

The Effects of Reiki Therapy and Companionship on Quality of Life, Mood, and Symptom Distress During Chemotherapy

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Abstract

This pilot study examined the effects of Reiki therapy and companionship on improvements in quality of life, mood, and symptom distress during chemotherapy. Thirty-six breast cancer patients received usual care, Reiki, or a companion during chemotherapy. First, data were collected from patients receiving usual care. Second, patients were randomized to either receive Reiki or a companion during chemotherapy. Questionnaires assessing quality of life, mood, symptom distress, and Reiki acceptability were completed at baseline and chemotherapy sessions 1, 2, and 4. Reiki was rated relaxing with no side effects. Reiki and companion groups reported improvements in quality of life and mood that were greater than those seen in the usual care group. Interventions during chemotherapy, such as Reiki or companionship, are feasible, acceptable, and may reduce side effects.

Keywords

Reiki, chemotherapy, companion, breast cancer, quality of life

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Introduction

In 2014, 232 670 women will be diagnosed with breast cancer in the United States.¹ Many underwent chemotherapy that often causes side effects such as nausea and fatigue. These side effects can lower quality of life, increase mood disturbance, and produce symptom distress. Therefore, management and reduction of negative side effects has become an area of emphasis. It is important to search for effective palliative interventions in order to support chemotherapy patients and provide symptom relief.² A Japanese technique, Reiki, is one intervention that may help make chemotherapy a less aversive treatment.³ Another approach may be to provide companions to patients during their chemotherapy treatments. While the research on this approach is limited, many nonprofit organizations regularly mobilize volunteers to be chemotherapy companions for strangers.⁴ Both interventions are feasible and easy to implement in a clinical setting. Therefore, the present study compared both approaches to each other and to a usual care control group. The companion condition served as an additional control for the receipt of social support during Reiki. Therefore, evidence that participants in either the Reiki or companion conditions reported better quality of life, less symptom distress, and

lower negative mood states would support the use of these interventions in clinical practice.

Reiki

Reiki is a technique used to promote healing through stress reduction and relaxation. It is administered through a series of hand positions held on a patient's body to help balance life force energy.³ Patients often report warm energy flowing through their bodies.⁵

Although uncommon, Reiki has gained in popularity. According to the 2007 Health Interview Survey, 1.2 million adults and 161 000 children received 1 or more sessions of energy healing such as Reiki in the past year.² Additionally, around 15% of hospitals offered Reiki as a service in 2007.²

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Reiki does not require special facilities and is easy for practitioners to practice.⁶ Therefore, Reiki can be performed in any location, including outpatient chemotherapy units.

Although research on Reiki has grown in recent years, studies have been limited by poor experimental designs with lack of control groups and random assignment.^{3,6,7} Nevertheless, prior research has yielded positive results (ie, reduction in anxiety and pain) in healthy populations, populations affected with HIV/AIDS, and populations affected with other conditions.⁷⁻¹⁰ This research supports Reiki as a potential breakthrough form of nontraditional medicine. Research examining the effects of Reiki among cancer populations is scarce.^{8,11} However, 2 studies examining the effectiveness of Reiki during chemotherapy found that pain and anxiety decreased, while comfort and well-being improved during Reiki, suggesting that Reiki may be an effective intervention during chemotherapy.^{11,12} There were several weaknesses that may have affected the findings in these studies, such as lack of a control group or randomization, few patients who completed the 4 treatment sessions or only consisting of 1 treatment session, and patients who were diagnosed with different cancers. Finally, the studies did not assess Reiki's effects on symptom distress, mood, and cancer-related quality of life. Although one study examined the efficacy of Reiki against a sham Reiki condition, the study only consisted of one assessment and never assessed the long-term effects of Reiki on patients undergoing a chemotherapy cycle. The present study was a pilot feasibility study that sought to examine Reiki through a more structured experimental design. Patients either received Reiki or had a companion present as each underwent a chemotherapy treatment cycle (4 sessions) and were compared to patients receiving usual care.

Chemotherapy Companions

The companion group served as an additional control for the beneficial effects of social support on health because even though Reiki practitioners do not actively engage with their patients while performing Reiki, their presence during chemotherapy is a form of social support.¹³ Although research examining companions is limited, research suggests that social support helps improve quality of life and symptom distress, as well as mood. These are important issues for women undergoing chemotherapy because these impairments are often a result of the disease that so many women have.¹⁴⁻¹⁶

Therefore, the goal of this pilot study was to gather preliminary data on the efficacy of Reiki during chemotherapy on quality of life, mood and symptom distress, and the overall acceptance of the treatment and compare it with the effects of companionship. Specifically, it was hypothesized that patients undergoing Reiki would find treatment relaxing and not report complications (Hypothesis 1). Furthermore, both Reiki and companion patients would report better quality of life and less symptom distress at the conclusion of the chemotherapy treatment cycle, but that Reiki patients would experience greater benefit (Hypothesis 2). Next, it was hypothesized that both the Reiki and companion groups would report better mood

at the conclusion of the chemotherapy treatment cycle, including increases in vigor and reductions in anxiety, depression, anger, fatigue, and confusion, but that the Reiki group's improvement would be the greatest (Hypothesis 3). Finally, it was hypothesized that the effects of Reiki and companionship would be most pronounced acutely from before to immediately following the end of one chemotherapy session (Hypothesis 4).

Materials and Methods

The study consisted of 36 patients (35 females, 1 male) with breast cancer (stages I to III) seen at the Magee Women's Cancer Center and/or at the University of Pittsburgh Medical Center Cancer Centers. Patients were between 34 and 67 years of age (mean [M] = 48.81). Thirty-five patients were European American (97.3%) and 1 was African American (2.7%). Patients had to be at least 18 years of age or older, be diagnosed with breast cancer, and have a chemotherapy prescription of at least 4 cycles in order to be included in the study.

Study Outcomes

Demographic and Medical Variables. Demographic and medical variables were collected at the initial assessment. Patients reported their age, gender, marital status, employment status, education status, number of children, and current and past tobacco and alcohol use. Stage of cancer was recorded from the participant's medical chart.

Quality of Life. Multidimensional quality of life was measured using the Functional Assessment of Cancer Therapy: Breast Cancer Version 4 scale,¹⁷ which consisted of 36 items rated on a 5-point Likert-type scale (0 = *Not at all* to 4 = *Very much*). Items were summed to yield a total breast cancer-related quality of life score. Scores ranged from 0 to 144, with higher scores indicating higher quality of life ($\alpha = .94$).

Symptom Distress. Distress related to cancer symptoms (eg, nausea) was measured using the Symptom Distress Scale.¹⁸ The scale consisted of 13 items rated on a 5-point Likert-type scale (1 = *Normal or no distress* to 5 = *Extensive distress*) that were summed to yield scores ranging from 13 to 65, with higher scores indicating higher symptom distress ($\alpha = .68$).

Mood States. Mood states were assessed using the Profile of Mood States–Short Form questionnaire.¹⁹ The scale consisted of an adjective checklist of 37 items (eg, fatigue) rated on a 5-point Likert-type scale (0 = *Not at all* to 4 = *Extremely*). The scale was divided into 6 subscales: anxiety, depression, anger, vigor, fatigue, and confusion. The total mood disturbance score was calculated by summing 5 subscales and subtracting the vigor score. Scores for total mood disturbance ranged from 0 to 100, with higher scores indicating higher mood disturbance ($\alpha = .91$).

Questions Related to Reiki Therapy. Patients undergoing Reiki answered 2 questions about their treatment with a “yes” or “no” response. The first item assessed relaxation during Reiki: “Was the intervention relaxing?” The second item assessed problems related to Reiki: “If you had Reiki therapy, did you have any problems as a result of the therapy?”

Procedures

There were 2 phases of the study. The first established a base rate for the outcome variables by collecting data from patients ($n = 10$) undergoing chemotherapy (Usual Care). In the second phase, patients were randomized into 1 of 2 conditions, Reiki ($n = 15$) or Companion ($n = 11$), after collection of the baseline assessment. The Companion condition was chosen as a comparison group because it was an alternative intervention modality that was realistic and feasible and could easily be used in the clinic in the future.

Patients completed questionnaires at baseline prior to the start of chemotherapy and after chemotherapy sessions 1, 2, and 4 by a research assistant. To test the immediate effects of Reiki, at the last chemotherapy session, an additional questionnaire assessing mood states was administered before the beginning of the chemotherapy session. For patients in the Reiki group, 6 different Reiki practitioners (5 Level II practitioners, 1 Master Level practitioner) administered Reiki to the patients. During chemotherapy, there was a 30-minute Reiki/Companion session. To simulate a more naturalistic environment and demonstrate real-world applicability, both companion and Reiki sessions were conducted in the chemotherapy unit at a hospital. The patient room was in a common area separated with curtains. No environmental enhancements were done (eg, music, lighting, etc). For patients in the Companion group, a companion (Reiki practitioner) accompanied the patients and provided support by talking with the patients, but did not administer therapeutic intervention or physical contact. Conversation between the companion and patient was patient directed. In the Reiki group, there was an initial conversation regarding the session, but there was no conversation during the Reiki session. Each Reiki session involved a series of hand positions, over the body, that were held for approximately 3 minutes. The positions included placing hands on the hands, ears, solar plexus, hips, knees, and feet. All questions related to Reiki were administered to patients in the Reiki group at the end of the chemotherapy cycle. No research personnel were present during the chemotherapy sessions for the patients in the Usual Care group.

Statistical Analyses

There were no demographic or medical differences among the groups (Table 1). However, patient age and stage of cancer were chosen as covariates in all analysis of covariance designs, because previous research suggested that those who were younger and with increased disease severity experienced poorer psychological well-being.^{20,21} The analyses for the first hypothesis were conducted using descriptive statistics. All other analyses were conducted using an analysis of covariance design. Bootstrapping, a commonly used and accepted resampling technique, was used to account for the small sample sizes.²² Bonferroni corrections were used to adjust for Type 1 error rate among multiple comparisons.

Results

Participant Flow

Three patients withdrew from the study (1 in the Companion group, 2 in the Reiki group) due to either “religious beliefs” or “scheduling conflicts.” The patient in the Companion group withdrew from the study before the beginning of the first chemotherapy session and cited “religious beliefs” as reason for withdrawal. The 2 patients in the Reiki condition withdrew at

the last chemotherapy session and cited “scheduling conflicts” as reason for withdrawal.

Acceptability of Reiki Therapy

After the conclusion of the last Reiki session, patients who underwent Reiki were asked whether they found the intervention relaxing or had any problems as a result of the therapy. As expected, all patients in the Reiki group found it relaxing and none reported experiencing any problems as a result of Reiki.

Symptom Distress

It was hypothesized that both Reiki and Companion patients would report less distress associated with the negative symptoms related to chemotherapy than usual care patients. However, there were no significant differences between groups across chemotherapy sessions, $F(6, 44) = 0.95$, $P < .47$, partial $\eta^2 = .12$.

Quality of Life

Results revealed a significant group by time interaction for breast cancer–related quality of life, $F(6, 140\ 806) = 8851.99$, $P < .001$, partial $\eta^2 = .08$. As expected, at all time points, the Usual Care group reported worse quality of life than the Companion and Reiki groups. However, contrary to expectations, at all time points, the Companion group reported better quality of life than the Reiki group. As expected, for the Usual Care group, quality of life was lower at chemotherapy session 4 than at baseline. In the Reiki and Companion groups, quality of life was higher at chemotherapy session 4 than at baseline (Table 2).

Mood Across Chemotherapy Treatment

Changes in mood throughout the course of the chemotherapy sessions were examined, and partial support was found. Contrary to expectations, significant group by time interactions for anxiety, depression, anger, and fatigue were not found, $F(6, 44) = 0.76$, $P = .388$, partial $\eta^2 = .07$; $F(2, 27) = 0.60$, $P = .555$, partial $\eta^2 = .04$; $F(6, 46) = 0.84$, $P = .544$, partial $\eta^2 = .10$; $F(6, 46) = 1.57$, $P = .176$, partial $\eta^2 = .17$, respectively.

Results revealed a significant group by time interaction for confusion, $F(6, 291\ 726) = 4225.193$, $P < .001$, partial $\eta^2 = .08$. Although confusion was lower at chemotherapy session 4 than at baseline for all groups, contrary to expectations, the Companion group reported less confusion at chemotherapy session 4 than did the Reiki and Usual Care groups. However, as expected, the Reiki group reported less confusion than did the Usual Care group (Table 2).

Next, a significant group by time interaction for total mood disturbance was found, $F(6, 251\ 286) = 23116.49$, $P < .001$, partial $\eta^2 = .41$. Even though total mood disturbance at chemotherapy session 4 was lower than at baseline for all groups,

Table 1. Descriptive Statistics for Demographic and Medical Variables.

Variable	Reiki (N = 15)	Companion (N = 11)	Usual Care (N = 10)	F/χ^2	P	df
Age	49.13	51.73	45.45	1.36	.268	34
Number of children	2	2.2	2.3	0.19	.823	32
Marital status				0.689	.509	34
Married/living together	10	9	8			
Single	1	1	0			
Divorced	2	1	1			
Widowed	2	0	1			
Missing	0	0	0			
Employment status				0.275	.761	32
Working full-time	11	7	7			
Working part-time	0	1	0			
Not currently employed/looking	1	1	0			
Retired	1	2	0			
Homemaker	2	0	1			
Missing	0	0	2			
Education				1.36	.270	32
Some high school or less	0	1	0			
High school graduate/GED	2	1	3			
Some college	5	4	3			
College degree	3	2	4			
Some graduate work	2	1	0			
Graduate degree	3	1	0			
Missing	0	0	0			
Past tobacco use				2.04	.146	34
Yes	6	7	5			
No	5	4	5			
Missing	4	0	0			
Current tobacco use				0.34	.720	14
Yes	2	2	2			
No	2	5	3			
Missing	11	4	5			
Alcohol use				1.81	.179	34
Yes	10	8	3			
No	5	3	7			
Missing	0	0	0			
Current alcohol use				0.86	.438	19
Yes	4	7	10			
No	0	1	0			
Missing	11	3	0			
Stage of cancer				.05	.950	33
Early stage	10	8	7			
Late stage	5	3	3			

Abbreviations: N, number; F, F statistics; χ^2 , chi square; p, probability; df, degrees of freedom.

as expected at session 4, the Reiki group reported lower total mood disturbance than the Usual Care group. However, contrary to expectations, the Companion group reported the lowest total mood disturbance (Table 2).

Contrary to expectations, the Reiki group did not report the highest levels of vigor, but a significant group by time interaction for vigor was found, $F(6, 301.848) = 3873.58$, $P < .001$, partial $\eta^2 = .07$. At baseline, the Companion group reported the highest levels of vigor while the Reiki group reported more vigor than the Usual Care group. However, vigor decreased for all groups by the conclusion on the chemotherapy cycle and at session 4, the Reiki group reported the lowest levels of vigor (Table 2).

Acute Effects of Reiki on Mood

Finally, the immediate effects of Reiki and companionship on mood following one chemotherapy session were examined. The hypothesis was partially supported. Contrary to expectations, anxiety, depression, anger, confusion, vigor, and total mood disturbance did not change following one chemotherapy session, $F(2, 27) = 0.76$, $P = .959$, partial $\eta^2 = .003$; $F(2, 27) = 0.76$, $P = .959$, partial $\eta^2 = .003$; $F(2, 27) = 0.30$, $P = .747$, partial $\eta^2 = .02$, $F(2, 27) = 0.71$, $P = .499$, partial $\eta^2 = .05$; $F(2, 24) = 0.21$, $P = .810$, partial $\eta^2 = .02$, respectively.

A significant group by time interaction for fatigue was found, $F(2, 155.987) = 2936.73$, $P < .001$, partial $\eta^2 = .04$.

Table 2. Means for All Significant Analyses (With Standard Error in Parentheses) by Group and Time.

Variable	Reiki, M (SE)	Companion, M (SE)	Usual Care, M (SE)
<i>Breast cancer-specific quality of life</i>			
Baseline	103.36 (0.05)	110.72 (0.06)	99.67 (0.06)
Chemotherapy session 1	113.36 (0.06)	116.53 (0.06)	103.54 (0.05)
Chemotherapy session 2	113.84 (0.06)	120.75 (0.07)	101.56 (0.06)
Chemotherapy session 4	105.53 (0.06)	114.48 (0.07)	98.79 (0.06)
<i>Mood across chemotherapy sessions</i>			
Confusion			
Baseline	4.06 (0.01)	5.17 (0.02)	4.97 (0.02)
Chemotherapy session 1	2.69 (0.01)	3.16 (0.02)	3.96 (0.02)
Chemotherapy session 2	1.92 (0.01)	1.16 (0.01)	3.06 (0.01)
Chemotherapy session 4	2.25 (0.01)	1.76 (0.01)	4.26 (0.01)
Vigor			
Baseline	7.59 (0.02)	10.54 (0.03)	7.31 (0.03)
Chemotherapy session 1	7.31 (0.02)	9.84 (0.02)	7.80 (0.02)
Chemotherapy session 2	7.14 (0.02)	13.32 (0.02)	9.41 (0.02)
Chemotherapy session 4	3.60 (0.02)	9.62 (0.02)	5.71 (0.03)
Total mood disturbance			
Baseline	38.28 (0.08)	47.28 (0.08)	52.78 (0.10)
Chemotherapy session 1	24.23 (0.04)	34.38 (0.05)	39.20 (0.06)
Chemotherapy session 2	24.48 (0.05)	18.96 (0.05)	35.43 (0.06)
Chemotherapy session 4	29.46 (0.04)	22.26 (0.05)	43.84 (0.05)
<i>Acute effects of Reiki therapy on mood</i>			
Fatigue			
Before	6.10 (0.01)	4.12 (0.01)	6.57 (0.02)
After	5.64 (0.01)	2.63 (0.02)	6.66 (0.02)

Abbreviations: M, mean; SE, standard error.

Specifically, the Usual Care group reported an increase in fatigue from before to after chemotherapy treatment, while the Companion and Reiki groups reported decreases in fatigue. As expected, the Usual Care group reported the most fatigue. However, contrary to expectations, the Reiki group reported more fatigue than the Companion group (Table 2).

Discussion

The aims of this pilot study were to determine the acceptability of Reiki among chemotherapy patients and compare Reiki with Companion and Usual Care control groups to examine potential effects of Reiki on symptom reporting, quality of life, and mood. All patients felt that Reiki was relaxing and did not report any negative side effects as a result of the treatment. Despite the high acceptability of Reiki, symptom distress remained the same across groups. However, compared to the Usual Care group, both the Reiki and Companion groups reported improvements in breast cancer-related quality of life and mood across time and immediate reductions in fatigue following a chemotherapy session. Contrary to predictions, patients in the Companion group consistently reported more improvement than those in Reiki. Unexpectedly, the Reiki group also reported the least amount of vigor after the fourth chemotherapy session.

Although past research has found improvements in quality of life for patients undergoing Reiki, the present study only observed effects when compared with the Usual Care group.²³

Although the Companion group reported the highest levels of quality of life, this was tempered by the fact that the Companion group reported higher quality of life than the Reiki group at baseline. Therefore, it was not surprising that the Companion group maintained higher quality of life because they started off higher. Some of the effects found in the Companion group may have been because patients interacted more with the Reiki practitioners when their role was only to be a Companion versus when they were focused on administering Reiki. Therefore, the Companion group may have received more social support during chemotherapy, which has been shown to improve quality of life.^{24,25} The effect of social support has been noted with other varieties of intervention therapies during chemotherapy. Specifically, one qualitative study found art therapy to engender social support and was described as “relaxing” and “helpful” by chemotherapy patients.¹¹ However, a similar effect of social support within the Reiki group cannot be ruled out as previous research examining the efficacy of Reiki compared with sham Reiki during chemotherapy yielded similar results with patients in both groups reporting improved comfort and well-being after treatment.²⁶

Studies examining the effects of Reiki on reductions of symptom distress among chemotherapy patients are limited. The present study did not find significant differences in symptom distress. If the presence of social support were driving the differences observed in quality of life, one would expect similar differences in symptom distress. A previous study with women with breast cancer found that having more social

support was associated with less symptom distress.¹⁵ However, distress associated with symptoms related to chemotherapy may be persistent and not be alleviated by the presence of a companion or by Reiki treatment.

Both Reiki and the Companion conditions had significant effects on certain mood states. Previous research conducted with university students who had high levels of mood disturbance was found to have improved mood after Reiki intervention.²⁷ Reiki may help relax patients and consequently improve overall mood and confusion. However, a similar effect may be observed when a companion is present during chemotherapy. Unexpectedly, patients in the Reiki group reported the least amount of vigor. However, this effect may be explained by the effectiveness of Reiki, which is designed to relax the patient³ (instead of invigorate). Mood states such as anxiety, depression, anger, and fatigue did not change over the course of chemotherapy. This finding is contrary to previous work, which found decreases in these mood states following Reiki.^{23,28} However, this may be because previous findings were based on different patient populations (eg, patients with HIV).

The acute (rather than longer term) effects of Reiki and Companion conditions on mood were also analyzed. Previous literature has found that chemotherapy causes fatigue in breast cancer patients and that Reiki helps reduce fatigue in cancer patients.^{29,30} The present study found further support and expanded it to include significant reductions in fatigue among patients in the Companion group while at the same time showing increases in fatigue among patients in the Usual Care group. Even though the Companion group reported lower levels of fatigue than the Reiki group, the Companion group reported lower levels of fatigue at baseline, indicating that these findings may not represent true group differences between Reiki and Companion. Past literature has found that Reiki helps decrease fatigue.³⁰ However, research examining this effect with companions is limited. An immediate effect of Reiki on anxiety, depression, anger, vigor, confusion, and total mood disturbance was not found. These effects may not have been observed immediately following chemotherapy, but may have been exhibited at later time points.

This pilot study used a more rigorous design, as noted by the Touchstone Process for the evaluation of Reiki in the scientific literature.⁶ According to the Touchstone Process, many studies examining Reiki exhibit methodological weaknesses such as lack of controls and information about participants, and the use of convenience samples. This present study provided information about participants, included 2 control conditions (including a viable alternate intervention, the Companion group, in order to account for the effects of social support), measured outcomes using standardized measures, and used only one single treatment modality. Even though the study used an experimental design, it may have benefited from an additional sham Reiki condition. Additionally, the study may have benefitted from an increased sample size and blinding of participants to treatment groups. Future studies should consider such factors. The current study included a heterogeneous sample of breast cancer patients, but did not include any breast cancer patients with stage IV. Future studies should focus on examining this

patient population and whether the effects of Reiki and Companions are more pronounced in early- versus late-stage disease and the effects of Reiki and Companions on responses to chemotherapy among patients with other types of cancers.

The current study examined the effect of Reiki and Companions on health outcomes among breast cancer patients undergoing chemotherapy, as well as tested the feasibility of performing Reiki in this setting. It is important to note that overall Reiki was an accepted form of treatment, suggesting that Reiki is a feasible therapy in this type of setting. In addition, Reiki was an effective form of treatment when compared with the Usual Care group, even though the same effects were not always observed when compared with the Companion group. It is important to note that the Reiki group was compared with a group that reported better quality of life and mood at the onset of the study, despite the researchers' best efforts to randomize the 2 conditions. This resulted in the Reiki group being compared with a group that, in general, reported better outcomes at the beginning of treatment. Therefore, comparing the 2 groups might not have yielded the most appropriate comparisons. Nevertheless, the Companion condition appeared to be an effective intervention in its own right. Previous research examining the effects of companions during chemotherapy has found that patients perceived that the presence of a companion was important and those with companions reported greater satisfaction with their medical care.^{31,32} However, the effects of a companion on psychosocial outcomes have not received attention. Yet there are numerous community volunteer groups who regularly provide these services to cancer patients. The current findings support the lay notion that having a companion present may ameliorate the negative psychosocial effects of chemotherapy.

Although previous research has established Reiki as an effective therapy, research is limited as to its effectiveness in a chemotherapy setting.^{8,26} The present study set out to examine the efficacy of Reiki therapy during chemotherapy using a more rigorous experimental design. Breast cancer patients undergoing chemotherapy experience many aversive side effects that affect well-being. The present study found that Reiki is an accepted form of treatment, has no adverse effects, and helps improve well-being, making chemotherapy a more bearable treatment. Although further research is warranted, simple interventions, such as Reiki or a companion during chemotherapy, may be potential treatment methods for alleviating aversive side effects of chemotherapy.

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Authors' Note

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FL; August 2012. Requests for additional information and access to the research materials may be addressed to the corresponding author.

Author Contributions

ALD, AB, and AS contributed to the design of the project, acquisition of data, and the conduct of the project. MK offered analytical support. ALD and GO contributed to the statistical analysis of the project and generated the initial draft of the article. All authors read and approved the final article.

Declaration of Conflicting Interests

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Ethical Approval

Ethical approval for this project was provided by the institutional review boards at the University of Pittsburgh and the University of Texas at Arlington.

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