkpoints biometric registration processes and digital identification programs frequently operate through gendered assumptions about risk and security. For example, women may be subjected to invasive forms of identification including facial recognition and biometric scanning under the justification of ensuring safety or preventing infiltration. However, these practices can also reinforce patriarchal structures by limiting women's mobility and autonomy.

Scholars have emphasized that surveillance is not experienced uniformly but is shaped by social categories such as gender race and class. Nira Yuval-Davis's work on intersectionality provides a useful framework for understanding how multiple forms of inequality intersect in such contexts. Women in conflict zones often face compounded vulnerabilities as they navigate both the violence of war and the constraints imposed by surveillance systems. Testimonies from regions such as Afghanistan and Syria indicate that surveillance technologies can exacerbate fears of exposure, particularly in societies where gender norms are strictly enforced. The possibility that personal data or images may be accessed by authorities or hostile actors can lead to heightened anxiety and self-censorship. Biometric data collection has become a central component of refugee management in many conflict-affected regions. International organizations and governments increasingly rely on technologies such as fingerprinting iris scanning and facial recognition to register and monitor displaced populations. United Nations High Commissioner for Refugees has implemented biometric systems in refugee camps to streamline aid distribution and prevent fraud. While these systems are often presented as efficient and secure, they also raise significant concerns about privacy consent and long-term data security. Refugees who are already in precarious situations may have little choice but to comply with data collection processes in order to access essential services.

5.5 Narrative Techniques Representing Invisible Trauma

Fragmented Narration Unreliable Voices and Digital Aesthetics in Contemporary War Fiction

Contemporary war fiction has undergone a significant transformation in its narrative strategies reflecting the changing nature of conflict in the digital age. As warfare becomes increasingly mediated through surveillance technologies remote interfaces and data-driven systems literary forms have adapted to represent these shifts. Among the most notable developments are the use of fragmented narration unreliable narrators second-person perspectives that mimic surveillance and the incorporation of digital interface aesthetics. Together these techniques challenge traditional modes of storytelling and offer new ways of representing the psychological and epistemological complexities of modern warfare.

Fragmented narration is one of the most prominent features of contemporary war literature. Unlike linear narratives that present events in a coherent and chronological sequence fragmented narratives disrupt temporal continuity presenting experiences in disjointed non-linear segments. This technique reflects the disorientation and instability characteristic of both trauma and digitally mediated conflict. Cathy Caruth argues that trauma resists straightforward representation often emerging through repetition gaps and disruptions in narrative form. In war fiction fragmentation mirrors the fractured nature of memory and perception particularly in environments where information is partial delayed or mediated through technological systems. For example, Kevin Powers's The Yellow Birds employs a non-linear structure that moves back and forth in time reflecting the protagonist's struggle to process his experiences in the Iraq War.[2] The fragmentation of the narrative not only conveys the psychological impact of war but also resonates with the fragmented flow of data in digital warfare where events are encountered through screens reports and intermittent signals rather than direct experience. Similarly, Phil Klay's Redeployment presents a series of interconnected stories that offer multiple perspectives on the same conflict emphasizing the multiplicity and incompleteness of war narratives.

6. NEUROBIOLOGICAL AND PHARMACOLOGICAL DIMENSIONS OF SURVEILLANCE-INDUCED TRAUMA

Neurobiological and Pharmacological Dimensions of Surveillance-Induced Trauma

Digital surveillance in warfare creates a distinct form of psychological pressure because it produces a continuous sense of being watched assessed classified or targeted. Unlike direct battlefield injury surveillance-related trauma may develop through prolonged exposure to uncertainty and anticipatory fear. Civilians living under drones soldiers operating in digitally monitored environments refugees subjected to biometric tracking and drone operators involved in remote warfare may experience different forms of stress but all are connected by the psychological burden of technological observation. This stress may gradually affect neurobiological functioning and contribute to trauma-related disorders.

Stress Response and HPA Axis Activation

The hypothalamic-pituitary-adrenal axis plays a central role in the body's response to stress. When an individual perceives danger, the hypothalamus activates the pituitary gland which then stimulates the adrenal glands to release cortisol. In normal circumstances cortisol helps the body respond to immediate threats. However, when the threat is continuous or unpredictable as in the case of permanent surveillance or drone monitoring the stress response may remain activated for prolonged periods. This may result in

cortisol dysregulation emotional instability impaired sleep irritability and heightened fear responses. In surveillance-based warfare the threat is often not visible or predictable. The individual may not know when monitoring is occurring or whether observation will lead to detention targeting questioning or attack. This uncertainty increases the psychological intensity of the stress response. Over time such exposure may disturb the balance between the stress system and emotional regulation mechanisms thereby contributing to anxiety and PTSD-like symptoms.

Hypervigilance and Autonomic Arousal

Hypervigilance is one of the most common responses to trauma and chronic threat. It refers to a condition in which the individual remains excessively alert to danger constantly scanning the environment for possible harm. In digitally mediated warfare hypervigilance may arise from the sound of drones the awareness of satellite monitoring fear of biometric identification or suspicion of digital tracking. This may activate the sympathetic nervous system producing symptoms such as increased heart rate restlessness sweating sleep disruption irritability and exaggerated startle responses.

Such autonomic arousal can become harmful when it persists beyond the immediate threat. Individuals exposed to continuous surveillance may find it difficult to relax or feel safe even when no direct violence occurs. This creates a condition in which the body remains prepared for danger producing long-term psychological and physiological strain.

PTSD Anxiety and Sleep Disturbance

Post-traumatic stress disorder is generally associated with exposure to life-threatening events violence or severe psychological shock. However modern warfare demonstrates that trauma may also emerge from indirect prolonged and technologically mediated exposure to threat. Surveillance-induced trauma may involve intrusive thoughts nightmares avoidance behaviour emotional numbness irritability sleep disturbance and persistent fear. The constant possibility of being watched or targeted may prevent affected individuals from developing a stable sense of safety. Sleep disturbance is particularly significant in surveillance-related trauma. Populations living under drones or conflict-zone monitoring may report difficulty sleeping due to fear of sudden attack or intervention. Lack of sleep further worsens anxiety reduces emotional control weakens cognitive functioning and increases vulnerability to depression and PTSD. Therefore, sleep regulation becomes an important therapeutic concern in the management of surveillance-induced stress.

Neurochemical Dimensions of Trauma

Trauma-related disorders involve changes in several neurochemical systems including serotonin norepinephrine dopamine gamma-aminobutyric acid and glutamate. Serotonin is associated with mood regulation anxiety control and emotional balance. Norepinephrine is linked to arousal attention and fear response. Dopamine affects motivation and reward processing while GABA and glutamate regulate neural excitation and inhibition. Chronic stress may disturb these systems and contribute to symptoms such as anxiety depression impulsivity emotional numbness and memory disturbances. Surveillance-induced trauma may therefore be understood as a condition involving both psychological and neurochemical disruption. This pharmacological understanding is important because it helps identify possible treatment approaches. Instead of viewing surveillance stress only as a political or literary issue it can be studied as a mental health condition requiring clinical awareness and therapeutic support.

Pharmacological Management of Trauma-Related Symptoms

Pharmacological treatment for trauma-related symptoms generally depends on the nature and severity of the condition. Selective serotonin reuptake inhibitors are commonly used in the management of PTSD anxiety and depression because they help regulate serotonin levels and improve mood stability. Serotonin-norepinephrine reuptake inhibitors may also be useful in cases involving anxiety depression and chronic stress. In some cases, anxiolytics may be used for short-term relief of severe anxiety although long-term use requires caution due to the risk of dependence. Beta-blockers may be relevant in controlling physical symptoms of hyperarousal such as increased heart rate and tremors. Sleep-modulating agents may be required where insomnia nightmares or disturbed sleep patterns are severe. However pharmacological intervention should not be treated as a standalone solution. Trauma-related conditions generally require a combination of medication psychological therapy social support and long-term rehabilitation.

Non-Pharmacological and Psychotherapeutic Interventions

Non-pharmacological interventions are equally important in managing surveillance-induced trauma. Trauma-focused cognitive behavioural therapy helps individuals identify and restructure fear-based thoughts and behavioural responses. Eye movement desensitization and reprocessing may assist in processing traumatic memories and reducing emotional distress. Mindfulness-based interventions may help reduce hypervigilance and improve emotional regulation. Community-based psychosocial support is also important for affected populations especially civilians and refugees living in conflict zones. In the context of digital warfare therapy must also address the unique psychological features of surveillance stress including loss of privacy fear of technological targeting self-censorship and social distrust. A trauma-informed approach should therefore combine clinical care with legal social and public health protections.

Public Health Relevance

The psychological effects of surveillance-based warfare should be viewed as a public health concern. Large populations may be exposed to digital monitoring drone presence biometric tracking or cyber conflict without access

to mental health support. If untreated chronic stress may lead to long-term psychological disorders reduced productivity social isolation substance abuse and intergenerational trauma. Public health systems must therefore recognise technologically mediated trauma as an emerging area of concern. Mental health screening community counselling access to affordable medication digital rights protection and rehabilitation programmes should be integrated into humanitarian responses in conflict zones. This approach would help bridge the gap between technological warfare studies and therapeutic health sciences.

7. DISCUSSION

The analysis demonstrates that digital surveillance in modern warfare should not be understood merely as a technological or security practice. It also operates as a psychological stressor capable of producing trauma-related symptoms. The permanent possibility of being watched tracked classified or targeted creates a condition of chronic insecurity. This affects the individual's sense of safety autonomy sleep emotional stability and social behaviour. The findings suggest that surveillance-induced trauma may operate through both psychological and neurobiological pathways. At the psychological level it produces fear hypervigilance self-censorship distrust and loss of agency. At the biological level it may activate the hypothalamic-pituitary-adrenal axis disturb cortisol regulation increase autonomic arousal and affect neurochemical systems linked to anxiety and mood regulation. These processes are closely associated with PTSD depression insomnia and other stress-related disorders.

The discussion also highlights the importance of therapeutic intervention. Pharmacological treatment may be necessary for individuals suffering from severe anxiety depression insomnia or PTSD symptoms. However, medication alone cannot fully address the social and psychological dimensions of surveillance trauma. Trauma-focused psychotherapy community support legal protection and public health intervention are equally important. A combined model of care is therefore required. The study further suggests that digital warfare creates new responsibilities for health systems humanitarian agencies and policymakers. Mental health consequences of surveillance-based warfare should be recognised as part of conflict-related harm. Public health planning in conflict zones should include screening for trauma-related symptoms access to psychopharmacological care psychological counselling and rehabilitation programmes.

Reconceptualizing trauma therefore requires a shift from event-based models to process-oriented frameworks that account for continuous exposure. Individuals living under surveillance do not necessarily experience a single moment of rupture; instead, they inhabit environments characterized by uncertainty anticipation and constant observation. Judith Herman's emphasis on safety as a foundational condition for psychological well-being is particularly relevant in this context. When the possibility of being watched or targeted is ever-present the sense of safety required for recovery is fundamentally undermined. Trauma becomes not a past incident but a lived condition that persists in the present. This shift in understanding aligns with broader theoretical perspectives on power and governance. Michel Foucault's concept of the Panopticon illustrates how surveillance operates not merely through direct coercion but through the internalization of observation. In digital environments this logic is extended through networked technologies that monitor behaviour across multiple domains from communication to movement. The result is a form of power that is both pervasive and subtle shaping subjectivity at a deep level. Within this framework, surveillance can be understood as a form of structural violence. The concept of structural violence often associated with scholars such as Johan Galtung refers to social structures that systematically harm individuals by preventing them from meeting their basic needs or achieving well-being. Unlike direct violence which is visible and immediate structural violence operates through institutions and systems producing harm that is often normalized or invisible. Digital surveillance fits within this model by creating conditions that constrain autonomy generate anxiety and reinforce existing inequalities. The structural nature of surveillance is particularly evident in its integration into everyday life. Technologies that were once associated with military or intelligence operations are now embedded in civilian contexts blurring the boundaries between war and peace. As Shoshana Zuboff demonstrates data extraction and behavioural prediction have become central to contemporary forms of governance extending beyond security to encompass economic and social domains. In conflict zones these dynamics are intensified as surveillance systems are deployed to monitor populations identify threats and control movement.

Understanding surveillance as structural violence also highlights its differential impact on marginalized groups. As discussed in earlier sections women refugees and ethnic minorities are often subjected to more intensive forms of monitoring which intersect with existing social hierarchies. This intersectional dimension underscores the need to consider not only the presence of surveillance but also the ways in which it is distributed and experienced across different populations. It is within this theoretical and empirical context that the concept of the "panoptic wound" emerges as a useful analytical tool. Drawing on Michel Foucault's notion of panopticism the term "panoptic wound" refers to the psychological and affective injuries produced by continuous surveillance. Unlike physical wounds which are localized and visible panoptic wounds are diffuse internalized and often difficult to articulate. They manifest through symptoms such as hypervigilance anxiety self-censorship and a diminished sense of agency.

8. FINDINGS

1. Digital surveillance in contemporary warfare can function as a chronic psychological stressor.
2. Surveillance-induced trauma differs from traditional war trauma because it is continuous anticipatory and often invisible.

3. Persistent monitoring may lead to hypervigilance anxiety sleep disturbance emotional instability and PTSD-like symptoms.
4. The hypothalamic-pituitary-adrenal axis cortisol dysregulation autonomic arousal and neurochemical imbalance may play an important role in surveillance-related stress.
5. Civilians soldiers refugees ethnic minorities women in conflict zones and drone operators may experience different forms of surveillance-induced psychological harm.
6. Pharmacological interventions such as antidepressants anxiolytics beta-blockers and sleep-modulating drugs may be relevant in the management of trauma-related symptoms.
7. Non-pharmacological therapies including trauma-focused cognitive behavioural therapy EMDR mindfulness-based therapy and psychosocial support are essential for long-term recovery.
8. Surveillance-induced trauma should be recognised as an emerging public health and neuropharmacological concern.

9. CONCLUSION

This study has explored the transformation of contemporary warfare through the lens of digital surveillance advancing the central argument that the proliferation of monitoring technologies has produced new forms of invisible trauma that demand critical attention. By examining war narratives theoretical frameworks and real-world practices the research has proposed the concept of "panoptic wounds" as a means of understanding the psychological and affective consequences of living under conditions of constant observation. This conclusion synthesizes the key findings highlights the theoretical contributions of the study reflects on its relevance to digital governance and military ethics and outlines directions for future research. At the core of the study is the recognition that warfare in the twenty-first century has shifted from predominantly physical confrontation to digitally mediated forms of conflict. Technologies such as drones biometric systems satellite intelligence and algorithmic targeting have redefined the battlefield as a dispersed and networked space. Within this environment violence is no longer limited to direct physical harm but extends to forms of psychological and informational impactthat are often less visible yet equally significant. The analysis of contemporary war narratives has demonstrated how these changes are reflected in literary form with authors employing fragmented structures unreliable narration and digital aesthetics to capture the experience of surveillance and uncertainty.

One of the key findings of this study is that traditional models of trauma which emphasize discrete events and bodily injury are insufficient for understanding the complexities of digitally mediated warfare. Drawing on the work of Cathy Caruth and Judith Herman the research has shown that trauma can also emerge from continuous exposure to conditions of, insecurity and observation. In surveillance environments individuals experience not only the past events but also the constantanticipation of potential harm. This anticipatory dimension transforms trauma into an ongoing process characterized by hypervigilance anxiety and a fragmentedconsequences sense of self. The study has further demonstrated that surveillance operates as a form of structural violence shaping behaviour and subjectivity through mechanisms of observation and control. Michel Foucault's concept of panopticism has been central to this analysis illustrating how the possibility of being watched leads individuals to internalize disciplinary power. In the context of digital warfare this dynamic is amplified by the scopeand opacity of surveillance systems which extend across physical and virtualof space. The integration of insights from Shoshana Zuboff further underscores how data extraction and behavioural prediction contribute to new forms of governance that blur the boundaries between military and civilian life.

REFERENCES

1. Arendt, Hannah. 1963. *Eichmann in Jerusalem*. New York: Viking Press.
2. Bryant, Brandon. 2015. *The Predator*. New York: Metropolitan Books.
3. Caruth, Cathy. 1996. *Unclaimed Experience: Trauma, Narrative, and History*. Baltimore: Johns Hopkins University Press.
4. Chamayou, Grégoire. 2015. *A Theory of the Drone*. New York: The New Press.
5. Foucault, Michel. 1977. *Discipline and Punish: The Birth of the Prison*. New York: Pantheon Books.
6. Foucault, Michel. 1978. *The History of Sexuality, Vol. 1: An Introduction*. New York: Pantheon Books.
7. Galtung, Johan. 1969. "Violence, Peace, and Peace Research." *Journal of Peace Research* 6 (3): 167–191.
8. Herman, Judith. 1992. *Trauma and Recovery*. New York: Basic Books.
9. Klay, Phil. 2014. *Redeployment*. New York: Penguin Press.
10. Martin, Matt J. 2010. *Predator: The Secret Origins of the Drone Revolution*. Minneapolis: Zenith Press.
11. Powers, Kevin. 2012. *The Yellow Birds*. New York: Little, Brown and Company.
12. Rid, Thomas. 2013. *Cyber War Will Not Take Place*. Oxford: Oxford University Press.
13. Snowden, Edward. 2019. *Permanent Record*. New York: Metropolitan Books.
14. Yuval-Davis, Nira. 2006. "Intersectionality and Feminist Politics." *European Journal of Women's Studies* 13 (3): 193–209.
15. Zuboff, Shoshana. 2019. *The Age of Surveillance Capitalism*. New York: PublicAffairs.

16. Amnesty International. 2013. *Reports on Drone Strikes in Waziristan*.
17. United Nations High Commissioner for Refugees. 2015–present. *Biometric Registration Initiatives*.
18. World War I Medical Archives. Various years. *Studies on Shell Shock and Early Psychiatric Trauma*.
19. Literature on network-centric warfare and information superiority.
20. Contemporary studies on automation, cyber conflict, and digital warfare.
21. War literature and testimonies from Iraq and Afghanistan conflicts.
22. Military media and digital warfare studies.
23. Reports on gender and conflict in Afghanistan and Syria.