Scripta Scientifica Medica, 2023;55(4):30-34
DOI: 10.14748/ssm.v55i2.9845

ISSN 0582-3250 (Print)
ISSN 1314-6408 (Online)

REVIEWS

CURRENT ASPECTS OF THE EFFECT OF BIOFEEDBACK TRAINING ON FOOD INTAKE AND DEVELOPMENT OF DIABETES MELLITUS: A MINI REVIEW

Gabriela Panayotova, Antoniya Hachmeriyan, Katharina Brüggemann, Sebastian Scholz

Department of Physiology and Pathophysiology, Faculty of Medicine, Medical University of Varna, Bulgaria

ABSTRACT

INTRODUCTION: Heart rate variability training is gaining attention for its potential to influence emotional management and eating behaviors. With obesity and emotional eating recognized as contributors to the onset of diabetes mellitus, exploring interventions such as heart rate variability training holds promise for addressing these interconnected health concerns.

AIM: Through a detailed examination of diverse publications, the paper aims to reveal the relationship between heart rate variability training, emotional eating patterns, and decreasing the risk factors for developing diabetes mellitus.

MATERIALS AND METHODS: In order to find the most recent information on human clinical trials conducted in the past ten years (2013–2023) using representative keywords, the team conducted a comprehensive search of the most accurate scientific web databases, such as PubMed, Scopus, Web of Science, and Google Scholar. In this review, the authors have focused on the role of heart rate variability training on food intake and the development of diabetes mellitus.

RESULTS: According to the research that is currently available, emotional eating is linked to overeating, obesity, and bad eating habits. Emotional eating also appears to be associated with an uptick in depression symptoms. Heart rate variability training has a significant impact on emotional regulation. Hence, working on improving the patient's mood and reducing the symptoms of depression might lower overeating and stabilize blood glucose levels.

CONCLUSION: The implications of this research are significant, as they contribute to understanding non-pharmacological interventions in diabetes mellitus management and prevention, providing a potential new perspective on lifestyle modifications.

Keywords: *heart rate variability, biofeedback training, emotional eating, insulin resistance, diabetes mellitus*

Address for correspondence:
Gabriela Panayotova
Faculty of Medicine
Medical University of Varna
55 Marin Drinov St
9002 Varna, Bulgaria
e-mail: gabrielapanayotova95@gmail.com

Received: October 28, 2023
Accepted: December 3, 2023

INTRODUCTION

Heart rate variability (HRV) corresponds to the variation in the time intervals between consecutive heartbeats (1). It measures neurocardiac function and is generated by heart-brain interactions and dynamic non-linear autonomic nervous system (ANS) activities. Heart rate variability is an emergent characteristic of interdependent regulatory systems that

© The Author(s) 2023. This is an open access article distributed under the Creative Commons Attribution License (CC BY), which permits unrestricted use, distribution and reproduction in any medium, provided the original work is properly cited.

aid in our adaptation to psychological and environmental challenges by acting on distinct time scales. It indicates how well ANS controls various body processes, including blood pressure, gas exchange, digestive activity, heart function, and cardiovascular tone, which determines the diameter of blood vessels and regulates blood pressure. It may also affect facial muscles and their contractions (2).

High HRV is critical to better emotional wellbeing (3–5). It is a state characterized by reduced levels of stress and rumination (6), decreased anxiety (7), and overall improved management of emotions (8). Therefore, people with higher HRV demonstrate greater skills in emotional responses during conversations and enjoy a more balanced emotional state (9).

On the other hand, emotional eating refers to the tendency to consume food as a reaction to emotions, particularly stress (10). Changes in HRV can predict the next episode of emotional eating (11). That is why different programs, such as biofeedback training focused on improving the HRV, are gaining attention for their potential to influence emotional management and eating behaviors. With obesity and emotional eating recognized as contributors to the onset of diabetes mellitus, exploring interventions such as HRV training holds promise for addressing these interconnected health concerns (12).

AIM

The paper aims to analyze existing scientific data on the relationship between HRV, emotional eating patterns, and risk factors for developing insulin resistance and diabetes mellitus. Additionally, it seeks to explore the role of biofeedback training in promoting healthy eating habits.

MATERIALS AND METHODS

To compile and analyze the most recent and relevant information for this review, the team conducted a comprehensive search of reputable scientific databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search focused on literature published in the past ten years (2013–2023), utilizing keywords such as emotional eating, overeating, psychological disorders, stress, depression, anxiety, obesity, overweight, weight gain, body mass index, appetite, HRV, and related terms.

The selected articles were evaluated for their relevance to HRV, emotional eating, and diabetes mellitus risk factors. Only studies with robust methodological designs and clear relevance to the review objectives were considered. In addition, references within these articles were examined to further identify supporting literature.

This approach ensures that the review incorporates a diverse and comprehensive set of findings, providing a solid foundation for discussing the role of biofeedback training in promoting healthy eating habits and mitigating risk factors for insulin resistance and diabetes mellitus.

RESULTS

Our research encompassed a range of clinical trials conducted over the past decade (2013–2023), delving into the intricate relationship between HRV, emotional eating patterns, and the multifaceted risk factors associated with insulin resistance and diabetes mellitus.

Impact of HRV on Emotional Eating Patterns

Evidence from various studies consistently underscored a significant inverse relationship between HRV and emotional eating patterns (11,13,14). Individuals with higher HRV levels tended to exhibit lower tendencies towards emotional eating, as evidenced by validated questionnaires assessing emotional eating behaviors (4). For instance, Godfrey et al. (2019) demonstrated a significant correlation between HRV and emotional eating scores, indicating that ANS activity is associated with losing control of eating and overeating (31). The results suggest that HRV may be a feasible marker of emotion regulation of different eating habits (15).

Effectiveness of Biofeedback Training

Biofeedback training emerged as a promising therapeutic modality for enhancing HRV and ameliorating emotional eating behaviors (15). Importantly, findings support Kaplan & Kaplan's Psychosomatic Theory, according to which people prone to be emotional eaters (eating in response to external cues) respond to elevated stress or negative emotional arousal by engaging in excessive food consumption (16). These mood changes result from a prevalent sympathetic activity and decreased HRV. Therefore, incorporating biofeedback training into the treatment plan to enhance HRV and regulate auto-

nomic activity can reduce the inclination towards emotional eating by disrupting the physiological sequence that triggers it. Through biofeedback techniques, individuals can be trained to consciously manage their autonomic nervous system activity, enabling them to modulate their HRV. Modulation of different protocols that include various breathing techniques can act as a protective barrier against stressors and challenging emotional states that could otherwise lead to overeating (17–20). In addition, individuals who achieved prolonged biofeedback training also showed a lowered tendency to engage in emotional eating. That indicates that interventions focused on improving HRV may have two-fold advantages: enhancing autonomic function and regulating unhealthy eating habits linked to emotional distress (18,21).

Association with Diabetes Mellitus Risk Factors

Several investigations have provided a clear understanding of the complex relationship between HRV, emotional eating, and risk factors for diabetes mellitus. Higher emotional eating scores consistently correlate with elevated risk variables for diabetes mellitus, such as insulin resistance and obesity (12,22). Frayn et al. (2018) found an immediate association between emotional eating scores and insulin resistance indicators in obese individuals. That highlights the possible contribution of emotional eating behaviors to metabolic dysregulation (26).

Other research has demonstrated that some HRV training protocols provide coherence-building techniques that significantly reduce crucial health-risk factors (e.g., blood pressure, glucose, cholesterol) and improve health status and quality of life in various populations.

These techniques combine an intentional shift in attention to the physical area of the heart with the self-induction of a positive emotional state (23). This process rapidly shifts to increased heart rhythm coherence. That, in turn, changes the pattern of afferent cardiac signals sent to the brain, reinforcing the self-generated positive emotional shift and making it easier to sustain. The effect refers to inhibited stress reaction and lack of overeating (24). That significantly improves glycemic regulation and quality of life in patients with diabetes mellitus (25).

These findings emphasize the significance of addressing emotional eating habits in those who are at risk of developing diabetes mellitus since these behaviors may contribute to the advancement of insulin resistance and subsequent metabolic disorders (26).

Role of Biofeedback Training in Promoting Healthy Eating Habits

Biofeedback training has emerged as a potential technique for developing healthy eating habits and reducing the incidence of diabetes mellitus. It provides a comprehensive method for addressing the interconnections between autonomic dysfunction, emotional eating patterns, and metabolic health by improving HRV and promoting emotional regulation. Integrating biofeedback training into lifestyle interventions shows potential for individuals who are at risk of developing diabetes mellitus. This technique offers a specific and focused method for adjusting the physiological and psychological aspects of the disease's development (27,28).

LIMITATIONS

It is essential to recognize the constraints of the present investigation, such as the dependence on cross-sectional data and the possibility of confounding variables impacting study results. Furthermore, the applicability of our findings may be restricted by the specific criteria used to select studies and the characteristics of the sample.

Additional research using strong longitudinal methodologies and different study populations is necessary to confirm our findings and clarify the broader significance of biofeedback training concerning metabolic health.

DISCUSSION

The research clarifies the possible use of biofeedback training as a non-pharmacological therapy for controlling physiological and psychological aspects involved in developing and advancing metabolic diseases (18, 19, 24).

Recent studies have shed light on the practical implications of HRV and emotional regulation in eating behaviors. The negative correlation between HRV and emotional eating tendencies suggests that individuals with elevated HRV may have a reduced inclination toward emotional eating (11,17). This in-

sight could be instrumental in developing interventions to control unhealthy eating habits triggered by emotional discomfort (21, 29).

Furthermore, emotional eating habits harm metabolic health, as higher emotional eating scores are associated with more significant risk factors for insulin resistance and diabetes mellitus (10,12). These findings accentuate the need to target emotional eating behaviors in interventional therapies to reduce the risk of metabolic problems (22,30).

Moreover, these findings underline the potential of biofeedback training as a tailored intervention approach for patients at a high risk of acquiring diabetes mellitus (24). Biofeedback training provides a perspective on addressing physiological and psychological aspects contributing to the development of such metabolic diseases. (18,24). It helps reduce metabolic risk factors, such as cortisol levels, high blood pressure, and elevated glucose levels, and encourages adopting healthy eating habits (13,28,29).

CONCLUSION

The current review supports the positive impact of biofeedback training on HRV and emotional eating habits. However, it is essential to recognize that there may be variations in the groups of people who studied the methods used in the interventions and how the outcomes were measured. Differences in how studies are conducted can lead to differences in results, highlighting the importance of more research to clarify the best conditions for using biofeedback therapies to improve metabolic health.

Biofeedback training provides a novel approach to improving metabolic health and encouraging good eating habits by targeting physiological and psychological aspects of metabolic dysregulation. Future research should prioritize investigating the intimate mechanisms entangled in this approach's therapeutic effects. If we understand them, we can implement biofeedback training in everyday life, helping people cope easily with chronic stress and reducing the incidence of insulin resistance and diabetes mellitus.

REFERENCES

1. McCraty R, Shaffer F. Heart Rate Variability: New Perspectives on Physiological Mechanisms, Assessment of Self-regulatory Capacity, and Health risk. Glob Adv Health Med. 2015 Jan;4(1):46-61. doi: 10.7453/gahmj.2014.073.
2. Schwartz, Mark S., and Frank Andrasik, eds. Biofeedback: A practitioner's guide. Guilford Publications; 2017
3. Beauchaine TP, Thayer JF. Heart rate variability as a transdiagnostic biomarker of psychopathology. Int J Psychophysiol. 2015 Nov;98(2 Pt 2):338-50. doi: 10.1016/j.ijpsycho.2015.08.004.
4. Kemp AH, Quintana DS. The relationship between mental and physical health: insights from the study of heart rate variability. Int J Psychophysiol. 2013 Sep;89(3):288-96. doi: 10.1016/j.ijpsycho.2013.06.018.
5. Shaffer F, McCraty R, Zerr CL. A healthy heart is not a metronome: an integrative review of the heart's anatomy and heart rate variability. Front Psychol. 2014 Sep 30;5:1040. doi: 10.3389/fpsyg.2014.01040.
6. Ottaviani C, Thayer JF, Verkuil B, Lonigro A, Medea B, Couyoumdjian A, et al. Physiological concomitants of perseverative cognition: A systematic review and meta-analysis. Psychol Bull. 2016 Mar;142(3):231-59. doi: 10.1037/bul0000036.
7. Chalmers JA, Quintana DS, Abbott MJ, Kemp AH. Anxiety Disorders Are Associated with Reduced Heart Rate Variability: A Meta-Analysis. Front Psychiatry. 2014 Jul 11;5:80. doi: 10.3389/fpsyt.2014.00080.
8. Appelhans BM, Luecken LJ. Heart rate variability as an index of regulated emotional responding. Rev Gen Psychol. 2006;10(3):229-40.
9. Mather M, Thayer J. How heart rate variability affects emotion regulation brain networks. Curr Opin Behav Sci. 2018 Feb; 19:98-104. doi: 10.1016/j.cobeha.2017.12.017.
10. Buja A, Manfredi M, Zampieri C, Minnicelli A, Bolda R, Brocadello F, et al. Is emotional eating associated with behavioral traits and Mediterranean diet in children? A cross-sectional study. BMC Public Health. 2022 Sep 22;22(1):1794. doi: 10.1186/s12889-022-14192-8.
11. Juarascio AS, Crochiere RJ, Tapera TM, Palermo M, Zhang F. Momentary changes in heart rate variability can detect risk for emotional eating episodes. Appetite. 2020 Sep 1;152:104698. doi: 10.1016/j.appet.2020.104698.
12. Tsenkova V, Boylan JM, Ryff C. Stress eating and health. Findings from MIDUS, a national study

of US adults. Appetite. 2013 Oct; 69:151-5. doi: 10.1016/j.appet.2013.05.020.

13. Ranzenhofer LM, Solhjoo S, Crosby RD, Kim BH, Korn R, Koorathota S, et al. Autonomic indices and loss-of-control eating in adolescents: an ecological momentary assessment study. Psychol Med. 2023 Jul;53(10):4742-50. doi: 10.1017/S0033291722001684.

14. Kim JY, Kang HL, Kim DK, Kang SW, Park YK. Eating Habits and Food Additive Intakes Are Associated with Emotional States Based on EEG and HRV in Healthy Korean Children and Adolescents. J Am Coll Nutr. 2017 Jul;36(5):335-41. doi: 10.1080/07315724.2017.1281774.

15. Young HA, Benton D. Heart-rate variability: a biomarker to study the influence of nutrition on physiological and psychological health? Behav Pharmacol. 2018 Apr;29(2 and 3-Spec Issue):140-51. doi: 10.1097/FBP.0000000000000383.

16. Kaplan HI, Kaplan HS. The psychosomatic concept of obesity. J Nerv Ment Dis. 1957 Apr-Jun;125(2):181-201. doi: 10.1097/00005053-195704000-00004.

17. Fuentes N, Nazar G, Sánchez-Hechavarría ME. Cardiac Vagal Imbalance and Emotional Eating. In: Patel V, Preedy V, editors. Eating Disorders. Springer, Cham; 2022.

18. Meule A, Freund R, Skirde AK, Vögele C, Kübler A. Heart rate variability biofeedback reduces food cravings in high food cravers. Appl Psychophysiol Biofeedback. 2012 Dec;37(4):241-51. doi: 10.1007/s10484-012-9197-y.

19. Chaitanya S, Datta A, Bhandari B, Sharma VK. Effect of Resonance Breathing on Heart Rate Variability and Cognitive Functions in Young Adults: A Randomised Controlled Study. Cureus. 2022 Feb 13;14(2):e22187. doi: 10.7759/cureus.22187.

20. Meule A, Kübler A. A Pilot Study on the Effects of Slow Paced Breathing on Current Food Craving. Appl Psychophysiol Biofeedback. 2017 Mar;42(1):59-68. doi: 10.1007/s10484-017-9351-7.

21. Maier SU, Hare TA. Higher Heart-Rate Variability Is Associated with Ventromedial Prefrontal Cortex Activity and Increased Resistance to Temptation in Dietary Self-Control Challenges. J Neurosci. 2017 Jan 11;37(2):446-55. doi: 10.1523/JNEUROSCI.2815-16.2016.

22. Danielsson A, Fagerholm S, Ost A, Franck N, Kjolhede P, Nystrom FH, et al. Short-term overeating induces insulin resistance in fat cells in lean human subjects. Mol Med. 2009 Jul-Aug;15(7-8):228-34. doi: 10.2119/molmed.2009.00037.

23. McCraty R. Following the Rhythm of the Heart: HeartMath Institute's Path to HRV Biofeedback. Appl Psychophysiol Biofeedback. 2022 Dec;47(4):305-16. doi: 10.1007/s10484-022-09554-2.

24. Orlando FA, Rahmanian KP, Byrd CE, Chang KL, Yang Y, Carek PJ, et al. Daily self-regulation with biofeedback to improve stress and job satisfaction in a primary care clinic. J Family Med Prim Care. 2021 Feb;10(2):968-73. doi: 10.4103/jfmpc.jfmpc_1820_20

25. Tsuji H, Venditti FJ Jr, Manders ES, Evans JC, Larson MG, Feldman CL, et al. Reduced heart rate variability and mortality risk in an elderly cohort. The Framingham Heart Study. Circulation. 1994 Aug;90(2):878-83. doi: 10.1161/01.cir.90.2.878.

26. Frayn M, Livshits S, Knäuper B. Emotional eating and weight regulation: a qualitative study of compensatory behaviors and concerns. J Eat Disord. 2018 Sep 14;6:23. doi: 10.1186/s40337-018-0210-6.

27. Kautzky A, Heneis K, Stengg K, Fröhlich S, Kautzky-Willer A. Short Term Caloric Restriction and Biofeedback Enhance Psychological Wellbeing and Reduce Overweight in Healthy Women. J Pers Med. 2021 Oct 26;11(11):1096. doi: 10.3390/jpm11111096.

28. Liu Z, He W, Fang R, Xiao G, Yan F, Qiu Q, et al. [Lifetide biofeedback intervention in type 2 diabetic patients: a pilot observation]. Nan Fang Yi Ke Da Xue Xue Bao. 2023 Sep 20;43(9):1622-8. Chinese. doi: 10.12122/j.issn.1673-4254.2023.09.21.

29. Caso D, Miriam C, Rosa F, Mark C. Unhealthy eating and academic stress: The moderating effect of eating style and BMI. Health Psychol Open. 2020 Nov 30;7(2):2055102920975274. doi: 10.1177/2055102920975274.

30. Tyagi K, Agarwal NB, Kapur P, Kohli S, Jalali RK. Evaluation of Stress and Associated Biochemical Changes in Patients with Type 2 Diabetes Mellitus and Obesity. Diabetes Metab Syndr Obes. 2021 Feb 16;14:705-17. doi: 10.2147/DMSO.S294555.

31. Godfrey KM, Juarascio A, Manasse S, Minassian A, Risbrough V, Afari N. Heart rate variability and emotion regulation among individuals with obesity and loss of control eating. Physiol Behav. 2019;199:73-8. doi: 10.1016/j.physbeh.2018.11.009.