



Research Models and Practices Pertaining to Carnatic Music Therapy- Where We Stand??

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ABSTRACT

Carnatic music therapy has been known to exist since vedic times. However, when compared to music therapy studies from the West, not much of active research has been pursued in the field of Carnatic music therapy. This could be due to the fact that proper hypothesis drafting and organized research design is lacking in most of the studies. This review article gives an insight into the various research models available and also enriches the reader on how to design a Carnatic music therapy study.

Key Words: *Carnatic Music Therapy, Research Models, Experimental Research, Clinical Research, Epidemiological Research.*



INTRODUCTION

The carnatic music tradition is a form that has its roots in the southern states of India. It is a musical form which has been in vogue from the ancient times till date. Infact, carnatic music has been used to cure illness since the 9th century. This gives the reader a picture as to how old and ancient, the practice of music therapy is in our country. It is well known that India is a land with a glorious and golden past. Even though, the scientific practice of music therapy has been in existence for the past 30 years in various parts of the globe, Carnatic music therapy as a specialized branch has not received adequate importance and visibility. In fact, the use of ragas to cure diseases has been referred to in the scriptures as ragachikitsa and several ragas have been known to have significant curative powers¹. Evidence from a recently published bibliometric analysis has cited the use of music therapy as an adjunct to address physiological, psychological, social and behavioral disorders in the human race². The results of this scientifically performed analysis has revealed that between 2000 and 2020, 1004 music therapy studies have been performed. The United States of America tops the list with a total of 362 publications. Norway has recorded the maximum number of citations, while Austria has demonstrated the highest number of music research collaborations. It is also noteworthy that Melbourne has been regarded most productive with regard to music therapy research². From the bibliometric analysis, it could be perceived that Western music and musical forms predominate the music therapy research scene in the globe rather than Indian musical forms. Despite the fact that Indian music is ancient in origin and carnatic music therapy traces its origin way back to 9th century, it is intriguing that carnatic music therapy research is still in its nascent stage and has not attained global significance.

The reasons that could be attributed to the absence of a significant number of publications in the field of carnatic music therapy could be the fact that research methodologies and research models have not been devised and employed in a scientific manner in this research domain. The present review sheds light on important components of research in biomedical science and explains all the research models that could be used by carnatic music therapy researchers to make their findings more valid and publishable.

Definition Of Research and Types of Research in Biomedical Science

Research is defined as the creation of new knowledge and/or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings. The practice of medicine and the field of biomedical science has been constructed based on valuable research findings which form the basis of understanding the aetopathogenesis of various diseases and the methodology to treat the ailments. When discussing about research, it is apt to define a



research model which is described as a theoretical image of the object of study. A model can be considered a useful way of describing or explaining interrelationships of ideas. It is always considered worthwhile to plot a research model based on a pre-planned hypothesis prior to performing the actual research per se.

With regard to research in medicine and biomedical areas, 3 broad types are being recognized significant, namely, basic/experimental research, clinical research and epidemiological research³. Basic or experimental research revolves around experiments done on in vitro systems and cell lines in addition to experiments performed on animals. Analysis of biomarkers in samples obtained from human subjects with disease also forms an essential component of basic / experimental research. Clinical research generally encompasses interventional studies performed on humans to assess the efficacy of one treatment modality over the other and could be randomized or non-randomized. Epidemiological studies refer to population level studies to assess the prevalence, incidence of disease and to assess the effects of certain health policies.

Epidemiological research could involve population based questionnaire studies. With regard to music therapy, all the 3 types of research namely basic/experimental, clinical and epidemiological have been performed. Evidences in this connection can be mined from published data. With regard to carnatic music therapy, the applications of music therapy research done world over till date has to be used as a template to plan future studies as we reiterate at this point that research in carnatic music therapy is very scanty with very few articles published.

Basic /Experimental Research in Music Therapy

As earlier described, basic/experimental research forms the base of the pyramid with regard to research methodologies. In this form of research, cell lines, animals, in vitro systems are used mainly to study diseases. Analysis of samples obtained from patients for biochemical, serological and genetic markers also falls under the category of basic research.

With regard to cell line based experiments, a study has been performed assessing the effects of music exposure on gastric carcinoma cell lines also called AGS cells⁴. It was observed that exposure to heavy metal music increased the proliferation of the AGS cells while exposure to western classical music reduced proliferative activity. Moreover, it was found that caspase 3, 8 and cyclin B1 expression reduced in the cell lines upon music exposure⁴. This novel in vitro study revealed the subtle molecular effects exerted by music exposure on cells. Other studies have also focused on the effect of music exposure on various somatic and cancer cells. A study on the MCF-7 breast cancer cell line found Mozart and Ligetti's music pieces to cause apoptosis and reduced viability of the cancer cells⁵. A similar study on prostate carcinoma cell line exposed to Quranic recitation found reduced proliferation and viability denoting anti-cancer effects of Quranic



music⁶. Music exposure not only has been found to affect human cells, but can also affect microbial growth and viability. In this connection, a study performed on exposure of *Serratia marcescens*, *Chromobacterium violaceum*, *Xanthomonas campestris*, *Saccharomyces cerevisiae*, *Lactobacillus plantarum*, *Bacillus parabrevis* to ahiri bhairav and piloo ragas found distinct antimicrobial activity exerted by the ragas⁷. Another study on the same microbial set up found antimicrobial effects exerted by the raga Malhar⁸.

In connection with animal studies, plenty of data is available to demonstrate the use of animal models in music therapy research. An animal study performed on 2 week old mice demonstrated enhanced expression of NR2B protein and NMDA upregulation in the music treated animals with better hippocampal development compared to the music non exposed animal group⁹. The profound effect of music on elevation of neurochemicals and neurotransmitters such as ACTH, dopamine and cortisol has been demonstrated in male wistar rats exposed to traditional Chinese-5 element music therapy¹⁰. Another interesting study on 40 male wistar rats using an asthma stress model found that music exposure reduced IL-4 cytokine levels and also dramatically decreased eosinophil and total leukocyte numbers¹¹. This finding reveals the subtle effects of music on the immune system. With regard to immune mediated cancer development, a study has found that exposure of mice to broadband music for 5 hours daily after injection with carcinoma cell lines reduced the development of metastatic nodules and also caused immunoenhancement. This finding was contrast to the control music unexposed mice which quickly developed metastatic nodules¹². Other than the rodent model, the zebrafish model has also been used in music therapy research. A study on zebrafish exposed to Vivaldi music found increased auditory enrichment and enhanced metabolism in the fish compared to the music unexposed group¹³.

With regard to analysis of biochemical, serological and genetic markers, there are a few studies available. The levels of the hormone cortisol, a marker of emotional stress in saliva has been found to reduce upon music listening and exposure. This biochemical marker has been employed abundantly in music therapy research^{14,15,16}. Another interesting basic research in music therapy has focused on the genetic effects of music¹⁷. A study on music exposed and music learned individuals found the elevation of six microRNAs (hsa-miR-132-3p, hsa-miR-361-5p, hsa-miR-421, hsa-miR-23a-3p, hsa-miR-23b-3p, hsa-miR-25-3p) and downregulation of two microRNAs (hsa-miR-378a-3p, hsa-miR-16-2-3p) compared to music non exposed individuals. This study shows the epigenetic effects exerted by music therapy and learning which could further afford protection from many diseases such as diabetes mellitus type 2, Alzheimer's disease and cardiovascular disease.

From the evidences gathered so far, it appears that there is ample basic research that is available in the field of music therapy so far.



Clinical Research in Music Therapy

There has been ample clinical research performed in the field of music therapy for the past 30 to 40 years. Studies on patients with Alzheimer's disease¹⁸, cancer pain¹⁹, anxiety²⁰, depression²¹, pain from obstetric²², orthopedic²³ and cardiovascular²⁴ procedures have also demonstrated the superior effects of music therapy in pain alleviation.

All the above studies have been performed as clinical interventional studies with or without randomization and can be regarded as clinical trials. Standard pain relieving drugs have been used in the studies as a comparison group and indices to evaluate pain, stress and anxiety have been employed to assess the effects of music therapy. Some studies have also employed salivary markers such as cortisol to evaluate the reduction of stress and anxiety following music exposure.

Epidemiological Research in Music Therapy Research

Epidemiological research mainly focuses on the incidence and prevalence of human diseases and also uses statistical tools to measure disease burden in human populations. With regard to music therapy, only a few questionnaires based surveys are available to assess the awareness of populations, medical practitioners and researchers about the existence of a field called music therapy and its applications in disease management^{25,26,27}.

Research Methods That Have Been Followed in Carnatic Music Therapy

The above mentioned literature and supporting reference demonstrate the applications of basic/experimental research, clinical research and epidemiological research in music therapy. It is noteworthy that all the 3 types of research have not been employed in Carnatic music therapy. There is no evidence for basic/experimental research and epidemiological research in the field of Carnatic music therapy. No data is available with regard to effect of Carnatic music ragas on cell lines, cancer lines and animal models. Questionnaire based surveys on the awareness about Carnatic music therapy among medical professionals and patients have also not been performed till date.

All the studies performed in the field of Carnatic music therapy fall under the category of clinical research performed on human patients. In this connection, Carnatic ragas have been tested for their therapeutic abilities. A recently published case report highlights the positive effects of about 40



carnatic ragas on a patient with schizophrenia over 8 years administered in the form of 4 phases²⁸. A study of Carnatic ragas and their effects on depression and self-esteem in 132 adults with unipolar depression has found that the ragas Atana, Kanada, Mohanam, Revagupti and Neelambari have significant effects on the Beck's Depression Inventory (BDI) and Rosenberg's Self-esteem Scale scores of the patients and helped them combat depression and low self-esteem²⁹. A study on 15 institutionalized adults has found significant physical, psychological and social benefits of Carnatic music therapy provided by a physician although the therapy details have not been fully provided³⁰. Another interesting study on 18 women with anxiety, depression, stress and negativity found positive effects the ragas Bilahari, Shankarabaranam, Kannada and Vakulabharanam. While Kannada and Vakulabharanam caused reduction in anxiety and induced calmness, Bilahari and Shankarabaranam induced cheerful attitude, optimism and positivity in the participants³¹. In a hospital setting study on patients with traumatic brain injury, the effects of raga hindolam in the morning, raga todi in the afternoon and raga kalyani in the evening found significant improvement of vital signs in the post operative phase³². It is noteworthy that neuroscience research on madhyamavathi and shankarabharanam, two well-known ragas has shown that these ragas have significant effects on electroencephalograms of human subjects even without music knowledge or training³³. The learning and repeated practicing of notuswaras, a typical musical genre has found to improve cognition, learning and memory of preschool children as evaluated by standardized indices³⁴. The therapeutic effect of Bhimplas, thodi and Hindolam ragas on lowering heart rate and blood pressure has been documented in clinical setting³⁵. The use of Ananda bhairavi for its pain allaying effects in terminally ill cancer patients³⁶ and the antipyretic effects of the raga bhagesri³⁷ are typical examples of Carnatic music therapy prescriptions with positive effects.

Future Recommendations for Research in Carnatic Music Therapy

As evident from the above sections, it is well understood that research in the field of Carnatic music therapy is still in its infancy. It is to be noted that research process consists of formation of a hypothesis and construction of a research model which needs to be essentially done in all forms of research investigations. Moreover, literature survey has revealed that basic/ experimental research in Carnatic music therapy is lacking. It is this sphere of research that requires maximum attention by Carnatic music therapy researchers. Studies on stem cells, cancer cell lines and other somatic cells are required following exposure to Carnatic ragas. Similarly, animal studies on models such as the rat, mouse, hamster and zebrafish are required to understand the effects of various Carnatic ragas on diseases such as diabetes, cancer, atherosclerosis and cardiovascular disease. With regard to clinical studies, even though ample literature is available, sample sizes have not been well determined. Moreover, all the studies have not performed as clinical trials, which are considered the highest evidence in clinical medicine. Many clinical studies performed in Carnatic music therapy have also not followed randomization and are not reported according to



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the CONSORT statement which is a prerequisite for clinical trials. In a similar manner, epidemiological research has also never been performed in the field of Carnatic music therapy. Such studies with a questionnaire survey based design are required to understand Carnatic music awareness among doctors and patients so that necessary implementations can be made to create the awareness. In conclusion, the authors recommend that Carnatic musicians and medical researchers collaborate to together and perform Carnatic music therapy research in a more scientific and standardized form. This would indeed exploit the fullest benefits of Carnatic music as an alternative system of healing and medicine.

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REFERENCES

1. Sairam, T.V. (2012). Nada yoga and Raga Chikitsa: Two eyes of music therapy. *Bhavan's J.*, 58:89–94.
2. Li K, Weng L, Wang X. The State of Music Therapy Studies in the Past 20 Years: A Bibliometric Analysis. *Front Psychol.* 2021 Jun 10; 12:697726. doi: 10.3389/fpsyg.2021.697726. PMID: 34177744; PMCID: PMC8222602.
3. Röhrig, Bernd et al. "Types of study in medical research: part 3 of a series on evaluation of scientific publications." *Deutsches Arzteblatt international* vol. 106,15 (2009): 262-8. doi:10.3238/arztebl.2009.0262.
4. Ramírez-Rivera S, Bernal G. Music Is Capable of Inducing Changes in Gene Expression in Gastric Cancer Cells. *J Gastrointest Cancer.* 2019 Mar;50(1):175-180. doi: 10.1007/s12029-019-00203-2. PMID: 30632030.
5. Lestard NR, Capella MAM. Exposure to music alters cell viability and cell motility of human nonauditory cells in culture. *Evid Based Complement Alternat Med.* 2016; **2016**:1–7.
6. Mehrafsar A, Mokhtari MJ, Effect of exposure to Quran recitation on cell viability, cell migration, and BCL2L12 gene expression of human prostate Adenocarcinoma cell line in culture. *Health Spiritual Med Ethics.* 2018 Dec;5(4):46–52.
7. Shah A, Raval A, Kothari V. Sound stimulation can influence microbial growth and production of certain key metabolites. *J Microbiol Biotechnol Food Sci.* 2016 Feb;9(5):330–4.
8. Sarvaiya N, Kothari V. Audible sound in form of music can influence microbial growth, metabolism and antibiotic susceptibility. *J Appl Biotechnol Bioeng [Internet].* 2017 Apr [cited 2020 Mar 30];2(6).
9. Korsos, G., Horvath, K., Lukacs, A., Vezér, T., Glavits, R., Fodor, K., et al. (2018) Effects of Accelerated Human Music on Learning and Memory Performance of Rats. *Applied Animal Behaviour Science*, 202, 94-99. <https://doi.org/10.1016/j.applanim.2018.01.011>.



10. Hao J, Jiang K, Wu M, Yu J, Zhang X. The effects of music therapy on amino acid neurotransmitters: Insights from an animal study. *Physiol Behav.* 2020 Oct 1; 224:113024. doi: 10.1016/j.physbeh.2020.113024. Epub 2020 Jun 21. PMID: 32579893.
11. Lu Y, Liu M, Shi S, Jiang H, Yang L, Liu X, Zhang Q, Pan F. Effects of stress in early life on immune functions in rats with asthma and the effects of music therapy. *J Asthma.* 2010 Jun;47(5):526-31. doi: 10.3109/02770901003801964. PMID: 20560827.
12. Núñez MJ, Mañá P, Liñares D, Riveiro MP, Balboa J, Suárez-Quintanilla J, Maracchi M, Méndez MR, López JM, Freire-Garabal M. Music, immunity and cancer. *Life Sci.* 2002 Jul 19;71(9):1047-57. doi: 10.1016/s0024-3205(02)01796-4. PMID: 12088764.
13. Barcellos, Heloisa HA, et al. "The effects of auditory enrichment on zebrafish behavior and physiology." *PeerJ* 6 (2018): e5162.
14. Uedo, Noriya, et al. "Reduction in salivary cortisol level by music therapy during colonoscopic examination." *Hepato-gastroenterology* 51.56 (2004): 451-453.
15. Suda, Miyuki, et al. "Emotional responses to music: towards scientific perspectives on music therapy." *Neuroreport* 19.1 (2008): 75-78.
16. Nakayama, Hisako, Fumio Kikuta, and Hidekatsu Takeda. "A pilot study on effectiveness of music therapy in hospice in Japan." *Journal of Music Therapy* 46.2 (2009): 160-172.
17. Nair, Preethy Sasidharan, et al. "Music-listening regulates human microRNA expression." *Epigenetics* 16.5 (2021): 554-566.
18. Guetin, Stephane, et al. "Effect of music therapy on anxiety and depression in patients with Alzheimer's type dementia: randomised, controlled study." *Dementia and geriatric cognitive disorders* 28.1 (2009): 36-46.
19. Krishnaswamy, Priyadharshini, and Shoba Nair. "Effect of music therapy on pain and anxiety levels of cancer patients: A pilot study." *Indian journal of palliative care* 22.3 (2016): 307.
20. Gutiérrez, Enrique Octavio Flores, and Víctor Andrés Terán Camarena. "Music therapy in generalized anxiety disorder." *The Arts in Psychotherapy* 44 (2015): 19-24.
21. Erkkilä, Jaakko, et al. "Individual music therapy for depression: randomised controlled trial." *The British journal of psychiatry* 199.2 (2011): 132-139.
22. Liu, Yu-Hsiang, Mei-Yueh Chang, and Chung-Hey Chen. "Effects of music therapy on labour pain and anxiety in Taiwanese first-time mothers." *Journal of clinical nursing* 19.7-8 (2010): 1065-1072.
23. Lin CL, Hwang SL, Jiang P, Hsiung NH. Effect of Music Therapy on Pain After Orthopedic Surgery-A Systematic Review and Meta-Analysis. *Pain Pract.* 2020 Apr;20(4):422-436. doi: 10.1111/papr.12864. Epub 2020 Jan 9. PMID: 31785131.
24. Zimmerman L, Nieveen J, Barnason S, Schmaderer M. The effects of music interventions on postoperative pain and sleep in coronary artery bypass graft (CABG) patients. *Sch Inq Nurs Pract.* 1996 Summer;10(2):153-70; discussion 171-4. PMID: 8826769.
25. Kern, Petra, and Daniel B. Tague. "Music therapy practice status and trends worldwide: An international survey study." *The Journal of Music Therapy* 54.3 (2017): 255-286.
26. Tsiris, Giorgos. "Music therapy and spirituality: An international survey of music therapists' perceptions." *Nordic Journal of Music Therapy* 26.4 (2017): 293-319.



27. Braswell, Charles, Cheryl Dileo Maranto, and Anthony Decuir. "A survey of clinical practice in music therapy part I: The institutions in which music therapists work and personal data." *Journal of Music Therapy* 16.1 (1979): 2-16.
28. Ravi, Meenakshi, and Ruma Chakravarty. "IMPACT OF CARNATIC MUSIC THERAPY INTERVENTION ON A PATIENT WITH SCHIZOPHRENIA—A CASE REPORT." *International Journal of Alternative and Complementary Medicine* (2021): 33-39.
29. Priyadarsini, A. C. "Carnatic Music Therapy for Management of Depression and Enhancement of Self-Esteem." *Bharti Publications*: 63.
30. Choolayil, Anoop C., and Laxmi Putran. "Music Therapy: A Catalyst for Promoting Well Being of Institutionalised Seniors." *Indian Journal of Gerontology* 34.2 (2020): 189-202.
31. Ravi, Meenakshi, and Miss Sharnya Govindaraj. "Emotional impact of four specific ragas of carnatic music." *International Journal of Alternative and Complementary Medicine* (2021): 01-05.
32. Reddy, Bobba Ushasree, et al. "Effect of music therapy in patients with moderate-to-severe traumatic brain injury." *Journal of Datta Meghe Institute of Medical Sciences University* 12.1 (2017): 51.
33. J. Satheeshkumar, S. Arumugaperumal, R. Rajesh, and C. Kesavadas, "Does brain react on Indian music? - A functional magnetic resonance imaging study", 2008 IEEE International Joint Conference on Neural Networks (IEEE World Congress on Computational Intelligence), pp. 2696-2702, 2008
34. M. A. Rajalakshmi, "Dikshitar's music and neurodevelopment", *Int. J. Public Mental Health Neurosci.*, vol. 4, Dec. 2017.
35. Raghavi Janaswamy, Saraswathi K. Vasudev. *World Academy of Science, Engineering and Technology International Journal of Humanities and Social Sciences* Vol:14, No:12, 2020.
36. T. S. Kumar, M. Muthuraman, and R. Krishnakumar, "Effect of the raga Ananda Bhairavi in post-operative pain relief management", *Indian J Surg.*, vol. 76, pp. 363-370, Oct. 2012.
37. P. Bharathi, K. Jaiganesh, R. Sobana, and S. Parthasarathy, "Effect of Indian Raga Bageshri on the body temperature of cancer patients on chemotherapy", *Int. J. Cur. Sci. Res.*, vol. 2, pp. 243-245, 2012.