Psychotraumatology and Artificial Intelligence: A Public Health Approach

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Abstract

Public health is increasingly becoming a central perspective of psychotraumatology. Exposure to trauma and its impact is a pervasive and critical issue worldwide and is associated with substantial costs to individuals, communities and wider societies. In this review, it is argued that there is a need to extend beyond individual–level trauma interventions that target specific populations, diagnoses and risk factors. A 'paradigm shift' towards a public health approach provides health and social care institutions with a multi-level framework that focuses on early intervention, prevention, care and treatment at a population level. It is postulated that adopting a wider systems perspective can benefit from rapid innovations in artificial intelligence (AI) technologies that will accelerate understandings of trauma and its impacts and help forge pathways to identifying protective factors which have the potential to facilitate post-traumatic growth. The importance of addressing AI bias through the co-creation of machine learning algorithms with a range of stakeholders, including those with lived experiences, is emphasised. The need to harness computational approaches to big data on trauma in a secure, private, sensitive and ethical manner in accordance with 'best practice' governance structures for public health data science is essential.

Keywords: Psychotraumatology; Trauma; Artificial Intelligence; Public Health; Mental Health; Well-Being; Narrative Review

Abbreviations: PTSD: Post-Traumatic Stress Disorder; AI: Artificial Intelligence.

Introduction

There has been increasing interest in the discipline of traumatic stress in the field of public health [1]. Exposure to trauma is associated with substantial costs to individuals, communities, societies and wider economies [2]. Epidemiological research from countries worldwide indicate that traumatic events occur commonly across the lifespan [3], often with major consequences for mental and physical health [4]. Psychological trauma has increasingly been understood as a transdiagnostic risk factor across a wide range of mental health conditions such as depression, anxiety and substance abuse. People who have experienced psychological trauma also have higher rates of serious and life-threatening physical illnesses including cardiovascular disease, neuroendocrine dysfunction and gastrointestinal disorders [5,6]. Of all the various factors which affect an individual's potential to develop such conditions, the most significant concerns the availability of effective social support after the traumatic event [7], access to healthcare resources and services [8] and the opportunity to recover in a relatively low stress environment [9].

Such protective factors have been significantly challenged in recent years with the heightened stressors associated with the coronavirus disease (COVID-19) pandemic [10]. Systematic reviews and meta-analytical

studies have evidenced the adverse mental health outcomes on the general population [11]; with approximately three in every ten survivors of coronavirus, about two in every ten healthcare workers, and about one in every ten individuals of the general population reported to have trauma related symptoms or a diagnosis of post-traumatic stress disorder (PTSD) during and/or after the outbreaks [12]. Evidence suggests increased prevalence of poor mental health outcomes, during the implementation of public health measures and social restrictions, predominantly among young people, females, and people with chronic somatic conditions [13,14]. While meta-analyses do not equally represent all regions across the world, with a lack of studies from low to middle income countries, emerging evidence indicates that the mental health impacts will be severe, long-lasting and greatest in under-resourced, low-income countries and disadvantaged populations [15].

Research has highlighted significant inequities and disparities in access to mental health services, care and trauma treatment worldwide [16]. The objective of this review is to argue that there is an urgent need to extend beyond individual–level trauma interventions that target specific populations, diagnoses and risk factors. Given the ongoing barriers to seeking support associated with trauma exposure [17] and lengthy waiting times to accessing mental health services [18], attention needs to be focused on finding alternative solutions to a critical problem. It is argued that adopting a public health approach that harnesses the benefits of rapid innovations in artificial intelligence (AI) technologies, drawing upon big data presents opportunities and responsibilities for public health researchers, policy makers and practitioners moving forward.

Method

A knowledge synthesis grounded in a narrative review approach [19] was adopted to enable the inclusion of a wide variety of studies and provide a nuanced interpretation and critique of the existing evidence base concerning psychotraumatology, AI and public health. This allowed the researcher to describe what is known on this topic while conducting a subjective examination and critique of relevant literature. Such reviews are useful for exploring topics for new insights or ways of thinking regarding well-developed research fields [20]. The electronic search included the databases, MEDLINE, PsycINFO, Embase, CINAHL, Scopus, Web of Science, Cochrane library and Google Scholar. The following search terms were used: 'psychotraumatology', 'trauma', 'artificial intelligence', 'public health', 'mental health' and 'well-being'. The inclusion criteria were: all types of articles, including primary qualitative, quantitative and mixed methods data, case studies, reviews, opinion texts and related only to humans. The exclusion criteria were: articles for which full text was not available, were not in English, or were grey literature. From the articles retrieved in the first round of search, additional references were identified by a manual search among the cited references.

Paradigm Shift: Individual to Public Health Approaches to Trauma

There is clear evidence highlighting the effectiveness of individual [21] and group based psychotherapeutic interventions that can treat trauma-related conditions [22] and medication may have a secondary role to treat co-morbidities [23]. People who suffer repeated traumatic events, especially if they occur during childhood, are at increased risk of developing more complex PTSD [24,25] and, in general, require a period of stabilisation before they can engage in intensive trauma-focussed treatment [26]. Problematically, most people who develop PTSD do not seek professional help due to ongoing barriers including the stigma of mental health help-seeking [17,27] and lengthy waiting times to accessing over-stretched mental health supports and services [28]. Of those that do seek treatment, drop-out rates are reportedly as high as 20.9% [29]. Evidence suggests that increased uncertainty about global safety, cost of living, job security, social disconnection, and environmental challenges (e.g., living in a post-pandemic world, digital era, global warming), contribute to the reported increasing rates of poor mental health and traumatic stress conditions worldwide [30]. This draws attention towards finding an alternative solution to an already urgent and critical public health problem.

A public health approach outlines how trauma-based interventions should not just be provided by stand-alone services offered by a specialist trauma team [31]. Instead, it should be integrated into all aspects of community life. This asks all members of a community to recognise and respond to traumatic events and responses [32]. Promoting positive mental health and wellbeing is positioned as a priority which contributes to wider goals (like improving community sense of belonging, reducing loneliness, facilitating post-traumatic growth and providing trauma-informed care). Public health is increasingly becoming a central perspective of psychotraumatology [33] representing a 'paradigm shift' in terms of the vast body of trauma research, policy and practice which has tended to adopt a more individualised model of 'diagnosis and treat' trauma conditions using evidence-based interventions [34]. Instead, a 'whole systems intervention' is advocated which involves embedding trauma informed resources, supports, education and policies across entire communities, rather than targeting specific individuals [35]. It does not preclude the use of individualised evidence-

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based trauma interventions (e.g., trauma focused cognitive behavioural therapy or eye movement and desensitisation reprocessing), but views this as complementary to efforts conducted at the population level. Importantly, this approach also advocates for mental health, physical activity, resilience and wellbeing concurrently, widening benefits to all, regardless of their characteristics or vulnerabilities towards trauma, by prioritising prevention, early intervention and positive mental health promotion efforts [36]. By adopting such an approach, individuals already experiencing trauma, as well as those who are at a relatively low risk, can be supported and safeguarded [37,38].

A public health framework for trauma-informed care, support and intervention can reduce the increasing demands on counselling and mental health services and has the potential to improve population-level wellbeing and resilience. It makes clear that trauma care, support and interventions will have to consider not only the individual but the community and wider societal impact(s) of trauma [39]. Extending beyond individual-level interventions that target specific populations, diagnoses, risk factors and treatments (i.e. increasing the number of counsellors, trauma therapists), a wider systems perspective considers social, psychological, economic, environmental, contextual, generational and historical factors that can synergistically impact on population-level mental health and wellbeing [40,41]. With a focus on the prevention of trauma and early intervention, mitigation against the onset of more severe mental health conditions such as complex PTSD is possible [2].

The implementation of scalable and widely accessible screening, assessment and interventions for traumatic stress as well as policy directives to help reduce the negative impact of exposure to traumatic events on population-level mental health is a major public health challenge and priority [42]. Trauma-informed and trauma-specific policies and care are gaining increasing attention as they provide a comprehensive framework for understanding and responding to complex stress and trauma-related situations [43]. Given the intergenerational effects of trauma and how this compounds health inequities, increases socio-economic hardship and decrease the effectiveness of trauma informed interventions and policies [44], public health strategies require a multi-prolonged and multi-systemic approach [45]. Exploring the sequelae of trauma and its determinants in terms of individual, relational, community, societal and generational influences provides a foundation for the development of public health interventions and policies [46]. Understanding such huge, complex processes requires access to big data [47] and the application of cutting-edge technologies to facilitate enhanced insights into trauma.

What Role does Artificial Intelligence Play in a Public Mental Health Approach to Trauma?

There is a rapidly growing interest and deployment of AI strategies to achieve public health outcomes using novel datasets, surveillance tools and machine learning models [48]. AI and machine learning describe a broad range of algorithm types that can be trained based on datasets to make predictions. The utility of such computational tools have been evidenced in acute trauma care [49]. The data-intensive nature of public mental health makes it one of the most promising fields for the application of AI and machine learning algorithms [50]. A major strength of AI is rapid pattern analysis of large datasets [51]. AI has the potential to improve the efficiency and effectiveness of processes that make possible personalised predictive and preventative approaches to the onset of trauma-related conditions. These algorithms can analyse large quantities of data on population-level mental health outcomes, like electronic mental health records, mood rating scales, tracking of physical activity levels, brain imaging data, and find trends and anticipate how trauma symptoms and wellbeing improvements will change over time. Data from social media platforms, web search engines, novel monitoring systems (e.g. smartphones), wearables and apps provide information about the determinants of trauma that is more nuanced than that from traditional sources. Such data can be used to predict, classify or subgroup trauma-related conditions and comorbid issues such as depression, anxiety and suicidal ideation [52]. Online tools, apps and chatbots powered by AI technologies can also provide highly accessible digital interventions [52]. AI-based applications have the potential to provide cost-efficient and interactive solutions to trauma-based education and promotion, assist in the self-management of trauma symptoms, including flashbacks, sleep disturbance and hypervigilance [53].

AI technologies can also help people to access remote or automated mental health services, screenings, diagnosis, and therapy [54]. Mental health care technologies (e.g., avatar-assisted therapy) offer promising solutions to address accessibility among individuals who are experiencing trauma [55]. A combination of mixed realities utilising augmented and virtual reality platforms with real world interventions provide digital solutions that have the potential to contribute to increasing society's wellbeing [56]. The capacity of AI to provide constant, tireless and rapid analyses of public health data offers the potential to transform society's approach to promoting positive mental health, resilience and wellbeing and preventing and managing trauma conditions.

Increasingly, there has been widespread applications of AI-supported technologies in medical and healthcare

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institutions [57]. Since AI encompasses machine learning, natural language processing, and robotics, AI-based technologies provide vast opportunities for innovation in the healthcare industry [58]. While AI technology is more prevalent in medicine for physical health conditions [59], its application in mental health is emerging [60]. Mental health practitioners tend to be patient-centered in their clinical practice, relying more on interpersonal and communication skills, including forming and building therapeutic relationships with patients and directly observing patient behaviours, emotions and trauma responses [61]. There is considerable heterogeneity in the pathophysiology of trauma and the identification of biomarkers may allow for objective measurement of these conditions. Equally, trauma data is often subjective, self-report and/or qualitative patient statements and written clinical notes that cannot be quantitatively analysed or easily coded. This data is rich, in-depth and inductive in nature. Utilising both deductive and inductive approaches to dealing with both objective and subjective data-sets will provide an in-depth, multi-layered 'deep learning' approach to machine learning algorithms that use multiple layers to progressively extract higher level features from raw data input [62].

AI Ethics, Bias and Governance

Trauma-based research and practice has the potential to benefit from AI technology if such data is sensitively handled, moderated and securely stored with no potentially identifiable information in accordance with data protection legislation. AI has great potential to accelerate understandings of trauma conditions as well as empower people to recognise early signs and symptoms, self-manage and be empowered to know how and when to seek professional help when needed. Leveraging AI techniques offers the opportunity to develop pre-diagnosis screening tools and formulate risk models to determine an individual's predisposition for, or risk of developing PTSD [63]. It also has the potential to help facilitate understandings of protective factors that foster post-traumatic growth. To implement a public mental healthcare approach to trauma as a long-term goal, there is a need to harness computational approaches best suited to big data in a sensitive and ethical manner with adherence to governance structures and best practice guidelines for maintaining privacy and security of such personal data [64] and mental health data science [65].

Despite the advantages of efficiency of scale and depth of AI generated data and digital innovations, concerns have been expressed by scientists, practitioners and the general public about the systematic datafication of people's lives and their lived experiences of health and illness [66]. It is unclear whether AI-assisted health care leads to better patient outcomes, whether it empowers and enables patients/ service users, carers and their families, and whether patients or the public have a meaningful say over AI-assisted processes of care or design of such systems. With such rapid innovations comes great responsibility and consideration of existing ethical and governance frameworks to guide AI activities and analytic processes [67].

Addressing AI biases by ensuring that population-level data captures those from diverse backgrounds and minority groups and that this be incorporated into AI algorithms to help increase digital inclusivity is essential [68]. Successfully integrating such innovations and technologies in health and social care settings should include reviews and modernisation of existing organisational data and governance infrastructures, developing collaborative partnerships and co-producing machine learning algorithms to align with best practices in consideration of equity and inclusivity for all. Before accepting the therapeutic potential of AI in trauma research policy and practice, public health professionals and researchers should evaluate how to prevent it perpetuating and precipitating bias. This issue in particularly relevant to public mental health, in which diagnoses can lead to shame, discrimination, social exclusion and marginalisation [69]. Equity must be central to the implementation of AI across trauma-informed health and social care systems. Large datasets are pivotal to the development of these technologies, but must be representative of the population to ensure all can benefit. Typically, minority groups are less represented in datasets used to develop AI algorithms and the mental health challenges for these communities are less obvious to data science teams, which tend not to be representative of these populations. AI has the potential to widen social and health disparities and divert attention from collective action. The public mental health community must be actively involved in not just creating the circumstances for the safe and effective development of AI in psychotraumatology that delivers for whole populations but also in the development of AI technologies to ensure the narrative around personalisation and the responsibilities of the individual does not distract governments from their continued responsibility for the mental health and wellbeing of their citizens [11]. Encouraging collaborative practices and partnership working among experts of diverse stakeholders (eg, professions, race/ethnicity) working in public health [70] as well as co-creating algorithms with the end user from onset is a promising area of future research and practice. Adopting participatory methods in the co-creation of AI algorithms with people with lived experiences of trauma and comorbid conditions is likely to promote their inclusion and provides a means of challenging the structural deficits and inequalities that

cause distress and exacerbate trauma symptoms in the long term [71-73].

Considerations

Public mental health is increasingly being accepted as an important and integral part of psychotraumatology research, policy and practice. Adopting such an approach involves a paradigm shift away from individual 'diagnose and treat' models of trauma conditions to a much broader focus on population-level mental health and wellbeing. It adopts a wider systems perspective, considering social, psychological, economic, environmental, contextual and generational factors that can synergistically impact on mental health and wellbeing. Recontextualising trauma through a public health 'lens' shifts the focus from identifying individual risk factors or providing one to one therapeutic treatment, and instead highlights multiple leverage points across individual, relational, community and societal levels of trauma-informed mental health systems to support promotion, early intervention, prevention, treatment, and recovery. Understanding both risks and protective factors for trauma as well as factors that help facilitate post-traumatic growth is paramount to a public health approach which not only seeks to prevent the full spectrum of traumatic conditions from traumatic stress through to severe, complex PTSD but to improve wellbeing and build resilience in the aftermath of exposure to trauma [72-79]. Furthermore, incorporating interdisciplinary perspectives and building collaborative working partnerships is essential to developing a 'whole systems' approach to the pertinent issues concerning trauma and the potential for post-traumatic growth. Taken together, the evidence base for public health in psychotraumatology is growing as innovations embracing new technologies are emerging. The application of AI will be increasingly employed in public health research and practice. While advances in AI for analysing big data will improve the timeliness and robustness of public health data on trauma, it is essential that AI biases that could misrepresent 'at risk' populations or skew results are addressed through inclusivity and co-created algorithms with people from marginalised groups with lived experiences of trauma. Collaboration between experts from different areas of public health knowledge is necessary. Despite the ethical biases and challenges that the use of AI brings with it, this new tool could benefit those most vulnerable to trauma by bringing a relevant, collaborative and participatory approach to computational methods to big data in psychotraumatology. The time is now ripe to move from knowledge to action to innovation to benefit those most vulnerable to trauma today and in the years ahead in addressing this significant global public health concern [80-82].

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