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IoT and E-learning with the Impact of COVID 19 Pandemic Lockdown on the Undergraduate University Student Blood Pressure Levels

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Abstract

Since December 2019, Millions of people around the world suffer from the effects of hypertension due to COVID 19 pandemic and all the stressed caused by this new virus. Around 40-50% of people worldwide can be assumed to have some form of hypertension especially after the pandemic lockdown. However, the advancement of using the new technologies, IoT and the E-learning during this lockdown period can support the education performance of the university students and continue their study without spreading the virus due to the direct contact with infected patients. This paper will study and compare the factors that contribute to hypertension which are caused by changes in systolic and diastolic blood pressure during this lockdown period. many students were surveyed and their blood pressures (BP)were monitored using automatic devices. The BP of undergraduate students during the lockdown period were identified as having higher systolic and diastolic readings however the results reflected no direct causation between stress and blood pressure, and rather were representative of the factors which will be studied further in this paper. The readings are compared with the definitions of hypertension according to the American Heart Association (AHA). A thorough understanding of the factors is important in the field of Internet of medical things (IoMT) medicine and therapy to help patients suffering from hypertension and to monitor this situation.

Keywords

COVID 19, E-learning, hypertension, blood pressure, IoT, IoMT

1. Introduction and Literature Review

Globally, all of us around the world open our eyes on nightmare called coronavirus COVID-19 in December 2019 which was originate in China, Wuhan [1–8]. The raped increased of COVID 19 make it a pandemic within few months [6–7], Studies on the 31st August 2020 reported that the number of cases and deaths by COVID 19 is 850,673 deaths and 25.3 million cases and it even goes higher to 2,619,767 deaths and 118,094,348115 cases on 10th March 2021 [6-7]. In terms of education and in order to continue the life during this hard period the E-learning during the COVID 19 pandemic

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lockdown period can support the education performance of the university students and continue the study without spreading the virus due to the direct contact with infected patients [2, 3, 4, 9, 10, 11, 12].

[13] They proposed IoT-based method uses an Arduino Uno-based system, Then the results achieved IoT smart application to saving humans live thru COVID-19 pandemic.

Blood creates a force on the blood vessel walls, which is known as blood pressure (BP). The correct measurement of hypertension commences with the true measurement of elevated BP [14]. The range of high BP among students during COVID 19 pandemic period is given as diastolic pressure greater than 90 mmHg while systolic greater than 140 mmHg. According to worldwide reports, approximately half of the 17 million human deaths reported yearly are due to heard diseases and high blood pressures seem to play a main role in these [15]. The most alarming diseases such as strokes, kidney failures, heart failures and narrowing of arteries are due to an increase in the BP above 140/90 mmHg. It is hence very important to supervise the issue of hypertension to overcome such deadly diseases. The number of patients of high BP are increasing by 60% approximately and it is expected that increased hypertension issues will affect around 1.6 billion individuals by 2025 [16].

The heart pumps the blood to the body at a known systolic reading of 140 mm Hg. Whereas, when the heart relaxes and replenishes itself with blood, the diastolic reading is around 90 mmHg [5]. The American Heart Association (AHA) explains the following ranges of blood pressure (in mmHg), as shown in Table 1:

Table 1

A guide to different levels of Blood Pressures in a human body

	Systolic	**Diastolic**
Normal Blood Pressure	120	80
Pre-Hypertension	Between 120 and 139	Between 80 and 89
Stage 1 Hypertension	Between 140 and 159	Between 90 and 99
Stage 2 Hypertension	160	100
Hypertensive Crisis	180	110

It is not easy to control high BP as there are many obstacles in controlling hypertension. Firstly, the development of hypertension is indirect and undefined. Awareness before failure is usually a big challenge. Secondly, it is common that patients tend to not follow the doctor's advices and thus their careless behaviours in adopting healthy lifestyles and lack of punctuality in consuming the right medicines is a huge danger. Therefore, the risk factors change, and anti-hypersensitive therapies are usually recommended [17 – 18].

Thirdly, the treatments received by the high BP patients remains unreliable. Hence, a low range of less than 130/80 mmHg is considered as a standard for recommendation to patients suffering from increased CVDs or diabetes instead of the normal less than 140/80 mmHg range [19]. Even then, uncertainty cannot be avoided in decreasing BP ranges [20].

Furthermore, there is a change in BP at different timings of the day. For instance, BP tends to increase at the time when a person is awakening from a deep sleep and decreases during sleep. BP also varies due to changes in behaviour and it is normal for an individual to have high BP for short periods in a day, often as a response to several circumstances occurring in one's life. Stress and heavy exercise lifestyles can also result in a rise in the BP of a strong and fit individual as well. In such a situation, it is preferred several illustrations of checks performed at different timings before the declaration of hypertension in an individual.

2. Risk Factors

There are several risk factors associated to increased blood pressures in humans. For instance, age is one of such risk factors. Age above 60 years is a common cause for increased BP. This is usual as arteries are firmer and tend to become narrow at this age because of the development of plague in the relevant passages. Even a person's ethnicity has a huge role in developing BP as some cultural groups are more susceptible to hypertension, depending on their surrounding influences. Obesity is one of the

main risk factors and overweight individuals tend to suffer more by increased BPs. In terms of the genders, these also play a key role. While both, men and women have the same lifetime risk, males are more likely to develop hypertension from a young age. Whereas, for women, this occurs at much older ages. Existing health conditions such as the presence of CVDs or other chronic diseases may also be a representative of developing hypertension, especially with growing ages [21].

Additionally, the use of alcohol, smoking tobacco and the adoption of unhealthy lifestyles also plays a vital role in developing hypertension. Other reasons include idleness and lack of exercise and physical activities. It is also known that increased BP is more common in people using processed foods, junk foods and foods with high input of salts. Family history also plays a chief role in the development of hypertension, which is unintentional. Even the use of certain medicines can lead to such issues. Vasoconstricting hormones are produced by the nervous systems, which can increase BP, and under increased stress levels, which are due to elevated BP levels, one can have hypertension. It is well known that the main factors for stress are employment issues and the stress incurred during an employment, social and cultural pressures and family tensions. BP rates are multiplied when stress factors join with risk factors [21].

Hypertension can be classified as primary, secondary and silent killer. Any other diseases do not affect primary BP. It depends upon blood plasma volume and hormone secretion can change blood volume along with the blood pressure [22]. Environmental reasons also regulate BP due to stress and inactivity [23]. Secondary hypertension happens due to other conditions. For instance, these include diabetes occurring because of kidney issues and nerve damages, other kidney diseases, cancers and disorders of adrenal glands, over activity of thyroid glands, imbalances in calcium and phosphorous levels along with the occurrence of pregnancy in females, obesity and sleep issues [24].

Silent killer is often referred to the type of hypertension in a person, which is mainly unnoticed, or the symptoms are undetected. It can cause damages to the cardiovascular system and various vital organs in the body [25]. Long term hypertension is responsible for issues occurring through atherosclerosis [26], which can result in heart problems such as heart attacks and failures. Aneurysm may also take place due to long term hypertension, which is mainly an irregular bulge in a wall of the artery [27]. Such a burst can lead to serious bleeding and probably deaths in some circumstances. In addition, it can also result in kidney failures, amputation and hypertensive retinopathies [28] leading to loss of sight.

To avoid the serious problems arising from high BP levels, it is important to regulate BP levels by testing each individual. It is worth mentioning that hypertension tends to be a permanent disorder, which deserves to be treated. Hence, for an optimal regulation, a lasting binding is needed to the current and future lifestyle patterns while making any necessary modifications. Also, continuous psychotherapies along with awareness can assist in overcoming increased BP issues as well as reducing several CVD risk factors.

Since youngsters are more prone to developing harmful diseases due to several reasons, and since it is extremely important that youngsters are also monitored for their current blood pressure levels, this study was aimed on estimating and comparing the Systolic and Diastolic Blood Pressure levels for students before and after corona virus. One of the main motivations behind this study was to analyse the effects of different educational types on the students' BP levels as well and to comprehend the students' health conditions.

Section 1 provides a brief background on hypertension and the associated increased blood pressure levels. It then introduces the scope of the current study performed. Section 2 provides the research methodology adopted in this study whereas section 3 provides the results and the useful discussion of such results relevant to the current study. The main conclusions drawn from this research are provided in section 4.

3. Methodology

A prospective cross-sectional study was conducted over the period before and after COVID 19 pandemic. For this study, 335 students who fulfilled the inclusion criteria were enrolled. Each student was provided a detailed questionnaire survey asking important questions relevant to their health and lifestyle patterns. All of the data collected from these surveys is included in

this study. Some questions in the questionnaire included: recent measurement value of blood pressure, date of birth, sex, ethnicity, weight, height, whether the student was consuming any antihypertensive drugs, presence of diabetes, smoking status, whether the student had any heart attacks or strokes, consumption of alcohol and preference of arm for measuring blood pressure.

The students were then directed to blood pressure measurements where the participating students were asked to sit appropriately in a proper manner. Three readings were then taken of these students and the relevant mean was calculated of the three readings taken. It was also ensured that the participants had not smoked in the last 15 minutes. In addition, to prevent any influence of other factors, it was also made sure that the students did not communicate to anyone during this time and the patients were not in any type of anxiety.

All BP measurements were performed with properly calibrated automatic pressure measurement devices. These measurements were taken in the morning in suitable surrounding conditions and the readings were based on the JNC 8 Guidelines. The students considered for this study had to pass the inclusion criteria, as mentioned previously. This inclusion criteria involved students having a normal body weight and age above 18 years for both colleges investigated. Whereas, the exclusion criteria for this study involved the following factors: any history of hypertension, obesity, secondary causes of hypertension and the presence of any chronic medical therapies such as NSAID or steroid along with anti-hypertensive drugs.

For the statistical analysis, the statistical assessment was achieved using the SPSS package, Version 20. The unpaired t-test was used when comparing the mean values between groups. A significance level of P values less than 0.05 was selected.

Internet of Medical Things- (IoMT) based health monitoring systems are attention on staying healthy by knowing your body mass index (BMI) immensely among students from the students during COVID 19 and before COVID 19. This study presents an IoMT-based system that is a real-time health monitoring system utilizing the measured heart rate, systolic and diastolic blood pressure and blood pressure for the students.

Figure 1; shows the flow chart of the IoMT. When the statistical analysis (BMI, heart rate, blood pressure and blood temperature) is measured for each student, it starts measuring values, determined levels and sends it to the main controller then comparing receiving the measured value to prevention programs and strengthening protective factors. The IoMT will displays health rate and sends an alert to both the doctor and the student patient.

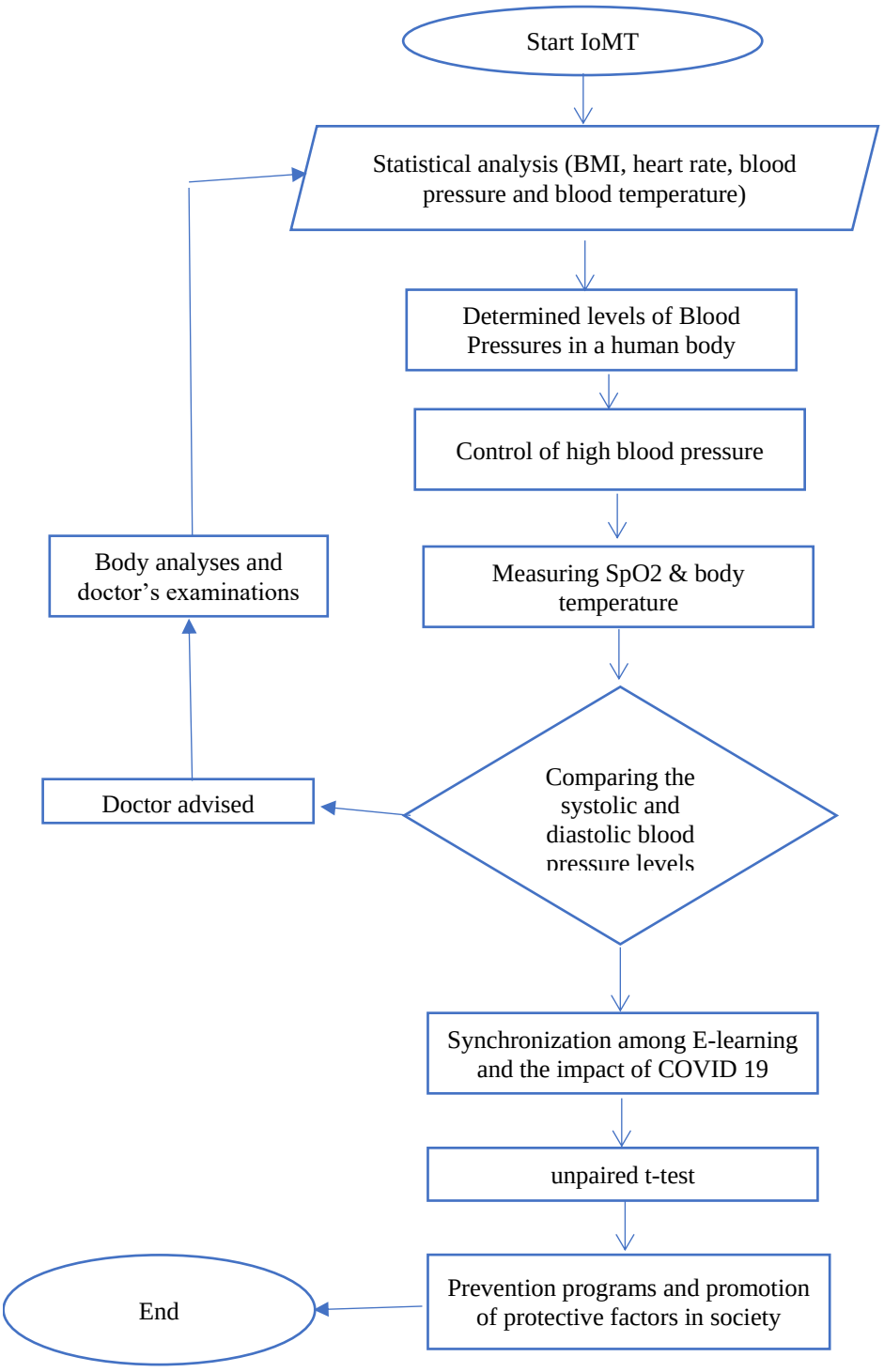

Figure 1: Flow chart of IoMT application system

4. Results

The total number of students in this work were 335. Amongst the students, there are 26 (19.5%) smokers, 107 (80.5%) non-smokers; as shown in table 2.

Table 2
Demographic distribution of students in the Colleges of Arts and Medicines

		Groups					
		Before COVID		After COVID		Total	
		N	%	N	%	N	%
gender	Female	47	49.0%	73	54.9%	120	52.4%
	Male	49	51.0%	60	45.1%	109	47.6%
	Total	96	100.0%	133	100.0%	229	100.0%
ethnicity	Arabic	94	97.9%	128	96.2%	222	96.9%
	Kurdish	2	2.1%	5	3.8%	7	3.1%
smoking	Smoker	36	37.5%	26	19.5%	62	27.1%
	Non-smoker	60	62.5%	107	80.5%	167	72.9%
alcohol	Never or rarely	90	93.8%	133	100.0%	223	97.4%
	One a week	4	4.2%	0	0.0%	4	1.7%
	Regular	2	2.1%	0	0.0%	2	0.9%
arm	Right	47	49.0%	62	46.6%	109	47.6%
	Left	49	51.0%	71	53.4%	120	52.4%

The mean of the systolic BP in the students associated to the College of Medicine was 121.8, while the mean of the diastolic BP in these students was 79.6. The Heart Rate (HR) was 99.8 and the BMI was 22.4. On the contrary, the students from the College of Arts had a mean of systolic BP as 120.23. For them, the mean diastolic BP was 75.4, HR was 91.9 and BMI was 22.4. Hence, there was no statistical significance between the students from the two types of colleges. Table 3 details the data results in terms of the systolic BP (P value of 0.37), diastolic BP (P value of 0.227) and HR (P value 0.316).

Table 3

Mean, SD, SE among students during COVID 19 and before it.

Groups		N	Mean	Std. Deviation	Std. Error mean	P value
Age	After COVID 19	133	21.0675	1.8878	1.8878	0.005
	Before COVID 19	96	21.8439	2.2384	2.2384	
Systolic	After COVID 19	133	121.823	13.2848	1.1519	0.37
	Before COVID 19	96	120.234	13.0585	1.3328	
Diastolic	After COVID 19	133	79.6368	55.3025	4.7953	0.468
	Before COVID 19	96	75.4792	10.3053	1.0518	
Weight	After COVID 19	133	64.015	12.9545	1.12329	0.89
	Before COVID 19	96	63.7708	13.4567	1.37342	
Height	After COVID 19	133	168.323	9.8493	0.8541	0.84
	Before COVID 19	96	168.052	10.2571	1.0469	
HR	After COVID 19	133	99.8226	76.0304	6.5927	0.316
	Before COVID 19	96	91.9417	13.2844	1.3558	
BMI	After COVID 19	133	22.4284	3.05476	0.26488	0.98
	Before COVID 19	96	22.4393	3.40393	0.34741	

As mentioned previously, both types of students after COVID 19 were investigated, the ones studying normal leering and the E-learning with IoMT ones. Hence, for the students studying the normal learning (before covid 19), the mean systolic BP was 122.38, the mean diastolic BP was 81.61, HR was 94.18 and BMI was 22.22. Whereas, for the students studying the E-learning, the mean of systolic BP was 23.80, the diastolic BP was 73.39, HR was 117.60 and BMI was 23.07. Also, there was no statistical significance between the normal learning (i.e in person education before COVID 19) and E-learning

students with the systolic BP (P value 0.391), diastolic BP (P value 0.466) and HR (P value 0.129), as detailed in table 4.

Table 4

Mean, SD, SE among students during COVID 19 studying the Normal learning and E- learning.

Category	Type of study	N	Mean	Std. Deviation	Std. Error mean	P value
Age	Normal	101	20.2006	1.10492	0.10994	0
	E-learning	32	23.8039	1.02869	0.18185	
Systolic	Normal	101	122.3812	13.67505	1.36072	0.391
	E-learning	32	120.0594	12.00056	2.12142	
Diastolic	Normal	101	81.6149	63.23916	6.29253	0.466
	E-learning	32	73.3937	8.31341	1.46962	
Weight	Normal	101	63.7426	13.01895	1.29543	0.668
	E-learning	32	64.875	12.91598	2.28324	
Height	Normal	101	168.7327	9.94373	0.98944	0.397
	E-learning	32	167.0313	9.5832	1.69409	
HR	Normal	101	94.1871	14.20965	1.41391	0.129
	E-learning	32	117.6094	153.40432	27.11831	
BMI	Normal	101	22.2234	3.08736	0.3072	0.17
	E-learning	32	23.0753	2.90135	0.51289	

The following Fig. 2 that's depend on IoMT application shows that there is no difference in the BMI between the students before and after COVID 19.

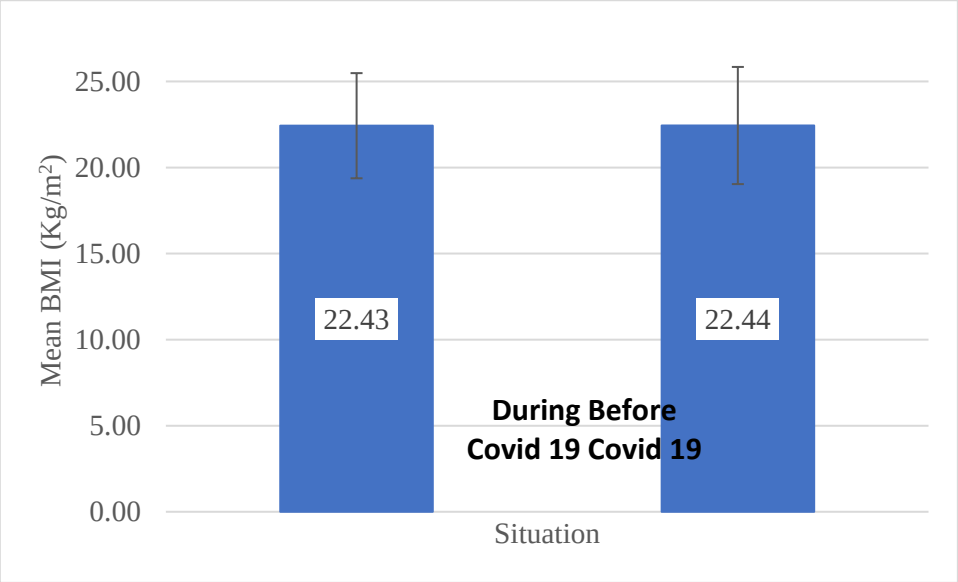

Figure 2: Distribution of BMI among students from the students during and before COVID 19

Fig. 3 shows the mean of HR of during Covid students is 99.8 which is higher than the mean of art students which is 91.9.

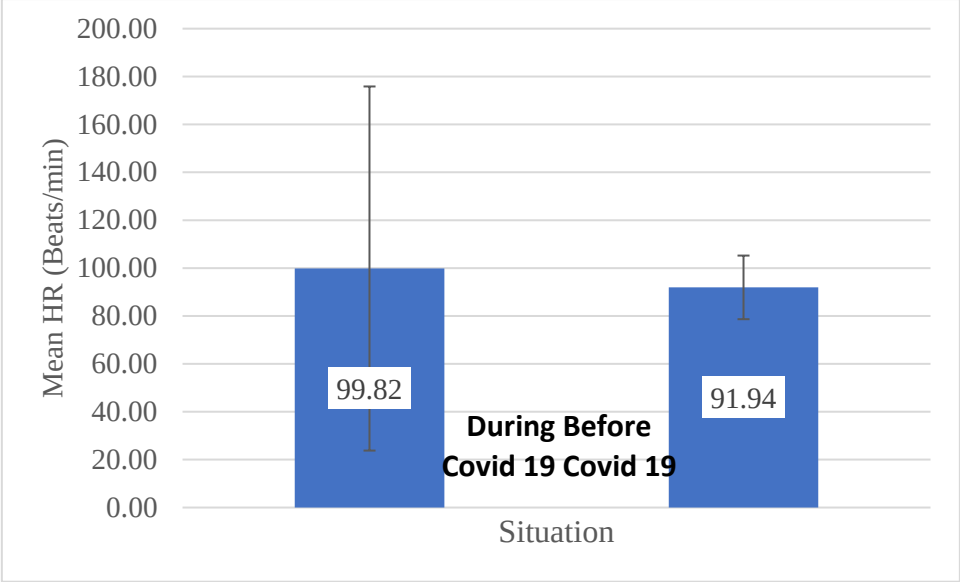

Figure 3: Mean of HR among students *during COVID 19 and before COVID 19*

Fig. 4 shows the mean age in each college which is 21.8 for art students and 21.1 for during COVID 19.

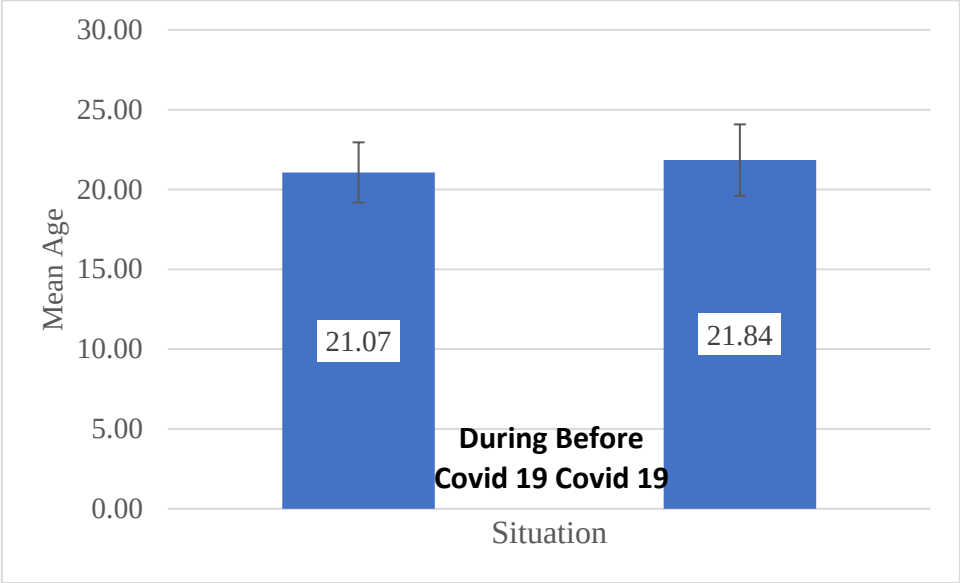

Figure 4: Mean age among students *during COVID 19 and before COVID 19*

After measuring the blood pressure in both cases students, i.e. during COVID 19 and before COVID 19, it was discovered that systolic and diastolic blood pressure of student during the covid in comparison with students before it was slightly elevated. After further analysis this elevation was deemed as insignificant. The results are shown in Fig. 5 and 6, below:

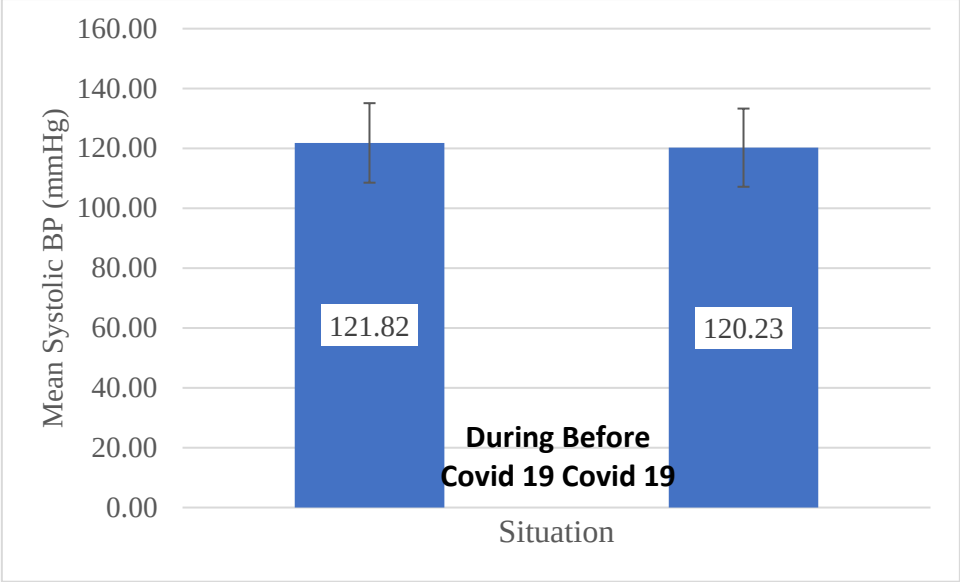

Figure 5: Mean systolic BP (in mmHg) among students *during COVID 19 and before COVID 19*

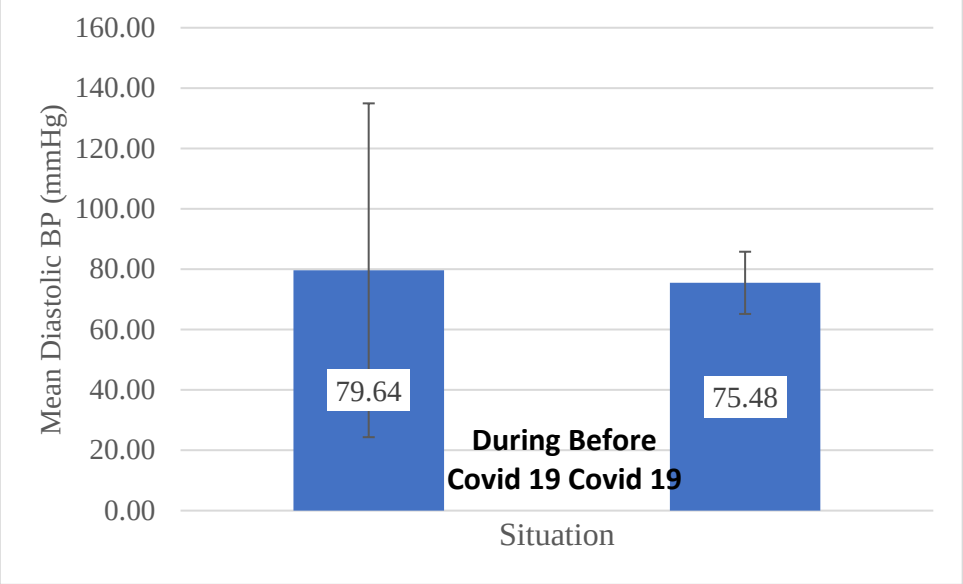

Figure 6: Mean diastolic BP (in mm Hg) students *during COVID 19 and before COVID 19*

A further comparison was undertaken within students. This comparison was between the normal and the E-learning studies by use IoMT application as shown in Fig. 7, where the graph indicates that BMI is higher in normal (23.1) than E-learning (22.2).

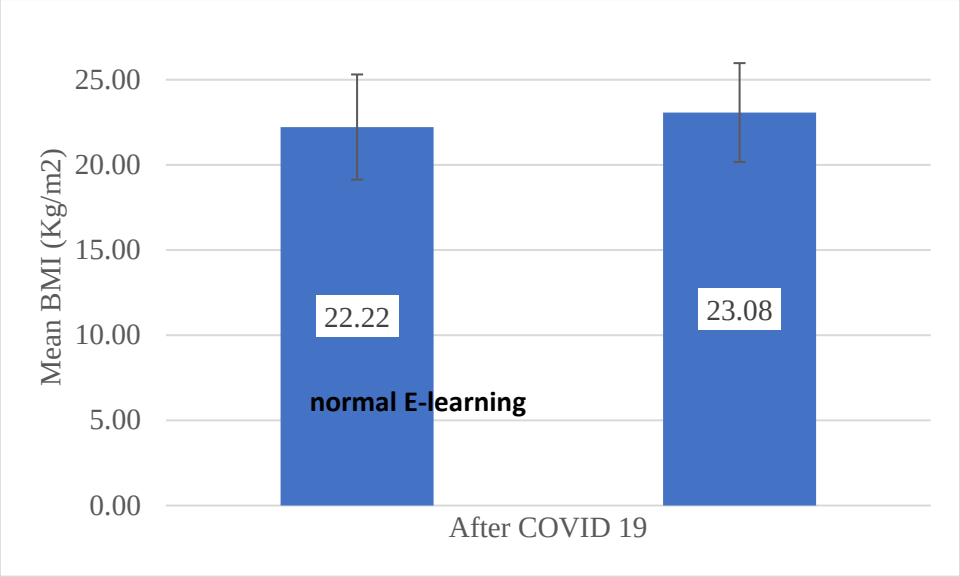

Figure 7: Mean BMI (in kg/m^2) among students using normal and E-learning, respectively

Figure8 shows the mean of age of students After COVID 19 in both *normal and IoT with E-learning*. The mean age is 23.8 in normal learning and 20.2 in E-learning.

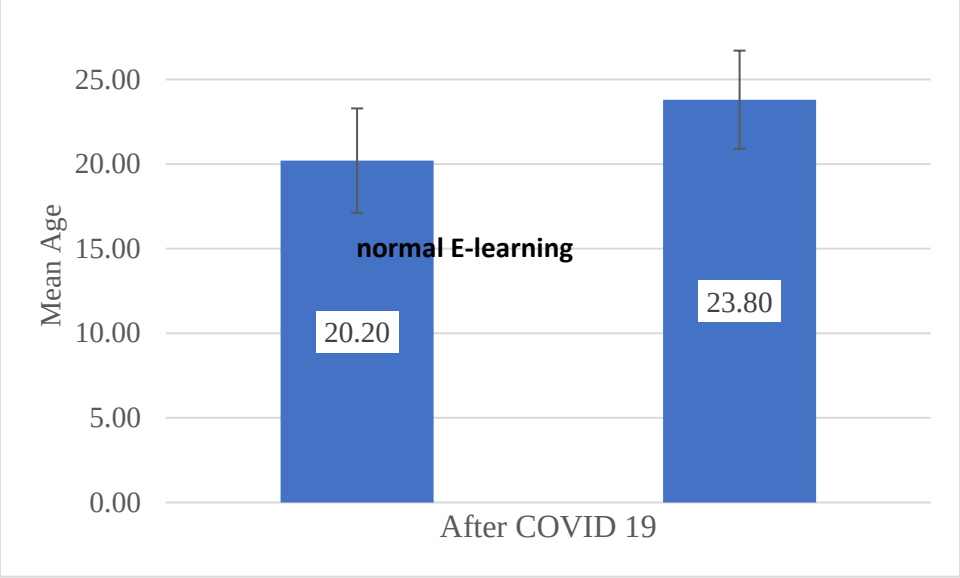

Figure 8: Mean age among students studying in normal and E-learning.

The blood pressure measurements of students after COVID 19 in both systems included last two grades from the normal system and first four grades were included form the E-learning system. An elevation in both systolic and diastolic blood pressure was noticed in the new system when compared to the normal learning. As this elevation was not significant, no further analysis was undertaken. The mean systolic and diastolic blood pressures are shown in the Figure 9 and 10, respectively.

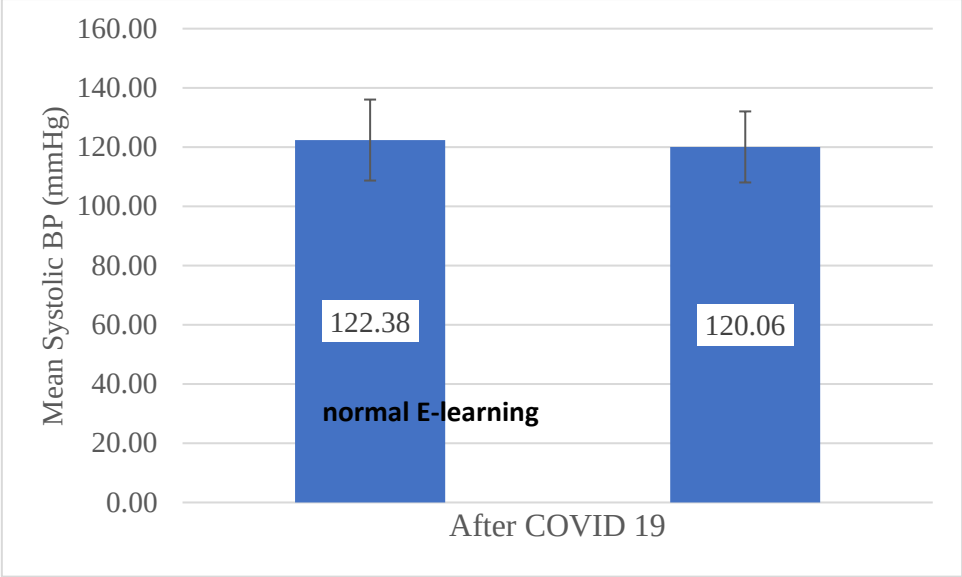

Figure 9: Mean systolic BP (in mm Hg) among students after and before covid 19 using normal learning and E-learning with IoMT, respectively

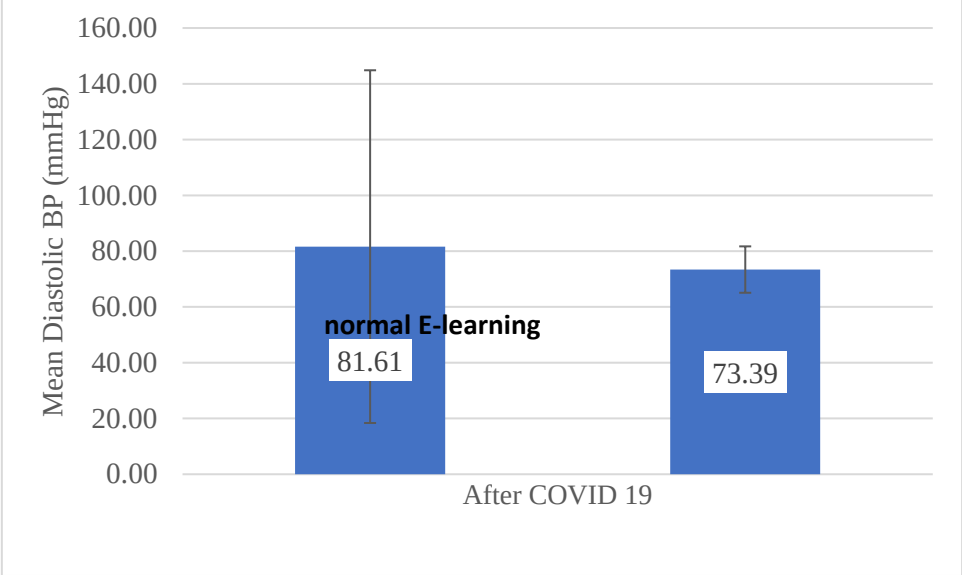

Figure 10: Mean systolic BP (in mm Hg) among students after and before covid 19 using normal learning and E-learning, respectively

5. Discussion

Hypertension is a worldwide problem, which is estimated to cause 7.5 million deaths yearly. This accounts for about 12.8 % of the total of all deaths occurring in the world. Raised blood pressure levels are a major risk for coronary heart diseases, ischemic and haemorrhagic strokes. Hypertension is caused by multiple key factors, where one of these key factors is stress. This study focuses on stress and its effect on blood pressure levels. Whilst conducting this study the IoMT focus was to determine any difference in blood pressure measurements (systolic & diastolic) and heart rate between students.

The aim of this study was to correlate between stress and elevation of blood pressure levels. A very detailed analysis of the results was undertaken to determine any correlation. It was discovered that after COVID 19 students had slightly elevated blood pressure levels and heart rates when compared with the

students before the pandemic. Within the students after COVID 19, a further deviation was noticed between Normal and IoMT with E-learning studies. Even though a difference was noticed, the results were not significantly different which resulted in a low probability "P" value.

A definite conclusion can not be determined due to the assumptions and limitations of the study. Some of these limitations are listed as follows:

1- A small sample size;

2- Period during which measurements were taken. As no exams were being undertaken hence stress levels were low;

3- No analysis or records were noted on high risk factors such as smoking and alcohol consumption;

4- The participants were only subjected to one measurement. A single measurement is not enough to detect any hypertension. A better prospect would have been to take multiple measurements from the same test subject over the period of few days.

Previous studies undertaken indicate a greater level of stress in students after COVID 19 which leads to elevated blood pressures [29 – 30].

A study conducted in India on 18 to 21-year-old individuals concluded that the prehypertension and hypertension percentage was 67% among students after COVID 19, where it is also noted that the prevalence is high among males compared to females and the difference is statistically significant [31].

A similar study undertaken in Ethiopia demonstrated that college students showed a prevalence of hypertension of 7.7%. Higher rates of hypertension were observed among males, overweight people and participants who suffered sleep deprivation or slept for less than 5 hours [32].

6. Conclusions

Young people are more prone to developing harmful diseases due to several reasons. Hence, it is extremely important that youngsters are also monitored for their blood pressure levels. This study was aimed on estimating and comparing the Systolic and Diastolic Blood Pressure levels in undergraduate students before and after COVID 19. One of the main motivations behind this study was to analyse the effects of different educational types on the students' BP levels as well and to comprehend the students' health conditions.

The main conclusions drawn from this research show that there was a significant association between stress and blood pressure elevation (both systolic and diastolic) when comparing BP students from both after and before COVID 19. The HR and BP were also not statistically significant in comparing normal and E-learning.

Further recommendations for this study are as follows:

- Additional research on the topic is required;
- Increase in knowledge and education of people about the complications of hypertension is needed
- People need to be advised to measure their blood pressure regularly
- Prevention programs can strengthen protective factors among people
- Larger samples should be tested where students from several colleges and universities must be scrutinised
- IoMT applications were used to improve readings and to know the exact health details of each student, depending on a flowchart adopted by researchers.
- Measurements carried on students must be made during a longer period of time, perhaps for the full academic term in order to comprehend their overall health conditions.

7. Acknowledgment

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