Turkish Journal of Sport and Exercise /
Türk Spor ve Egzersiz Dergisi
http://dergipark.gov.tr/tsed
Year: 2023 - Volume: 25 – Issue 2 - Pages: 255-263
10.15314/tsed.1295102

Turkish Journal of
Sport and Exercise
Türk Spor ve Egzersiz Dergisi
ISSN: 2147-5652
https://dergipark.org.tr/tr/pub/tsed

Examination of Yoga on Heart Rate Variability and Mindfulness Levels

Esin KAPLAN [1A], Abdurrahman AKTOP [2B]

[1] *Burdur Mehmet Akif Ersoy University, Faculty of Sports Science, Burdur, Turkey*
[2] *Akdeniz University, Faculty of Sports Science, Antalya, Turkey*

Address Correspondence to E. KAPLAN: e-mail: ekaplan@mehmetakif.edu.tr

Conflicts of Interest: The author(s) has no conflict of interest to declare.
Copyright & License: Authors publishing with the journal retain the copyright to their work licensed under the ***CC BY-NC 4.0.***
Ethical Statement: It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.

(Date Of Received): 10/05/2023 (Date of Acceptance): 21.07.2023 (Date of Publication): 31.08.2023
A: Orcid ID: 0000-0002-8417-1266 B: Orcid ID: 0000-0002-5009-4004

Abstract

Today, yoga is a beneficial system that is at the forefront in terms of both physical and psychological health. It can be said that yoga is extremely suitable in terms of ensuring the harmony of mind and body. The aim of the study is to examine the effect of yoga practices on heart rate variability and mindfulness levels. A total of 52 women who did and did not do yoga (Mean age= 30.25±5.58) voluntarily participated in the study. Heart rate variability was measured using the emWave Pro Plus (Quantum Intech, Inc. Boulder Creek, CA, USA, designed by the Institute of HeartMath). Using the emWave Pro device, the resting heart rate variability measurements were taken for 5 minutes in the sitting position. For this study, SDNN, RMSSD, MeanHR, LF/HF, and coherence parameters were evaluated. The Mindful Attention Awareness Scale (MAAS) was used to determine the mindfulness levels of the participants. According to the findings, a statistically significant difference was found in favor of the yoga group in the levels of SDNN (p>.005), meanHR (p>.020), and awareness (p>.041)". There is no significant difference in RMSSD (P =.050), LF/HF (P <.232), and Coherence (P <.718) parameters. As a result, yoga practices increase HRV. Also, it can be said that it is an application that helps women to improve their mindfulness levels.

Keywords: Yoga, Heart rate variability, Mindfulness

Yoganın Kalp Atım Hızı Değişkenliği ve Bilinçli Farkındalık Düzeyine Etkisinin İncelenmesi

Özet

Günümüzde yoga hem fiziksel hem de psikolojik sağlık açısından ön planda olan faydalı bir sistemdir. Zihin ve beden uyumunun sağlanması açısından yoganın son derece uygun olduğu söylenebilir. Mevcut çalışmanın amacı yoganın kalp atım hızı değişkenliği ve bilinçli farkındalık düzeyine etkisini incelemektir. Çalışmaya yoga yapan ve yapmayan yaş ortalaması 30.25±5.58 olan toplam 52 kadın gönüllü olarak katılmıştır. Kalp atım hızı değişkenliği ölçümü, emWave Pro Plus (Quantum Intech, Inc. Boulder Creek, CA, USA, designed by the Institute of HeartMath) kullanılarak gerçekleştirilmiştir. emWave Pro+ cihazı kullanılarak oturur pozisyonda 5 dk boyunca dinlenik kalp atım hızı değişkenliği ölçümleri alınmıştır. Bu çalışma için SDNN, RMSSD, MeanHR, LF/HF, Coherence parametreleri değerlendirmeye alınmıştır. Katılımcıların bilinçli farkındalık düzeylerini belirleyebilmek için Mindful Attention Awareness Scale (MAAS) kullanılmıştır. Bulgulara göre, SDNN (p>.005), meanHR (p>.020), ve

farkındalık (p>.041), düzeylerinde yoga yapan grubun lehine istatistiksel olarak anlamlı farklılık bulunmuştur. RMSSD (p=.050), LF/HF (p<.232), ve Coherence (p<.718), parametrelerinde ise anlamlı farklılık gözlenmemektedir. Sonuç olarak yoga uygulamaları KAHD ni artırır. Aynı zamanda kadınların bilinçli farkındalık düzeylerinin de iyileşmesine yardımcı bir uygulama olduğu söylenebilir.

Anahtar kelimeler: Yoga, Kalp atım hızı değişkenliği, Bilinçli farkındalık

INTRODUCTION

Today, yoga is a system that is at the forefront in terms of both physical and psychological health. It can be said that yoga is extremely suitable in terms of ensuring the harmony of mind and body.

Yoga is a completely globalized phenomenon. In India and abroad, adults, children, and young people do yoga in different environments (gyms, schools, homes, work, yoga studios, and temples). Gyms, yoga studios, and schools offer yoga classes in almost every country. We continue to see the manifestations and use of yoga that started more than a century ago in the modern world (48). Yoga is about adapting to the universe itself. It uses a unique geometry to reach the highest level of perception and adaptation (6). Hatha Yoga is the most common form of yoga practices (23). Hatha Yoga is a preparation process for the body to maintain higher energy levels. This preparation begins with the body, breath, mind, and inner self (6). In addition, Hatha Yoga aims to gain control of breath (53).

Yoga-based practices are used as a support in the treatment of many problems such as muscular system diseases (7), chronic low back pain (3, 19), blood pressure (14, 41), multiple sclerosis (MS) (36), obesity (50), schizophrenia (26), cancer (59 , 2), attention deficit-hyperactivity (21). Considering the last 45 years, mental disorders, cardiovascular diseases, and respiratory system disorders are among the diseases supported by yoga practices (25). In addition to physical disorders, yoga has been done frequently to overcome psychological problems such as depression, especially anxiety (14). Huang et al. (24)'s study results show that Hatha Yoga's regular, long-term practices benefits health.

Heart rate variability (HRV) is a tool for estimating autonomous cardiac modulation (32). HRV is an expression of the change of time distance between increasing and decreasing QRS complexes at different time measurements (8). It is believed that temporal fluctuations in heart rate reflect changes in respiratory synchronization exhibitions and autonomous cardiac regulation (9). These changes can be measured by electrocardiography (ECG). ECG is the science and technology to interpret the potential electrical changes that accompany the efficacy of the heart (42). The changes in heart rate can be evaluated by time field (SDNN, SDANN, RMSSD, NN50, SDSD, HRVTI, TINN) and frequency (LF/HF, HF, LF, VLF, ULF) methods (31).

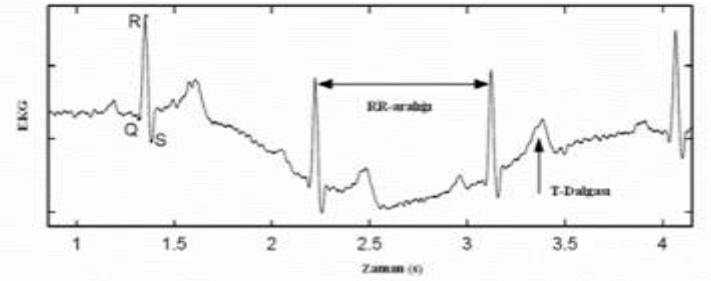

Figure 1. Demonstration of R-R on an ECG record (8)

HRV is used to determine health as an indicator of autonomous regulation (56). Heart rate variability changes depending on stress (physical or mental), exercise, respiratory, age, gender, and metabolism. A problematic experience we encounter during the day can reduce our HRV level. Whereas yoga and meditation practices play an important role in increasing HRV levels (22). Therefore, HRV is a suitable assessment method to evaluate changes in body practices that facilitate autonomous balance (56). In other words, HRV provides a strong way to observe the interaction between parasympathetic and sympathetic nervous systems (44). In the literature, there are studies examining how yoga practices affect heart rate variability in healthy and/or patient individuals (13, 15, 18, 29, 34, 35, 37, 43, 45, 46, 51, 52, 54, 56, 57, 58, 60). In addition, yoga studies show

that asana (posture) practices positively affect muscle strengthening, joint mobilization, respiratory arrangement, cardiovascular and endocrine system balance (19).

Mindfulness is a form of attention and awareness first defined in ancient Eastern meditation traditions and is widely discussed in contemporary Western culture. Mindfulness is defined as individuals' focusing on what is present in an accepting and non-judgmental way (5). In order to increase the level of mindfulness of individuals, practice such as mindfulness meditation (4, 55), Mindfulness-Based Cognitive Therapy and Mindfulness-Based Stress Reduction (MBSR) (55) are used. Mindfulness-Based Stress Reduction (MBSR) program is a program aimed at maintaining the integrity of body, mind, and soul. It generally includes an 8-week program, including daily life activities (such as eating, drinking, walking, and cooking), yoga, and meditation practices. The program requires the behaviors of interest, openness, and acceptance at the current time (27). In order to determine the mindfulness levels of individuals, evaluations can be made through surveys based on self-report. The most commonly used scale as a mindfulness measure in the litis the Mindful Attention Awareness Scale (MAAS). The mindfulness of individuals can also be measured by evaluating the extent to which the person can be aware of his daily activities. MAA S contains substances like "When something happens, I have difficulty focusing on what happened at that moment" or "I run to daily work without realizing what I am doing.". These statements mean that the mind is on autopilot and that internal and external experiences occur without deliberate consideration (12).

Experimental research shows the relationships between heart rate variability (HRV) and the regulation of emotions and behaviours. Similarly, the fact that a person's experience at the present moment is an accepting and non-judgmental focus on one's current experience is a key feature of mindfulness that promotes emotional and behavioral regulation. Furthermore, the ability to regulate one's attention is associated with higher HRV, the correlation between physical and psychological health. Therefore, mindfulness exercises have potential benefits (11).

Studies examining the relationship between yoga and HRV in general focus on factors such as depressive symptoms, mood, and anxiety disorders (1, 15, 16). There are also studies examining the relationship between Mindfulness-Based Yoga and HRV (40, 38). In this study, we wanted to examine the effect of long-term hatha yoga training (at least 6 months) on HRV and mindfulness. In general, being in a state of mindfulness promotes a calm mood (emotional regulation). Differentiation of emotional states also affects heart rate variability. Therefore, this situation can be regulated through yoga practices. Thus, the data obtained from individuals who have been practicing yoga for a long time will contribute to the literature . In this context, the aim of the study is to examine the effect of yoga practices on heart rate variability and mindfulness levels. We hypothesize that women who do yoga have higher heart rate variability parameters and levels of mindfulness than those who do not.

METHOD

Participants

A total of 52 women (30.25 ± 5.58 years) voluntarily participated in the study. Convenience sampling method was used in the study. Convenience sampling is a method in which data is collected from an easily accessible group of people. The individuals in the sample are selected not because they are most representative of the entire population, but because they are most easily accessible to the researcher (47).

In general, the criteria for being included in the yoga group is to practice hatha yoga for at least six (6) months . In addition, for two groups, Individuals who meet the criteria of being between 20-40 years of age, not suffering from systematic discomfort, and not using drugs were included in the study. The participants were divided into two groups as yoga and non-yoga group.

Table 1. Descriptive Statistics

	Groups	N	$\bar{X}$	Sd
Age	Yoga Group	27	30.74	4.80
	Non-Yoga Group	25	29.72	6.38

In Table 1, it is seen that the average age of the yoga group participating in the research is 30.74 ±4.80, while the non-yoga group is 29.72 ±6.38.

Data Collection Tools

Personal Information Form, the Mindful Attention Awareness Scale-(MAAS), and Heart rate variability (HRV) measurements were used as data collection tools.

Personal Information Form

The researchers prepared a personal information form to determine the participants' age, yoga practice, types of yoga, years of yoga, medication use, and systematic disorders.

Heart rate variability (HRV) Measurement

HRV was performed using the emWave Pro+ device of Heartmath. The Blood Volume measurement sensor was placed on the participant's earlobe for measurement. The breathing cycle for each participant was arranged to be 5.5-6 per minute. This breathing rate is at the average resonance frequency of the cardiovascular system for adults (30). For this study, SDNN, RMSSD, MeanHR, LF/HF, and Coherence parameters were evaluated.

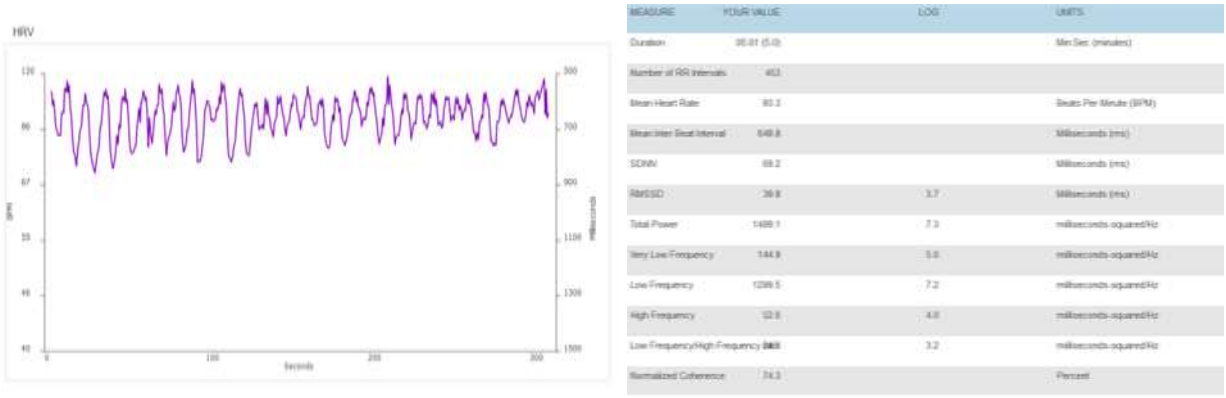

Figure 2. Example figure showing the QRS complex and heart rate variability parameters on the HRV device (emWave Pro+)

Mindful Attention Awareness Scale-(MAAS)

The MAAS developed by Brown and Ryan (10) was adapted into Turkish by Catak (12) in the adult population. The MAAS is designed to measure present-oriented attention and awareness. MAAS consists of 15 items. The six-point Likert-type inventory is scored as 1 (almost always) and 6 (almost no). High scores express high mindfulness. Catak (12) found that MAAS was a valid and reliable tool for evaluating the mindfulness of the Turkish population. Cronbach's Alpha coefficient of the scale is 0.85. In this study, Cronbach's Alpha coefficient was found to be 0.88.

Research Publishing Ethics

Ethics Committee Approval of the study was taken from the Ethics Committee of Burdur Mehmet Akif Ersoy University before starting the research (Decision No: GO 2022/922).

Collection of Data

Before the day of data collection, the participants were asked to avoid strenuous activity and not to consume alcohol and caffeine-containing beverages until at least 2 hours before the application and have a slight meal. Before the measurement, the participants rest in a sitting position for 5 minutes. After the rest, participants in the study first filled out the personal information form and MAAS. Then, using the emWave Pro+ device, the resting heart rate variability measurements were taken for 5 minutes in the sitting position.

Statistical Analysis

An appropriate statistics program was used in the analysis of the data. Z scores were examined to determine the extreme values of the data. Values above -2.50 +2.5 were excluded from the Z scores data. Then, for the values of EM score p> 0.05, loss data assignment was made according to the average of the series. Normality test was performed using Skewness and Kurtosis analysis. According to George and Mallery (20), skewness and kurtosis values should be between ±2.00. An Independent Sample T-test was used to determine the difference between the groups.

Table 2. Score distribution of measurement parameters

	N	$\bar{X}$	Sd	Skewness	Kurtosis	Min.	Max.
SDNN	52	87.07	24.76	.476	-.088	37.70	144.40
RMSSD	52	58.39	30.03	.775	.172	4.70	128.70
LF/HF	52	5.63	4.14	.576	-.576	.00	15.90
MeanHR	52	82.93	11.65	-.086	-.667	57.70	107.60
Coherence	52	67.13	13.29	-.386	-.523	34.70	89.20
Mindfulness	52	64.90	10.60	-.052	-.205	38.00	86.00

SDNNstandard deviation of normal to normal R-R intervals; RMSSDsquare root of the mean squared differences of successive R-R intervals; LF/HFthe ratio of LF to HF; MeanHR mean heart rate ;Coherence psychophysiological coherence

In Table 2. Since the average scores obtained from the parameters did not deviate from the normal distribution, parametric tests were applied in the current study.

RESULT

Table 3. Mindfulness levels and HRV parameter values of the yoga group and non-yoga group

		N	$\bar{X}$	Sd	t	p
SDNN	Yoga Group	27	96.11	23.86	2.929	**.005***
	Non-Yoga Group	25	77.32	22.27		
RMSSD	Yoga Group	27	66.19	30.54	2.005	.050
	Non-Yoga Group	25	49.96	27.62		
LF/HF	Yoga Group	27	6.30	4.29	1.211	.232
	Non-Yoga Group	25	4.91	3.92		
MeanHR	Yoga Group	27	79.34	11.44	-2.412	**.020***
	Non-Yoga Group	25	86.80	10.80		
Coherence	Yoga Group	27	67.78	13.52	.364	.718
	Non-Yoga Group	25	66.43	13.29		
Mindfulness	Yoga Group	27	67.77	10.77	2.097	**.041***
	Non-Yoga Group	25	61.80	9.69		

***p<0.05**

In table 3, a statistically significant difference was observed in favor of the yoga group in SDNN (p>.005), MeanHR (p>.020), and mindfulness (p>.041). There is no significant difference in RMSSD (P = .050), LF/HF (P < .232), and Coherence (P <.718).

DISCUSSION

Yoga is a science that facilitates homeostasis and aims to improve the individual's quality of life. Therefore, yoga practices are recommended to regulate the autonomic nervous system and to influence cardiovascular function (58). According to the current study findings, the SDNN values of the yoga group are higher than the non-yoga group. SDNN is the standard deviation of NN intervals. The parameter that gives the general HRV estimation in the evaluation of HRV is SDNN (31).

When the literature is examined, it is possible to come across studies showing the positive effect of yoga practices on the autonomous system. Papp et al. (39)'s study contains 12 healthy men and women participating in a yoga program once a week (60 minutes/ eight-week). According to the study's results, eight weeks of Hatha Yoga has significantly improved heart rate change. This result shows increased vagal tone and reduced sympathetic activity. Tyagi and Cohen (56)'s review studies suggest that yoga may affect cardiac autonomous

regulation with increased HRV and vagal dominance during yoga practices. It was found that yoga group has increased vagal tones at rest than non-yoga group. According to Vinay et al. (58), the autonomous balance leans towards parasympathetic dominance after a month of yoga practice. Chu et al. (15) study results show that yoga program is effective in increasing parasympathetic tone. They recommend regular yoga practice for women to improve their HRV. Tyagi et al. (57) examined the effects of yoga on HRV, emotion-flow state, and mental stress in individuals with metabolic syndromes. Study results show that yoga practitioners have greater homeostatic capacity, autonomous, metabolic, and physiological flexibility. When the studies evaluating the SDNN parameter in the literature are examined, many studies support the current study findings. Therefore, it can be said that doing yoga increases the SDNN parameter, which is the determinant of HRV.

According to the current study findings, the mean heart rate values of yoga group are lower than non-yoga group. Krishina et al. (28)'s studies examining the effect of heart rate, blood pressure, and cardiac autonomous function on heart failure show a significant decrease in heart rate compared to individuals in the control group of the yoga group. The results of the study by Devasena and Narhere (17) show that there is a significant decrease in heart rate in subjects who practice yoga. Therefore, it can be said that regular yoga practices support the work of the heart.

It is known that yoga practice, especially relaxation techniques and slow pranayama, provides sympathovagal balance and improves HRV (37). However, according to the current study's findings, no statistically significant difference was observed in the LF/HF ratio, which is an indicator of sympathovagal balance. There is disagreement in the literature regarding the LF component. Some studies show LF as a quantitative marker for sympathetic modulations, while others show LF as a parameter reflecting both sympathetic and vagal activity. As a result, the LF/HF ratio is considered by some researchers to reflect sympathovagal balance or to reflect sympathetic modulations (31).

The current study determined the mindfulness levels of women through self-report. The present study findings show that the mindfulness levels of yoga group, and SDNN, the predictor of HRV, are higher than non-yoga group. In the literature, it is possible to come across studies in which mindfulness and HRV are evaluated together. Sun et al. (49) used the Mindful Attention Awareness Scale (MAAS) to determine the level of mindfulness in their studies. The findings of the study show that as mindfulness increases, the ability of the autonomic nervous system to function to protect homeostasis improves Mankus et al. (33). The study of mindfulness and heart rate variability in individuals with high and low anxiety symptoms suggests that mindfulness can increase the parasympathetic effects on the heart rate for high-anxiety individuals.

Studies on mindfulness and HRV in the literature are often experimental. The content of the studies is aimed at examining the effect of mindfulness practices on HRV (55). Yoga and/or meditation practices are included in mindfulness-raising methods, such as the Mindfulness-Based Stress Reduction (MBSR) program and mindfulness meditation. Therefore, yoga and meditation are among the practices to improve mindfulness.

CONCLUSION

As a result, yoga practices increase HRV. It is also a practice that helps to enhance women's mindfulness levels. The limitation of this study is to include only female individuals in the research and only the evaluation of resting HRV parameters. Considering these limitations in future studies, including male individuals in the study may contribute to the literature.

Conflicts of Interest

The authors declare no conflicts of interest

Statement of Researchers' Contribution Rates

Both authors contributed equally at all stages of the research.

Contribution and Acknowledgment

We would like to thank the physical education teacher / yoga instructor Gizem Çıkla and Co-owner YogaKioo Institute Antalya / yoga instructor Onur Çifçi for their support, who helped reach yoga groups during the research process.

REFERENCES

1. Albracht-Schulte, K., & Robert-McComb, J. The effects of yoga and quiet rest on subjective levels of anxiety and physiological correlates: a 2-way crossover randomized trial. BMC Complementary and Alternative Medicine, 2018; 18, 1-11.
2. Arias, A. J., Steinberg, K., Banga, A., & Trestman, R. L. Systematic review of the efficacy of meditation techniques as treatments for medical illness. Journal of Alternative and Complementary Medicine, 2006; 12(8), 817-832.
3. Atılgan, E., and Erbahçeci, F. Kronik bel ağrılı bireylerde yoga ve fizyoterapi programının yaşam kalitesi, denge, ağrı düzeyi ve uyku kalitesi üzerine etkilerinin karşılaştırılması (Comparison of the effects of yoga and physiotherapy program on quality of life, balance, pain level, and sleep quality in individuals with chronic low back pain). Journal of Exercise Therapy and Rehabilitation, 2018; 5(3), 158-166.
4. Azam, M. A., Katz, J., Mohabir, V., & Ritvo, P. Individuals with tension and migraine headaches exhibit increased heart rate variability during post-stress mindfulness meditation practice but a decrease during a post-stress control condition–A randomized, controlled experiment. International Journal of Psychophysiology, 2016; 110, 66-74.
5. Baer, R., Caldera, C., & Nagy, L. M. Mindfulness. In Encyclopedia of Personality and Individual Differences, Cham: Springer International Publishing, 2020: 2898-2908
6. Basavaraddi, I. V. Yoga: Its origin, history and development. Ministry of External Affairs of Government of India, 2015.
7. Birdee, G. S., Legedza, A. T., Saper, R. B., Bertisch, S. M., Eisenberg, D. M., & Phillips, R. S. Characteristics of yoga users: results of a national survey. Journal of General Internal Medicine, 2008; 23(10), 1653-1658.
8. Bilgin, S. Kalp hızı değişkenliğinin dalgacık dönüşümü ve yapay sinir ağları kullanılarak analizi (The analysis of heart rate variability using wavelet transform and artificial neural networks). Doctoral Thesis, Sakarya University, Sakarya; 2008.
9. Billman, G. E. Heart rate variability–a historical perspective. Frontiers in Physiology, 2011; 2, 86.
10. Brown, K. W., and Ryan, R. M. The benefits of being present: Mindfulness and its role in psychological well-being. Journal of Personality and Social Psychology, 2003; 84, 822–848.
11. Burg, J. M., Wolf, O. T., & Michalak, J. Mindfulness as self-regulated attention: Associations with heart rate variability. Swiss Journal of Psychology, 2012; 71(3), 135.
12. Catak, P. D. The Turkish version of mindful attention awareness scale: preliminary findings. Mindfulness, 2012; 3(1), 1-9.
13. Cheema, B. S., Houridis, A., Busch, L., Raschke-Cheema, V., Melville, G. W., Marshall, P. W., Chang, D., Machliss, B., Lonsdale, C., Bowman, J., & Colagiuri, B. Effect of an office worksite-based yoga program on heart rate variability: outcomes of a randomized controlled trial. BMC Complementary and Alternative Medicine, 2013; 13(1), 1-10.
14. Chung, S. C., Brooks, M. M., Rai, M., Balk, J. L., & Rai, S. Effect of Sahaja yoga meditation on quality of life, anxiety, and blood pressure control. The Journal of Alternative and Complementary Medicine, 2012; 18(6), 589-596.
15. Chu, I. H., Lin, Y. J., Wu, W. L., Chang, Y. K., & Lin, I. M. Effects of yoga on heart rate variability and mood in women: A randomized controlled trial. The Journal of Alternative and Complementary Medicine, 2015; 21(12), 789-795.
16. Chu, I. H., Wu, W. L., Lin, I. M., Chang, Y. K., Lin, Y. J., & Yang, P. C. Effects of yoga on heart rate variability and depressive symptoms in women: a randomized controlled trial. The Journal of Alternative and Complementary Medicine, 2017; 23(4), 310-316.
17. Devasena, I., & Narhare, P. Effect of yoga on heart rate and blood pressure and its clinical significance. Int J Biol Med Res, 2011; 2(3), 750-3.
18. Dolgoff-Kaspar, R., Baldwin, A., Johnson, M. S., Edling, N., & Sethi, G. K. Effect of laughter yoga on mood and heart rate variability in patients awaiting organ transplantation: a pilot study. Alternative Therapies, 2012; 18(4), 53-58.
19. Dıraz, N. Kronik bel ağrılı hastalarda yoga temelli egzersizlerin etkinliği (Effects of yoga based exercises on chronic low back pain). Doctoral Thesis, Bursa Uludağ University, Faculty of Medicine, Bursa; 2008.
20. George, D., and Mallery, M. SPSS for windows step by step: A Simple Guide and Reference (10a Ed.). Boston: Pearson, 2010.
21. Harrison, L. J., Manocha, R., & Rubia, K. Sahaja yoga meditation as a family treatment programme for children with attention deficit-hyperactivity disorder. Clinical Child Psychology and Psychiatry, 2004; 9(4), 479-497.
22. Havuş, N. Kalp hızı değişkenliği ve meditasyon (Heart rate variability and meditation). Onto Journal, 2021; 42-46.
23. Hofmann, S. G., Andreoli, G., Carpenter, J. K., & Curtiss, J. Effect of Hatha yoga on anxiety: a meta-analysis. Journal of Evidence-Based Medicine, 2016; 9(3), 116-124.
24. Huang, F. J., Chien, D. K., & Chung, U. L. Effects of hatha yoga on stress in middle-aged women. Journal of Nursing Research, 2013; 21(1), 59-66.
25. Jeter, P. E., Slutsky, J., Singh, N., & Khalsa, S. B. S. Yoga as a therapeutic intervention: a bibliometric analysis of published research studies from 1967 to 2013. The Journal of Alternative and Complementary Medicine, 2015; 21(10), 586-592.
26. Kavak, F. Şizofreni Hastalarında Yoganın İşlevsel İyileşme Düzeyine Etkisi (The effect of yoga on functional recovery level in schizophrenic patients). Doctoral thesis, Atatürk University, Institute of Health Sciences, Erzurum; 2016.
27. Körükcü, Ö., and Kukulu, K. Beden-zihin-ruh bütünlüğünü korumaya yönelik bir program: Farkındalık temelli stres azaltma programı (A Program to Protect Integrity of Body-MindSpirit: Mindfulness Based Stress Reduction Program). Current Approaches in Psychiatry, 2015; 7(1), 68-80.

28. Krishna, B. H., Pal, P., Pal, G. K., Balachander, J., Jayasettiaseelon, E., Sreekanth, Y., Sridhar, M. G., & Gaur, G. S. Effect of yoga therapy on heart rate, blood pressure and cardiac autonomic function in heart failure. Journal of Clinical and Diagnostic Research: JCDR, 2014; 8(1), 14.
29. Kuppusamy, M., Kamaldeen, D., Pitani, R., Amaldas, J., Ramasamy, P., Shanmugam, P., & Vijayakumar, V. Effects of yoga breathing practice on heart rate variability in healthy adolescents: a randomized controlled trial. Integrative Medicine Research, 2020; 9(1), 28-32.
30. Lehrer, P., Vaschillo, B., Zucker, T., Graves, J., Katsamanis, M., Aviles, M., & Wamboldt, F. Protocol for heart rate variability biofeedback training. Biofeedback, 2013; 41(3).
31. Malik, M., Bigger, J. T., Camm, A. J., Kleiger, R. E., Malliani, A., Moss, A. J., & Schwartz, P. J. Heart rate variability: Standards of measurement, physiological interpretation, and clinical use. European Heart Journal, 1996; 17(3), 354-381.
32. Malik, M. Heart rate variability. Current Opinion in Cardiology, 1998; 13(1), 36-44.
33. Mankus, A. M., Aldao, A., Kerns, C., Mayville, E. W., & Mennin, D. S. Mindfulness and heart rate variability in individuals with high and low generalized anxiety symptoms. Behaviour Research and Therapy, 2013; 51(7), 386-391.
34. Markil, N., Whitehurst, M., Jacobs, P. L., & Zoeller, R. F. Yoga Nidra relaxation increases heart rate variability and is unaffected by a prior bout of Hatha yoga. The Journal of Alternative and Complementary Medicine, 2012; 18(10), 953-958.
35. Muralikrishnan, K., Balakrishnan, B., Balasubramanian, K., & Visnegarawla, F. Measurement of the effect of Isha Yoga on cardiac autonomic nervous system using short-term heart rate variability. Journal of Ayurveda and Integrative medicine, 2012; 3(2), 91.
36. Özdoğar, A. T. ve Ertekin, Ö. Multipl Skleroz'da Yoga (Yoga in multiple sclerosis). TFD Nörolojik Fizyoterapi Grubu Bülteni (Neurological Physiotherapy Group Bulletin), 2016; II, 8: 1-7
37. Pal, G. Yoga and heart rate variability. International Journal of Clinical and Experimental Physiology, 2015; 2(1), 2-2.
38. Paniccia, M., Knafo, R., Thomas, S., Taha, T., Ladha, A., Thompson, L., & Reed, N. Mindfulness-based yoga for youth with persistent concussion: a pilot study. The American Journal of Occupational Therapy, 2019; 73(1), 7301205040p1-7301205040p11.
39. Papp, M. E., Lindfors, P., Storck, N., & Wändell, P. E. Increased heart rate variability but no effect on blood pressure from 8 weeks of hatha yoga–a pilot study. BMC Research Notes, 2013; 6(1), 1-9.
40. Pascoe, M. C., Thompson, D. R., & Ski, C. F. Yoga, mindfulness-based stress reduction and stress-related physiological measures: A meta-analysis. Psychoneuroendocrinology, 2017; 86, 152-168.
41. Patel, C. Yoga and biofeedback in the management of hypertension. Journal of Psychosomatic Research, 1975; XIX, 5-6: 355–360.
42. Pehlivan F. Biyofizik (Biophysics). Pelikan Press, 1997: 195. Ankara
43. Posadzki, P., Kuzdzal, A., Lee, M. S., & Ernst, E.Yoga for heart rate variability: a systematic review and meta-analysis of randomized clinical trials. Applied Psychophysiology and Biofeedback, 2015; 40(3), 239-249.
44. Rajendra Acharya, U., Paul Joseph, K., Kannathal, N., Lim, C. M., & Suri, J. S. Heart rate variability: a review. Medical and Biological Engineering and Computing, 2006; 44(12), 1031-1051.
45. Sarang, P., and Telles, S. Effects of two yoga based relaxation techniques on heart rate variability (HRV). International Journal of Stress Management, 2006; 13(4), 460.
46. Satyapriya, M., Nagendra, H. R., Nagarathna, R., & Padmalatha, V. Effect of integrated yoga on stress and heart rate variability in pregnant women. International Journal of Gynecology & Obstetrics, 2009; 104(3), 218-222.
47. Simkus, J. Convenience sampling: Definition, method and examples. Retrieved Oktober, 6, 2022.
48. Singleton, M., & Byrne, J. (Eds.). Yoga in the Modern World. London: Routledge, 2008
49. Sun, S., Hu, C., Pan, J., Liu, C., & Huang, M. Trait mindfulness is associated with the self-similarity of heart rate variability. Frontiers in Psychology, 2019; 10, 314.
50. Tarhan Akbulut, S. Obez kadınlarda yoga tedavisinin denge ve fiziksel uygunluk üzerine etkisi (The balance and physical revelance effect of yoga therapy on obese women). Master Thesis, İstanbul Medipol University, Institute of Health Sciences, İstanbul; 2016.
51. Telles, S., Singh, N., Joshi, M., & Balkrishna, A. Post traumatic stress symptoms and heart rate variability in Bihar flood survivors following yoga: a randomized controlled study. BMC Psychiatry, 2010; 10(1), 1-10.
52. Telles, S., Sharma, S. K., & Balkrishna, A. Blood pressure and heart rate variability during yoga-based alternate nostril breathing practice and breath awareness. Medical Science Monitor Basic Research, 2014; 20, 184.
53. Theos, B. Hatha Yoga: the Report of a Personal Experience. Rider & Company, 1976
54. Tuna, M. E., Aras, D., Aras, N., Özçelik, M. A., & Aktop, A. Acute Changes in Energy Expenditure and Heart Rate Variability During and Right After One Hour of Hatha Yoga Practice. Polish Journal of Sport and Tourism, 2020; 27(4), 29-35.
55. Tung, Y. H., and Hsieh, J. C. The impacts of mindfulness on heart rate variability: a brief review. International Journal of Pharma Medicine and Biological Sciences, 2019; 8, 132-7.
56. Tyagi, A., and Cohen, M. Yoga and heart rate variability: A comprehensive review of the literature. International Journal of Yoga, 2016; 9(2), 97.
57. Tyagi, A., Cohen, M., Reece, J., Telles, S., & Jones, L. Heart rate variability, flow, mood and mental stress during yoga practices in yoga practitioners, non-yoga practitioners and people with metabolic syndrome. Applied Psychophysiology and Biofeedback, 2016; 41(4), 381-393.
58. Vinay, A. V., Venkatesh, D., & Ambarish, V. Impact of short-term practice of yoga on heart rate variability. International Journal of Yoga, 2016; 9(1), 62.

59. Yağlı Vardar, N. Meme kanseri geçirmiş hastalarda aerobik egzersiz eğitiminin ve yoga temelli egzersiz programının fonksiyonel kapasite ve yaşam kalitesi üzerine etkilerinin karşılaştırılması (comparison of the effects of aerobic exercise training and yoga based exercise on functional capacity and quality of life in breast cancer survivors). Doctoral Thesis, Hacettepe University, Institute of Health Sciences; 2012.

60. Zou, L., Sasaki, J. E., Wei, G. X., Huang, T., Yeung, A. S., Neto, O. B., Chn, K. W., & Hui, S. S. C. Effects of mind–body exercises (Tai Chi/Yoga) on heart rate variability parameters and perceived stress: A systematic review with meta-analysis of randomized controlled trials. Journal of Clinical Medicine, 2018; 7(11), 404.