ORIGINAL ARTICLE

Virtual triage reporting of mental health symptoms in Europe prior to and following the 2022 Russian invasion of Ukraine

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ABSTRACT

Objective: Compare the reporting of 16 mental health symptoms (MHS) through AI-based virtual triage (VT) in three European countries/language user groups, including Ukrainians, Poles, and Italians, before and following the onset of the Russian invasion of Ukraine in February 2022.
Methods: Frequencies of 16 MHS reported through VT were compared for 12 months prior to and after the onset of the 2022 Russia-Ukraine conflict (i.e., February 24, 2021 to February 23, 2022 pre-war and from February 24, 2022 through February 23, 2023 post-war, respectively). Italian patient-users served as a quasi-control group relative to Ukrainian and Polish language users, given the lower perception of national risk from Russian military aggression.
Results: In 93,877 VT encounters, at least one MHS was reported. MHS reporting among Ukrainians and Poles increased 11.6% and 3.7%, respectively, after the first onset of the conflict (p<.05). Italian MHS reporting decreased 1.6%. Among Ukrainians, MHS reporting increased for 10 of 16 symptoms, the largest being suicidal thoughts/intent (158.7%), sleep disorder (45.7%), insomnia (32.9%), and irritability (20.7%) (all p<.05). Among Poles, reporting increased for 10 symptoms, including sleep disorder (52.2%), fear of dying (27.9%), insomnia (25.3%), and suicidal thoughts/intent (13.6%) (all p<.05).
Conclusions: Individuals in nations more directly exposed to and potentially impacted by the war reported higher levels of MHS to AI-based automated VT. Virtual triage offers a new vehicle for enhancing detection of MHS, and for potentially accelerating referral to in-person or virtual/telemedical mental healthcare services among displaced populations needing care in conflict areas.

Key Words: Virtual clinical triage/care referral, Symptom checker, Wartime mental health symptom reporting, Russia-Ukraine invasion/war/conflict, War refugees/displaced persons

1. INTRODUCTION

In February of 2022, Russia engaged a major invasion of Ukraine, increasing the already elevated post-COVID-19 reporting of mental health related symptoms, including anxiety and depression.[1,2] The invasion produced the largest movement of displaced persons in Europe since the Second World War. Retrospective population meta-analyses from Eastern and Western Europe, USA, South America and China

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confirmed elevated levels of psychological distress/stress, depression, anxiety and post-traumatic stress disorder during the first two years of the pandemic.[3–5] The onset of the Russian-Ukraine conflict further increased demand for mental healthcare among Ukrainians,[6,7] with 97.8% reporting a mental health challenge, including anxiety, depression, stress and/or trauma-related symptoms affecting those exposed directly to military action or forced to leave Ukraine.[8,9]

In one comparative study, Ukrainians demonstrated significantly higher levels of depression, anxiety and stress than Polish and Taiwanese individuals.[10] Interestingly, the Taiwanese studied, who are threatened by potential armed conflict with China, showed levels of post-traumatic stress comparable to Ukrainians.[10] The war has negatively impacted the mental health of populations across Central Europe. Poles reported fear of war and refugee influx along with higher levels of distress,[11] and young adults in the Czech Republic reported moderate to severe levels of anxiety (34.0%) and depression (40.7%), respectively.[12]

To determine the degree to which the Russia-Ukraine conflict has impacted the mental health of Ukrainians, this analysis compares mental health symptom (MHS) reporting to a free online virtual triage (VT) and care referral engine before and after the onset of the Russian-Ukrainian war among three different language users in Europe - Ukrainians, Poles and Italians. Research evaluating the sensitivity of AI-based VT in detecting MHS and providing care referral during such a disruptive crisis is sparse. Understanding patterns of MHS reporting can help optimize VT and telemedical care delivery systems for future conflicts or other large-scale emergencies that disrupt healthcare delivery and sense of well-being. The present study addresses this gap by examining the ability of VT to detect MHS during the war, and can help inform the development of accessible and scalable mental health screening tools for crisis settings. Additionally, the research question sought to determine if geographic proximity to the war produced different levels of MHS reporting that VT could detect.

2. METHODS

2.1 Study objectives

The objective of this study was to compare the reporting of 16 MHS in three different countries/language groups in Europe, including Ukrainian, Polish, and Italian language speakers, before and after the onset of the February 24, 2022 Russian invasion. MHS reporting in three VT patient-user languages was used as a proxy for national identity to assess for differences in mental health impact of the war on the population of each nation.

2.2 Study design

Reporting for 16 MHS to a free online VT and care referral engine were analyzed during one-year pre- and post-invasion periods, and stratified by patient-user demographics, including age, gender, and language of use. Differences were evaluated for statistical significance at p<.05. The VT engine utilized does not capture the geographic location of the patient-user to protect patient privacy/confidentiality, so the language of the VT encounter was used as a reasonable proxy for possible national location.

The selection of the user languages of Ukrainian, Polish and Italian was intended to evaluate a spectrum of potential mental health impacts from the Russian-Ukrainian war. Ukrainian language users were thought to have likely experienced the most severe direct impact from the conflict. Since February 24, 2022, 18.8 million Ukrainian citizens have entered Poland, 1.8 million of whom have registered for temporary protection.[13] Poles could have been impacted directly by the large influx of Ukrainian refugees to Poland (in excess of two million individuals), but also could experience stress produced by war in a neighboring country. In the case of Russian victory and occupation of Ukraine, Poland is a North Atlantic Treaty Organization (NATO) member that might encounter Russian aggression. Thus, a moderate effect was anticipated on MHS reporting among Polish language users. Italian language users were included as a quasi-control proxy for a European nation not directly impacted by the conflict or at risk of becoming a frontline NATO state sharing a border with Russia or Russian occupied territory.

2.3 Setting and description of intervention/VT engine utilized

The Infermedica Symptomate VT engine is designed for free general public online use, and completes evidence-driven analyses informed by over 800 diseases, 1,500 symptoms, and 200 risk factors in 24 languages. Leveraging AI, machine learning and natural language processing, VT evaluates symptoms reported by patient-users, suggesting the most probable conditions matching the presentation and history, and refers to the most clinically appropriate and safest possible care. The technology identifies potential somatic or MHS that warrant further professional evaluation. There are no prescribed interview pathways, and in light of additional information reported, the VT AI explores various clinical queries and hypotheses (as physicians do). Prior to VT, patient-users are asked about their care intention. The VT interview concludes with an analysis of the reported symptoms and a recommendation to pursue one of four levels of care acuity: self-care, consult a primary care or specialist physician on an outpatient basis, proceed to an ED or call an

ambulance for ED transport. Over 21 million Symptomate encounters have been completed since 2012.

2.4 Sample selection and eligibility criteria

The sample constituted all VT patient-users during a 12-month period before and following the February 24, 2022 Russian invasion of Ukraine (i.e., February 24, 2021 to February 23, 2022 pre-war and from February 24, 2022 through February 23, 2023 post-war, respectively). Only VT encounters or automated interviews completed in of the three languages of interest were included. Study participants met the following eligibility criteria: (1) encounters with at least one reported MHS; and (2) reporting incidence was equal to or greater than 1.0% of the total remaining sample size. This yielded a study sample size of N=93,887 encounters where MHS were reported during the 25-month study period.

2.5 Data captured and analyses completed

Analyses were performed on a dataset of eligible Symptomate users to assess if the levels of reported MHS differed statistically and meaningfully between the two time periods, one year before and following the Russian invasion of Ukraine beginning on February 24, 2022 (February 24, 2021 through February 23, 2023). Completed VT encounters were examined for reporting of one or more of 16 MHS, including: acute anxiety and/or general anxiety; nervousness or weepiness; insomnia and/or sleep disorder; agitation; irritability; stress-related gastric symptoms; suicidal thoughts and/or intent; fear of dying; feelings of hopelessness; episodes of depressed mood; anhedonia; loss of will to live; feelings of guilt; and low sense of self-worth.

Differences in demographic variables were assessed (gender, age and language of VT encounter completion). If statistically significant, a sampling weights method made demographic groups comparable using combinations of gender, age, language and study period, with all calculations performed on the modified sample. For each time interval, the aggregate number of encounters reporting each MHS was determined. Results were stratified by MHS and demographic variables to evaluate trends by patient-user group, including gender, age and language, and differences in symptom reporting during the two study time intervals were evaluated for statistical significance. Z-testing with a significance level of p<.01 was used to compare the pattern of MHS reporting for each time interval. Chi-squared testing with a significance level of p<.01 was performed to compare the distribution of age and gender combinations between the three languages. Data calculations, analyses and statistical tests were completed using Google Sheets (Online Spreadsheet Editor) and Google Colab (a cloud-based Python programming environment).

3. RESULTS

3.1 Overall demographics and VT utilization across all MHS symptoms

Supplemental Tables A and B present patient-user composition by demographic variables during the pre- and post-invasion onset periods. Statistically significant differences at p<.01 were observed in the distribution of age and gender combinations across the three languages.

As shown in Table 1, a total of 274,507 VT encounters, including both mental health and somatic symptom reporting, occurred over the entire study period, with Polish language users constituting three-fourths of total users, Italian language users 22.0% and Ukrainians 2.5% of the sample. Overall VT utilization rates decreased modestly in all language user groups after onset of the Russia-Ukraine conflict.

3.2 Overall MHS reporting

A total of 49,396 (53.7%) encounters across the three language groups reported MHS in the year prior to the onset of the 2022 conflict, and 44,480 (46.3%) encounters in the year following, as shown in Table 2. Substantial percentages of each patient-user language group reported MHS during both the pre- and post-invasion periods, with a low of 30.4% (Ukrainians pre-invasion) and a high of 35.2% (Poles post-invasion). Ukrainian patient-users had the largest increase in MHS reporting post-invasion onset (+11.6%, p<.05), then Poles (+3.7%, p<.05), with no difference among Italians. Overall MHS reporting decreased post-invasion by 5.2% for all population groups.

3.3 Specific MHS reporting prior to and following Russian invasion

Table 3 presents MHS reporting changes before and after onset of the Russian invasion. For Ukrainians and Poles, increases in MHS reporting occurred in 10 of 16 symptoms evaluated (62.5%). Largest Ukrainian increases were for suicidal thoughts/intent (158.7%), sleep disorder (45.7%), insomnia (32.9%), and irritability (20.7%) (see Table 3). For Polish patient-users, largest increases were for sleep disorder (52.2%), fear of dying (27.9%), insomnia (25.3%), and irritability (16.0%) (all p<.05). Differences in Italian MHS reporting were not statistically significant.

Table 1. Pre- and post-invasion somatic and MHS reporting by patient-user language

Language	Pre-invasion Symptom Reporting*	Post-invasion Symptom Reporting*	Total Encounters
Ukrainian	3,680	3,224	6,904 (2.5%)
Polish	110,339	96,763	207,102 (75.4%)
Italian	32,232	28,269	60,501 (22.0%)
Total	146,251 (53.7%)	128,256 (46.3%)	274,507 (100.0%)

Note. *The pre-invasion interval was February 24, 2021 to February 23, 2022 and the post-invasion interval was from February 24, 2022 through February 23, 2023.

Table 2. Pre- and post-invasion MHS reporting by patient-user language

Patient-User Language	Pre-invasion MHS Reporting*	Post-invasion MHS Reporting*	Change in MHS Reporting
Ukrainian	1,117 (30.4%)	1,092 (33.9%)	+ 11.6% (p<.05)
Polish	37,423 (33.9%)	34,018 (35.2%)	+ 3.7% (p<.05)
Italian	10,856 (33.7%)	9,370 (33.1%)	- 1.6% (p>.05)
Total	49,396	44,480	93,876

Note. *The pre-invasion interval was February 24, 2021 to February 23, 2022 and the post-invasion interval was from February 24, 2022 to February 23, 2023.

Table 3. Post-invasion changes in MHS reporting by language

Mental Health Symptom	Ukrainian Post-invasion MHS Reporting*	Polish Post-invasion MHS Reporting*	Italian Post-invasion MHS Reporting*
Agitation	- 10.4%	- 5.3% (p<.05)	+ 7.6%
Anhedonia	+ 15.8%	+ 9.2% (p<.05)	+ 3.1%
Anxiety	+ 10.6%	- 2.4%	- 8.2%
Episodes of depressed mood	+ 5.8%	+ 7.4% (p<.05)	- 7.7%
Fear of dying	+ 17.7%	+ 27.9% (p<.05)	+ 13.3%
Feelings of guilt	- 38.2%	+ 9.9%	- 1.7%
Feelings of hopelessness	+ 16.3%	- 13.7% (p<.05)	- 34.3%
Gastric symptoms, stress-related	- 6.3%	- 12.4% (p<.05)	- 6.7%
General anxiety	- 12.1%	+ 2.4%	- 2.8%
Insomnia	+ 32.9%	+ 25.3%	- 1.2%
Irritability	+ 20.1%	+ 16.0% (p<.05)	+ 1.1%
Loss of will to live	- 0.5%	- 8.1%	+ 7.6%
Low sense of self-worth	+ 20.9%	- 0.8%	- 8.3%
Nervousness or weepiness	- 0.1%	+ 10.8% (p<.05)	- 11.3%
Sleep disorder	+ 45.7%	+ 52.2% (p<.05)	+ 9.5%
Suicidal thoughts/intent	+ 158.7%	+ 13.6%	+ 21.3%

Note. *The post-invasion interval was from February 24, 2022 to February 23, 2023.

3.4 Mental health symptom reporting stratified by patient-user demographic characteristics

3.4.1 *Ukrainian language users by gender*

Among Ukrainians, differences in overall MHS reporting between genders by period were not statistically significant, but women more often reported irritability, nervousness or weepiness, and men more often reported anxiety, general anxiety, and fear of dying (p<.05).

3.4.2 *Ukrainian language users by age*

Before the conflict, users under 45 reported anxiety more often. Those ages 75+ in the post-invasion period more frequently reported agitation, insomnia, and sleep disorder than other age groups (all statistically significant at p<.05).

3.4.3 *Polish language users by gender*

MHS reporting was greater for women in both study periods. In the pre-invasion period Polish women more frequently reported anxiety, irritability, sleep disorder, nervousness or weepiness, insomnia, episodes of depressed mood, anhedonia, feeling of hopelessness, loss of will to live, low sense of self-worth, and suicidal thoughts/intent. Men more often reported general anxiety, fear of dying, gastric stress symptoms, and agitation. Post-invasion Polish women more often reported irritability, sleep disorder, nervousness or weepiness, insomnia, suicidal thoughts/intent, episodes of depressed mood, anhedonia, feeling of hopelessness, loss of will to live, feeling of guilt, low sense of self-worth. Men more often reported general anxiety, fear of dying, gastric stress symptoms and agitation.

3.4.4 *Polish language users by age*

Pre-invasion Poles 18-59 years reported anxiety more often and those 75+ reported agitation more often than other age groups. Post-invasion those 18-59 more often reported anxiety (with 18-29 year olds more often reporting sleep disorder), and those 75+ reported agitation more often than other age groups (p<.05).

3.4.5 *Italian language users*

As Italian MHS reporting did not differ across time intervals, demographic differences in this group were not evaluated.

4. DISCUSSION

VT use following the start of the Russian-Ukraine war confirmed that Ukrainians experienced the greatest increase in mental health problems following the invasion of Ukraine (+11.6% across 10 MHS), likely resulting from the impact of the war on their nation, families and friends. In addition to those living in the war zone or as refugees in nearby Poland, Ukrainian diaspora may experience stress and concern about Ukraine's survival and future. This was, as expected, followed by Poles (+3.7% in MHS reporting across 11 symptoms), confirming prior research on conflict-related mental health incidence in Eastern/Central Europe.[6–11] Among Poles other factors likely contributed to increased MHS reporting, including an overlapping economic recession, and distress/tensions around an important 2023 parliamentary election where the nation decided if it would be led by liberal democratic or autocratic parties. There was no impact on Italian language users (-1.6% in MHS reporting). Most elevated among Ukrainians were reports of suicidal thoughts/intent (+158.7%) and sleep disturbances (sleep disorder +45.7%; insomnia +32.9%). Ukrainians reported increased feelings of hopelessness and anxiety after the war began.

Research has demonstrated that VT can not only early detect serious illness, but favorably impacts patient-user care intent and acuity level appropriate healthcare seeking behavior.[14, 15] Decreased availability/accessibility of in-person mental healthcare services among war impacted and displaced populations in or near conflict areas, and resultant increased demand is an opportunity for VT to enhance symptom detection and referral for virtual/telemedical mental healthcare. These findings support an important potential role for VT in improving healthcare for war victims and displaced refugees, including future climate refugees. Given that wars increase demand for somatic and mental healthcare, VT combined with virtual/telemedical care delivery offer a means to cost-effectively increase availability of appropriate healthcare services when existing capabilities are either overwhelmed or interrupted.

A study limitation is the small sample of Ukrainian-speaking patient-users, to be expanded in future studies. Another is lack of national identity and location of patient-users, with language employed as a proxy for probable nationality. Location data is not collected to ensure patient-user confidentiality and anonymity. While defensible for relatively homogenous nations (like Poland and Italy), in Ukraine only 58% speak exclusively Ukrainian at home, 19%-30% speak Russian and Ukrainian, and 11% only Russian.[16, 17] Ukraine's population is diverse, with 130 different nationalities and ethnic groups present in the last 20 years, and 8.3 million identifying as ethnic Russians (21.9%) in 2023.[18, 19] Geographic locating is needed to also differentiate the large Ukrainian, Polish and Italian global diaspora. The analysis is limited as well by inability to ascertain whether reported VT encounters were unique individuals versus repeat visits by the same individual.

5. CONCLUSIONS

VT somatic and MHS reporting among Ukrainians and Poles increased substantially following the Russian invasion of Ukraine. Ukrainian language users reported increases in MHS at 3.1 times the level of Polish language users, while MHS reporting declined among Italian language users. VT effectively screened and provided care referral for patient-users presenting with MHS during the first year of the invasion. Virtual triage offers a valuable additional vehicle to surveil and detect MHS, and to potentially accelerate care referral for patients needing care, including those experiencing a direct or indirect impact of wartime conflict.

AUTHORS CONTRIBUTIONS

GAG conceptualized the study and hypotheses. All authors were involved with design of the methods, completing and interpreting analyses. AKK and MMG completed data anal-

yses and table generation. GAG wrote the first and subsequent manuscript drafts. All authors reviewed and edited manuscript drafts. GAG and GLG completed revisions. GLG led project and submission management.

FUNDING
No external funding supported this work.

CONFLICTS OF INTEREST DISCLOSURE
GAG and AN are medical advisors to Infermedica; AKK, TP and MMG are employees of Infermedica; and GLG is a contractor for Infermedica.

INFORMED CONSENT
VT patient-users provided consent for the use of their de-identified, anonymized data for analyses and reporting in the aggregate.

ETHICS APPROVAL
The Publication Ethics Committee of the Sciedu Press. The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

PROVENANCE AND PEER REVIEW
Not commissioned; externally double-blind peer reviewed.

DATA AVAILABILITY AND SHARING STATEMENT
The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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