

MACHINE LEARNING METHODS FOR THE PSYCHOLOGICAL DISTRESS (OR DEPRESSIVE AND ANXIETY SYMPTOMS) OF THE GREEK GENERAL POPULATION DURING THE COVID19 LOCKDOWN

Georgia Konstantopoulou¹, Theodoros Iliou², Katerina Karaivazoglou³, Konstantinos Assimakopoulos⁴, Panagiotis Alexopoulos⁵, George Anastassopoulos⁶

¹Department of Education and Social Work, School of Humanities and Social Sciences, University of Patras, Greece

²Department of Medicine, Democritus University of Thrace, Greece

^{3, 4, 5}Department of Psychiatry, University Hospital of Patras, Greece

⁶Department of Medicine, Democritus University of Thrace, Greece

Received: 27 August, 2021; Accepted :10 September,2021; Published :30 September, 2021

Copyright © 2021 Georgia Konstantopoulou et al. This is an open access article distributed under the Creative Commons Attribution 4.0 International (CC BY 4.0) license which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract: *The third wave of the pandemic due to COVID-19 promotes fear on a social level, but also on an individual level exacerbates anxiety and symptoms that look like depression and seems to lead to other mental issues (eg mood problems, sleep problems, phobia-like behaviors, panic-like symptoms). While most of us at this time may experience anxiety and "heavy" mood due to incarceration, in a significant portion of the world the condition has triggered serious psychological problems, with experts worried that these growing disorders will continue to exist and after the end of the pandemic. Research shows that machine learning techniques help significantly in tool development by helping physicians anticipate mental disorders and support patient care. Early detection and treatment can help any patient in the early stages of any disease. In this work we carried out stress and depression prediction using seven Machine Learning algorithms achieving 100% correct prediction with Multilayer Perceptron classifier.*

Keywords- : machine learning, COVID-19, psychological distress, anxiety, depression, lock-down, Hospital anxiety and depression scale (HADS)

I. INTRODUCTION

According to the World Health Organization, fear, anxiety, intense insecurity and increased stress are normal reactions to various types of "threats", as well as in cases where we are faced with the "unknown". In this case, we were faced with an emerging disease, which experts have not yet fully understood, but also with a home confinement, which seems to be endless, without currently knowing exactly when it will occur its coveted ending [1].

The high transmissibility of COVID-19 and the lack of effective prevention and treatment have greatly troubled scientists. The pandemic seems to be causing a global crisis. The third wave of the pandemic surprises experts and governments as it came quickly and with greater intensity than expected in our country. In addition to the morbid effects of the virus, especially on vulnerable populations, including the elderly, patients with immunosuppressed and chronic diseases, there has been a great deal of public debate about the direct and indirect effects of the pandemic on people's psychological health and quality of life [2-3]. Research in a wide range of national conditions has shown that during the first wave of the pandemic a large percentage of individuals experienced strong

reactions to stress and increased levels of anxiety and depression symptoms [4-7]. According to a recent review [3], COVID19-related psychological reactions may include uncontrollable fear, diffuse anxiety, frustration, boredom, and activation of loneliness and are related to the quality of life attenuation that can lead to an increased prevalence of anxiety, post-traumatic stress and depressive disorders.

According to the CDC (US Centers for Disease Control and Prevention), increased stress can cause [8]:

- Phobias, anger, numbness, depression.
- Problems with food, energy, activities.
- Difficulty concentrating and making decisions.
- Difficulty sleeping.
- Physical problems such as headaches, physical aches, stomach upsets and skin problems.
- Exacerbation of chronic diseases.
- Exacerbation of pre-existing psychological problems.
- Increased consumption of alcohol and substances, but also increased smoking

A study conducted by the Psychiatric Clinic of the University Hospital of Patras, and examined the mental footprint of the general population in Greece showed that a significant

percentage of the population had clinically significant anxiety and depressive symptoms, while a significant percentage suffered from clinically significant PTSD-related symptoms with COVID-19 during exclusion measures. The vast majority of participants observed protection measures during the lockdown period and considered COVID-19 a serious, threatening, worrying situation with a high probability of transmission, especially without the application of protective measures. In addition, stress levels were closely linked to female gender, educational level, and increased perception of severity and concern about COVID-19. Levels of depression were correlated with educational level, marital status and increased perceived severity of personal status in case of COVID-19 infection. The diagnosis of anxiety disorders is very complicated and hard work. Therefore, we must be careful about the diagnosis them with high precision. Machine learning and data mining techniques can be used to analyze the patient's history for diagnosis the problem, helping to copy human reasoning or smuggling reasonable decisions [10]. Many researched have been conducted focus on posttraumatic stress, anxiety and depression using some ILIOU and PCA Machine Learning preprocessing methods as in order to enhance classification techniques for psychosomatic symptoms prediction (i.e., depression, anxiety) [11-13]. In research during prior virus outbreaks has examined vulnerability factors associated with increased anxiety and fear and Shrinkage machine learning algorithms performed best, indicating that stress and rumination were the most important variables in modeling COVID-19-related anxiety severity. Health anxiety was the most potent predictor of perceived threat of death from COVID-19 [14].

The shifting directions of the COVID-19 widespread in different nations provide a chance to examine the distinct impact of 'macro-level' environmental elements and 'micro-level' psychological variables on anxiety and perceived health. In response to the COVID-19 pandemic, we examine indicators of anxiety and perceived health using machine learning approaches as lockdown constraints. COVID-19 pandemics were introduced in Austria, Spain, Poland, and the Czech Republic in reaction to the COVID-19 pandemic. Over the course of seven weeks, 533 individuals completed weekly self-report surveys that assessed the goal variables of subjective fear of the virus and perceived health, as well as potential predictors such as psychological factors, social factors, Perceived Vulnerability to Disease (PVD), and financial situations. As potential environmental variables, viral propagation, death, and government actions were also considered. Our models were able to accurately predict fear of the virus (accounting for approximately 23% of the variance) using predictive factors such as concern about food shortages and perceived vulnerability to disease (PVD), but environmental factors such as virus spread and governmental restrictions did not contribute to this prediction. Furthermore, our findings demonstrated that, with smaller impact sizes, perceived health could be predicted using PVD, physical exercise, attachment anxiety, and age as input parameters. Our findings highlight the importance of 'micro-level' psychological factors, rather than 'macro-level' environmental factors, in predicting fear and perceived health, and provide a starting point for further research into the effects of pathogen threat and governmental restrictions on fear and health

psychology [15]. During the COVID-19 epidemic, another study sought to uncover markers of psychological suffering. Participants (N = 2,787) gave demographic information, a history of adversity as a child, present coping techniques (implicit and explicit emotion regulation), and current psychological distress. The overall prevalence of clinical levels of anxiety, depression, and post-traumatic stress was higher than the rate reported among healthcare workers and survivors of severe acute respiratory syndrome outside of a pandemic, and it was higher than the rate reported among healthcare workers and survivors of severe acute respiratory syndrome. Across all measures of distress, younger participants (45 years), women, and non-binary people reported a higher prevalence of symptoms. The strongest predictors of distress were identified using a random forest machine learning technique. Individuals at higher risk for anxiety, depression, and post-traumatic stress were identified using regression trees. Greater distress was linked to somatization and a lower reliance on adaptive defensive mechanisms. These findings emphasize the need of assessing people's physical experiences of psychological distress and emotion control mechanisms in order for mental health clinicians to personalize assessments and treatment amid a global health crisis [16].

II. DATASET

An anonymous online survey was designed and conducted by the Department of Psychiatry of the University Hospital of Patras, in collaboration with the Special Office of Health Counseling Services and the Medical School of Democritus University of Thrace. The survey questionnaire was prepared online with Google Form, included multiple scales and was distributed through social media and a number of press releases. In this study we used the data set of 1200 participants from all over Greece who completed the Hospital Anxiety and Depression Scale (HADS) scale. The participants were people from 18 years old to 70+ and of different educational level, from all the Regions of Greece. The study was conducted from April 10 to May 4, 2020, a period during which the entire country was under strict lock-in measures in an attempt to control the transmission of viruses. The study protocol complied with the principles of the Helsinki Declaration and was approved by the Board of Directors of the University Hospital of Patras.

III. MATERIALS AND METHODS

Depressive and anxiety symptoms are the most common psychiatric manifestations, which complicate the treatment and prognosis of patients with physical illnesses. The HADS is a reliable, valid and practical tool for identifying anxiety and / or depression, as well as for quantifying them. Psychological functioning was evaluated by the validated Greek version of the HADS, which comprises seven items for anxiety and seven items for depression. The items on the questionnaire that relate to anxiety are:

- I feel tense or wound up
- I get a sort of frightened feeling as if something awful is about to happen
- Worrying thoughts go through my mind
- I can sit at ease and feel relaxed

- I get a sort of frightened feeling like 'butterflies' in the stomach
- I feel restless as I have to be on the move
- I get sudden feelings of panic

The items that relate to depression are:

- I still enjoy the things I used to enjoy
- I can laugh and see the funny side of things
- I feel cheerful
- I feel as if I am slowed down
- I have lost interest in my appearance
- I look forward with enjoyment to things
- I can enjoy a good book or radio or TV program

Each item is rated on a four-point scale (0–3) and each subscale is scored from 0 to 21 [15-16]. Higher scores indicate greater symptom severity. A number of researchers have explored HADS data to establish the cut-off points for caseness of anxiety or depression. A literature review of a large number of studies identified a cut-off point of 8/21 for anxiety or depression. In the Greek bibliography a cut-off score of 11 is used to detect clinically significant anxiety and depression symptoms, to identify individuals at a significant risk of suffering from an anxiety or depressive disorder, based on the instructions of the initial validation study. According to this cut-off score, subsyndromal anxiety or depression symptoms (HADS score 8–10) were not considered clinically significant. There are a large number of studies that have explored the underlying factor structure of the HADS. Many support the two-factor structure but there are others that suggest a three or four factor structure. Some argue that the tool is best used as a unidimensional measure of psychological distress. [17-18]. In the scale study [18], HADS was weighted in a sample of the Greek general hospital patient population, as well as in community controls.

Its psychometric properties are particularly good and significant internal and external reliability. Factor analysis of the scale revealed the existence of two factors, corresponding to anxiety and depression.

Thus, the scale can be considered evaluates these two parameters independently of each other. The findings of the present study show that the Greek translation of HADS is valid, reliable and easy to use. It can be an important tool in the hands of physicians of other specialties in the general hospital, helping them to better recognize anxiety and depression in their patients and thus seek the help of a psychiatrist in a timely manner [18].

IV. EXPERIMENTAL RESULTS

The experiments conducted using seven classification schemes (Table 1, 2): IBk (Nearest-neighbour classifier, k=3), J48 (C4.5 algorithm implementation), Random Forest, MLP (Multilayer Perceptron), FURIA (Fuzzy Unordered Rule Induction Algorithm, Naïve Bayes and HMM (Hidden Markov Models), respectively. In order to estimate the classification accuracy and achieve generalization of the classification results to an independent data set, we used the repeated 10-fold cross validation technique [19]. The experiments conducted using WEKA 3.8 data mining software [20] by their default WEKA parameters. We evaluated the performance of the classification schemes using Accuracy, Precision, Recall, Kappa statistics, Weighted Avg ROC area, F-Measure, True Positive Rate, False Positive Rate, Matthews correlation coefficient (MCC) and Root mean squared error metrics (Table 1, 2) [21-23].

As we can observe in Table 1 and 2, MLP classifier achieved to predict stress and depression 100% while HMM classifier had the worst classification performance. The rest classifiers can predict very well stress and prediction as well. According to table 1, 2 their classification performance was about 95-97%.

Table 1. Stress Classification Results

Classifiers	Correctly Classified Instances (%)	Pre	Rec	k	ROC	F-Measure	TP Rate	FP Rate	MCC	Root mean squared error
IBk(KNN=3)	96.35	0.96	0.96	0.92	0.99	0.96	0.96	0.03	0.92	0.15
J48	95.42	0.95	0.95	0.90	0.96	0.95	0.95	0.04	0.90	0.06
Ran For	96.52	0.96	0.96	0.92	0.99	0.96	0.96	0.03	0.93	0.14
MLP	100	1	1	1	1	1	1	0.00	1	0.00
FURIA	97.20	0.97	0.97	0.94	0.98	0.97	0.97	0.02	0.94	0.16
Naïve Bayes	96.52	0.96	0.96	0.92	0.99	0.96	0.96	0.03	0.93	0.16
HMM	44.45	0.44	0.44	0.00	0.5	0.61	0.44	0.44	0.01	0.5

Table 2. Depression Classification Results

Classifiers	Correctly Classified Instances (%)	Pre	Rec	k	ROC	F-Measure	TP Rate	FP Rate	MCC	Root mean squared error
IBk(KNN=3)	96.35	0.96	0.96	0.87	0.98	0.96	0.96	0.12	0.87	0.16
J48	95.08	0.95	0.95	0.83	0.92	0.95	0.95	0.13	0.83	0.21
Ran For	97.20	0.97	0.97	0.90	0.99	0.97	0.97	0.08	0.90	0.14
MLP	100	1	1	1	1	1	1	0.00	1	0.02
FURIA	95.00	0.94	0.95	0.83	0.95	0.94	0.95	0.15	0.83	0.19
Naïve Bayes	94.32	0.94	0.94	0.82	0.98	0.94	0.94	0.06	0.83	0.20
HMM	19.13	0.19	0.19	0.00	0.5	0.32	0.19	0.19	0.01	0.5

V. CONCLUSIONS

In this paper we focused on stress and depression prediction using Machine Learning algorithms. Our experimental results has shown that MLP algorithm significantly outperforms the rest algorithms classification performance. Moreover, table 1 and 2 reveals that MLP classifier is the most suitable for stress and depression prediction according to our dataset. In our point of view, Machine Learning algorithms can be used by physicians anticipate mental disorders and support patient care. Furthermore, early detection and treatment can help any patient in the early stages of any disease. The application of Machine Learning to mental health has demonstrated a range of benefits across the areas of diagnosis, treatment and support, research and clinical administration. With the majority of studies identified focusing on the detection and diagnosis of mental health conditions, it is evident that there is significant space for the application of Machine Learning to improve other areas of psychological functioning [24].

In future work, it would be preferable to make the same experiments in more datasets using more classifiers and some data reduction techniques.

REFERENCES

- [1] World Health Organization (WHO). WHO Official Updates – Coronavirus Disease, 2019. WHO, 2020 (www.who.int/emergencies/diseases/novel-coronavirus-2019).
- [2] Luo M, Guo L, Yu M, Jiang W, Wang H. The psychological and mental impact of coronavirus disease 2019 (COVID-19) on medical staff and general public – a systematic review and meta-analysis. *Psychiatry Res* 2020; 291: 113190.
- [3] Serafini G, Parmigiani B, Amerio A, Aguglia A, Sher L, Amore M. The psychological impact of COVID-19 on the mental health in the general population. *QJM* 2020; 113(8): 531–7.
- [4] Wang C, Pan R, Wan X, Tan Y, Xu L, Ho CS, et al. Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int J Environ Res Public Health* 2020; 17(5): 1729.
- [5] Varshney M, Parel JT, Raizada N, Sarin SK. Initial psychological impact of COVID-19 and its correlates in Indian community: an online (FEEL-COVID) survey. *PLoS One* 2020; 15(5): e0233874.
- [6] Rodríguez-Rey R, Garrido-Hernansaiz H, Collado S. Psychological impact of COVID-19 in Spain: early data report. *Psychol Trauma* 2020; 12(5): 550–2.
- [7] Rodríguez-Rey R, Garrido-Hernansaiz H, Collado S. Psychological impact of COVID-19 in Spain: early data report. *Psychol Trauma* 2020; 12(5): 550–2.
- [8] Le Shi et al, (2020) «Prevalence of and Risk Factors Associated With Mental Health Symptoms Among the General Population in China During the Coronavirus Disease 2019 Pandemic» *JAMA Network Open*. 2020;3(7):e2014053. doi:10.1001/jamanetworkopen.2020.14053
- [9] CDC 2021 Mental Health and Coping during COVID-19, Accessed 11/4/2021. <https://www.cdc.gov/coronavirus/2019-ncov/daily-life-coping/managing-stress-anxiety.html>
- [10] Katerina Karaivazoglou, Georgia Konstantopoulou, Maria Kalogeropoulou, Theodoros Iliou, Theofanis Vorvolakos, Konstantinos Assimakopoulos, Philippos Gourzis and Panagiotis Alexopoulos (2021) *BJPsych Open* 7, e59, 1–7. doi: 10.1192/bjo.2021.17
- [11] Pintelas et al, 2018 « A review of machine learning prediction methods for anxiety Disorders» *DSAI* 2018, June 20–22, 2018, Thessaloniki, Greece
- [12] Iliou T., Konstantopoulou G., Stephanakis I., Anastasopoulos K., Lymberopoulos D., Anastassopoulos G. (2018) Iliou Machine Learning Data Preprocessing Method for Stress Level Prediction. In: Iliadis L., Maglogiannis I., Plagianakos V. (eds) *Artificial Intelligence Applications and Innovations*. AIAI 2018. IFIP Advances in Information and Communication Technology, vol 519. Springer, Cham, https://doi.org/10.1007/978-3-319-92007-8_30.
- [13] Iliou et al 2019 «ILIOU Machine Learning Preprocessing Method for Depression Type Prediction» *Evolving Systems* (2019) 10:29–39 DOI 10.1007/s12530-017-9205-9
- [14] Konstantopoulou et al, 2020 “Detection of post-traumatic stress disorder (PTSD) symptoms associated with coronavirus disease 2019 (covid-19) in the student population”, *European Journal of Special Education Research*, ISSN: 2501-2428, 2020
- [15] Jon D Elhai et al, 2021 “Modeling anxiety and fear of COVID-19 using machine learning in a sample of Chinese adults: associations with psychopathology, sociodemographic, and exposure variables” *Mar*;34(2):130-144.doi: 10.1080/10615806.2021.1878158.
- [16] Stephanie Josephine Eder, et al, 2021 “Predicting fear and perceived health during the COVID-19 pandemic using machine learning: A cross-national longitudinal study” <https://doi.org/10.1371/journal.pone.0247997>
- [17] Tracy A Prout et al 2020, “Identifying Predictors of Psychological Distress During COVID-19: A Machine Learning Approach”, <https://doi.org/10.3389/fpsyg.2020.586202>
- [18] Zigmond AS, Snaith RP. The Hospital Anxiety and Depression Scale. *Acta Psychiatr Scand* 1983; 67(6): 361–70.
- [19] Michopoulos I, Douzenis A, Kalkavoura C, Christodoulou C, Michalopoulou P, Kalemi G, et al. Hospital Anxiety and Depression Scale (HADS): validation in a Greek general hospital sample. *Ann Gen Psychiatry* 2008; 7: 4.
- [20] R. Kohavi, "A study of cross-validation and bootstrap for accuracy estimation and model selection". Proceedings of the Fourteenth International Joint Conference on Artificial Intelligence, vol. 2, no. 12, 1995, pp. 1137–1143.

- [21] Waikato Environment for Knowledge Analysis, Data Mining Software in Java, available online: <http://www.cs.waikato.ac.nz/ml/index.html>, Accessed 19/5/2021.
- [22] Matthews, B. W. (1975). "Comparison of the predicted and observed secondary structure of T4 phage lysozyme". *Biochimica et Biophysica Acta (BBA) - Protein Structure*. 405 (2): 442–451. doi:10.1016/0005-2795(75)90109-9.
- [23] Lehmann, E. L.; Casella, George (1998). *Theory of Point Estimation* (2nd ed.). New York: Springer. ISBN 0-387-98502-6. MR 1639875.
- [24] Powers, David M W (2011). "[Evaluation: From Precision, Recall and F-Measure to ROC, Informedness, Markedness & Correlation](#)". *Journal of Machine Learning Technologies*.
- [25] Adrian B. R. Shatte et al (2019) "Machine learning in mental health: A systematic scoping review of methods and applications" *Psychological Medicine* 49(9):1-23