International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 09 Issue: 12 | Dec - 2025 SJIF Rating: 8.586 ISSN: 2582-3930

Assessing Mental Workload in Rural Women: A Heart Rate Variability Analysis of Working Women vs. Homemakers.

Yanu Poonia* (Ph.D. Scholar, RMCS, COCS, HAU Hisar)
Promila K Chahal (Assistant Professor, RMCS, COCS, HAU Hisar)
*Corresponding author: ypoonia03@gmail.com
CCS Haryana Agricultural University Resource Management and Consumer Science
I.C. college of Community Science

Abstract
Mental workload is a growing health concern among rural women in developing nations where traditional family responsibilities often overlap with emerging professional roles. his study quantitatively assessed mental workload in 80 rural women (40 working women and 40 homemakers, aged 25-40) from Hisar district, India, using Heart Rate Variability (HRV) during breakfast preparation. HRV measurements were recorded using a Polar H10 chest belt during breakfast preparation on both working days and holidays. Time-domain (RMSSD, SDNN, SD1) and frequency-domain (LF/HF ratio) parameters were analyzed along with stress indices. Working women showed higher mental workload than homemakers, with elevated mean heart rate (91.5±7.5 vs. 90.9±7.4 bpm), reduced RMSSD (14.8±4.6 vs. 15.8±4.7 ms), and increased stress index (22.1±6.2 vs. 21.5±5.3), though differences were not always statistically significant. Family composition and additional responsibilities significantly influence mental workload patterns across both groups. The study provides empirical evidence that working women experience comparatively higher physiological stress during domestic tasks than homemakers, particularly on working days, highlighting the need for interventions like workload redistribution or stress management programs to enhance work-life balance.

Keywords: Mental workload, Heart rate variability, Working women, Homemakers, Stress index, Rural health, Physiological stress

Introduction

'*Mental workload is the difference between the capacities of the information processing system that are required for task performance to satisfy performance expectations and the capacity available at any given time*'. **(Gopher and Donchin, 1986)** *HRV reflects autonomic nervous system dynamics, offering a window into physiological responses to cognitive and emotional demands* **(Kim et al., 2018).**

In the present era mental workload is an unavoidable component of life due to increasing complexities and competitiveness in living standards. Everyone experiences mental workload across various domains: within family settings, workplace environments, educational pursuits, and organizational contexts. Most of the women experience mental workload in the family due to crowded and unhygienic living conditions, conflict, urbanization and lack of motivation from family members. Concerning the cause of mental workload, most studies have pointed to the fact that the incidence of mental workload is due to overwork. **(Sultanpur, M. N. 2019).** The basic area of mental health reveals significant differences between working and non-working women (House wives). The non-working woman received a higher mean score 73.92 as compared to the working woman 68.80. The mean difference is 5.12 and the standard deviation score of the working woman received 9.26 and the non- working woman received 10.72. So we can say that non-working women have better mental health than working women. The t value of mental health is 2.36. It is clearly revealed from the calculated data that there is a significant difference in mental health between working and non-working women. **Dudra and Jogsan (2012)** found that non-working women exhibited better mental health than working women, with significant differences in mean scores, suggesting that employment may exacerbate psychological strain.

Despite these insights, physiological assessments of mental workload among rural women remain scarce, necessitating this study to quantify stress using HRV in the context of domestic and professional demands.

Mental workload among women

Mental workload, often manifesting as stress, refers to the cognitive and emotional demands placed on individuals, particularly women managing household, family, and professional roles **(Gopher and Donchin, 1986; Hashmi et al., 2007).**

The status of women in India has evolved with industrialization, urbanization, and education, shifting their roles from domestic to professional spheres **(Ramesh and Naresh, 2011).** This transition often increases mental workload, as women juggle household duties, motherhood, and employment, leading to role overload and conflict **(Hashmi et al., 2007).** Studies by **Kermane (2016), Arpaci and Sanlier (2007), and Rajasekhar and Saikala (2013)** consistently report higher stress scores among working women compared to homemakers, attributing this to dual responsibilities, job demands, and family pressures.

Khodidas (2013) found a significant difference in the mental health level among working women and homemakers. Mean score of mental health for 40 working women was 68.25 & SD was
9.25 similarly mental health mean for 40 house wives was 70.50 & SD was 10.50 and difference between their t value was 2.35 and was significant at 0.05 level. Therefore, the results reveal that mental health is better for homemakersthan for working women. **Maqbool *et al.* (2014)** conducted a study on 100 educated women of Baramulla district of J&K out of which 50 were working and 50 were homemakers. Study revealed that Mental Health of working women is 63.54 (Moderate) and for non- working women is 71.94 (Moderate). The difference of means is 8.4. Hence the results clearly indicated that mental health mean scores were higher among homemakers in comparison to working women.

Mental workload and HRV

HRV is a non-invasive electrocardiographic method that is used to measure the autonomic nervous system in a variety of situations (e.g., during psychological stress evaluations). Researchers have conducted studies that used HRV to measure stress, is a reliable index of stress **(Kim et al., 2018)**. HRV measures are calculated from the tachogram, also called RR interval time series. The variance in time between two consecutive R-peaks reflects the status of the autonomic nervous system (ANS).

Figure 1 illustrates the RMSSD (Root Mean Square of Successive Differences) derived from RR interval variations, reflecting autonomic nervous system activity under varying levels of mental workload.

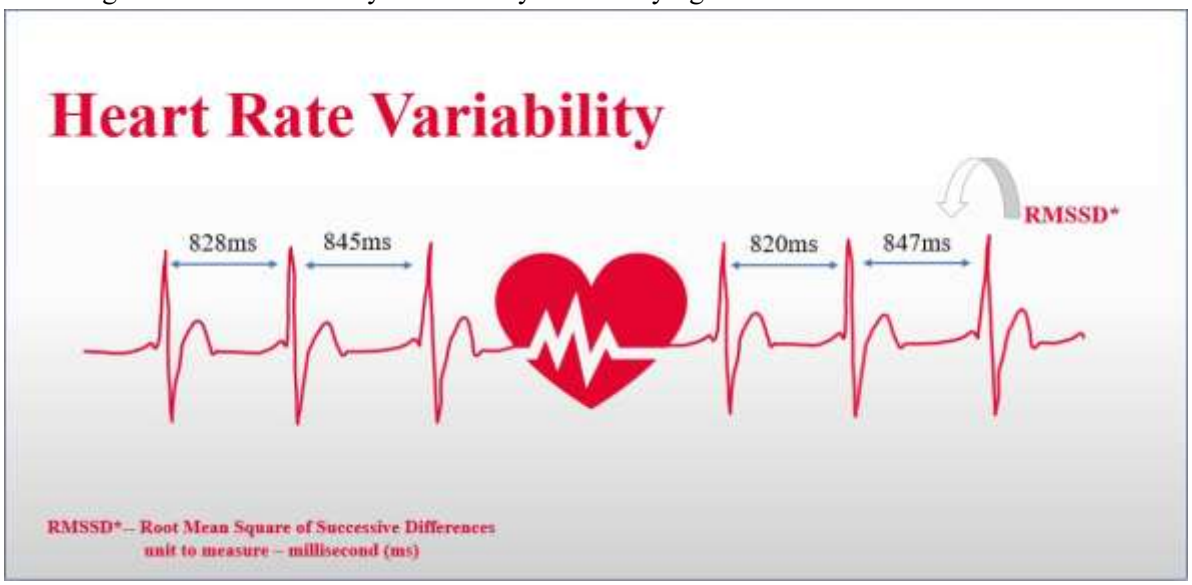


Fig. 1 Heart Rate Variability Why is HRV important to measure mental workload?

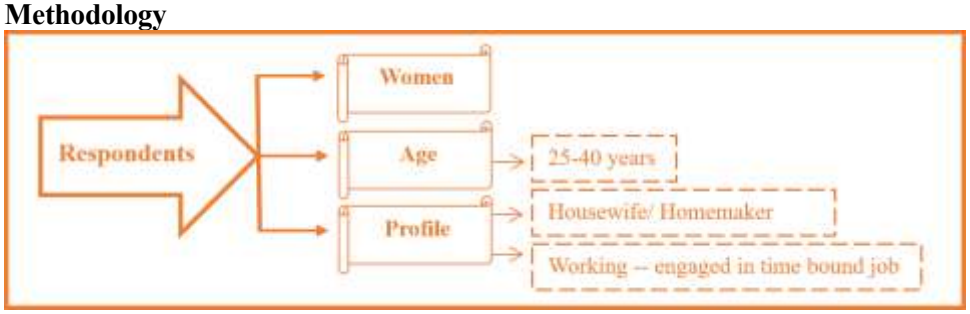
Mental workload and stress represent significant societal challenges, with approximately half of work-related illnesses linked directly or indirectly to stress. While stress originates psychologically, it manifests in multiple physiological processes.

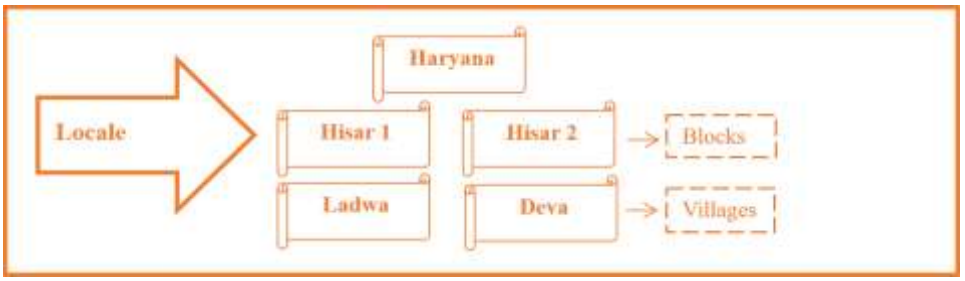
The impact of mental workload on health has been widely investigated, particularly the links between mental workload and cardiovascular diseases. Job-strain (high job demands and/or low decision latitude) is found to raise the risk of

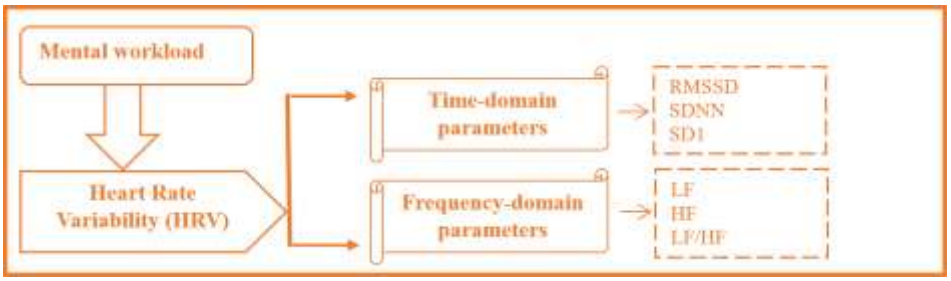
coronary heart disease **(Bosma *et al*.1997; Kivimäki *et al*. 2012 and Netterstrom *et al.* 2006).** Subtler cardiovascular modifications, also linked to an increased cardiovascular risk, have been described as a result of heart rate variability analysis (HRV). HRV is a highly sensitive marker of clinical status, especially of cardiac disease and autonomic neuropathy. Furthermore, HRV has been successfully used to assess environmental or physiological conditions likely to modify sympathetic-parasympathetic balance even without any cardiac disease or autonomic neuropathy. HRV is lowered by mental effort and mental workload probably due to sympathetic activation and/or to parasympathetic withdrawal (**Mulder and Mulder, 1981; Hjortskov *et al*. 2004; Wang *et al*. 2005).**

HRV can be influenced by different factors like age (declines with age), gender (lower in women), ethnicity, physical fitness, health status, body composition, use of alcohol, tobacco, illicit drugs and medicine in regular use **(Shaffer & Ginsberg, 2017; Dantas *et al*. 2018; Koenig & Thayer, 2016),** as well as physiological conditions like circadian rhythms, the sleep cycle, core body temperature, metabolism **(Shaffer & Ginsberg, 2017; Yaniv & Lakatta, 2015)** and environmental factors like noise, temperature, humidity and the time of the day.

Methodology







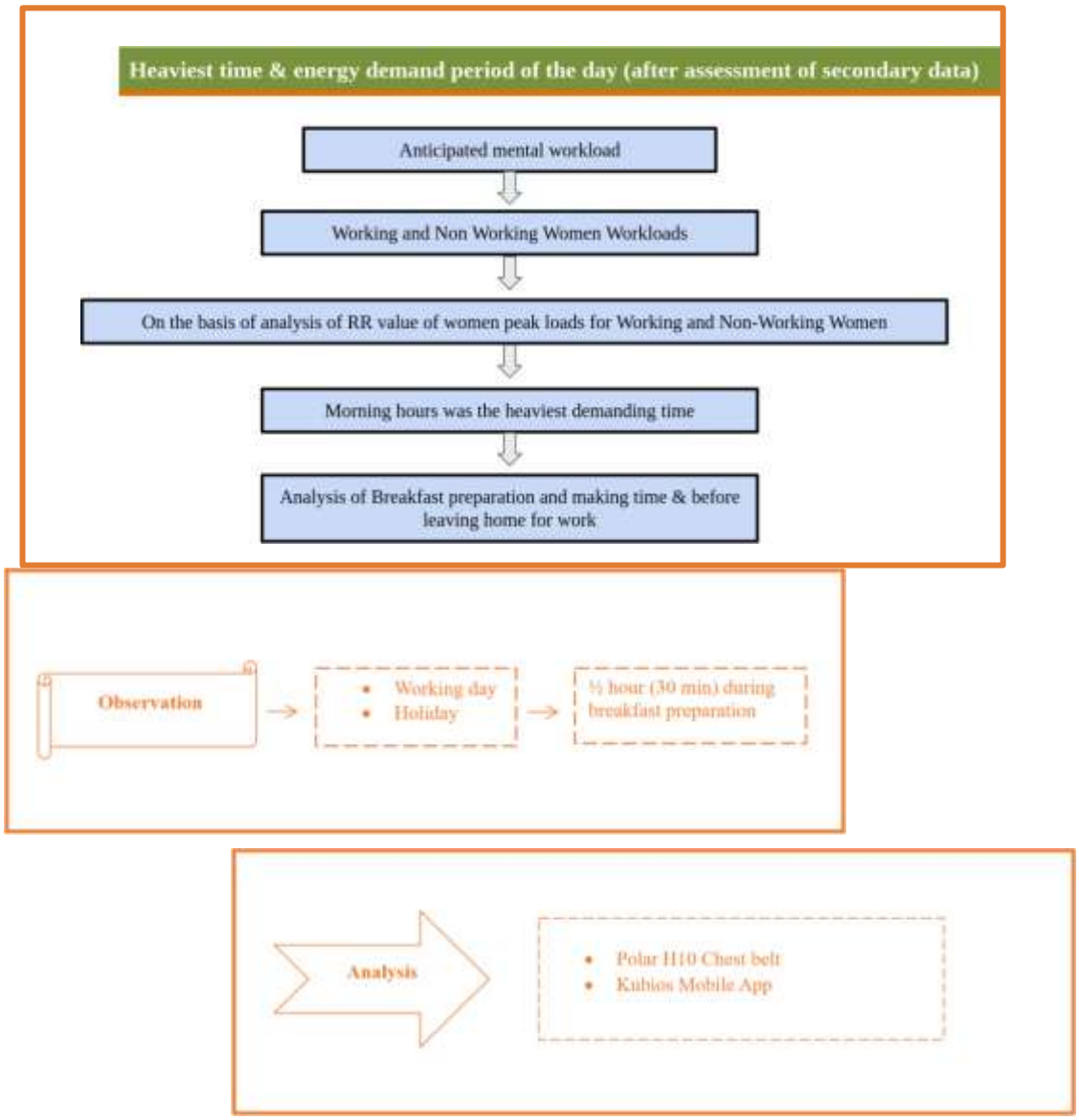


Fig. 2 Methodology

The study methodically examined mental workload among rural women using heart rate variability (HRV) as a physiological marker. n Hisar, India, 80 women (40 working, 40 homemakers, aged 25-40) were purposively sampled, excluding those with cardiovascular disease, diabetes, or pregnancy affecting HRV. Using Polar H10 chest belts synchronized with Kubios software, HRV measurements were recorded during 30-minute breakfast preparation sessions across both working days and holidays, with three replications per condition to ensure reliability. The methodology analyzed time- domain parameters (RMSSD, SDNN, SD1) and frequency-domain measures (LF/HF ratio, Stress Index) to quantify mental workload, demonstrating that parasympathetic indicators decrease while sympathetic dominance increases with heightened stress. Data processing involved artifact removal, parameter computation, and comprehensive statistical analysis using Excel and PSPP software, including paired and independent t-tests to compare HRV parameters between groups and conditions, alongside correlation analyses between demographic factors, task complexity, and physiological stress responses—ultimately providing empirical evidence that working women experience comparatively higher physiological stress during domestic tasks than homemakers.

Table 1: Experiment Design

Variable	Working day	Holiday
Duration of experiment	1/2 hour	1/2 hour
Time of experiment	Breakfast preparation time	Breakfast preparation time
No. of replica	3	3
Observation	Heart rate variability (HRV)	Heart rate variability (HRV)

Note: "Replica" refers to repeated trials (n=3) conducted to ensure measurement reliability.

HRV of women was assessed to check their mental workload during breakfast preparation. An experiment was carried out in two conditions: working day and holiday. A woman HRV was studied during the time of breakfast preparation for half an hour. The peak time/hours were taken for experiment and their HRV was observed. The Polar H10 belt was attached to the respondents 5-10 minutes before starting the experiment. After completion of the experiment, data from the chest belt attached to the mobile was taken for analysis.

HRV was analysed both in the frequency and in the time domains to compute workload indexes. Time domain-based indexes, the Standard Deviation of NN intervals (SDNN), the decrease of this parameter reflects an increase in mental workload. SDNN is often associated with the Root Mean Square of Successive Differences (RMSSD) that varies inversely proportional to the stress variation, i.e., when stress increases the RMSSD decreases. A low value of SD1 indicates a high level of stress. The frequency domain-based indexes, Low to High Frequency (LF/HF) ratio is a widely used parameter because it provides information about the parasympathetic and sympathetic activities of the body. A higher LF/HF value is related to a higher level of workload and lower values of SD1 and SDNN are associated with higher workload level.

Heart Rate Variability (HRV) and its variables

Exposure to stressors triggers the autonomic nervous system (ANS): suppressing parasympathetic activity while activating sympathetic responses. This activation cascade results in epinephrine and norepinephrine secretion, leading to vasoconstriction, elevated blood pressure, increased muscle tension, and alterations in heart rate (HR) and heart rate variability (HRV). This physiological cascade represents the 'fight-or-flight' response, with RR interval variations reflecting autonomic nervous system (ANS) status.

Heart rate variability (HRV) is the fluctuation of the length of heart beat intervals. The HRV was monitored with the Polar H10 chest strap synchronized to the app Kubios.

Parameters	Relationship with mental workload
RMSSD	Inversely proportional
SDNN	Inversely proportional
SD1	Inversely proportional
LF/HF	Directly proportional
Stress Index	Directly proportional

RMSSD: Root Mean Square of Successive Differences, is a measure of short-term heart rate variability. It quantifies the variation between consecutive heartbeats. A higher RMSSD generally indicates increased parasympathetic nervous system activity, often associated with relaxation and a lower indicates mental workload. RMSSD is calculated by taking the square root of the average of the squared differences between successive R-R intervals, expressed in milliseconds. **(Castaldo *et al.,* 2015; Zangróniz *et al.,* 2017; Salazar *et al.,* 2024)**

Mean RR: Mean RR, or Mean R-R Interval, is simply the average time between consecutive heartbeats. It is a basic measure of heart rate and is inversely proportional to the mental workload. Mean RR is expressed in milliseconds. **(Castaldo *et al.,* 2015; Zangróniz *et al.,* 2017; Salazar *et al.,* 2024) SDNN:** Standard Deviation of Normal-to-Normal

Intervals, measures the overall variability of heartbeats over a longer period. It reflects both sympathetic and parasympathetic nervous system influences. A higher SDNN generally indicates better heart rate regulation and lower value indicates mental workload. SDNN is calculated by taking the standard deviation of all R-R intervals in a specific recording period, expressed in milliseconds. **(Castaldo *et al.,* 2015; Zangróniz *et al.,* 2017; Salazar *et al.,* 2024)**

SD1: Standard Deviation of the first Poincaré plot component is a geometric measure of short- term heart rate variability derived from the Poincaré plot. It reflects the beat-to-beat fluctuations in heart rate. A higher SD1 indicates increased parasympathetic activity and lower indicates mental workload. SD1 is expressed in milliseconds. **(Castaldo *et al.,* 2015; Salazar *et al.,* 2024)**

LF/HF: Low Frequency to High Frequency Ratio, is a frequency-domain measure that compares the power in two specific frequency bands of the heart rate spectrum. The LF band (0.04-0.15 Hz) is associated with sympathetic nervous system activity, while the HF band (0.15-0.4 Hz) is primarily influenced by parasympathetic activity. A higher LF/HF ratio suggests increased sympathetic dominance and potentially higher mental workload. LF/HF is a unitless ratio. **(Castaldo *et al.,* 2015; Salai *et al*., 2016; Zangróniz *et al.,* 2017; Salazar *et al.,* 2024)**

Stress Index: A stress index is a calculated value derived from various HRV parameters, aiming to quantify the overall stress level. Generally, a higher stress index indicates increased sympathetic nervous system activity and potential mental workload. **(Castaldo *et al.,* 2015; Salai *et al*., 2016; Salazar *et al.,* 2024)**

Statistical Analysis and Data Processing

Data analysis proceeded through two main phases. Initial HRV analysis utilized Kubios HRV analysis software for time-domain and frequency-domain computations. Subsequently, Microsoft Excel and PSPP software facilitated additional statistical analyses, including frequency, percentage, mean, standard deviation, comparative assessments between working women and homemakers, and correlation analyses between various study parameters.

Result

The present study examined mental workload patterns among rural women aged 25-40 years,
a period characterized by the expanding stage of the family life cycle with peak responsibilities. Educational analysis revealed that approximately 50% of participants held bachelor's degrees, with family education scores indicating medium educational levels across households. Occupational distribution showed that two-thirds of working women were working in the private sector, with the remaining one-third in government positions.

All participants resided in joint family structures, typically comprising 6-7 members. Family composition analysis revealed distinct patterns: homemakers predominantly lived in simple family structures (47.5%), while working women more frequently resided in moderate structures (42.5%). This structural difference aligns with findings from previous studies suggesting that family composition significantly influences women's mental workload **(Hashmi et al., 2007)**. Research by **Sanlier and Arpaci (2007)** further supports this finding, noting that family structure is a significant determinant of stress levels among women, with those in complex family arrangements experiencing higher psychological burden.

Most families had 2-3 children, predominantly attending private schools. Families commonly had 4 members in time-bound jobs. Notably, most women (77.5% of homemakers, 80.0% of working women) received help during breakfast preparation. Study conducted by **Cezar-Vaz *et al*. (2015)** also emphasized that most of the working women had her husband's help in housework.

Analysis of task complexity during breakfast preparation revealed distinct patterns. Most women (65.0% of homemakers and 55.0% of working women) experienced moderate changes in their routine. The majority of both groups prepared 2 meals during breakfast, and frequently customized meals based on individual preferences, with working women varying meals more often. More working women (65.0%) than homemaker women (57.5%) reported to handle additional responsibilities during breakfast preparation which adds complexity to task and hence comparatively higher mental workload. **Kermane (2016)** in psychological study on stress among working women and homemakers, revealed significantly higher stress scores among working women (60.78%) compared to homemakers (43.30%). This finding underscores the increased mental burden experienced by women managing both professional and domestic responsibilities.

Task complexity analysis revealed that both groups identified additional responsibilities as the most challenging aspect, with homemakers reporting a mean score of 2.6 (weighted mean 13.9) and working women scoring slightly higher at 2.7 (weighted mean 14.5). Experience of preparing new recipes emerged as the second most complex factor, with homemakers scoring a mean of 2.0 (weighted mean 13.3) compared to working women's scores of 2.1 (weighted mean 14.0). **Rajasekhar and Saikala (2013)** also conducted a study on stress levels in working women and concluded that working women faced stress because of family responsibilities, job insecurity, workplace culture and high demand for job performance.

Heart Rate Variability Analysis During Breakfast Preparation

HRV analysis revealed distinct patterns between homemaker and working women. Working women exhibited higher heart rates and stress indices across both working days and holidays, while RMSSD and SDNN were consistently lower, indicating greater physiological stress. Homemakers showed more stable parasympathetic responses, with less pronounced differences between day types.

Table 2 and Fig. 3 examines Heart Rate Variability (HRV) in women during breakfast preparation. It compares homemaker women and working women on both working days and holidays, measuring various HRV parameters at the beginning, middle, and end of the task.

For homemaker women, Heart Rate (HR) demonstrated a progressive increase throughout the task on both working days (88.7 bpm to 92.8 bpm) and holidays (88.6 bpm to 92.8 bpm). This increase in heart rate during task progression is consistent with findings by **Zangróniz et al. (2017),** who observed similar cardiac patterns during domestic task performance. Root Mean Square of Successive Differences (RMSSD) showed a general increase on both working days (14.0 ms to 18.3 ms) and holidays (13.6 ms to 18.3 ms), indicating potential adaptation to the task over time. Mean RR decreased in the middle of the task on working days (657.3 ms to 613.1 ms) and holidays (625.3 ms to 608.8 ms), then increased slightly at the end, reflecting initial stress response followed by regulation. This pattern aligns with observations by **Castaldo et al. (2015),** who noted that Mean RR values typically decrease during acute stress exposure.

Standard Deviation of Normal-to-Normal Intervals (SDNN) decreased throughout the task on both working days (23.1 ms to 19.8 ms) and holidays (22.9 ms to 20.3 ms), indicating reduced overall heart rate variability as the task progressed, which **Salazar et al. (2024)** associate with increased mental workload. SD1 showed a small increase in the middle of the task on both working days (9.9 ms to 10.1 ms) and holidays (9.8 ms to 10.4 ms), reflecting short-term variability changes. Stress Index increased throughout the task on working days (19.5 to 22.3) and holidays (17.6 to 22.9), confirming progressive stress accumulation regardless of day type. This finding is consistent with **Salai et al. (2016),** who found that Stress Index reliably increases during mentally demanding activities.

For working women, Heart Rate followed an increasing pattern on both working days (89.5 bpm to 92.8 bpm) and holidays (88.5 bpm to 93.0 bpm), similar to homemakers but with slightly higher overall values. RMSSD showed a decrease throughout the task on working days (16.2 ms to 13.6 ms) but increased slightly on holidays (14.3 ms to 15.9 ms), indicating better parasympathetic recovery during non-working days. These differential patterns between working days and holidays support findings by **Mulder and Mulder (1981),** who observed that recovery patterns in HRV parameters are influenced by overall stress levels and recovery opportunities.

Mean RR in working women showed different patterns compared to homemakers, increasing in the middle of the task on working days (578.5 ms to 619.3 ms) but then decreasing slightly (613.1 ms). On holidays, it showed a slight increase throughout the task (601.5 ms to 605.8 ms). SDNN decreased initially on working days (22.3 ms to 19.6 ms) but increased at the end (22.6 ms), while on holidays, it showed a small increase throughout (20.3 ms to 22.4 ms), suggesting better autonomic regulation during holidays. This aligns with findings from **Wang et al. (2005),** who noted that SDNN typically shows better recovery patterns during lower-stress periods.

SD1 in working women increased in the middle on working days (10.9 ms to 14.1 ms) but decreased at the end (10.8 ms), while on holidays, it showed a small decrease followed by an increase (11.9 ms to 10.9 ms, then 11.6 ms). Stress Index increased throughout the task on both working days (20.1 to 22.9) and holidays (21.4 to 21.8); however, on holidays, it decreased slightly at the end (20.4), indicating better stress recovery. LF/HF ratio showed varied patterns, decreasing throughout the task on working days (6.5 to 5.6) but showing a more complex pattern on holidays (5.7 to 6.7, then 5.2). These findings support **Hjortskov et al.'s (2004)** conclusion that HRV responses to mental workload are multifaceted and influenced by both immediate demands and background stress levels.

Table 2: Level of HRV (Heart Rate Variability) variables among women during breakfast preparation (N=80)

Sr. No.	Variables	Homemaker women (n=40) (Mean)						Working women (n=40) (Mean)					
		Working day			Holiday			Working day			Holiday		
		Beginning	Mid	End	Beginning	Mid	End	Beginning	Mid	End	Beginning	Mid	End
1	HR (bpm)	88.7	91.2	92.8	88.6	90.5	92.8	89.5	91.6	92.8	88.5	90.6	93.0
2	RMSSD (ms)	14.0	14.9	18.3	13.6	15.1	18.3	16.2	14.7	13.6	14.3	14.1	15.9
3	Mean RR (ms)	657.3	613.1	641.8	625.3	608.8	640.1	578.5	619.3	613.1	601.5	602.6	605.8
4	SDNN (ms)	23.1	21.8	19.8	22.9	21.1	20.3	22.3	19.6	22.6	20.3	20.6	22.4
5	SD1 (ms)	9.9	10.1	10.1	9.8	10.4	9.7	10.9	14.1	10.8	11.9	10.9	11.6
6	Stress Index	19.5	22.4	22.3	17.6	21.7	22.9	20.1	22.5	22.9	21.4	21.8	20.4
7	LF/HF	5.1	6.1	5.7	6.3	4.8	5.7	6.5	5.4	5.6	5.7	6.7	5.2

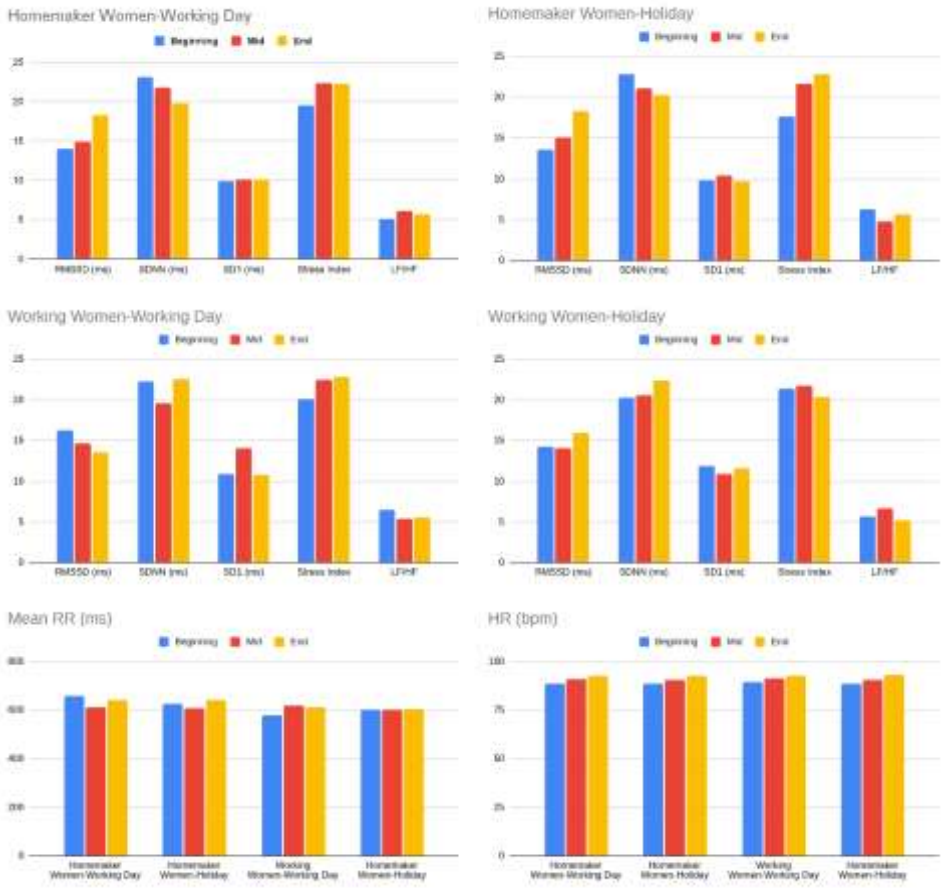


Fig. 3 Level of HRV (Heart Rate Variability) variables among women during breakfast preparation

Table 3 presents the average Heart Rate Variability (HRV) variables among women during breakfast preparation, comparing homemaker women and working women on both working days and holidays.

For homemaker women on working days, the average Heart Rate was 90.9 ± 7.4 bpm, while RMSSD averaged 15.8 ± 4.7 ms. Mean RR was 638.5 ± 64.5 ms, SDNN was 21.4 ± 6.4 ms, and SD1 was 10.1 ± 3.6 ms. The average Stress Index was 21.5 ± 5.3, and the LF/HF ratio averaged 5.6 ± 3.6. On holidays, homemakers showed a slightly lower average HR at 90.7 ± 7.5 bpm, similar RMSSD at

15.7 ± 4.8 ms, decreased Mean RR at 625.2 ± 63.2 ms compared to working days, slightly lower SDNN at 21.2 ± 6.8 ms, unchanged SD1 at 10.1 ± 3.6 ms, decreased Stress Index at 20.8 ± 5.3, and stable LF/HF ratio at 5.6 ± 4.2.

These findings align with observations by **Shaffer and Ginsberg (2017),** who noted that HRV parameters typically show modest improvements during lower-stress periods, even when performing similar tasks. The relatively stable RMSSD values across both day types suggest that parasympathetic regulation in homemakers remains consistent regardless of day type, which **Koenig and Thayer (2016)** associate with better overall stress resilience.

For working women on working days, the average HR was notably higher at 91.5 ± 7.5 bpm, while RMSSD was lower at 14.8 ± 4.6 ms compared to homemakers. Mean RR was 603.1 ± 69.4 ms, SDNN was similar to homemakers at 21.3 ± 6.8 ms, SD1 was higher at 11.9 ± 3.8 ms, the Stress Index was higher at 22.1 ± 6.2, and the LF/HF ratio was lower at 5.1 ± 3.1. On holidays, working women showed a slight decrease in average HR to 90.9 ± 7.5 bpm, unchanged RMSSD at 14.8 ± 4.7 ms, similar Mean RR at 601.9 ± 71.1 ms, stable SDNN at 21.2 ± 6.8 ms, slightly lower SD1 at 11.8 ± 3.8 ms, decreased Stress Index to 21.4 ± 6.2, and increased LF/HF ratio to 5.8 ± 3.2.

These patterns support findings by **Bosma et al. (1997) and Kivimäki et al. (2012),** who observed that individuals with higher overall stress levels (such as those balancing multiple responsibilities) typically show higher sympathetic dominance markers. The lower RMSSD values in working women compared to homemakers across both day types align with **Netterstrom et al.'s (2006)** conclusion that chronic stress exposure can lead to sustained reductions in parasympathetic tone.

Table 3: Average HRV (Heart Rate Variability) variables among women (N=80)

Sr. No.	Variables	Homemaker women (n=40) (Mean±SD)		Working women (n=40) (Mean±SD	
		Working day	Holiday	Working day	Holiday
1	HR (bpm)	90.9±7.4	90.7±7.5	91.5±7.5	90.9±7.5
2	RMSSD (ms)	15.8±4.7	15.7±4.8	14.8±4.6	14.8±4.7
3	Mean RR (ms)	638.5±64.5	625.2±63.2	603.1±69.4	601.9±71.1
4	SDNN (ms)	21.4±6.4	21.2±6.8	21.3±6.8	21.2±6.8
5	SD1 (ms)	10.1±3.6	10.1±3.6	11.9±3.8	11.8±3.8
6	Stress Index	21.5±5.3	20.8±5.3	22.1±6.2	21.4±6.2
7	LF/HF	5.6±3.6	5.6±4.2	5.1±3.1	5.8±3.2

Table 4 presents the differences in HRV variables among homemaker women on working days and holidays, with t-tests used to determine statistical significance.

For Heart Rate and RMSSD, no statistically significant differences were observed ($p=0.168$), suggesting that these parameters remain relatively stable for homemakers regardless of day type. However, significant differences were observed for several other variables. Mean RR, SDNN, SD1, and Stress Index all showed statistically significant differences ($p<0.001$), with Mean RR lower on holidays, and SDNN and SD1 showing significant reductions. The Stress Index was significantly lower on holidays compared to working days. These findings suggest that homemaker women generally experience less stress on holidays, supporting observations by **Yaniv and Lakatta (2015**) that even without significant changes in workload, contextual factors can influence autonomic regulation. The LF/HF ratio showed no significant difference ($p=0.951$), indicating that sympathovagal balance remains relatively consistent regardless of day type for homemakers.

Table 4: Difference in HRV variables among homemaker women on working day and holiday (N=40)

Sr. No.	Variables	Working day (mean)	Holiday (mean)	't' value	'p' value
1	HR (bpm)	90.9	90.7	-1.40	0.168
2	RMSSD (ms)	15.8	15.7	-1.40	0.168
3	Mean RR (ms)	638.5	625.2	-5.96	0.003
4	SDNN (ms)	21.4	21.2	-7.74	0.002
5	SD1 (ms)	10.1	10.1	-7.26	0.009
6	Stress Index	21.5	20.8	-15.91	0.003
7	LF/HF	5.6	5.6	-0.06	0.951

*0.05 significance level

Table 5 examines the differences in HRV variables among working women on working days and holidays. The results reveal significant differences in several variables. Heart Rate showed a significant decrease on holidays ($p=0.001$), suggesting lower cardiovascular stress, which aligns with **Dantas et al.'s (2018)** observations that reduced background stress is reflected in lower resting heart rates. SDNN also decreased significantly on holidays ($p=0.003$), while SD1 and Stress Index both showed highly significant decreases on holidays ($p<0.001$), indicating reduced stress levels. These findings support **Zangróniz et al.'s (2017)** conclusion that individuals with higher baseline stress levels typically show more pronounced improvements in HRV parameters during recuperative periods.

Interestingly, RMSSD, Mean RR, and LF/HF ratio did not show significant differences ($p>0.05$) between working days and holidays for working women. This finding partially contradicts Salazar et al.'s (2024) observation that all HRV parameters typically show improvements during lower- stress periods. The inconsistency suggests that for working women, certain aspects of autonomic regulation may remain altered even during holidays, potentially indicating insufficient recovery time or persistent stress effects.

Table 5: Difference in HRV variables among working women on working day and holiday (N=40)

Sr. No.	Variables	Working day (mean)	Holiday (mean)	't' value	'p' value
1	HR (bpm)	91.5	90.9	-3.59	0.001
2	RMSSD (ms)	14.8	14.8	-0.20	0.844
3	Mean RR (ms)	603.1	601.9	-0.57	0.572
4	SDNN (ms)	21.3	21.2	-3.22	0.003
5	SD1 (ms)	11.9	11.8	-12.49	0.002
6	Stress Index	22.1	21.4	-35.47	0.012
7	LF/HF	5.1	5.8	-0.11	0.912

*0.05 significance level

Table 6 compares HRV variables between working women and homemaker women on working days. Despite visible differences in mean values, particularly for Mean RR and LF/HF ratio, no statistically significant differences were found between the two groups for any of the HRV variables measured (all p-values>0.05). The closest to significance was SD1 (p=0.074), with working women showing a slightly higher mean value. This finding is somewhat unexpected given the theoretical framework that suggests working women should experience higher stress levels. However, it aligns with observations by **Maqbool et al. (2014),** who found that while subjective stress differences existed between working women and homemaker, physiological markers sometimes showed less pronounced differences than expected.

This relative similarity in physiological stress responses between working women and homemakers on working days may indicate compensatory mechanisms or adaptation to chronic stress, as proposed by **Castaldo et al. (2015).** Alternatively, it might suggest that domestic responsibilities impose significant stress regardless of employment status, supporting **Dudra and Jogsan's (2012)** conclusion that different sources of stress can result in similar overall burden levels.

Table 6: Difference in HRV variables among working women and homemaker women on Working day (N=80)

Sr.	Variables	Working women)	Homemaker women)	't'	'p'
1	HR (bpm)	91.5	90.9	-0.13	0.900
2	RMSSD (ms)	14.8	15.8	0.82	0.415
3	Mean RR	603.1	638.5	1.55	0.130
4	SDNN (ms)	21.3	21.4	0.01	0.990
5	SD1 (ms)	11.9	10.1	-1.84	0.074
6	Stress Index	22.1	21.5	-0.51	0.613
7	LF/HF	5.1	5.6	-0.31	0.760

*0.05 significance level

Table 7 presents a comparison of HRV variables between working women and homemaker women on holidays. Most HRV variables did not differ significantly between the two groups on holidays. However, there was a statistically significant difference in Mean RR (p=0.027), with homemaker women showing a higher mean value, suggesting potentially lower stress levels. SD1 approached significance (p=0.059), with working women showing a higher mean value. All other variables showed no significant differences (all p-values>0.05).

This limited differentiation between groups on holidays supports **Arpaci and Sanlier's (2007)** observation that when occupational stressors are removed, baseline differences between working women and homemaker become less pronounced. The significant difference in Mean RR, however, suggests that working women may maintain higher background stress levels even during holidays, potentially due to anticipatory stress or incomplete recovery, a phenomenon noted by **Khodidas (2013)** in comparative studies of mental health between professional women and homemakers.

While working women consistently showed higher stress indices and lower parasympathetic markers (e.g., RMSSD), only Mean RR on holidays (p=0.027) reached statistical significance between groups. Within groups, working women exhibited significant reductions in HR (p=0.001), SDNN (p=0.003), SD1 (p=0.002), and Stress Index (p=0.012) on

holidays, while homemakers showed significant differences in Mean RR (p=0.003), SDNN (p=0.002), SD1 (p=0.009), and Stress Index (p=0.003), highlighting the impact of day type on stress levels.

Table 7: Difference in HRV variables among working women and homemaker women on holiday (N=80)

Sr.	Variables	Working women)	Homemaker women)	't'	'p'
1	HR (bpm)	90.9	90.7	-0.33	0.745
2	RMSSD (ms)	14.8	15.7	0.93	0.360
3	Mean R R	601.9	625.2	2.29	0.027
4	SDNN (ms)	21.2	21.2	0.05	0.963
5	SD1 (ms)	11.8	10.1	-1.95	0.059
6	Stress Index	21.4	20.8	-0.49	0.624
7	LF/HF	5.8	5.6	-0.57	0.571

*0.05 significance level

Table 8 compares HRV variables between working women and homemaker women on working days. t-tests were conducted to assess the statistical significance of differences. Interestingly, the results indicate no statistically significant differences between the two groups for any of the HRV variables measured (all p-values>0.05). The closest to significance was SD1 (p=0.074), with working women showing a slightly higher mean value. Despite the lack of statistical significance, there were some noticeable differences in mean values, particularly for Mean RR and LF/HF ratio. However, these differences were not large enough to be statistically significant. This suggests that on working days, the physiological stress responses of working women and homemaker women, as measured by HRV, are relatively similar.

Table 8: Difference in HRV variables among working women and homemaker women on Working day (N=80)

Sr. No.	Variables	Working women (mean)	Homemaker women (mean)	't' value	'p' value
1	HR (bpm)	91.5	90.9	-0.13	0.900
2	RMSSD (ms)	14.8	15.8	0.82	0.415
3	Mean RR (ms)	603.1	638.5	1.55	0.130
4	SDNN (ms)	21.3	21.4	0.01	0.990
5	SD1 (ms)	11.9	10.1	-1.84	0.074
6	Stress Index	22.1	21.5	-0.51	0.613
7	LF/HF	5.1	5.6	-0.31	0.760

*0.05 significance level

Table 9 presents a comparison of HRV variables between working women and homemaker women on holidays. As with the previous tables, t-tests were used to determine statistical significance. The results show that most HRV variables did not differ significantly between the two groups on holidays. However, there was a statistically significant difference in Mean RR (p=0.027), with homemaker women showing a higher mean value, suggesting potentially lower stress levels. SD1 approached significance (p=0.059), with working women showing a higher mean value. All other variables (HR, RMSSD, SDNN, Stress Index, and LF/HF ratio) showed no significant differences (all p-values>0.05). These findings indicate that while there are some differences in HRV parameters between working women and homemaker women on holidays, these differences are limited, suggesting that both groups experience similar levels of physiological stress on non-working days.

Table 9: Difference in HRV variables among working women and homemaker women on holiday (N=80)

Sr. No.	Variables	Working women (mean)	Homemaker women (mean)	't' value	'p' value
1	HR (bpm)	90.9	90.7	-0.33	0.745
2	RMSSD (ms)	14.8	15.7	0.93	0.360
3	Mean RR (ms)	601.9	625.2	2.29	0.027
4	SDNN (ms)	21.2	21.2	0.05	0.963
5	SD1 (ms)	11.8	10.1	-1.95	0.059
6	Stress Index	21.4	20.8	-0.49	0.624
7	LF/HF	5.8	5.6	-0.57	0.571

*0.05 significance level

These HRV shifts suggest chronic sympathetic dominance in working women, potentially reflecting adaptive autonomic responses to sustained workload, a pattern with broader implications for stress biology (Shaffer & Ginsberg, 2017).

Conclusion

Mental workload/Stress is a very complex subject and measuring stress is not an easy task. There are many markers that could be used, many algorithms that could be applied, and many forms of stress which could be observed. Heart rate variability, being simple and non-invasive, has recently become one of the most popular methods for detecting stress. Still, this is not an easy task, since HRV is not a single value; rather, it consists of many features that can be observed in time domain and frequency domain or using nonlinear analysis. The literature generally reports that, under mental workload, the mean RR, RMSSD, SD1 and SDNN features decrease, while the LF, LF/HF and stress features increase significantly. The study was conducted on working rural women and rural homemaker women, it further reveals similarities in demographic characteristics, with both groups predominantly in the 25-30 age range, having graduate-level education, and belonging to medium-sized joint families. Working women were primarily employed in the private sector, with modest annual incomes, and faced varying commute distances. The analysis of Heart Rate Variability (HRV) parameters provides compelling evidence of the differential mental workload experienced by homemaker women and working women in rural settings. The data consistently indicates that working women face comparatively higher mental workload than homemaker women. This is evidenced by several key physiological indicators: working women exhibited a slightly higher average heart rate (91.5±7.5 bpm) compared to homemaker women (90.9±7.4 bpm), lower RMSSD values (14.8±4.6 ms vs 15.8±4.7 ms), and a lower LF/HF ratio (5.1±3.1 vs 5.6±3.6). Additionally, the Stress Index was found to be higher in working women (22.1±6.2) compared to homemaker women (21.5±5.3). These findings collectively suggest that the demands of balancing professional responsibilities with domestic duties result in increased physiological stress for working women. Working women consistently showed indicators of higher stress levels, including lower Mean RR values. Ultimately, this study advocates for targeted strategies—such as workload redistribution, flexible work policies, and family support systems—to mitigate mental workload and enhance the well-being of rural women, particularly those juggling multiple roles.

Abbreviations

HRV- Heart Rate Variability
ANS - Autonomic Nervous System HR- Heart Rate
RMSSD- Root Mean Square of Successive Differences SDNN- Standard Deviation of all Normal-to-Normal intervals
SD1- Standard Deviation of the first differences of NN intervals LF- Low Frequency
HF- High Frequency SD- Standard Deviation ms- millisecond
NN - Normal-to-Normal intervals bpm - Beats per minute

References

Arpaci, F., and Şanlier, N. (2007). A Study into The Effects of Stress on Woman's Health., *(HSSJ) Humanity Social Sciences Journal,* 2**(2)**, 104-109.

Bosma, H., Marmot, M. G., Hemingway, H., Nicholson, A. C., Brunner, E., and Stansfeld, S. A. (1997). Low job control and risk of coronary heart disease. *Whitehall II (prospective cohort) study*. *BMJ* 314, 558–565.

Castaldo R., Melillo P., Bracale U., Caserta M., Triassi M., and Pecchia L. (2015). Acute mental stress assessment via short term HRV analysis in healthy adults: A systematic review with meta-analysis. *Biomedical Signal Processing and Control*, 18, 370-377.

Cezar-Vaz, M.R., Bonow, C.A., and Da Silva, M.R.S. (2015). Mental and physical symptoms of female rural workers: Relation between household and rural work. *International Journal of Environmental Research and Public Health, 12**(11)**,* 11037-11049.

Dantas, E.M., Kemp, A.H., and Andreão, R.V. (2018). Reference values for short-term resting-state heart rate variability in healthy adults: results from the Brazilian Longitudinal Study of Adult Health-ELSA- Brasil study. Psychophysiology.55**(7)**, e13052.

Donoho, C. J., Seeman, T. E., Sloan, R. P., and Crimmins, E. M. (2015). Marital status, marital quality, and heart rate variability in the MIDUS cohort. *Journal of Family Psychology*, *29***(2)**, 290–295.

Dudra, R.R., and Jogsan, A.Y. (2012). Mental health and depression of working and non-working women. *International Journal of Scientific and Research Publication,* 2**(2).**

Gopher, D. and Donchin, E. 1986. Workload: An examination of the concept. Handbook of Perception and Human Performance, 2: 1-49.

Hashmi, H. A., Khurshid, M., and Hassan, I. (2007). Marital adjustment, stress and depression among working and non-working married women. *Internet Journal of Medical Update*, 2**(1)**,19-26.

Hjortskov, N., Rissén, D., Blangsted, A. K., Fallentin, N., Lundberg, U., and Søgaard, K. (2004). The effect of mental stress on heart rate variability and blood pressure during computer work. *European Journal of Applied Physiology.* 92, 84–89.

Kermane, M. M. 2016. A psychological study on stress among employed women and housewives and its management through progressive muscular relaxation technique (PMRT) and mindfulness breathing. *Journal of Psychology and Psychotherapy*, 6(1): 1-5.

Khodidas, N. Z. (2013). A comparative study of mental health among working women and housewives.
Department of Psychology Saurashtra University Rajkot.

Kim, H. G., Cheon, E. J., Bai, D. S., Lee, Y. H. and Koo, B. H. 2018. Stress and heart rate variability: a meta- analysis and review of the literature. Psychiatry investigation, 15(3): 235.

Kivimäki, M., Nyberg, S. T., Batty, G. D., Fransson, E. I., Heikkilä, K., Alfredsson, L., et al. (2012). Job strain as a risk factor for coronary heart disease: a collaborative meta-analysis of individual participant data. *Lancet* 380, 1491–1497.

Koenig J., and Thayer J.F. (2016). Sex differences in healthy human heart rate variability: a meta-analysis. *Neuroscience and Biobehavioral Reviews,* 64, 288–310.

Maqbool, M., Shrivastava, N., and Pandey, M. (2014). A comparative study of mental health of working women and housewives. *Indian Journal of Health and Wellbeing.* 5**(11),** 1398-1400

Mulder, G., and Mulder, L. J. M. (1981). Information processing and cardiovascular control. *Psychophysiology* 18, 392–402.

Netterstrom, B., Kristensen, T. S., and Sjol, A. (2006). Psychological job demands increase the risk of ischaemic heart disease: a 14-year cohort study of employed Danish men. *European Journal of Cardiovascular Prevention & Rehabilitation,* 13, 414–420.

Rajasekhar, D. and Sasikala, B. (2013). An impact of stress management on employed women, *Language in India*, 13**(4)**, 1930-2940.

Ramesh, R. and Naresh, G. (2011). Women entrepreneur in the new millennium, Research Journal of Social Sciences and Management ,1(6), 235-242.

Salai, M., Vassányi, I., and Kósa, I. (2016). Stress detection using low cost heart rate sensors. *Journal of healthcare engineering*, *2016*(1), 5136705.

Salazar-Martínez, E., Naranjo-Orellana, J., and Sarabia-Cachadiña E. (2024). Heart rate variability: Obtaining the stress score from SDNN values. *Isokinetics and Exercise Science*, 32**(4)**:301-307. doi:10.3233/IES- 230088.

Shaffer, F., Ginsberg, J.P. (2017). An overview of heart rate variability metrics and norms. Front Public Health, 5, 258.

Sonnentag, S., and Bayer, U.V. (2005). Switching Off Mentally: Predictors and Consequences of Psychological Detachment From Work During Off-Job Time. *Journal of Occupational Health Psychology, 10***(4)**, 393-414.

Sultanpur, M. N. (2019). Stress level between housewives and employed women. *International Education & Research Journal*, *5*(6), 20-23.

Wang, Z., Yang, L., and Ding, J. (2005). Application of heart rate variability in evaluation of mental workload. *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi,* 23, 182–184.

Yaniv Y., and Lakatta E.G. (2015). The end effector of circadian heart rate variation: the sinoatrial node pacemaker cell. *BMB Reports,* 48, 677–684

Zangróniz, R., Martínez-Rodrigo, A., Pastor, J. M., López, M. T., and Fernández-Caballero, A. (2017). A Comparison Study of Time-Varying Mental Stress Level Analysis Using Physiological Responses. *Frontiers in Public Health*, 5:258. doi: 10.3389/fpubh.2017.00258