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AI-Powered Predictive Analytics for Identifying Domestic Violence Risk Factors Across Cultures- An Overview

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Abstract: *This study offers a comprehensive examination of the use of AI-driven predictive analytics to discern risk variables for domestic violence across various cultural frameworks. Domestic violence (DV) is a widespread global concern with significant physical, psychological, and societal consequences, disproportionately affecting women while also influencing men. Conventional detection and intervention efforts are frequently reactive and inadequately funded, underscoring the necessity for innovative, data-driven approaches. Recent advancements in artificial intelligence (AI)—encompassing machine learning, natural language processing, and deep learning—present significant opportunities for enhanced timeliness and precision in risk assessment. These tools can assist in recognising patterns of abuse, forecasting escalation, and providing targeted support services instantaneously. Utilising AI in this delicate field necessitates meticulous attention to ethical dilemmas, encompassing privacy, data bias, and the possibility for technological exploitation. Furthermore, cultural norms, legal structures, and socioeconomic conditions can profoundly affect the occurrence of domestic abuse and the effectiveness of AI-driven remedies. This study highlights the significance of a culturally informed, ethically principled, and interdisciplinary methodology through the analysis of contemporary literature and practical implementations. Future research directions encompass the creation of more inclusive and transparent algorithms, the expansion of cross-cultural datasets, and the integration of AI into comprehensive public health and social services frameworks to guarantee safe and successful domestic violence prevention globally.*

Keywords: *Domestic Violence, Predictive Analytics, Artificial Intelligence, Machine Learning, Cross-Cultural*

1. INTRODUCTION

DV against women is a global problem occurring in every country worldwide. It affects women's mental, physical, reproductive, and sexual health and is considered a significant issue in most communities and cultures [1]. Intimate partner and domestic violence are two terms that, although similar in meaning, are different. Domestic violence can be between family members, roommates, or even children. On the other hand, intimate partner violence, which occurs between intimate partners, prior either to or after the dates, is involved with various types- physical, sexual, emotional, and physiological abuses, even though the terms are used interchangeably [2]. The prevalence of domestic violence against women in all its manifestations remains high in societies and nations throughout the world. It is also associated with marital problems and poor health implications for the victims, their children, their immediate families, and the community as a whole [3]. The United Nations Declaration defines violence against women as "any act of gender-based violence that results in, or is likely to result in, physical, sexual, or psychological harm or suffering to women, including threats of such acts, coercion, or arbitrary deprivations of liberty, whether occurring in public or private life." Physical violence includes both physical aggression and controlling behaviours. Psychological violence refers to a situation where a victim is controlled, isolated, or economically abused. Sexual violence involves non-consensual sexual contact [4].

It is a pervasive problem that cuts across cultural and geographical boundaries, affecting millions worldwide. The identification of risk factors well in advance can substantially improve intervention strategies and supporting mechanisms for victims [1]. AI-driven predictive analytics opens a data-driven gateway to understand and mitigate DV, which enables the stakeholders to identify patterns leading to such events with a high degree of accuracy [2]. This work discusses various AI methodologies applied to DV risk prediction and highlights the cultural nuances affecting their performance.

The World Health Organisation estimates that 641 million to 753 million women aged 15 years and older, who have ever been in a relationship, have experienced at least one form of physical or sexual violence globally. Violence against women is considered a serious global health and social problem due to its severe consequences on victims, their families, and society as a whole [4]. How the community perceives the incidence of domestic violence by an intimate partner determines significantly in what manner DV is perpetuated, the manner of response or reaction to being victimised and disclosure-seeking process by women and the community and societal responses towards DV. More than 35 population-based studies undertaken in Asia, Africa, and the Middle East have shown that discriminatory gender norms about male power and control, as well as attitudes that justify domestic violence, have proved remarkably predictive of both victimization and perpetration [5]. While domestic abuse is a common crime around the world, police responses to it tend to be hugely disparate.

What is even more alarming is that a search via EBSCOhost revealed very few scholarly publications regarding the issue since 2005. This is considered one of the largest academic search engines in the world, yet it contained only 17 research publications. This is a concern indeed. Outcome studies and better, more specialized training on this dismal problem are not aiding our police forces as domestic violence continues [6]. Most DV or IPV complaints have tended to relate to violence against women. According to that fact, it was estimated that one of three women globally would face the physical form of violence, or IPV, which refers to as the common violence against the victim committed by their intimate partner, including the sexual abuses. However, the public, scientific community, and therapeutic community are increasingly aware of DV or IPV against men. It is estimated that one in four males may experience physical abuse from an intimate partner at some point in their lives, just like violence against women does [7]. DV against women affects individuals, families, communities, and society as a whole.

People who suffer because of it face injury and death, reproductive health problems, hazardous use of drugs and alcohol, anxiety, depression, post-traumatic stress disorder, self-harm, and suicide. Low birth weights, early births, stillbirths, forced abortions, miscarriages, and increased violent crimes against families are common. Loss of agency in communities and society, low involvement, and reduced economic production follow. It accounts for a significant share in the global burden of disease for women's morbidity and mortality, including rates of HIV and other STDs, psychological trauma and depression, suicide and homicide, chronic pain, fractures, injuries, and disability [1], [8]. Every day, it is estimated that an intimate partner or a family member worldwide murders 137 women. Sub-Saharan African (SSA) countries have incredibly high rates of violence against women, especially in places with low socioeconomic status and limited educational opportunities [1].

Although most civilisations forbid violence against women, in practice, abuses of women's rights are sometimes excused by local customs and conventions or by misinterpreting religious principles. Implicit silence and inactivity of the state's and law enforcement apparatus effectively condones the abuse when it takes place within the home, which is often where this violence occurs [3]. In that way male power was kept on top, holding it firmly through violence on women. This male-superiority and female-inferiority culture created an environment in which domestic abuse was accepted and normalised and further legitimized violence against women. Consequently, women internalized and normalized this oppressive mindset, which in turn contributed to maintaining the cycle of domestic violence [4]. A relatively large body of research exists concerning the composition of attitudes towards DV at the individual or household level in low- and middle-income countries, including several multi-country studies. Yet few cross-national, country-level data exist concerning how social, economic, and political empowerment tactics of which are recognised as markers of gender equality, affect the acceptance of domestic violence in society [5]. Technology has been a double-edged sword when it comes to domestic violence.

It might be used as a means for abusers to harass, monitor, and control their partners, knowing their whereabouts, their use of social networks, and whom they talk with,. On the other hand, it is also applied to service in preventing or reducing domestic violence and supporting victims with hotlines, online support and therapy, and mobile apps for safety planning [9]. Digital, online, and AI-based smart technological services, applications, and tools provide novel methods for the management of intimate partner and domestic violence [10]. Since the appearance of AI in the mid-20th century, this exponential development and increasing importance to contemporary society have stimulated an increasingly extensive debate relating to its nature, ethical effects, and possible consequences for human rights. Probably one of the most important features of AI, with particular implications for fundamental rights and underprivileged groups, refers to the emergence of biases. These biases can either prolong and exacerbate existing disparities or introduce new types of bias based on the discipline's development and data processing procedure [11].

2. LITERATURE REVIEW

Only recently has the potential of digital technology and AI been explored in regard to the response to GBV, especially domestic abuse. The meeting of feminist discourses and AI methodologies opens a privileged site for exploring critically both the possible risks involved with these technologies and to better diagnose and prevent domestic violence [11]. Interventions reducing the impact of domestic violence against women can be done by the health services. According to some earlier research, psychologists can be a platform where victims of domestic abuse can convey their issues. Another study also suggests that nurses can contribute to reducing the prevalence and impacts of domestic abuse among women through providing cognitive behavior therapies. Such efforts are geared at enabling the victims of domestic abuse to lead their lives in a better manner [12].

Figure 1 shows that women's personalized knowledge has been on a gradual rise, meaning a little knowledge will help build confidence among women to their understanding and at the same time create room for them to get better in meaningful discussions.

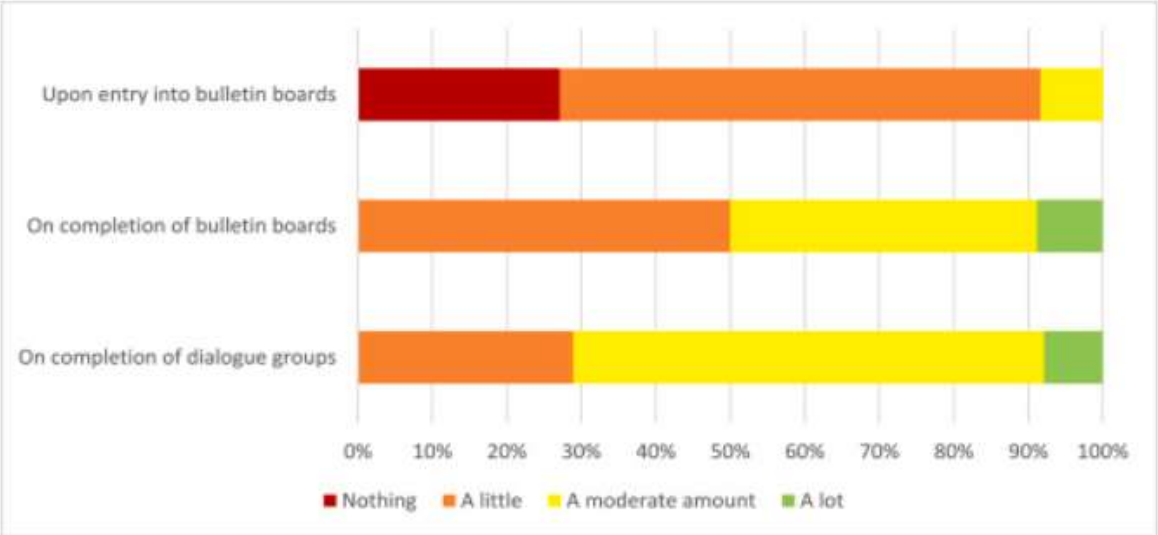

Figure 1: Questionnaire response: Awareness of artificial intelligence [19]

Ongoing research initiatives are targeted at finding more effective and meaningful ways in which technology can contribute to the reduction of domestic violence. For the time being, some review publications report on the use of technology for combating domestic violence. These publications take a sociological approach and place less emphasis on reviewing diverse engineering, information technology, and mathematics approaches [9]. [13] have analyzed the set of academic articles that were published from the year 2010 to 2020. These works targeted the detection of violence- both online as well as offline while also highlighting the usage of new methods that could be deployed to educate and ensure safety for preventing violent actions.

Some technology-based experimental family violence was observed and discussed by [14]. Their findings listed technology-related strategies to counter technology-driven family violence. They analyzed that the studied solutions were necessary, not sufficient, given their intrinsic limits. They concluded the need for developing human resources to support the victims of marital violence. [15] reviewed how technology might enhance the safety of women who have experienced domestic abuse. They also explored expert testimonies through a qualitative examination an apparatus that can warn ladies when they are in potentially hazardous situations. Their study has analyzed the potential of this solution, as well as the limitations and effects thereof in preventing intimate partner violence. A review of the literature on the technology used in detecting and mitigating domestic violence is relevant today, considering continuous developments in research and the creation of new technologies [9].

With the tremendous surge of data over the internet and in electronic health record systems, ML applications for detecting hidden changes and predicting the likelihood of DV from digital text data have been one of the hot topics in health science studies. However, few articles have discussed and reviewed the application of ML in DV research [16]. A growing number of smartphone apps are being developed to help protect users against the risks of domestic violence. Cell phone applications can be used as a means of defense and protection. For instance, in dangerous or violent situations, women can call and seek help from local friends, family, and organizations. This approach was more effective than the use of pepper spray [17]. This is a time of fast growth of technology, and any new work has to be evidence-based research while developing the subject of ML in DV.

However, to the best of our knowledge, recent reviews have only covered technology-based interventions for violence against children, mental health detection, and discussion of challenges and opportunities of ML in general healthcare. While applications of ML to the DV population have evolved over the last decade, there is a lack of evidence indicating the current state of science in ML applications in the DV field [16]. Thus, technical approaches may mitigate the psychological and emotional consequences of domestic abuse through the provision of treatment and assistance in the recovery of victims, support services, and safety plans. It may include providing refuge and counseling assistance to victims, or providing them with tools to address the very roots of domestic violence [9]. This adoption of AI systems in the management of resources, as indicated among the women especially the widows by [4], should be adequately addressed to capture critical ends like precision, automation, computational power, capacity, real-time, and cost effective, saving.

It involves establishing the advantages of AI adoption based on a collected questionnaire, by which it has considered and processed information on information technology employees in China, thereby proposing a new framework for this

particular analysis. The outcome from this research, therefore, provided that those such as accuracy, computational power, capacity, and personalization drive significantly towards cost reductions and saving of time while automating experiences real-time have little influence. In the same vein, for the effective use of AI by for women's right protection and widowhood practices, the same method could be adopted to achieve an effective monitoring of women that are vulnerable in society. Figure 2 shows the conceptual framework as deployed in the study [29].

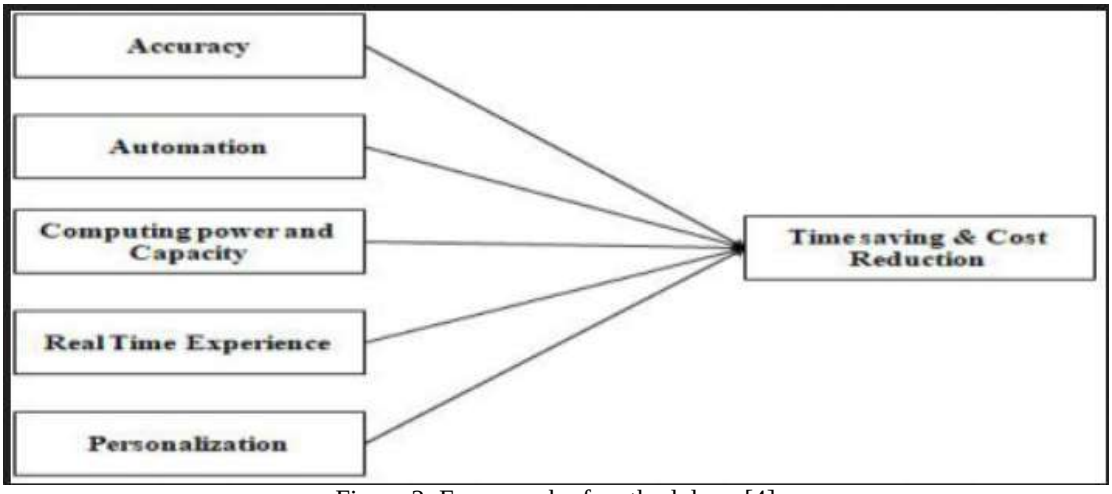

Figure 2: Framework of methodology [4]

Technological strategies can be used to enable domestic violence prevention and support networks that foster policy changes to address domestic abuse better, execute the laws and regulations of victim protection including reporting, reacting, restraining orders, and justice [9]. Further, we investigate the use of machine learning/artificial intelligence-based solutions in combating domestic violence and specifically its subtype-IPV. We call a digital technology a machine learning and artificial intelligence-based system that can perform intelligence demanding tasks by improving their task-specific performance through experience and learning over time [10].

A systematic online search was carried out to identify applications related to domestic violence, more precisely to preventing violence against women. In addition to "domestic violence," the following terms and phrases and related words are subject headings in library databases: Women's security, gender-based violence, intimate partner violence, family violence, wife abuse, battered women, partner abuse, violence against women, domestic abuse, and interpersonal violence [17]. Domestic violence is an area that might be benefited by using apps. Nowadays, mobile phones are one of the necessary devices and have become a very good means of communication; there are 6.567 billion users of smartphones, which is 82% of the global population of the worldwide population [31] [30]. Real-time data intelligence reveals that mobile connections are more than 10.57 billion worldwide, whereas the UN digital analyst estimates place it at 7.93 billion [17].

3. DISCUSSIONS

This study is particularly important because it addresses ethical and practical AI applications in the context of domestic violence [32]. Indeed, as the IMPROVE project (Improving Access to Services for Victims of Domestic Violence by Accelerating Change in Frontline Responder Organisations) has illustrated, there is an urgent need for the development of digital tools offering victims concrete support while avoiding the reinforcement of harmful social norms [10]. Applications of AI technologies, such as chatbots and predictive algorithms, have been increasingly integrated into systems for detection and prevention, but all too often without a critical gender lens. This omission underlines the need to ensure that technological innovations are aligned with feminist frameworks if they are not to collude inadvertently with patriarchal structures [11].

The latest technological developments create a unique opportunity to build innovative strategies that go beyond accepted practices. For example, artificial intelligence can be used to develop prediction models that recognize risk factors and initiate early interventions. Similarly, campus security can be improved by deploying real-time monitoring and alarm IoT-powered devices. Therefore, cloud and mobile computing can ensure easily accessible incident reporting and support-request platforms at ease, avoiding making a victim lonely and therefore helping them with support in the best way possible on time [18]. Domestic violence, being a highly complex problem itself, requires essential detailed review based on theoretical justification, practical solution, methods and approach for subsequent research in that area [10].

It is also imperative that technology be utilized to raise public awareness of domestic violence by highlighting available resources and support systems, identifying warning signs of abuse [33], and putting strategies into place to address the root causes and risk factors of domestic violence, such as encouraging gender equality, healthy relationships, and conflict resolution [9]. Various machine learning techniques have been utilized to deal with the immense amount of text provided by social media platforms and analyze it systematically in order to identify trends. Machine learning is a technique for learning from data patterns and predicting results using that learning [34]. ML research has accelerated in radiology,

cardiology, and oncology throughout the last ten years. Machine learning algorithms have been used in early detection, diagnosis prediction, prognosis evaluation, and therapy along the spectrum of health research. They have been applied to a range of health data, including clinical notes, patient narratives, social media data, and patients' free-text responses to questionnaires for improving outcomes, deeper understanding of patients' psychological conditions, and to develop supportive management strategies [16].

Together, such state-of-the-art technologies are approaching violence against women at schools in a way that is more proactive and data-driven than conventional methods allow for [18]. It enables clinicians and researchers to better understand how machine learning can be applied in the domain, what data sources are available, what results have been assessed, and what difficulties have more often been faced by conducting an integrated evaluation of ML applications in the DV domain [37]. This will help the researchers and clinicians in the design of future ML applications by enhancing their understanding of existing data sources and challenges facing ML applications, yielding therapeutic and policy consequences [16]. Moreover, apart from responding to active incidents of domestic violence by dispatching emergency services, providing victims with counseling, and facilitating legal interventions, technological tools can identify emerging cases of domestic violence in real time, such as recognizing patterns of abuse and threats [38].

Various research works have applied AI and ML techniques to detect potentially offensive or damaging online content against women. In these studies, the researchers applied ML algorithms on images, videos, text, or a combination of these to classify them as violent or non-abusive against women automatically [39]. Several artificial intelligence (AI) methods that can be used to evaluate online interactions and data to spot patterns of abusive behaviour were studied, including computer vision (CV), large language models (LLMs), natural language processing (NLP), and machine learning (ML) algorithms [18].

Among the long list of AI algorithms, some literature contributions compare various conventional machine learning classifiers, such as Support Vector Machine (SVM), k-Nearest, usefulness of Decision Trees, Naive Bayes, and Neighbours (KNN) for the classification of internet messages related to domestic abuse. The SVM has shown a general lead over other conventional machine learning classifiers in the classification of online information about domestic abuse [19]. Deep learning is an advanced version of machine learning that involves the use of a neural network with several layers. Deep learning algorithms, like CNN and RNN, can learn directly from raw data such as online posts [40-44]. Various models developed under deep learning have achieved super performance in recent years in fields such as image analysis, natural language processing, and many more. Figure **3** below show the classification of domestic violence-related posts using a deep learner and the two major classes of models tried in deep learning for classification, taking raw data from the content of social media, are CNN and RNN [44].

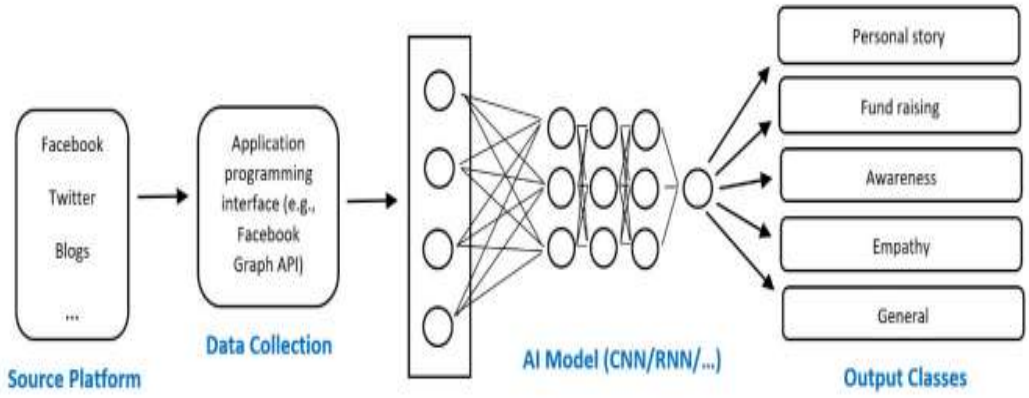

Figure 3: Classification of domestic violence-related posts using a deep learner [9]

Victims of domestic abuse have increasingly used online communities and virtual spaces-such as social media-to call for support and assistance [45]. They utilized a means to connect through emotional expressiveness, indirect and direct posts in asking for assistance, and in-depth narrative. In general, these posts come in the form of text, audio, and video [46]. Thus, survivors may use these posts to connect with individuals who can potentially provide support and empathy. Work by [20] outlines the design process involved in creating chatbots to support victims of domestic abuse with much emphasis on the incorporation of empathy, security, privacy, and provision of useful information along with emotional support. Such tools, when well-designed to meet victims' needs and ensure their safety, have the potential to significantly reduce barriers to accessing support services and to encourage victims to disclose abuse. Safety should be the guiding principle in the development of such tools. Ensuring that interactions are acceptable and sensitive requires careful planning of conversational flows [47]. One of the key roles that involve thoughtful consideration and cooperation on the part of multi-agents, including the victims themselves, is advising those being abused on how to reach safety [11].

4. CONCLUSION

These AI-powered online detection systems have several benefits, such as the capacity to analyze and evaluate enormous amounts of data, give real-time monitoring, and lessen dependency on biased or emotionally unstable human moderators. These tools can assist victims, facilitate quick reactions, and help create safer online spaces for women and children by automatically recognizing harmful content and behaviour. However, there are additional issues with accuracy, privacy, and ethics when using AI for internet detection. It will become more difficult to balance proactive detection with the protection of individual rights as these technologies advance and are used.

AI-powered predictive analytics has the potential to revolutionize the identification of domestic violence risk factors across cultures. By addressing methodological, cultural, and ethical challenges, stakeholders can leverage these technologies to enhance prevention strategies and support systems. A collaborative, culturally sensitive approach will ensure that AI-driven solutions contribute to a safer, more equitable society.

Future studies should concentrate on creating predictive Artificial Intelligence solutions that are more automated, inclusive, and morally acceptable to close these gaps in detecting recent risk factors. It is crucial to promote interdisciplinary cooperation and make sure that technological solutions are easily used, accessible, and considerate of ethical and privacy issues. A safer and just society for families can eventually be achieved by using Artificial Intelligence to develop creative, long-lasting, and efficient solutions that support international efforts to end violence against women and girls.

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