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# Ranking of Human Stress Measurement using a Hybrid MCDM Method

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***Abstract:*** Physical Stress is a reaction to daily physical or psychological factors. It is necessary to assess stress levels to manage stress regularly. Physical stress may be measured using physician-recommended metrics such as Heart Rate (HR), Blood Pressure (BP), and respiratory activity. The technique of measuring stress is still not fully automated. The doctor will have to diagnose this using numerous factors manually. There is a pressing need to develop an easy method for automatically assessing the physical stress levels of several patients. When presented with several choices and multiple conflicting and non-commensurable decision criteria, multi-criterion decision-making (MCDM) is one of the most efficient ways to arrive at an optimal conclusion. Because of its inherent capacity to appraise several options regarding decision criteria, this technique is a well-known solution for addressing difficult real-life situations. Some of the most effective MCDM techniques are Combined Distance-based Assessment (CODAS), Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS), and Distance-Based Approach (DBA). In this paper, a hybrid weighted CODAS (W-CODAS) has been proposed and implemented on a dataset of 15 patients, and their stress level has been measured and ranked.

***Keywords:*** *Stress, MCDM, W-CODAS, Ranking*

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## 1. INTRODUCTION

Hypertension is linked to increased vascular oxidative stress; however, whether oxidative stress is a cause or an outcome of hypertension is still debated. Human studies have been conflicting, but animal studies have usually confirmed the concept that increasing blood pressure is connected with more significant oxidative stress. Proliferation and hypertrophy of vascular smooth muscle cells and collagen deposition are induced by oxidative stress, resulting in the thickening of the vascular media and narrowing of the vascular lumen. Oxidative stress can also damage the endothelium and increase vascular contractility. Oxidative stress may induce hypertension through vascular effects. Antioxidant treatment lowers oxidative stress and blood pressure [3].

Stress management is especially crucial for modern people's health. Due to its close relationship with the autonomic nervous system, heart-rate variability (HRV) is crucial in stress investigations. Stress resilience—adapting to stress—has received little attention. Stress-induced SNS and PNS alterations affect HRV. Most experiments showed different HRV responses to stress. Low parasympathetic activity, a drop in HF, and increased LF was the most common component of HRV fluctuation. HRV may be associated with operating a dynamically structured network of brain regions that respond to environmental stressors [8].

This paper is divided into the following sections: section II discusses prior work by different authors, section III outlines the suggested image compression algorithm, section IV describes the experimental results, and Section V finishes the paper by summarizing the conclusion and future scope.

## 2. LITERATURE REVIEW

Sunderland et al. (1989) employed a sensitive electronic dynamometer to test 38 stroke patients to determine the value of voluntary grip strength as an indicator of arm function recovery. Grip strength was significantly associated with performance on the other tests, and this approach enabled grip to be measured in many patients. Throughout a six-month follow-up period, grip was used as a sensitive indicator of intrinsic neurological healing [1]. Gizdulich and colleagues (1997) & Grossman (2008) evaluated clinical studies on antioxidant supplements and found they failed to show any consistent benefit. It's worth noting that using antihypertensive drugs lowers blood pressure and reduces oxidative stress. As a result, oxygen stress appears to be a consequence of hypertension rather than a cause [3]. Gasperinet al. (2009) predicts that non-transmissible disorders, including arterial hypertension, will primarily cause functional impairment in 20 years. Hypertension is a public health issue due to its incidence, hazards, burdensome regulation, high medical and social expenses, and severe cardiovascular and renal effects. In 2002, hypertension caused over 7 million fatalities, 13% of all deaths. By 2025, the number of hypertensive adults will have risen to 1.5 billion, accounting for nearly 30% of the global population [4].

Choi and Gutierrez-Osuna (2009) proposed employing discreet wearable sensors to detect mental stress. The method focuses on analyzing heart rate variability to determine the condition of the autonomic nervous system. The authors found that PDM features were more stable and less subject-dependent than spectral features, despite the latter's superior classification performance within subjects [5]. The computerized finger-tapping test is a rapid and accurate method for determining the speed and kinetics of finger-tapping that may be relevant in motor performance research and clinical studies. Hubel et al. (2013) observed differences in tapping rate, movement initiation, and button-down times, as well as a decline in tapping speed over subsequent 10-second intervals between dominant and non-dominant hands. The tapping rate declined in older participants, linked to more significant internal variability. Men had higher tapping rates in all age groups than women [6].

Most conventional neuropsychological evaluations include the Finger Tapping Test (FTT) as an integrated measure of performance validity. Based on FTT (2014), Axelrod et al. investigated the efficacy of three alternative scoring techniques for identifying invalid performance. In clinical and independent neuropsychology instances, passing all performance validity assessments or failing two or more validity indices was used to establish credible performance [7]. According to Kim et al. (2018), HRV is associated with decreased threat perception and is mediated by brain areas that evaluate stressful situations (e.g., the ventral side of the mPFC). HRV can be utilized in clinical settings to monitor heart activity and general autonomic function rather than particular mental illnesses or disease states. When investigating the relationship between stress and HRV, it is crucial to examine the patient's medical and mental history and overall autonomic context [8]. Chhetryet al. (2018) constructed and tested a stretchy resistive sensor for pressure and strain detection. An Au-sputtered microstructure PDMS

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base electrode and an AgNPs-reinforced conductive fabric counter electrode were used. The low-surface-energy sandpaper template directly produced the microstructured PDMS layer without surfactants. Ag precursor absorption and reduction created the conductivity fabric [9].

Yu et al. (2018) thoroughly evaluated biofeedback systems for stress management, focusing on bio-sensing techniques, bio-data computation methodologies, biofeedback protocol, and feedback modalities [10]. Rodic-Trmcic et al. (2018) demonstrated creating an IoT system for stress management in students [10]. Rodic-Trmcic et al. (2018) show how electronic health, mobile health, the Internet of Things, and wearable computing may all be integrated. The IoT infrastructure in place allows respondents' critical characteristics to be monitored. During the defense of the thesis, a mobile health application with relaxing material may have an impact on reducing arousal in respondents. The proposed solution can be used in educational settings. The proposed solution, unlike the traditional educational system, allows for biofeedback. Professors receive information about students' arousal levels, which they might use to alter the exam flow [11]. Nature watching, outdoor walks, outdoor exercise, and gardening were all evaluated by Kondo et al. (2018). Nature watching, outdoor walks, outdoor activity, and gardening are among the types of exposures examined in this study. The study design, stress measurement modalities, and statistical estimations of effect and significance are all described [12]. Epel et al. (2018) created an integrated working model that emphasizes how stressor exposure over time influences habitual responses and stress reactivity and how stress interacts with health behaviors. The authors suggested a Stress Typology [13] that defined stress assessment timeframes (acute, event-based, daily, and chronic) and a more explicit language for stress characteristics.

Wu et al. (2018) created a mental stress index using an approach based on the relationship between salivary cortisol and HRV time/frequency domain features (MSI). Thirty college students were recruited to evaluate the suggested strategy's feasibility by locating a specific stressful occurrence. The findings indicate that MSI levels are acutely stress-sensitive and can accurately predict the extent of linkage between an average person and a stress group. The outcomes of this study may provide new insights into self-tracking and stress training in dynamic situations employing a wearable sensor system [14]. Kassymova et al. (2018) emphasized the biology of stress, a significant concern for students in today's culture. It proposes Japanese finger stress reduction and yoga pranayama for students and teachers to employ in class. Today, stress harms mental and physical health. The study's primary objectives were to assess how stress affects students' academic performance and health and to suggest stress-management strategies [15]. Dong et al. (2018) took electrocardiograms from 14 healthy participants during mental arithmetic and physical exercise. Thus, stress reactivity and recovery were positively correlated with resting HRV values, particularly parasympathetic activity. These HRV properties may be used to measure stress resilience [16].

Petilli et al. (2018) suggested a sustained Paced Finger Tapping (S-PFT) test for sustained attention without external stimuli. Eighty-five teenagers took the S-PFT and other attentional measures (visual sustained attention, visuospatial attention ability, selective attention, and split attention). As a result, they established that S-PFT can induce performance decline over time, a crucial property of sustained attention tasks [17]. Natsagdorj et al. (2019) proposed a machine-learning approach for reliably predicting the amount of human mental stress using wearable physiological sensors and a stress monitoring and relief system based on Android and Arduino [19]. Muntner et al. (2019) amended the American Heart Association's scientific statement on human blood pressure measurement [20]. Can et al. (2019) looked at previous studies that used cell phones and wearable technologies to detect stress in everyday life. Although there have been many studies on stress detection in controlled laboratory settings, there have been few investigations on stress detection in daily life [21].

Lodging limits, a significant constraint in the maize-soybean intercropping system, endanger agricultural development and sustainability. Due to maize's higher stem length, the maize-soybean intercropping method causes shade. Various morphological and anatomical factors and the chemical arrangement of the stem impact the lodging phenomena. Soybean stems elongate and lodge due to maize shadowing. However, the primary agricultural methods needed to study lodging stress in a maize-soybean intercropping system for sustainable agriculture have not been specified. Consequently, Raza et al. (2020) connected conceptual insights to previously published studies and gave crucial ways for mitigating the adverse effects of accommodation. According to the authors, lodging stress management relies on various treatments, including agronomic, chemical, and genetic approaches, all of which might be beneficial in minimizing lodging risks in the maize-soybean intercropping system [22]. Gupta et al. (2021) performed a multi-criteria stress intensity analysis in India's metropolitan districts during COVID-19. The authors used a TOPSIS comparative study to determine how to rank India's most significant cities regarding stress levels. The CRITIC approach was used to quantify the relative relevance of different types of stress experienced by people of India's major cities [24]. Lahane(2021) presented a brain interface system for detecting and analyzing stress. The study seeks the best algorithm and classifier for alpha and beta wave-based recorded input accuracy. Average sensitivity, specificity, and F-scores were examined [25].

## PROPOSED METHODOLOGY

## THE METHODOLOGY: W-CODAS

To optimize e-learning websites, this research introduces the W-CODAS strategy, a powerful combination of the Shannon Entropy and CODAS methodologies. The procedure is explained below for your convenience.

### 3.1 Shannon Entropy Approach

Shannon's Entropy method prioritizes the weight computation of the performance indices utilized in any decision-making situation [20-22]. After the performance ratings of the alternatives are collected for all performance indices, a decision matrix is created, which serves as the foundation for the weight computation. This method's implementation procedure is as follows:

Let $[A_{ij}]_{mxn}$ be the decision matrix of size $[m\ x\ n]$, where 'm' and 'n' denotes the number of alternatives and performance indexes, respectively.

$$[A_{ij}]_{mxn} = \quad n_1 \quad n_2 \ \dots \ n_n \ m_1 \ m_2 \ \vdots \ m_n \ [A_{11}\ A_{12}\ \dots\ A_{1n}\ A_{21}\ A_{22}\ \dots\ A_{2n}\ \vdots\ \vdots\ \dots\ \vdots\ A_{m1}\ A_{m2}\ \dots\ A_{mn}\ ]$$

Eq. 1 normalizes the decision matrix.

$$norm[A_{ij}]_{mxn} = \frac{A_{ij}}{\sum_{i=1}^{m} A_{ij}} \qquad (1)$$



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Once the decision matrix is normalized, eq. (2) calculates the entropy value for each performance index.

$$E_{ij} = -k \sum_{j=1}^{n} norm[A_{ij}](ln\, ln\, (norm[A_{ij}])) \qquad (2)$$

Where $k = \frac{1}{ln(n)}$

After obtaining the entropy values, eq. (3) estimates the priority weights of all the performance indexes.

$$[w_i]_{mx1} = \frac{E_i}{\sum_{i=1}^{m} E_i} \qquad (3)$$

**3.2 CODAS**

In 2016, Ghorabaee et al. developed CODAS to solve the decision-making dilemma. It calculates Euclidean and taxicab distances. Taxicab distance is based on Euclidean space's incompatibility of two alternatives. Stages of CODAS implementation:

The CODAS method formulates the decision matrix $[A_{ij}]_{mxn}$ consisting of performance ratings of the alternatives w.r.t. all performance indexes.

$$[A_{ij}]_{mxn} = \quad n_1 \quad n_2 \quad \dots \quad n_n \; m_1\, m_2 \, \vdots \, m_n \, [A_{11}\, A_{12} \, \dots \, A_{1n}\, A_{21}\, A_{22} \, \dots \, A_{2n} \, \vdots \vdots \, \dots \, \vdots \; Am1\, Am2 \dots Amn \qquad (4)$$

1) The decision matrix is now normalized using the linear normalization method as given below:

$$norm[A_{ij}]_{mxn} = \{\frac{A_{ij}}{A_{ij}} \; if\; j \in N_b \; \frac{A_{ij}}{A_{ij}} \; if \; j \in N_c \qquad (5)$$

2) Multiply the weight matrix $[w_i]_{mx1}$ obtained using the Shanon entropy approach with the $norm[A_{ij}]_{mxn}$ obtained in the previous step as follows:

$$weighted[A_{ij}]_{mxn} = [w_i]_{mx1} * norm[A_{ij}]_{mxn} \qquad (6)$$

3) Identify the negative ideal solution following step 3.

$$[ns_j]_{1xn} = (weighted[A_{ij}]_{mxn}) \qquad (7)$$

4) Now, calculate the Euclidean and taxicab distance for each of the alternatives as given below:

$$ED_i = \sqrt{\sum_{j=1}^{n} weighted[A_{ij}] - [ns_j]} \qquad (8)$$

$$TD_i = \sum_{j=1}^{n} |weighted[A_{ij}] - [ns_j]| \qquad (9)$$

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5) Formulate the relative preference matrix as given below:

$R_p = [R_{ik}]_{mxn}$

Where $R_{ik} = (ED_i - ED_k) + (\varphi(ED_i - ED_k) * (TD_i - TD_k))$

Here $k \in 1 \ldots m$ and $\varphi$show a threshold function used to analyze the Euclidean distance equality of two alternatives. The threshold function is:

$\varphi(y) = \{1\ if\ |y| \geq \tau\ 0\ if\ |y| < \tau$ (10)

Here $\tau$ ranges from 0.02 – 0.05.

6) Calculate the final preference index value for all alternatives as given below:

$P = \sum_{k=1}^{m} R_{ik}$ (11)

7) Now, the alternatives are ranked based on the calculated preference index value in step 7.

## 3. EXPERIMENTAL RESULTS

The data set is obtained at the Alfla Hospital in Faridabad under the direction of Dr................. The medical data of 15 individuals was gathered, including age, body temperature (Fahrenheit), blood pressure systolic, blood pressure diastolic, and heart rate. Only the BP systolic, BP diastolic, and Heart Rate parameters are considered selection criteria. To evaluate the physical stress level from the acquired patient data, the MCDM technique W-CODAS has been used in this study. Table 1 represents the medical record of 15 patients and the stress level in terms of scores given by doctors.

**Table 1:** Medical record of patients & score from the doctor

| | AGE | TEMP | BP(SYS) | BP(DIS) | Heart Rate | Score from the Doctor |
|---|---|---|---|---|---|---|
| **PATIENT 1** | 50 M | 97.6 | 120 | 77 | 89 | 1 |
| **PATIENT 2** | 46 M | 97.3 | 120 | 88 | 69 | 2 |
| **PATIENT 3** | 45 F | 98 | 140 | 83 | 76 | 2.5 |
| **PATIENT 4** | 37 F | 97 | 124 | 85 | 91 | 2 |
| **PATIENT 5** | 38 M | 97.3 | 94 | 71 | 75 | 1 |
| **PATIENT 6** | 56 M | 97.8 | 117 | 71 | 84 | 1 |
| **PATIENT 7** | 43 F | 98 | 121 | 81 | 91 | 2 |
| **PATIENT 8** | 21 F | 97 | 109 | 71 | 90 | 1 |
| **PATIENT 9** | 35 M | 98 | 136 | 112 | 100 | 3 |
| **PATIENT 10** | 50 F | 97 | 130 | 85 | 94 | 2 |
| **PATIENT 11** | 20 M | 98.5 | 123 | 62 | 58 | 1.5 |
| **PATIENT 12** | 36 M | 102.9 | 115 | 68 | 106 | 1 |
| **PATIENT 13** | 50 F | 96.4 | 160 | 100 | 77 | 4 |

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|---|---|---|---|---|---|---|
| **PATIENT 14** | 26 M | 96.8 | 100 | 60 | 77 | 1 |
| **PATIENT 15** | 11 F | 98 | 110 | 60 | 98 | 1 |

Table 2 represents the patient's data and the rankings obtained from the CODAS technique. It is found that patient 11 is on rank 1, having the maximum stress level, followed by patient 14 at rank 2, and patient 9 is in the last class, i.e., at 15, having the minor stress level.

**Table 2:** Stress level Ranking obtained from CODAS techniques for patient-1 to patient-15

| | **AGE** | **TEMP** | **BP(SYS)** | **BP(DIS)** | **HEART RATE** | **Score from the Doctor** | **CODAS score** | **CODAS rank** |
|---|---|---|---|---|---|---|---|---|
| **PATIENT 1** | 50 M | 97.6 | 120 | 77 | 89 | 1 | -0.58119316 | 9 |
| **PATIENT 2** | 46 M | 97.3 | 120 | 88 | 69 | 2 | -0.442853052 | 8 |
| **PATIENT 3** | 45 F | 98 | 140 | 83 | 76 | 2.5 | -0.997122409 | 10 |
| **PATIENT 4** | 37 F | 97 | 124 | 85 | 91 | 2 | -1.666873962 | 12 |
| **PATIENT 5** | 38 M | 97.3 | 94 | 71 | 75 | 1 | 2.031702 | 4 |
| **PATIENT 6** | 56 M | 97.8 | 117 | 71 | 84 | 1 | 0.595339891 | 6 |
| **PATIENT 7** | 43 F | 98 | 121 | 81 | 91 | 2 | -1.116591589 | 11 |
| **PATIENT 8** | 21 F | 97 | 109 | 71 | 90 | 1 | 0.611338192 | 5 |
| **PATIENT 9** | 35 M | 98 | 136 | 112 | 100 | 3 | -4.335285029 | 15 |
| **PATIENT 10** | 50 F | 97 | 130 | 85 | 94 | 2 | -2.016306914 | 13 |
| **PATIENT 11** | 20 M | 98.5 | 123 | 62 | 58 | 1.5 | 4.094090696 | 1 |
| **PATIENT 12** | 36 M | 102.9 | 115 | 68 | 106 | 1 | 0.551892347 | 7 |
| **PATIENT 13** | 50 F | 96.4 | 160 | 100 | 77 | 4 | -2.743454997 | 14 |
| **PATIENT 14** | 26 M | 96.8 | 100 | 60 | 77 | 1 | 3.589622991 | 2 |
| **PATIENT 15** | 11 F | 98 | 110 | 60 | 98 | 1 | 2.425694997 | 3 |

## 4. CONCLUSION AND FUTURE SCOPE

To validate the results, the obtained results after applying the W-CODAS technique have been compared with existing methods such as TOPSIS and DBA, and found that the results after using proposed W-CODAS techniques gave better results. A graph is also included in Figure 1 to



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help comprehend the rating obtained by different approaches. The chart compares TOPSIS, DBA, and W-CODAS Rank for patients 1 through 15.

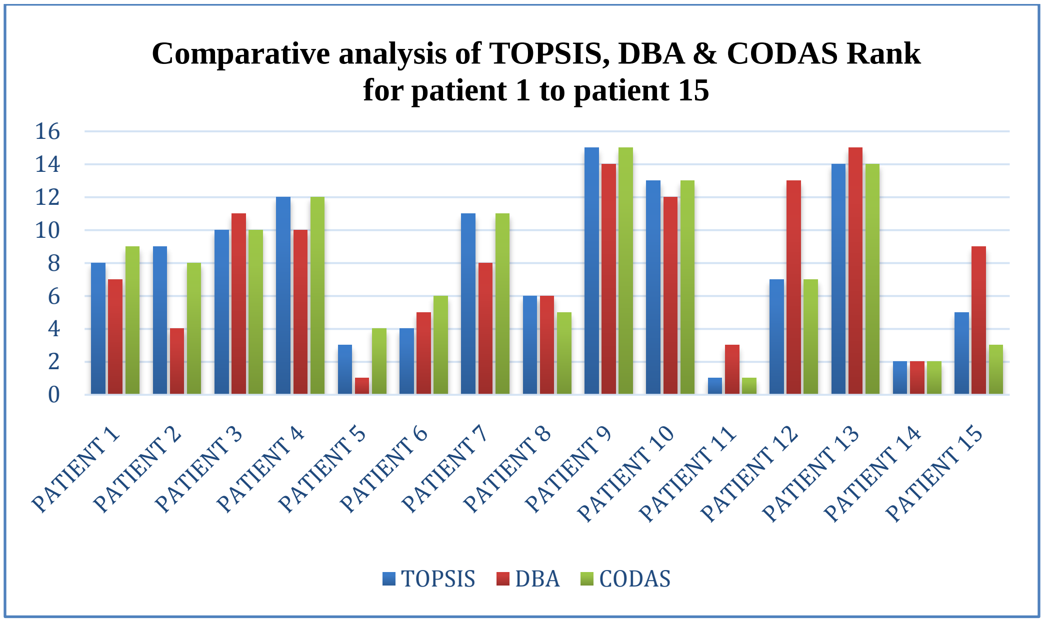


**Figure 1:** Comparative analysis of TOPSIS, DBA & CODAS Rank for patient 1 to patient 15

The dataset of more patients and more MCDM techniques applied altogether may be the scope for future research.

## REFERENCES

[1] Sunderland, A., Tinson, D., Bradley, L., & Hewer, R. L. (1989). Arm function after stroke. An evaluation of grip strength as a measure of recovery and a prognostic indicator. *Journal of Neurology, Neurosurgery & Psychiatry*, *52*(11), 1267-1272.

[2] Gizdulich, P., Prentza, A., & Wesseling, K. H. (1997). Models of brachial to finger pulse wave distortion and pressure decrement. *Cardiovascular Research*, *33*(3), 698-705.

[3] Grossman, E. (2008). Does increased oxidative stress cause hypertension? *Diabetes care*, *31*(Supplement_2), S185-S189.

[4] Gasperin, D., Netuveli, G., Dias-da-Costa, J. S., & Pattussi, M. P. (2009). Effect of psychological stress on blood pressure increase: a meta-analysis of cohort studies. *Cadernos de saude publica*, *25*(4), 715-726.

[5] Choi, J., & Gutierrez-Osuna, R. (2009, June). Using heart rate monitors to detect mental stress. In *2009 Sixth International Workshop on Wearable and Implantable Body Sensor Networks* (pp. 219-223). IEEE.

[6] Hubel, K. A., Reed, B., Yund, E. W., Herron, T. J., & Woods, D. L. (2013). Computerized measures of finger tapping: effects of hand dominance, age, and sex. *Perceptual and Motor Skills*, *116*(3), 929-952.

[7] Axelrod, B. N., Meyers, J. E., & Davis, J. J. (2014). Finger tapping test performance as a measure of performance validity. *The Clinical Neuropsychologist*, *28*(5), 876-888.

[8] Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H., & Koo, B. H. (2018). Stress and heart rate variability: a meta-analysis and review of the literature. *Psychiatry investigation*, *15*(3), 235.
[9] Chhetry, A., Das, P. S., Yoon, H., & Park, J. Y. (2018). A sandpaper-inspired flexible and stretchable resistive sensor for pressure and strain measurement. *Organic Electronics*, *62*, 581-590.
[10] Yu, B., Funk, M., Hu, J., Wang, Q., & Feijs, L. (2018). Biofeedback for everyday stress management: A systematic review. *Frontiers in ICT*, *5*, 23.
[11] Rodić-Trmčić, B., Labus, A., Bogdanović, Z., Despotović-Zrakić, M., & Radenković, B. (2018). Development of An Iot System For Students'stress Management. *Facta Universitatis, Series: Electronics and Energetics*, *31*(3), 329-342.
[12] Kondo, M. C., Jacoby, S. F., & South, E. C. (2018). Does spending time outdoors reduce stress? A review of real-time stress response to outdoor environments. *Health & Place*, *51*, 136-150.
[13] Epel, E. S., Crosswell, A. D., Mayer, S. E., Prather, A. A., Slavich, G. M., Puterman, E., & Mendes, W. B. (2018). More than a feeling: A unified view of stress measurement for population science. *Frontiers in neuroendocrinology*, *49*, 146-169.
[14] Wu, W., Pirbhulal, S., Zhang, H., & Mukhopadhyay, S. C. (2018). Quantitative assessment for self-tracking acute stress based on triangulation principle in a wearable sensor system. *IEEE journal of biomedical and health informatics*, *23*(2), 703-713.
[15] Kassymova, K., Kosherbayeva, N., Sangilbayev, S., & Schachl, H. (2018, September). Stress management techniques for students. In *International Conference on the Theory and Practice of Personality Formation in Modern Societies (ICTPPFMS 2018)* (pp. 47-56). Atlantis Press.
[16] Dong, S. Y., Lee, M., Park, H., & Youn, I. (2018, July). Stress resilience measurement with heart-rate variability during mental and physical stress. In *2018 40th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC)* (pp. 5290-5293). IEEE.
[17] Petilli, M. A., Trisolini, D. C., & Daini, R. (2018). Sustained-paced finger tapping: A novel approach to measure internal sustained attention. *Frontiers in Psychology*, *9*, 881.
[18] Katerji, M., Filippova, M., & Duerksen-Hughes, P. (2019). Approaches and methods to measure oxidative stress in clinical samples: Research applications in the cancer field. *Oxidative medicine and cellular longevity*, *2019*.
[19] Natsagdorj, U., Moon, K. S., & Park, H. (2019). Human Stress Monitoring through Measurement of Physiological Signals. *Journal of the Institute of Convergence Signal Processing*, *20*(1), 9-15.
[20] Muntner, P., Shimbo, D., Carey, R. M., Charleston, J. B., Gaillard, T., Misra, S., ... & Wright Jr, J. T. (2019). Measurement of blood pressure in humans: a scientific statement from the American Heart Association. *Hypertension*, *73*(5), e35-e66.
[21] Can, Y. S., Arnrich, B., & Ersoy, C. (2019). Stress detection in daily life scenarios using smartphones and wearable sensors: A survey. *Journal of biomedical informatics*, *92*, 103139.

ISSN PRINT 2319 1775 Online 2320 7876
Research paper  UGC CARE Listed ( Group -I) Journal Volume 11, Iss 12, 2022

[22] Raza, A., Asghar, M. A., Ahmad, B., Bin, C., Iftikhar Hussain, M., Li, W., ... & Weiguo, L. (2020). Agro-Techniques for Lodging Stress Management in Maize-Soybean Intercropping System—A Review. *Plants*, *9*(11), 1592.

[23] Sharma, S., Singh, G., & Sharma, M. (2021). A comprehensive review and analysis of supervised-learning and soft computing techniques for human stress diagnosis. *Computers in Biology and Medicine*, *134*, 104450.

[24] Gupta, S., Vijayvargy, L., & Gupta, K. (2021). Assessment of stress level in urban area's during COVID-19 outbreak using critic and topsis: A case of Indian cities. *Journal of Statistics and Management Systems*, *24*(2), 411-433.

[25] Lahane, P. (2021). Brain Computer Interfaces Techniques for Stress Management. Information Technology in Industry, *9*(3), 767-775.