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The impact of online education due to COVID-19 outbreak as a cause of anxiety among university students in Northern Cyprus using cross-sectional survey: A data driven based approach

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Abstract

Introduction: Coronavirus disease (COVID-19) or severe acute respiratory syndrome is an infectious disease caused by a newly found coronavirus strain. SARS-CoV-2 coronavirus is a type of virus that causes respiratory illnesses in people. Online learning system was switched due to the COVID-19 and GAD-7 Scales were used to measure the correlation and impact of online education as a reason for anxiety among university students in Northern Cyprus.

Methods: The Generalized anxiety disorder (GAD-7) scale was used to assess anxiety level. An e-questionnaire was formed using google form and shared on social media. An online survey was done, it was participated by 209 students of universities in Northern Cyprus in which the data analysis was done using statistical package for social science (SPSS), MLR, ANN, and ANFIS.

Results: 209 participants 64.6% of the participants had minimal to mild anxiety and 34.6% had moderate to severe anxiety according to generalized anxiety disorder (GAD-7) scale. Almost all Students with medium economic status have minimal to mild anxiety levels. The obtained data driven approach performance results indicates the ability of the hybrid techniques over the single models in simulation of the anxiety level of the students based on the performance evaluation indices used in the current research

Conclusion: The COVID-19 Outbreak imposes a serious challenge to university students undergoing online classes in Northern Cyprus as majority of the students with medium income reported to had minimal to mild anxiety which require the attention of the concern authorities to provide a solution. The proposed hybrid techniques prove to have the necessary efficiency in boosting the performance of the single models towards anxiety level of the student's simulation.

Keywords: COVID-19; Online Education; Anxiety; Lockdown; Data driven approach

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1. Introduction

Coronavirus disease (COVID-19) also known as severe acute respiratory syndrome is an infectious disease caused by a newly found coronavirus strain. SARS-CoV-2 coronavirus is a type of virus that causes respiratory illnesses in people. [1]. The novel virus was discovered in Wuhan city, China in December 2019 and it ravaged the world at an alarming rate leading to a global pandemic [2]. The world health organization (WHO) strictly advised everyone to maintain a social distance of at least 1 meter (3 Feet), wear a mask, and wash hands with soap or use sanitizer o regularly in order to protect themselves and to limit the spread of the virus [3]

In Northern Cyprus, COVID-19 started on the 9th of March 2020 with patient zero, a female German tourist who arrived on the island on the 8th Of March 2020[4] she was identified after showing symptoms of high fever. After the identification of COVID-19 in Northern Cyprus, the government established strategic precaution measures including the closure of their air, land and sea borders. A curfew was implemented after the first case on 9th march to control the pandemic and apart from a few service sectors, all other businesses were closed such as entertainment places, shops, private sectors, schools, and universities, the situation has compelled universities and schools to switch their education curriculum to online education [4]. Since then, the educational programs and various scientific activities are being carried out using various online applications all over the world including Northern Cyprus.

Any sort of learning that takes place over the Internet is classified as online education. It's a sort of online learning that makes use of the Internet to make teacher-student interaction and the distribution of class materials easier. (5)

Anxiety is defined as "a sensation of tension accompanied by anxious thoughts and physical changes such as elevated blood pressure." Recurrent intrusive thoughts or concerns are a hallmark of anxiety disorders. Because they are concerned, they may avoid particular situations. Sweating, trembling, dizziness, or a quick heartbeat are all possible physical symptoms. (6) (7)(8)

With a questionnaire about individuals social and also their demographic status, as well as GAD-7 and PHQ-9 anxiety and depression questionnaires, a study intends to analyse anxiety and depression disorders among students of a medical faculty during the COVID-19 pandemic. The results show that students made up 97.98 percent of the 340 participants. GAD-7 scores averaged 9.18 (M = 9.18; SD = 4.75); PHQ-9 scores averaged 12.72 (M = 12.72; SD = 6.62). GAD-7 and females have a positive significant association, with social alienation influencing finances, according to the findings. With a cut-off score of 10 for GAD-7, 157 students (46.17 percent) were recognized as having anxiety symptoms that range from mild to severe

Another study done in France during the mandatory detention of Covid-19, university students experienced stress and worry. Shows While vital for public health, Covid-19 confinement tactics frequently contradict evidence-based treatments for mental illnesses. Although university students may be more sensitive to mental health issues, new research has found that confinement methods have a limited influence. A survey of university students conducted by World Mental Health in France included concerns about Covid-19 confinement. During confinement, the participants of the experienced increase in their anxiety as well as moderate to severe stress. Those among the participants who did not return to their parents' homes suffered inordinate. Knowledge of the negative impacts of confinement can be used to lessen their influence on vulnerable populations. (9)

Sheela Sundarassen et al. did a study to describe COVID-19 and lockout have had a psychological impact on Malaysian university students. Out of a total of 1054 replies received, 983 were deemed valid after data cleaning. According to Zung's Anxiety Index, 201 (20.4%), 65 (6.6%), and 28 (2.8%) of the 983 respondents in the sample had mild to moderate anxiety, moderate to severe anxiety, and acute anxiety, respectively.

A cross-sectional study looked at anxiety and concern of mental health during the COVID-19 outbreak in a group of university students in Italy. The data on concern, anxiety, and trait mindfulness were obtained prior to the COVID-19 outbreak. During the COVID-19 lockdown in Italy, dysfunctional personality domains, as well as negative affectivity and detachment, emotional disorders, and supernatural beliefs, were found to be meaningful risk factors for decreased emotional well-being. Twenty-five university students took part in the study, and they all completed a series of self-report questionnaires. The Penn State Worry Questionnaire (PSWQ) was used to differentiate between persons who worry a lot and people who worry a lot. The Anxiety Sensitivity Index (ASI-3) was also used to assess how concerned people are about the potential negative implications of anxiety symptoms. Finally, the Mindful Attention Awareness Scale (MAAS) was used in order to determine individual differences in daily mindful states, which are defined as the ability to pay attention to what is happening right now. As a result, high worriers made up 60% of the pre-lockdown

sample and 68 percent of the post-lockdown sample. During the pre-lockdown period, 53.3 percent of the males and 46.7 percent of the females were high worriers. Following the lockdown, the percentage of high worriers in the male group was 58.8% and 41.2 percent in the female group (20) When comparing males and females, it was discovered that following lockdown, the proportion of high anxieties increased in males (53.3 percent vs. 58.8%), but reduced in females (20)

Despite the importance of anxiety as major public health problems, there is no previous study dealing with the prevalence of anxiety and there is no any published scientific research available to understand the severity of the problem among population in Northern Cyprus. It's critical to examine university students' experiences in Northern Cyprus during the COVID-19 outbreak so that appropriate measures and interventions can be developed and implemented. This could assist to tackle the negative impacts of the pandemic as well as the stress produced by online education on the mental health and well-being of university students in Northern Cyprus as well as to better prepare for any future pandemic which we are not hoping for.

Thus, the study attempted to examine the prevalence of anxiety as a result of the impact of online education during COVID-19 outbreak among university students in Northern Cyprus.

Online courses have the following advantages: they are convenient, also flexible, bring education to our doorsteps, help you meet new people, provide real-world skills, promote lifelong learning, provide financial rewards, educate you self-discipline, and connect you to the global village.

Online courses have the following disadvantages: they take more time than on-campus classes, they make it easier to procrastinate, they require a very good time-management skills, they may create a sense of isolation and feeling of loneliness, they allow you to be more independent, they require you to be an active learner, they don't have an instructor hounding you to stay on task, they give you more freedom, perhaps more than you can handle, they require you to find your own path to learning, and they require you to be responsible for your learning (10)

In an attempt to curb the disease's spread, many governments have passed restrictive laws to reduce crowd gatherings and formations. Schools have also been impacted, with some having to reduce or cancel courses entirely. If school closures are prolonged for a protracted period of time, not only are educational possibilities lost, but also human capital and economic prospects are lost in the long run. To counteract the negative consequences of school closures, educators have been exploring new technologies such as online courses, video classes, and electronic textbooks to deliver education to children all over the world. As in Bangladeshi, Spanish, Italian, and Indonesian cases.

In Accordance to the World Health Organization, anxiety disorders are one of the most common mental disorders worldwide, with specific phobia, major depressive disorder, and social phobia being the most frequent anxiety disorders. When evaluating GAD, mental health specialists check for the following signs and symptoms: Anxiety and stress over a wide range of topics, events, or activities. It is apparent that worry is excessive when it occurs more often than not for at least six months. Anxiety is believed to be particularly difficult to manage. Adults and children's concerns can easily change from one topic to another. Anxiety and concern are accompanied by at least three of the physical or cognitive symptoms described below. (in children, only one of these symptoms is required for a GAD diagnosis): Anxiety or restlessness are two words that come to mind when describing edginess, I'm easily tired; I'm more tired than usual. Irritability, inability to concentrate or a feeling as if the mind is blank (which may or may not be observable to others), Muscle aches and pains, as well as sleeping issues (due to trouble falling asleep or staying asleep, restlessness at night, or unsatisfying sleep). A total of 2.2 percent of adolescents were estimated to have generalized anxiety disorder, with 0.9 percent having severe impairment. Females (3.0 percent) had a higher prevalence of generalized anxiety disorder than males (2.4 percent) (1.5 percent) (12–15). Finally, the study equally involves the implementation of both single and hybrid data driven techniques in predicting the anxiety level of the students.

2. Methods

2.1. Study site and duration

This study was conducted in the public health department of Near East University, Nicosia, Northern Cyprus and Faculty of Medicine Cyprus International University. The duration of the study was from September to October 2020. The data for the study was collected between 22nd September – 30 September 2020.

2.2. Study design and study population

A descriptive cross-sectional study design was used for this study. In this study, all students, regardless of program, registered to a university in Northern Cyprus were eligible to participate in the study.

2.3. Sample size calculation

According to the Higher Education Planning, Evaluation, Accreditation and Coordination Council (YODAK), which was created within the Ministry of Education of North Cyprus to supervise and organize the activities of newly created universities, as well as to issue new practitioners with licenses, over 101,000 students study at 16 universities, 14 of which are local and two of which are branches of Middle East Technical University in Ankara and Istanbul Technical University in Istanbul. 87 percent of students are international students from over 135 countries, 55 percent are Turkish Cypriot students, and 13 percent are local Turkish Cypriot students. The number of international students climbed by more than 35 times in the current academic year, from around 2,500 in the 2009-2010 school year. (11)

The sample size for this investigation was estimated with the OpenEpi sample size calculator. (<https://www.openepi.com/SampleSize/SSPropor.htm>) with Population size (for finite population correction factor or fpc) (N): 100001 students.

The true mean of the population was set at 95 percent of 100 (absolute +/- percent) (d)5 percent to contain the hypothesized percent frequency of outcome factor in the population with prevalence(p): 50 percent +/-5, Confidence limits were set at 95 percent of 100 (absolute +/- percent) (d)5 percent to contain the true mean of the population. and the Design effect for cluster surveys-DEFF: 1 to proper find the survey sample size Which gives us a sample size of 383 participants.

2.4. Sampling method

Convenient sampling method will be used in the study. The link for the online survey will be distributed through researchers' personnel Facebook pages and other social media websites including WhatsApp, Twitter and Instagram. Furthermore, snowball sampling method will be used to increase the number of the participants in the study.

2.5. Study tool

A structured questionnaire was developed through an intensive review of relevant literatures. The questionnaire consisted of five components. Starting with an introduction asking the participant for consent as well as whether they're a university student or not. A negatory answer would end the questionnaire and the participant won't be able to participate in the study

In the last components, standard scale was adopted to assess the level of anxiety among participants. The Generalized anxiety disorder (GAD-7) scale was used(12). Which was composed of 7 questions with four answering options of "Not at all sure", giving zero points, "Several days", giving one point, "More than half the days", giving two points and "Nearly every day", giving three points. The total points are then calculated to measure the severity of anxiety. Mild, moderate, and severe anxiety cut-offs were chosen at 5, 10, and 15, respectively. For generalized anxiety disorder, the GAD-7 has a sensitivity of 98 percent and a specificity of 82 percent.

The GAD-7 score is calculated by addition of the scores from each of the seven questions and assigning 0, 1, 2, or 3 to the response categories of "not at all," "a few days," "more than half the days," and "nearly every day," respectively. Mild, moderate, and severe anxiety have cut-off scores of 5, 10, and 15 points, respectively. A score of 10 or higher indicates that more inquiry is required when used as a screening tool. When utilizing a threshold score of 10, the GAD-7 has a sensitivity of 89 percent and a specificity of 82 percent for GAD. Panic disorder (sensitivity 74%, specificity 81%), social anxiety disorder (sensitivity 72%, specificity 80%), and post-traumatic stress disorder (sensitivity 66%, specificity 81%) are all quite well-screened disorders. (17).

2.6. Pre-test

Pretest was conducted to ensure the reliability of the questionnaire that the questions asked accurately reflect s to the information we required from the respondents. A total of 42 questionnaire were distributed among known students in which 20 was answered by English speaking students and 22 was answered by the Turkish speaking students. Majority of them reported to have answered the questionnaire in about 5-9 minutes.

After obtaining the result a modification was done to both the English and Turkish version of the questionnaire so that both questionnaires contain same format.

2.7. Ethical considerations

The study was done with the best possible ethical standards in mind, and the ethical committee at Near East University approved it with project number YDU/2020/83-1165.

All participants read and agreed to participate in the study after reading and understanding the permission form.

2.8. Data analysis

The data was evaluated using a social science statistical software (SPSS.) All variables were subjected to descriptive analysis. It offered us an understanding of how our data was distributed, assisted us in detecting outliers, and allowed us to identify relationships between variables, preparing us for additional statistical research.

We calculated and displayed mean, median, range, standard deviation, minimum and maximum values for continuous variables.

We made frequency tables for categorical variables. These methods offered us a notion of variable distributions and data entry issues.

2.9. Data driven approaches

2.9.1. Artificial Neural Network (ANN)

Artificial neural networks (ANNs) are computer systems that were created based on a computational study to duplicate or outperform how human brains handle and interpret data [17]. In this architecture, different neurons act as processing units, which are then linked together via customizable weights and biases. The input, hidden, and output layers of ANNs act as a single or multi-layered system [18]. The feed-forward network with backpropagation algorithms is used in this innovative study (FFNN-BP). Artificial neural networks, according to what we've learnt so far from the literature, are information-processing tools that are built and function like the brain's organic nervous system, and feature a neuron which is a basic component (node). ANNs with FFNN-BP have proven to be useful instruments for overcoming significantly non-linear processes in various fields of science and engineering due to their promising capabilities. (13).

FFNN-BP also includes training the network with trained input data, which is subsequently processed within the network and sent to the output layer, potentially resulting in errors propagating through the system until the desired output is produced. FFNN-main BP's claim is that it decreases the number of mistakes made by the network such that it can comprehend the training data and forecast the true value [20]. The initial weights are multiplied by the inputs, and the resulting value is passed to the second layer before being sent to the output layer. Equation 3 illustrates this. (14).

$$z_i = \sum_{j=1}^m w_{ij} x_{ij} \quad (1)$$

where w_{ij} is the weight transferred from the j th input to the i th node, x_{ij} is the input, and z_i is the consequent sum of the i th node's outputs. The difference between the predicted value and targeted values is calculated, backpropagation is utilized to determine the mistake. It's usually done backwards, starting with the output layer and working backwards to the input layer. The error node j in layer l is indicated by $(l)_j$, which shows the difference. Equation 4 expresses the error term for a training set (x_j, y_j) mathematically:

$$e_p = y_d - y_a \quad (2)$$

where y_d is the output of the neuron p and y_a is the training model's actual output?

The hidden layer has a large number of neurons., on the other hand, can influence the neural network's generalization ability and capacity, raising computational burden because lower neurons are unable to achieve the necessary prediction accuracy [21]. The learning process is ongoing, with biases and connection weights adjusted until the desired outcome is achieved. This procedure could either be supervised or unsupervised. The use of supervised learning to reduce the differences between computed and desired values is common. [22]. The learning rate is significant because it determines the network's intelligence by minimizing the probability of a local minimum by converging the network

structure. The trial and error technique use both the learning rate and the architecture, which includes the number of layers, transfer function, and neurons. The output layer uses the linear activation function, whereas the hidden and input layers employ the sigmoid activation function. The activation function of each neuron is a mathematical formula that transforms a linear function into a non-linear function. (15) (see Equation 5).

$$F(x) = \frac{1}{1+e^{(-x)}} \quad (3)$$

2.9.2 Adaptive-Neuro Fuzzy Inference System (ANFIS)

Adaptive neuro-fuzzy inference system (ANFIS) is a data-intelligence method that employs neural networks' learning capacity with fuzzy logic. Because of its capacity to estimate real functions, ANFIS is used as a real-world estimator [24]. Tsumoto, Sugeno, and Mamdani are the three forms of ANFIS, with the Sugeno system having the most uses [25]. The fuzzy database system's two most important components are the fuzzyer and defuzzifier. Fuzzy logic is the use of membership functions to convert input data into fuzzy values. The numbers range from 0 to 1 and are in ascending order. Nodes act as membership functions (MFs) and can also be used to model input-output interactions. Triangular, sigmoid, Gaussian, and trapezoidal membership functions are among the functions available. (Elkiran and colleagues, 2019) (16).

Assume the FIS contains two inputs 'x' and 'y' and one output 'f', a first-order Sugeno fuzzy has the following rules.

$$\text{Rule 1: if } \mu(x) \text{ is } A_1 \text{ and } \mu(y) \text{ is } B_1 \text{ then } f_1 = p_1x + q_1y + r_1 \quad (4)$$

$$\text{Rule 2: if } \mu(x) \text{ is } A_2 \text{ and } \mu(y) \text{ is } B_2 \text{ then } f_2 = p_2x + q_2y + r_2 \quad (5)$$

A_1, B_1, A_2, B_2 Parameters are membership functions for x and y inputs

$p_1, q_1, r_1, p_2, q_2, r_2$, Are parameters for the output function The ANFIS structure and formulation is based on a five-layer neural network architecture? For further details about ANFIS, see [9].

2.9.2. Multi-Linear Regression (MLR)

In general, linear regression is divided based on the aim of the prediction, into two categories: multiple and basic linear regression [27]. For example, simple linear regression is used to estimate the linear correlation between a single predictor and a single criterion variable (SLR). The model is referred to as Multiple Linear Regression if the goal is to forecast the linear correlation that exists between more than one predictor while still using a single criterion variable. [28, 29] (MLR). Multilinear regression (MLR) is the most popular sort of linear regression used in analysis, in which each value from the independent variables is related to the value of the dependent variable. MLR is a statistical method for determining the degree of correlation between a single response variable (the dependent variable) and two or more predictors (the independent variables). [29]-[30]. Equation 7 depicts the entire expression of MLR.

$$y = b_0 + b_1x_1 + b_2x_2 + \dots + b_ix_i \quad (6)$$

Where x_1 , is the value of the i^{th} predictor, b_0 is the regression constant, and b_i is the coefficient of the i^{th} predictor.

2.9.3. Model validation

The purpose of data-driven models is to fit the model to the given data using the same indicators that were utilized to create an accurate prediction on an unknown data set. [32]. Because of overfitting issues, satisfactory training performance does not always match testing performance. Cross-validation (also known as k-fold cross-validation), holdout, leave one out, and other validation procedures can all be employed in the validation process. The holdout technique is a simplified variant of the k-fold approach, in which the data is separated into two sets at random, referred to as the training and testing phases. One of the primary advantages of the k fold cross validation approach is that the validation and training sets are independent in each round. [33-40]. this results in a performance goal, which provides a solid framework for model optimization. Using the 4-fold cross-validation approach, the acquired data is divided into two samples, 70 percent for training and 30 percent for testing. Other methods of validating and segmenting the data could also be used.

2.9.4. Model performance criteria

The performance accuracy of any data-driven strategy is assessed using a set of criteria based on a comparison of expected and measured outcomes. The models were assessed using the determination coefficient (R^2) as a goodness-of-fit criterion and one statistical error, the mean-squared error (MSE), in this study [40-45]:

$$R^2 = 1 - \frac{\sum_{j=1}^N [(Y)_{obs,j} - (Y)_{com,j}]^2}{\sum_{j=1}^N [(Y)_{obs,j} - (\bar{Y})_{obs,j}]^2} \dots\dots\dots (7)$$

$$MSE = \frac{1}{N} \sum_{i=1}^N (Y_{obsi} - Y_{comi})^2 \quad (8)$$

3. Results

3.1. Statistical approach

Table 1 Distribution of the participants according to gender (N=209)

Sociodemographic Feature	n	%
Gender (n 209)		
Male	111	53.1
Female	95	45.5
Others	3	1.4
Total	209	100.0

Among all participants, 53.1% were males and 45.5% were females (Table 1).

Table 2 Distribution of the participants based on their economic status and source of financial support for study and living (N=209)

	n	%
Economic status		
High	22	10.5
Medium	158	75.6
Low	29	13.9
Total	209	100.0
Study and living support		
Scholarship	42	20.1
Family	133	63.6
Self sponsored	12	5.7
Combination of any of the above	21	10.0
Other	1	0.5
Total	209	100.0

The majority (75.6%) of the participants reported to have medium economic status follows by those who reported to have low and high economic status as 13.9% and 10.5% respectively. In terms of the study and living support, 63.6% of them stated that supported by their family, and 20.1% of them were having a scholarship (Table 2).

Table 3 Distribution of the participants according to the mental status before and during COVID-19 (N=209)

	n	%
Mental health before COVID-19		
Excellent	38	18.2
Very good	88	42.1
Good	58	27.8
Poor	14	6.7
Fair	11	5.2
Total	209	100.0
Mental health during COVID-19		
I feel the same	73	34.9
Become worse	124	59.3
Become better	12	5.8
Total	209	100.0

As seen in Table 3, the mental health among participants before COVID-19 were very good (42.1%), good (27.8%), excellent (18.2%) whereas during COVID-19, 59.3% of the participants were feeling worse and 34.9% were feeling the same.

Table 4 Distribution of the participants according to their smoking status (N=209)

	n	%
Smoking status		
No, never	110	52.6
Only tried	27	12.9
Was a smoker, but not any more	12	5.7
Yes, I currently smoke everyday	31	14.8
Smoke one cigarette a day	6	3.0
Social smoker	23	11.0
Total	209	100.0

Table 4 illustrates the smoking and alcohol status among participants. Among all, 52.6% of them were non-smokers and 14.8% were daily smokers.

Most of the participants (88.0%) were students in Near East University, (4.8%) were in Cyprus International University and (7.2%) were in other universities. Majority of the participants (69.8%) were studying medicine, 9.3% of them studying engineering, and 20.9% of them were studying in other faculties (Table 5).

Table 6 presents distribution of participants for online education in which 93.3% were studying online during Covid 19.

As seen in table 7 General anxiety disorder the participants displays (64/6%) reported to have minimal to mild anxiety and 35.4 shows moderate to severe anxiety

Table 5 Distribution of participants according to their university, faculty and program (N=209)

	n	%
University		
NEU	184	88.0
CIU	10	4.8
GAU	4	1.9
EMU	8	3.8
EUL	1	.5
BAU	1	.5
KSTU	1	.5
Total	209	100.0
Faculty and programmed (n=172)		
Medicine	120	69.8
Dentistry	3	1.7
Pharmacy	9	5.2
Engineering	16	9.3
Nursing	7	4.1
Economics	5	2.9
Law	2	1.2
Others	10	5.8
Total	172	100.0

Table 6 Distribution of participants' online education during COVID-19 (N=209)

Online education during COVID-19		
Yes	195	93.3
No	14	6.7
Total	209	100.0

Table 7 Distribution based on the participants' scores on general anxiety disorder-7/anxiety (N=209)

Anxiety level	n	%
Minimal to mild anxiety	135	64.6
Moderate to severe anxiety	74	35.4

135(64.6%) participants are reported to have minimal to mild anxiety and 74 participants (35.4%) have moderate to severe anxiety.

A statistically significant difference has been found between Anxiety level and economic status. Almost all participants were medium economic status had minimal to mild anxiety. ($P < 0.05$).

Table 9 show p value was statistically significant between study and living support and Anxiety level. The participants who had family study and living support and who had support by scholarship were minimal to mild anxiety. Otherwise

who had study and living support from combination of all of (family, scholarship and self-sponsored) had moderate to severe anxiety ($p < 0.05$).

Table 8 Relationship between Economic status and Anxiety level. (N=209)

Economic status	Anxiety level						P Value
	Minimal to mild anxiety		Moderate to severe anxiety		Total		
	N	%	n	%	n	%	
High	20	90.9%	2	9.1%	22	10.5%	
Medium	98	62.0%	60	38.0%	158	75.6%	0.02
Low	17	58.6%	12	58.6%	29	13.9%	
Total	135	64.6%	74	35.4%	209	100.0%	

Table 9 Relationship between study and living support and Anxiety level. (N=209)

Study and living support	Anxiety level						P value
	Minimal to mild anxiety		Moderate to severe anxiety		Total		
	N	%	n	%	n	%	
Scholarship	36	85.7%	6	14.3%	42	20.1%	0.003
Family	81	60.9%	52	39.1%	133	63.6%	
Self-sponsored	9	75.0%	3	25.0%	12	5.7%	
Combination of the any mentioned (Scholarship, Family Support or Self Sponsored)	9	42.9%	12	57.1%	21	10.0%	
Other	0	0.0%	1	100.0%	1	0.5%	
Total	135	64.6%	74	35.4%	209	100.0%	

3.2. The Data driven approach

In this study three various data driven approaches were used that involve MLR, ANN and ANFIS in the first scenario. The second scenario involve the use of hybrid model in order to increase the performance skills of the single models. Before starting the simulation process, correlation and descriptive statistics were conducted in order to have an idea about the data as shown in 10 below.

Table 10 The correlation and statistical analysis of the current study

Variables	gender	ES	SLS	SS	FP	ODC	AL
gender	1.00						
ES	-0.01	1.00					
SLS	0.13	0.13	1.00				
SS	0.01	0.06	0.06	1.00			
FP	0.06	0.16	0.27	-0.03	1.00		
ODC	-0.10	-0.02	0.05	-0.01	0.05	1.00	
AL	0.14	0.15	0.22	0.26	-0.13	-0.04	1.00
Variables	gender	ES	SLS	SS	FP	ODC	AL
Mean	1.48	2.03	2.07	2.35	2.28	1.07	1.35

Median	1.00	2.00	2.00	1.00	1.00	1.00	1.00
Mode	1.00	2.00	2.00	1.00	1.00	1.00	1.00
Standard Deviation	0.53	0.49	0.84	1.76	2.16	0.25	0.48
Kurtosis	-1.23	1.14	1.26	-0.47	1.31	10.27	-1.64
Skewness	0.36	0.08	1.10	0.98	1.58	3.49	0.61
Minimum	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Maximum	3.00	3.00	5.00	6.00	8.00	2.00	2.00

ES: Economical status, SLS: Study and living support, SS: Smoking status, FP: Faculty and program, ODC: Online education during COVID19, AL: anxiety level

Six different variables were considered as the predictors against anxiety level (AL), which is considered to be the dependent variable. Based on the correlation analysis depicted in Table 10, there is only weak negative and positive correlation between the independent variables and the dependent variable.

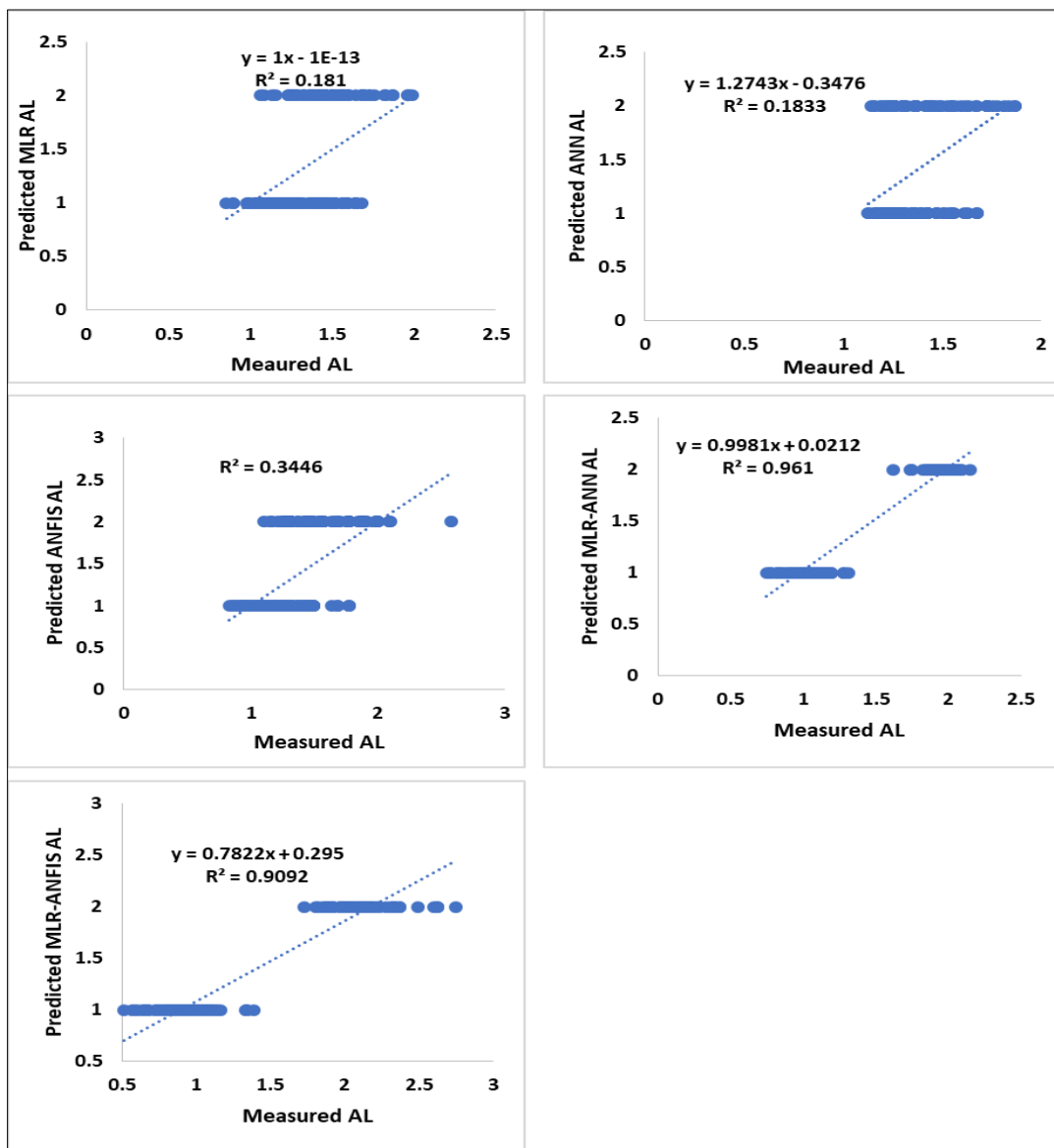


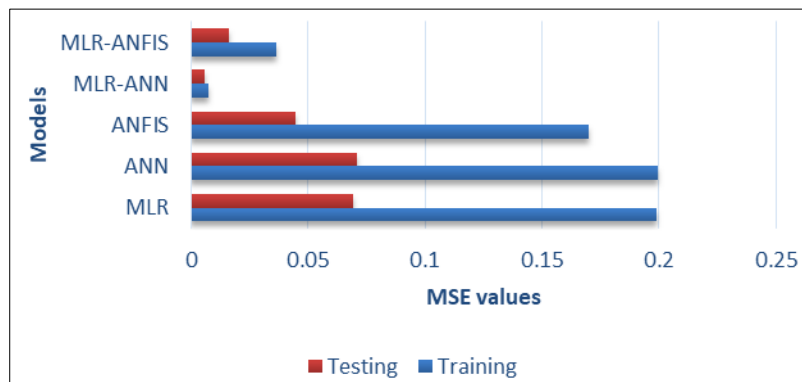
Figure 1 The performance of both the single and hybrid techniques

Table 11 Performance of the models

	Training		Testing	
	R ²	MSE	R ²	MSE
MLR	0.169502	0.198858	0.152852	0.06926
ANN	0.16609	0.199675	0.131746	0.070986
ANFIS	0.290714	0.169835	0.452607	0.044753
MLR-ANN	0.969732	0.007248	0.926249	0.00603
MLR-ANFIS	0.848198	0.036348	0.809857	0.016468

According to Table 11, it can be observed that all the three single models; MLR, ANN and ANFIS showed weak performance in both the training and testing phases. Furthermore, the hybrid technique was proposed in order to boost and enhance the performance of the single models. As demonstrated in Table 11 above both MLR-ANN and MLR-ANFIS were successfully able to capture the measured values with a determination co-efficient value higher than 0.8 in both the training and testing phases. Moreover, the performance of both the single hybrid models can be compared graphically using the scatter plot.

Moreover, the comparative performance of the models can equally be compared based on their error performance as shown Figure 2, which is in line with the findings shown in Table 11.

**Figure 2** Error performance of both the single and hybrid techniques

Based on the error performance depicted by the models in Figure, the models performance can be arranged into; MLR-ANN > MLR-ANFIS > ANFIS > ANN > MLR because the lower the MSE-values the higher the model performance and vice versa. Therefore, this indicates the robustness of the hybrid technique over the single models as it has the ability of modelling and predicting both the linear and non-linear features of the dataset.

4. Discussion

This cross sectional, questionnaire-based study showed how COVID-19 pandemic in Northern Cyprus had changed and forced the university students to make many adjustments in order to assure the safety of all and continuing the academic year in a proper manner, as best as possible. The data collected in this study covered many such as health condition, activity, economic status, sleeping habits, ability to concentrate, living condition, and many more, mainly focusing on the effect of lockdown on student's education and their mental health when it comes to anxiety wise. Social distancing and limitation of public and economic activities showed direct impact to the financial capability and resilience in multiple countries including studies here in Northern Cyprus. Even though many studies have stated that the using of technology, with its mobility and personalized benefits, helped lecturers promoting innovation in education, not just limited to the improvement of lecture-style teaching, but also through more humanistic approach in direct open discussion and a more controlled systematic information collection as shown in a study made in Indonesia (17). Our study results showed that out of 209 participant's shows 64.6% of participants had minimal to mild anxiety while 34.6% had moderate to severe anxiety in accordance with the generalized anxiety disorder – 7 (GAD-7) scale. In comparison with another study from Spain results show that, regarding the initial psychological responses of the members of the

University of Valladolid from March 28 to April 4, 2020, two weeks after the lockdown of the Spanish population due to the COVID-19 pandemic, 34.19% of participants reported moderate to extremely severe depression symptoms; 21.34% of participants re-reported moderate to extremely severe anxiety symptoms; and 28.14% reported moderate to extremely severe stress symptoms (18). One of the disadvantages of this study as most other studies is the lack of anxiety test results before lockdown which seems to be a critical factor as a study conducted in Italy with pre-lockdown available results showed indeed a significant correlation between the mental health of students and the pandemic and its lockdown effects by using completed self-report measures assessing worry (Penn State Worry Questionnaire, PSWQ), anxiety (Anxiety Sensitivity Index, ASI-3) but this study was as well limited due to the lack of sufficient participants as only Twenty-five students were able to participate since they had pre-lockdown available results (19).

5. Conclusion

In this study a total of 209 students from different universities in Northern Cyprus participated. The study aimed to measure anxiety level of students due to lockdown and struggles faced in online education measure by using GAD-7 for anxiety. Surprisingly the results showed that out of 209 participants shows 64.6% of participants had minimal to mild anxiety while 34.6% had moderate to severe anxiety in accordance with the generalized anxiety disorder - 7 (GAD-7) scale. The study also showed that there was no significant correlation between age, apartment type, medical condition and depression, anxiety levels during lockdown which a positive result during the outbreak, however almost all students with medium economic status and lower showed minimal to mild anxiety levels based on the GAD-7.

Other important results to shed light on were as follows: 31.1% of them having trouble falling or staying asleep, or sleeping too much for several days and 24.9% have trouble falling or staying asleep, or sleeping too much nearly every day. We can conclude from these results that even though the negative impact of the pandemic and lockdown on students wasn't as severe as seen in other studies and countries, it's worth noting still that students are affected and in need of attention and emotional support in order to prevent further complications of their mental health due to difficulties faced during lockdown.

The obtained data driven approach performance results indicates the ability of the hybrid techniques over the single models in simulation of the anxiety level of the students based on the performance evaluation indices used in the current research.

Limitation

There were limitations in our study as we didn't get the desired sample size which supposed to be 381 to represent the entire population of the university students in Northern Cyprus but only 222 students participate with 13 missing data giving us a total of 209 participate fully answered the questionnaire correctly.

Compliance with ethical standards

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Disclosure of conflict of interest

There are no conflicts of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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