

Effect of Laughter Yoga on Mood and Heart Rate Variability in Patients Awaiting Organ Transplantation: A Pilot Study

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ABSTRACT

Context • Research shows that laughter has myriad health benefits, yet the medical community has not implemented it formally as a treatment. Patients awaiting organ transplantation have significant physical disabilities and are at risk for psychological distress. Attenuated heart rate variability (HRV) is a risk factor for a negative long-term outcome in some patients.

Objective • The study intended to evaluate the clinical utility of laughter yoga in improving psychological and physiological measures in outpatients awaiting organ transplantation. Positive results would indicate promising areas to pursue in a follow-up study.

Design • Six participants met for 10 sessions over 4 weeks. The research team measured each participant's heart rate, HRV, blood pressure (BP), and immediate mood before and after the laughter and control interventions. The team assessed participants' longer-term mood (anxiety and depression) at the study's initiation, after a no-treatment control week, and at the end of the study.

Setting • The study occurred at the Department of Surgery and Medicine at the University of Arizona Health Sciences Center, Tucson.

Participants • Participants were patients awaiting transplants (three heart and three lung), two women and four men (ages 51-69 y). Participants had received no major surgery in the 3 months prior to the intervention, did not have a hernia or uncontrolled hypertension, and did not fall into the New York Heart Association function class 4.

Intervention • The 20-minute laughter intervention involved breathing and stretching exercises, simulated laughter (ie, unconditional laughter that is not contingent on the environment), chanting, clapping, and a meditation. The 20-minute control intervention involved the study's personnel discussing health and study-related topics with the participants.

Outcome Measures • The research team measured BP, heart rate, and HRV and administered the Profile of Mood States, Beck Anxiety Inventory, and Beck Depression Inventory-II to evaluate immediate and longer-term mood. The team had planned quantitative statistical analysis of the data at the study's initiation but did not complete it because the number of enrolled participants was too low for the analysis to be meaningful. The team visually examined the data, however, for trends that would indicate areas to examine further in a follow-up study.

Results • Participants showed improved immediate mood (vigor-activity and friendliness) and increased HRV after the laughter intervention. Both the laughter and control interventions appeared to improve longer-term anxiety. Two participants awaiting a lung transplant dropped out of the study, and no adverse events occurred.

Conclusion • This pilot study suggests that laughter yoga may improve HRV and some aspects of mood, and this topic warrants further research. (*Altern Ther Health Med.* 2012;18(4):53-58.)

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“**L**aughter is the best medicine”: Empirical research on laughter supports this folk wisdom, showing that laughter can have a variety of psychological and physiological health benefits, including improved coping skills, enhanced mood and feelings of well-being, decreased discomfort, and a higher pain tolerance as well as reduced neuroimmune and stress markers.¹⁻⁶ Laughter can increase natural killer cell activity,^{1,7} endothelial-dependent vasodilatation,⁸ and heart rate, respiration rate, and oxygen consumption.⁹ Considering the variety of health benefits, researchers Christie and Moore think that humor might be an excellent clinical intervention.⁶ Most controlled research on laughter has involved exposing participants to humorous videos. It remains unclear whether laughter associated with other conditions, including simulated laughter (ie, unconditional laughter that is not contingent on the environment), might have similar results.

Practitioners in India developed the practice of laughter yoga, and it combines unconditional laughter with *pranayama* (the rhythmic control of breath), stretching, and meditation.¹⁰ Individuals can practice it in a group setting or alone. Madan Kataria, MD, an East Indian physician and founder of Laughter Yoga International, developed a popular form of laughter yoga. The research team based the current intervention on his teachings, and the methods section describes this practice more fully. Practitioners have attributed a variety of health benefits anecdotally to laughter yoga; however, investigators have performed minimal controlled research on it. One study showed significant improvements in workplace stress levels and self-efficacy.¹¹ A therapeutic intervention based on laughter yoga is potentially an ideal intervention because patients can practice it alone, in a short time period, and without the need for other resources.

Heart rate variability (HRV) is a measure of the balance between the parasympathetic nervous system, which decreases the heart rate and increases the relaxation response via the vagus nerve, and the sympathetic nervous system, which increases both the heart rate and the activation response. These systems are the two arms of the autonomic nervous system. Each arm produces different frequency oscillations of the heart rate, allowing for a comparison of their relative contributions in regulating heart rate. Karemaker and Lie found that attenuated HRV, which reflects more sympathetic activity, is related to reduced vagal activity.¹² Attenuated HRV is a risk factor strongly associated with poor long-term outcomes, including mortality, in cardiac patients.¹³

The current study was an effort to evaluate the clinical utility of laughter yoga in improving psychological and physiological measures in outpatients awaiting organ transplantation. These patients have significant physical disabilities and are at risk for psychological distress¹⁴; thus

they potentially could benefit from such an intervention. The research team also chose this population because the participants were within the realm of the researchers' clinical expertise and were accessible. The team hypothesized that the practice of laughter yoga would increase HRV, decrease blood pressure (BP), and improve immediate and longer-term mood. If the researchers were to find positive results, they would interpret them as encouraging areas to pursue in a follow-up study.

METHODS

Participants

Over a period of approximately 3 months, the research team recruited participants who were patients of the Department of Surgery and Medicine at the University of Arizona's Health Sciences Center, Tucson. Participants were adults awaiting solid organ transplantation (three heart and three lung), two women and four men (ages 51-69 y). Participants had received no major surgery in the past 3 months, did not have a hernia or uncontrolled hypertension, and did not fall into the New York Heart Association function class 4. None of the participants were on vasopressors or intravenous inotropes. The University of Arizona's internal review board approved the study, and the research team obtained informed consent from each participant prior to the study.

Procedures

Participants formed one group who received control and laughter yoga interventions over a period of 4 weeks. The study started with a control period of 1 week during which the participants completed control interventions at the beginning and end of this week. After the control period, participants completed seven laughter yoga sessions over a period of 3 weeks. The research team thought that this time period was the minimum amount of time necessary to see clinical results from the practice and also to be feasible for patients' participation. After the laughter yoga treatment period, participants completed one additional control intervention at the termination of the study.

Interventions

Laughter Yoga Intervention. A laughter yoga therapist, certified by Laughter Yoga International, conducted the intervention. The 20-minute laughter yoga sessions consisted of three parts: (1) simple breathing and stretching exercises (5 min); (2) alternation of laughter exercises (eg, imitating laughter on a cell phone) with rhythmic clapping, chanting, movement while maintaining eye contact with others, gentle stretching, and deep breathing (10 min); (3) quiet, seated, deep breathing and guided meditation (5 min).

Control Intervention. The control intervention

consisted of participants and research team members sitting in a circle and discussing topics in an open format for 20 minutes. Topics included (1) the study's procedures and logistics; (2) personal introductions, including personal backgrounds; (3) participants' medical histories and experiences with stress; and (4) closing remarks and review of participants' experiences in the study.

OUTCOME MEASURES

On all three control days and on two of the treatment days (weeks 3 and 4), the research team administered the Profile of Mood States¹⁵ questionnaire to participants and measured their BP, heart rate, and HRV immediately before and after the relevant intervention. Participants additionally turned in the Beck Anxiety Inventory¹⁶ and the Beck Depression Inventory-II¹⁷ at the study's initiation, after the initial control week, and at the conclusion of the study.

Psychological Measures

To determine the state of participants' psychological functioning, the research team administered questionnaires to measure the following:

Fluctuations in Current Mood. The research team used the Profile of Mood States, which is a self-report survey with 65 items in seven different scales: (1) tension-anxiety, (2) depression-dejection, (3) anger-hostility, (4) vigor-activity, (5) fatigue-inertia, (6) confusion-bewilderment, and (7) friendliness.

Anxiety. The research team used the Beck Anxiety Inventory, which is a self-report scale of anxiety over the prior week, with 21 items contributing to a total score ranging from 0 to 63.

Depression. The research team used the Beck Depression Inventory-II, which is a self-report scale of depression over the prior 2 weeks, with 21 items contributing to total score ranging from 0 to 63.

Physiological Measures

To determine participants' physiological states, the research team measured the following:

Systolic and Diastolic Blood Pressure. The research team measured this function using a digital BP monitor with a wrist cuff.

Heart Rate. The research team measured this function using a blood-volume pulse sensor (emWavePC, HeartMath LLC, Boulder Creek, California) attached to the participant's earlobe.

Heart Rate Variability. The research team measured this function using the free Kubios HRV Version 2.0 software available online at <http://kubios.uku.fi>, which calculates HRV from the standard deviation of the beat-to-beat interval obtained from the heart-rate data (SDNN). The team also calculated the root mean square of successive differences in beat-to-beat intervals (RMSSD), an established measure of vagal activity.

DATA ANALYSIS

The research team had planned quantitative statistical analysis of the data at the study's initiation but did not complete it because the number of enrolled participants was too low for the analysis to be meaningful. The researchers visually examined the data, however, for trends that would indicate areas to examine further in a follow-up study. The team compared predata and postdata—from immediately before and after the intervention—on control days vs laughter days. For the Profile of Mood States questionnaire, pre-to-post changes in scores were calculated for each of the seven factors, averaged across day type (control vs laughter) and compared.

RESULTS

Participants were four men and two women who were awaiting either lung or heart transplantation (Table 1). No patients met the exclusion criteria, so the team excluded no one. One heart patient previously had undergone heart transplantation 10 years prior to the study. The enrolled

Table 1. Participant Characteristics and Outcome Data

No.	Gender	Age, y	Transplant Type
1	M	51	Heart
2	M	69	Lung
3	M	67	Heart
4	F	54	Lung
5	F	59	Lung
6	M	59	Heart

number of participants was lower than planned due to an unanticipated limited pool of available patients at the time of the study's recruitment. Two lung participants dropped out of the study for medical and personal reasons.

Psychological Measures

Immediate Mood. The Profile of Mood States produced a snapshot of mood immediately before and after the intervention. Substantial increases on the vigor-activity and friendliness factors occurred on the laughter days compared to the control days (Table 2). For the vigor-activity factor, scores increased by an average of 8 on laughter days, while they decreased by an average of 9.33 on control days (difference of 17). This factor includes the following descriptions: lively, active, energetic, cheerful, alert, full of pep, carefree, and vigorous. For the friendliness factor, scores increased an average of 9 on laughter days, while they decreased by 1.66 on control days (difference of 10.66). This factor may be related statistically to the vigor-activity factor, but it still provides useful information. It includes the following descriptions: friendly, clear-headed, considerate, sympa-

Table 2. Profile of Mood States

Factor	C1	C2	C3	CM	I1	I2	IM	CM vs IM
Tension-anxiety	-18	-8	-4	-10	-10	-1	-5.5	-4.5
Depression-dejection	-12	0	9	-1	-1	-2	-1.5	0.5
Anger-hostility	-1	3	-4	-0.66	2	0	1	-1.66
Vigor-activity	-5	-7	-16	-9.33	7	9	8	-17.3
Fatigue-inertia	-16	-1	-4	-7	-5	-11	-8	1
Confusion-bewilderment	-9	2	2	-1.66	-7	0	-3.5	1.84
Friendliness	2	7	-14	-1.66	7	11	9	-10.66

Abbreviations: C, Pre-to-post change in scores across participants by control day (1-3) and mean (m); I, pre-to-post change in scores across participants by intervention day (1-2) and m; CM vs IM, m control change score vs m intervention change score.

Table 3. Beck Anxiety Inventory

ID	Baseline	Post-control	Post-intervention
1	4	2	3
2	25	17	9
3	(18)	(12)	—
4	(23)	(8)	—
5	24	13	11
6	6	8	6
mean (n=4)	14.75	10	7.25

Table 4. Beck Depression Inventory

ID	Baseline	Post-control	Post-intervention
1	5	1	2
2	19	29	13
3	(4)	(3)	—
4	(23)	(23)	—
5	15	17	21
6	2	6	5
mean (n=4)	10.25	13.25	10.25

thetic, helpful, good-natured, and trusting.

Both the control and laughter interventions produced improvements on the fatigue-inertia and tension-anxiety factors. The changes were comparable for fatigue (decreases of 7 for control and 8 for laughter; difference of 1), while for tension, the control days actually showed greater reductions (decreases of 10 vs 5.5; difference of 4.5). Of note, the largest changes on the control days occurred on the first and last days of the study. No meaningful pre-to-post differences in scores existed between the groups on the factors depression-dejection, anger-hostility or confusion-bewilderment.

Longer-term Mood. The Beck Anxiety Inventory revealed mild reductions in anxiety across the study, showing a mean score of 14.75 at the study's initiation, 10 after the control week, and 7.25 at termination (Table 3). There were no meaningful differences in scores on the Beck Depression Inventory-II (mean score of 10.25 at study initiation, 13.25 after control week, and 10.25 at termination) (Table 4). Researchers should note that two of four participants began the study with minimal levels of anxiety and depression, and no room for improvement existed for these participants.

Physiological Measures

Heart rate data were available for only three participants (all heart) because one participant was not present for all of the measurements. In these participants, consistent pre-to-post increases occurred in both of the HRV measures after the laughter therapy intervention. Considering that the results were similar across days, the data were averaged for ease of interpretation (average of 2 laughter days: SDNN increased by 56% and RMSSD by 32%; Figure 1a). The results for the control days were variable (Figures 1b-1d), with consistent increases on the first control day (SDNN by 38% and RMSSD by 47%), no consistent changes on the second control day, and decreases on the last day (SDNN by 31% and RMSSD by 35%). Additionally, all participants consistently showed a small increase in diastolic BP after the laughter therapy days (ranging from 3% to 23%). No other consistent changes in BP or heart rate occurred.

DISCUSSION

Prior research has recorded HRV in healthy volunteers to average 48 mean (m) $\pm$ 22 (standard deviation [SD]) for

Figure 1a. Average Heart Rate Variability Data for Laughter Therapy Sessions

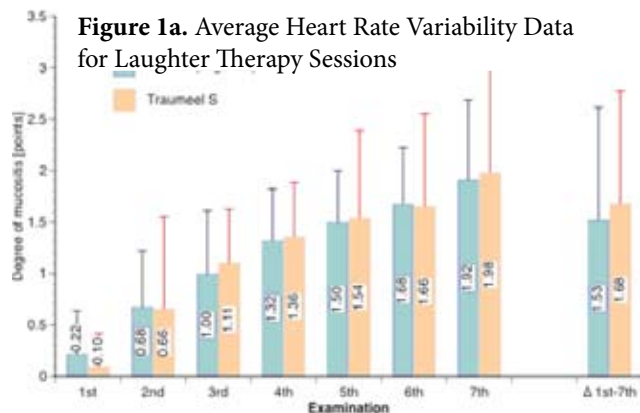


Figure 1b. Heart Rate Variability Data for Control Session 1

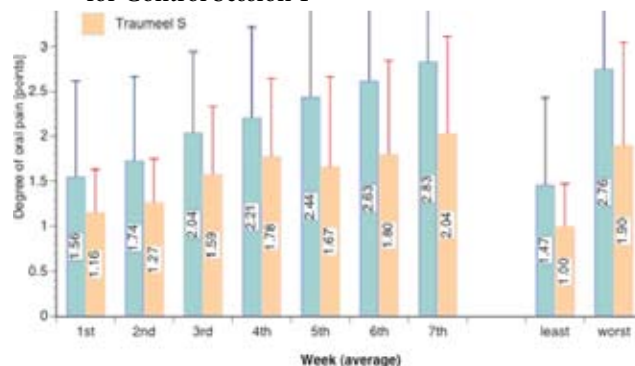


Figure 1c. Heart Rate Variability Data for Control Session 2

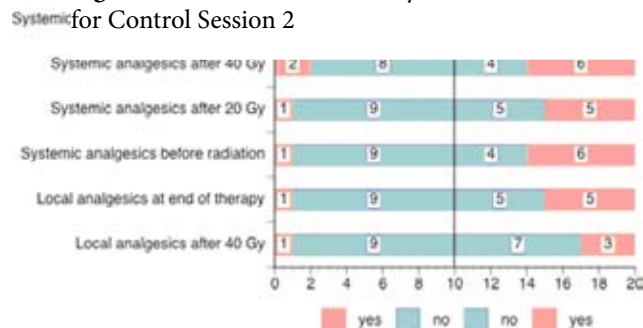
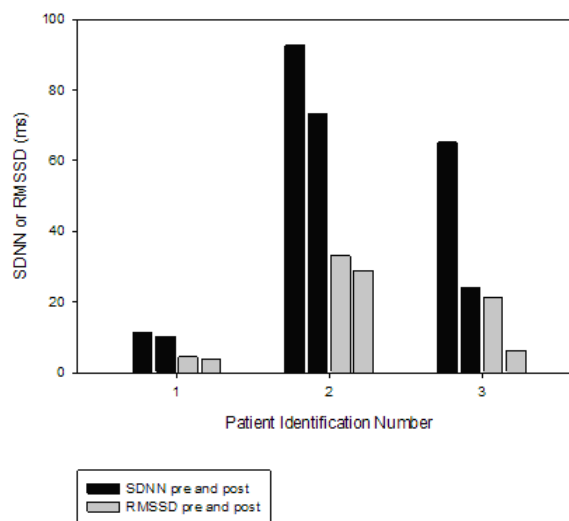


Figure 1d. Heart Rate Variability Data for Last Control Session



Abbreviations: RMSSD, root mean square of seccessive differences; SDNN, standard deviation of beat-to-beat interval.

SDNN and $43 \text{ m} \pm 29 \text{ (SD)}$ for RMSSD.¹⁸ In the current study, the participants often had baseline SDNN scores at the low end or below this value. Additionally, RMSDD was considerably below normal for all participants, suggesting reduced vagal stimulation (Figure 1b). The research team's results showed that participation in the laughter yoga intervention increased HRV measures for both SDNN and RMSDD so that participants' scores were within or closer to the normal ranges. Atrial stretch from increased venous return and/or some sympathetic reinnervation after transplantation may have caused the improved HRV in the participant with the transplanted heart.¹⁹ Considering the association of attenuated HRV with mortality in cardiac patients,¹³ these results suggest some potential therapeutic significance.

The study's results also suggested that laughter yoga may increase feelings related to liveliness, activation, cheerfulness, and friendliness. This finding was unique to the laughter intervention, as during the control days, overall decreases occurred in these areas. Improvements in tension and fatigue (immediate mood) and anxiety (longer-term) related to participation in the study also occurred. These reductions may have been due to general participation in the study, however, rather than being uniquely associated with the laughter condition.

In addition to the encouraging findings associated with laughter yoga, the control days had interesting physiological and psychological results. The first control day, which involved introductions to the study and the other parti-

pants, appeared to have some positive health benefits because the participants showed increases in HRV and decreases in tension, fatigue, confusion, and depression. It is likely that hope for the study's benefits had some therapeutic qualities that influenced these areas. By the second control day, however, these changes were absent for all measures except tension. On the final control day, decreases in HRV, vigor, and friendliness and increases in depression occurred. This result may have been due to a slight feeling of loss and disappointment that the study was ending. In future studies, it might be useful to consider these skewed treatment effects and to use controls that fall in the middle of the study.

The results did not show consistent improvements in heart rate or BP. A previous study suggested that post-laughter decreases in BP were small and highly time sensitive.⁹ Also, no consistent improvements in immediate depression, anger, or confusion or in longer-term depression occurred. The general lack of initial mood elevations in these areas may have influenced the lack of changes in these domains.

The research team's findings of improved HRV and some aspects of mood after participation in the laughter intervention are consistent with prior research that has shown improved physiological and psychological benefits to laughter. It is not possible to determine which specific component of the laughter yoga intervention—laughter, breathwork, stretching, meditation, or some combination of these—was the underlying factor for the positive findings in the study. As the research team hoped to develop a new clinical intervention, we were more interested in the therapeutic utility of laughter yoga as a whole rather than in the specific mechanisms involved.

CONCLUSION

The study's findings provide preliminary evidence that laughter yoga could indeed be a beneficial therapeutic practice. Considering the small sample size, limited follow-up period, and lack of quantitative statistics, researchers should interpret the results with caution. Nevertheless, the findings are encouraging and suggest the need for further research. Future studies may borrow from the methodology outlined here, perhaps targeting other populations with attenuated HRV and increased risk for mood disturbances. Future studies might also explore the specific mechanisms that underlie the observed clinical benefits.

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