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Effects of an educational intervention on female biomedical scientists' research self-efficacy

Lori L. Bakken · Angela Byars-Winston · Dawn M. Gundermann · Earlise C. Ward · Angela Slattery · Andrea King · Denise Scott · Robert E. Taylor

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Abstract Women and people of color continue to be underrepresented among biomedical researchers to an alarming degree. Research interest and subsequent productivity have been shown to be affected by the research training environment through the mediating effects of research self-efficacy. This article presents the findings of a study to determine whether a short-term research training program coupled with an efficacy enhancing intervention for novice female biomedical scientists of diverse racial backgrounds would increase their research self-efficacy beliefs. Forty-three female biomedical scientists were randomized into a control or intervention group and 15 men participated as a control group. Research

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L. L. Bakken (✉)
Department of Medicine, University of Wisconsin-Madison, 1300 University Avenue,
7255 MSC, Madison, WI 53706, USA
e-mail: lbakken@wisc.edu

A. Byars-Winston
Center for Women's Health and Research, University of Wisconsin-Madison,
700 Regent St., Rm 301, Madison, WI 5315, USA
e-mail: ambyars@wisc.edu

D. M. Gundermann
University of Wisconsin-Madison, 1300 University Avenue, 7255 MSC, Madison, WI 53706, USA

E. C. Ward
School of Nursing, University of Wisconsin-Madison, 600 Highland Ave., Box 2455, Madison,
WI 53792, USA
e-mail: ecward@wisc.edu

A. Slattery
Center for Clinical and Translational Science, Rockefeller University, 1230 York Ave.,
New York, NY 10065, USA
e-mail: aslattery@mail.rockefeller.edu

self-efficacy significantly increased for women who participated in the self-efficacy intervention workshop. Research self-efficacy within each group also significantly increased following the short-term research training program, but cross-group comparisons were not significant. These findings suggest that educational interventions that target sources of self-efficacy and provide domain-specific learning experiences are effective at increasing research self-efficacy for women and men. Further studies are needed to determine the longitudinal outcomes of this effort.

Keywords Career development · Educational intervention · Gender · Racial differences · Research self-efficacy

Increasing the number and diversity of biomedical scientists interested in clinical research is critical to advancing a vital healthcare workforce. The paucity of biomedical scientists in academic medicine was originally reported by Kelley and Randolph (1994) over a decade ago and remains a current concern within the medical profession (Nathan and Varmus 2000; Promoting Translational and Clinical Science 2006). Women and people of color especially continue to be underrepresented in academic medicine to an alarming degree considering that between 2002 and 2006 an average of 46% women and 36% racial minorities graduated from medical school (FACTS 2007). The proportion of underrepresented racial and ethnic minorities among clinical and, more broadly, biomedical researchers has not changed appreciably over three decades despite multiple efforts to promote their access to and interest in research careers (Final Report of the NAGMS Council 2006). Similarly, female academicians within the medical field have made only marginal gains in their research productivity (Jagsi et al. 2006) and minority female academicians, in particular, have made relatively undetectable professional gains (Wong et al. 2001). These trends threaten the translation of basic science discoveries into applications that can benefit human health, especially for populations experiencing great health disparities, such as racial and ethnic minorities. Moreover, these trends reduce the available number of diverse medical scientists to train emerging physicians.

A few studies have indicated that research interests and intentions to pursue a research career decline as one matriculates through medical school (Guelich et al. 2002) and decline even further during residency (Reck et al. 2006). Reck et al. (2006) reported that the reasons for this decline are largely due to environmental factors, such as bureaucratic obstacles, financial issues, lack of effective role models and mentors, and geographical location or practice environment. Women specifically cite lack of role models or poor career guidance as key factors in altering their career goals more frequently than men do (Watt et al. 2005). These issues are critical since female medical students are more interested in pursuing a clinical research career than are male medical students (Watt et al. 2005) and represent a large portion of the pool of potential biomedical researchers.

A. King
College of Medicine, Howard University, 520 “W” Street, Washington, DC 20059, USA

D. Scott
Collaborative Alcohol Research Center, College of Medicine, Howard University, 520 “W” Street, Washington, DC 20059, USA

R. E. Taylor
College of Medicine, Howard University, 520 “W” Street, Room 512, Washington, DC 20059, USA

Although environmental factors are important in shaping research interests (Gelso and Lent 2000), they contribute to only a portion of the factors that determine one's interests and productivity in research (Hollingsworth and Fassinger 2002; Kahn 2001; Kahn and Scott 1997).

Social Cognitive Career Theory (SCCT; Lent et al. 1994) posits that career interests largely form and career decisions are made based upon individuals' perceptions of their confidence to perform within a given career domain (career self-efficacy) and the outcomes they expect from pursuing that career pathway (i.e., outcome expectations). Within the domain of research, research self-efficacy (confidence in one's abilities to perform research-related tasks and activities) and outcome expectations mediate the relationship between the research training environment and interest in research and predict one's productivity as she or he pursues a research career (Hollingsworth and Fassinger 2002; Kahn 2001). The primary purpose of this study was to investigate whether a theoretically-informed intervention would increase the research self-efficacy beliefs for emerging and early career biomedical scientists. The secondary purpose of this study was to examine the potential variation in research self-efficacy beliefs across gender as well as racial groups.

Gender and racial/ethnic differences in self-efficacy beliefs have been observed in SCCT research. In general, women and minorities tend to have lower self-efficacy than men when making career-related decisions (Bakken et al. 2003; Blustein 1989; Taylor and Betz 1983); thus, they are less likely to retain their interests along a given career pathway (Bakken et al. 2003; Blustein 1989). Furthermore, underrepresented minority women tend to perceive more educational and career-related barriers than men and White women as a result of low perceived abilities to cope with these barriers (Luzzo and McWhirter 2001). A meta-analysis conducted by Multon et al. (1991) suggested that self-efficacy enhancing interventions may serve to strengthen relationships between self-efficacy, interest and ultimately, performance. Self-efficacy interventions, therefore, may be useful for stimulating or sustaining biomedical scientists' interest in clinical research careers, particularly that of women and underrepresented minorities. Recent studies also suggest that interventions be targeted to learning experiences since they may be the sources of previously reported gender differences in self-efficacy (Williams and Subich 2006).

In a previous study, we found higher clinical research self-efficacy beliefs for men than for women in a post-graduate physician population. This gender difference was exaggerated after a short research training program (i.e., a learning experience); although, self-efficacy for both women and men significantly increased after the training program (Bakken et al. 2003). One would expect an educational activity to increase self-efficacy beliefs (Bandura 1986); however, it seems unusual that gender differences would be exacerbated by it. Because there were more male faculty presenters, same-gender modeling may have enhanced research self-efficacy for men more so than for women. Subsequently, we designed this study to determine whether an intervention targeted at increasing research self-efficacy of female biomedical scientists would diminish this gap. What elements should a self-efficacy intervention contain?

Bandura (1986) described four types of experiences that inform self-efficacy beliefs: performance accomplishments, vicarious (observational) learning, emotional arousal, and verbal persuasion. *Performance accomplishments*, which are personal success experiences, for women often occur at a slower rate than they do in men, (Bickel et al. 2002; Buckley et al. 2000a, b) in part because of women's non-linear career paths (Bierema 2001), conflicting family responsibilities, and lack of institutional support (Andrews 2002; Reck et al. 2006). Performance accomplishments might also be indirectly influenced by the values that women, and especially underrepresented minority women, place on family over work (Buckley et al. 2000b; Flores and O'Brien 2002). Furthermore, women's performance accomplishments are often overlooked in the workplace (Valian 2000, pp. 127–129), which in turn, may deflate their efficacy beliefs. Women may lack female mentors or colleagues who contribute to *vicarious learning experiences* through positive role modeling and *verbal persuasion* (e.g., encouragement) that support a "you can do it" attitude (Stalker 1994). *Emotional arousal* can also influence women's efficacy beliefs such that negative affective states, in the form of anxiety or negative self-talk for instance, associated with a given task can decrease efficacy perceptions; the converse is also true. The potential consequences of low self-efficacy are avoidance behaviors, compromised performance and diminished persistence in the face of obstacles or disconfirming experiences (Bandura 1997). These behaviors can have profound consequences for women and underrepresented minorities during their career pursuits.

Previous researchers have used the four sources of self-efficacy as a framework for designing interventions to improve career related self-efficacy in women and underrepresented minority women (Ross-Gordon and Brown-Haywood 2000) with positive results (Luzzo et al. 1996; Sullivan and Mahalik 2000). However, only a few studies have examined self-efficacy in the context of biomedical research and to the best of our knowledge, no study has used SCCT to design an intervention to increase research self-efficacy of clinically-oriented biomedical scientists. Therefore, this study was designed to examine the effects of an intervention based on the work of Sullivan and Mahalik (2000) and others to better understand how self-efficacy beliefs toward research may affect the career decisions of biomedical scientists.

We hypothesized that an intervention emphasizing the four sources of self-efficacy (performance accomplishments, emotional arousal, vicarious learning experiences, and verbal persuasion) would increase women's confidence in their abilities to perform the tasks necessary to be an effective biomedical researcher. The specific hypotheses for this study were:

1. Women in the intervention will have greater differences in their pre- to posttest research self-efficacy scores following a two-day clinical research training program than the women who have not participated in the intervention.
2. Gender differences will exist in research self-efficacy following a two-day clinical research training program and these gender differences will be greater when men's scores are compared to the scores of women who do *not* participate in the self-efficacy intervention.
3. There will be no significant differences by race in women's pre- to posttest research self-efficacy scores following the self-efficacy intervention or two-day clinical research training program.

Knowledge gained from this study is important for designing educational interventions that effectively encourage, support, and facilitate clinician-scientists' entry and persistence in biomedical research careers and their ultimate contributions to and application of scientific discoveries. If we do not understand variables such as self-efficacy that underlie the career development of biomedical scientists, especially for women and underrepresented minorities, then our efforts to provide training programs, such as the two-day clinical research course described in this present study, will have limited impact on stimulating interest and retaining scientists in biomedical research careers.

Method

Participants

Study participants were recruited from 402 individuals who enrolled for the 2006 and 2007 Short Course in Clinical Research, a program jointly sponsored by a private historically-Black college/university (HBCU) in the mid-Atlantic US and a public, research-intensive predominantly-White institution (PWI) in the Midwest. Registrants who were graduate students or postdoctoral trainees and who were in clinically-oriented biomedical fields, such as clinical psychology, medicine, dentistry, nursing, pharmacy, or social work were eligible for the study. Undergraduates and tenure-track or tenured faculty were excluded from the study.

Male volunteers were automatically assigned to the control group. Women were randomized in blocks of six to either the control group or workshop intervention group to assure equal distribution of participants from each site within the two groups of women. Short Course participants who did not volunteer for the study, were excluded from our analyses.

Procedure

This study was approved by the Institutional Review Boards at both participating institutions. The quasi-experimental design for this study is diagrammed in Fig. 1. Briefly, the self-efficacy workshop (intervention) was conducted in the summers of 2006 and 2007 at the HBCU and the PWI within 1–15 days prior to the Short Course in Clinical Research. These two types of institutions were targeted for our intervention because they represent two racially diverse student populations, White and Black/African American, which allowed us to examine the variance in research self-efficacy beliefs across racial groups as well as gender. The Short Course was conducted using two-way videoconferencing with approximately equal numbers of instructors at each site (details to follow). In 2006, the intervention workshop was conducted three (at the HBCU) and four days (at the PWI) in advance of the Short Course which was held in June of that year. To accommodate the participants' schedules, the intervention workshop was held 15 (at the HBCU) and 7 days (at the PWI) before the Short Course which was conducted in August 2007.

Measures of research self-efficacy were obtained from the intervention group at the beginning of the self-efficacy workshop, immediately following the workshop, at the beginning of the Short Course and immediately following the Short Course. Control group participants did not participate in any educational activities in parallel with the self-efficacy workshop; therefore, they completed the self-efficacy assessment immediately

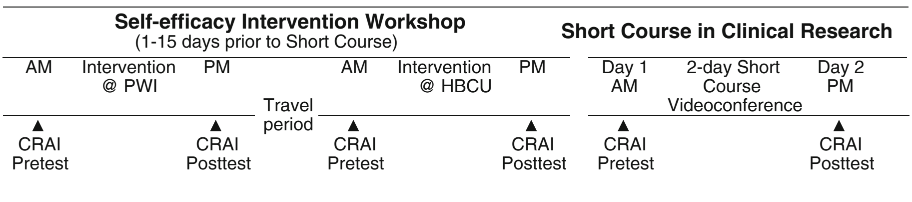

Fig. 1 Schematic of the quasi-experimental design and data collection points for the clinical research self-efficacy study period

Table 1 Data collection points for each measure

Measure	Enrollment	Intervention		Short Course	
		Pre	Post	Pre	Post
Demographic[a]	●				
CRAI		●	●	●	●
Productivity				●	

[a] Includes items for research interest and outcome expectations

before and after the Short Course only. Thus, there were four data collection points for the intervention group and two data points for the control group.

Measures of research interest, career outcome expectations, and productivity (number of manuscripts and grants submitted and published/awarded) were also obtained because they have been shown to correlate with measures of research self-efficacy in other studies (cf. Bieschke 2006). Measures of research interest and career outcome expectations were obtained with demographic data at the time of enrollment. Productivity data were obtained at the beginning of the Short Course. Table 1 presents a summary of the points in which the measures were administered.

Self-efficacy intervention workshop

The self-efficacy workshop consisted of a 45-min introductory session in which the researchers and participants introduced themselves, completed the Clinical Research Appraisal Inventory and reviewed the day's activities. This session was followed by four sessions, each directed toward enhancing one of the four sources of self-efficacy (Table 2). Each session was 60 min long except for the session on verbal persuasion that was 30 min long. A 60-min luncheon was held between the third and fifth sessions (Table 2) to encourage networking and peer support among the participants. A 30-min debriefing session was held at the end of the day during which participants were encouraged to reflect on their experience, evaluate the workshop, and complete the self-efficacy scale (posttest). The same protocol was followed at both of the study's sites.

An African-American female licensed counseling psychologist (employed by the PWI) facilitated all sessions at both sites. Her efforts were facilitated by an African-American woman from the HBCU who had counseling experience. Two tenured female faculty "role models," one European-American and one African-American, represented each of the two study sites and participated as coaches and instructors for the self-efficacy sessions. The same group of individuals conducted the workshop at both sites. The principal investigator (European-American) was present for the introductions, luncheon and debriefing session, but was not present during other sessions.

Short Course in Clinical Research

The Short Course in Clinical Research was held over a two-day period using two-way videoconferencing so that participants at each site would have a similar training experience. An average of fourteen male and nine female faculty representing both institutions were presenters for the 2006 and 2007 Short Course. Presenters were also approximately equally distributed by race (Black/African-American or White). The course content

Table 2 Protocol for the self-efficacy intervention workshop

Session number and title	Length (min)	Session description
1. Introduction	45	The introductory session began with a brief welcome by principal researcher and the workshop's pre- and posttest. Following the pretest, the principal researcher stated the purpose of the workshop and gave an overview of each session. Each participant was then given an opportunity to introduce themselves, state their academic title and describe their experiences in clinical research
2. Performance accomplishments	60	Each participant was asked to bring a copy of an updated curriculum vitae to this session. Two senior faculty investigators led a 10-min discussion focused on the importance of recognizing performance accomplishments. Participants were then divided into groups of two (self-selected) in which they were asked to review each other's curriculum vitae and discuss their performance accomplishments and how they were able to achieve them (20 min). During the last 20 min of the session the group reconvened and participants were asked to share what they had learned about their partner's performance accomplishments. The session concluded by asking each participant to record, in a journal, 1–2 accomplishments that they would like to achieve in the next 6–12 months (10 min)
3. Vicarious learning	60	In groups of two or three following a brief introduction by the facilitator, participants were asked to interview one of the Senior faculty investigators (role models). The faculty were notified in advance of the workshop of their role and asked to give attention during the interview to ways that she overcame barriers in her career development and engage empathy by acknowledging times of frustration and feelings of failure (30 min). Participants were then reconvened and to discuss ways to overcome barriers to career development and diminish feelings of frustration and failure
4. Networking	60	A luncheon was provided for participants to encourage networking and collegiality among them
5. Emotional arousal	60	The facilitator, a counseling psychologist, led this session by teaching relaxation training and adaptive self-talk. Participants were asked to practice relaxation techniques as a group and learn to become aware of negative self-talk through exercises examining self-defeating thoughts and low self-esteem
6. Verbal persuasion	30	Team leaders spent about 15 min discussing the importance of verbal persuasion and provided examples of when it has been used in career development. Participants were then given 15 min to work in small groups to discuss their own examples of verbal persuasion and examples when verbal persuasion may or could have been used to change the course of events that followed each example. The large group then reconvened for the last session
7. Conclusion	30	The workshop concluded with the posttest self-efficacy test, a 15-min debriefing discussion of the participants' reactions to the intervention, and a 15-min written evaluation of the workshop. Participants were encouraged to practice what they have learned in the workshop during the 12-month period following the intervention

included twelve 60-min sessions in 2006 and eleven 60-min sessions in 2007 on topics pertaining to study design, research methods, statistics, scientific writing, and research ethics. The major difference between the format of the course offered in 2006 compared to the one offered in 2007 was the occurrence of "off-line" breakouts sessions on subtopics during the afternoon periods in 2007. There were no significant statistical differences ($z = -.663$, $p = .508$) in the change in pre- to post-Short Course self-efficacy scores between the 2006 (Mdn = 1.09, $N = 27$) and 2007 (Mdn = 1.27, $N = 31$) cohorts.

Measures

Demographic characteristics, research interests, career outcome expectations, and research productivity

A written questionnaire was used to collect basic demographic information including participants' age, gender, race, academic title and degrees earned or in progress of being obtained. Participants were also asked to indicate whether they had conducted or helped to conduct a research study (one question), whether they were interested in conducting studies with human subjects or developing treatments for human diseases (one question), whether they were currently conducting research studies (one question) and whether or not that research involved the study of humans (one question). They were also asked their current level of *interest* (based on a scale of 1 indicating no interest, to 5 indicating extreme interest) in pursuing a biomedical research career (one question) and the proportion of time they would expect to spend conducting research when blended with clinical activities (one question). Finally, participants were queried about eight different *career outcomes* (one category being "other") they would expect if they pursued a career in clinical research (one question). The list of outcomes included: prestige/professional recognition, lucrative salary, personal/life satisfaction, steady employment, improved ability to provide clinical care, leadership or administrative role, expertise to care for a specific population or manage a specific disease, and "other". These data were collected from all participants upon entry to the study. On a separate form provided at the beginning of the Short Course, participants were asked to report the number of manuscripts and grants that they submitted or were published/funded over the previous six months as measures of research productivity.

Clinical Research Appraisal Inventory (CRAI)

The CRAI, as developed by Mullikin et al. (2007), contains 92 items and 10 subscales to assess an individual's perceived ability to perform various research-related tasks, i.e., clinical research self-efficacy. We computed total scale scores and conducted our analyses based on the 88 item and eight-factor structure determined by Mullikin et al. (2007) as optimal for this inventory. Respondents rate the degree to which they are confident in their ability to perform each item (e.g., "determine an adequate number of subjects for a study," "initiate research collaborations with colleagues" or "write a human subjects consent form") on a scale of 0 (*not confident*) to 10 (*completely confident*). Total scores were computed by converting the item responses to a 1–11 scale, summing them and dividing by the number of items contained in the scale. Mullikin et al. (2007) reported a median coefficient alpha across the eight subscale of .96 with a range of .89 to .97. Four-week (average = 29 days) test–retest correlation coefficients ranged from .82 to .96 with a median of .88.

Data analysis

Missing data were handled according to procedures recommended by Tabachnick and Fidell (2001). Randomly and infrequent missing item responses were replaced by the mean of subscale responses so that self-efficacy scores could be computed with a full set of responses. For four cases in which full sets of responses were missing for a subscale so that posttest Short Course scores could not be computed, data were replaced by adding the mean difference of scores across the study group to the pretest score for the participant. For one case in which the pretest score was not available, the missing value was substituted with the post-intervention score.

Because there were no significant differences ($z = -1.572$, $p = .116$) in intervention posttest and Short Course pretest scores for the participants in the intervention study group, only pretest Short Course scores were used as the second data collection point in our analyses for the group of participants in the intervention workshop.

Participants' clinical research self-efficacy scores were compared by gender, race and study group (control or intervention). All statistical analyses were performed using non-parametric procedures and SPSS Version 15.0. Non-parametric statistical procedures are preferred when sample sizes are small and assumptions of normality are likely to be violated (Pett 1997). Pair-wise comparisons of pretest/posttest self-efficacy scores within groups were computed using Wilcoxon signed ranks test and cross group comparisons were made using Mann–Whitney U or Kruskall–Wallis tests. Differences in test scores (pre-intervention, pre-Short Course and post-Short Course) for the intervention group were compared using a Freidman's test. The significance level of $p < .05$ was used to detect differences between median scores.

Results

Study sample

Seventy-five individuals volunteered for the study and 17 of them dropped out of the study prior to the intervention workshop or Short Course. Of those 17 individuals, six were male and 11 were female of which eight women had been randomized to the intervention group. Six of the seventeen individuals reported their race as Black and 11 of them reported as White.

The final study sample included 58 Short Course participants who volunteered for this study. The distribution of these 58 participants according to race, academic institution, and study group is shown in Table 3. Thirty-five participants self-identified as White, 19 as Black or African-American, 2 as Asian and 2 as biracial. Of the 58 participants, 18 were at the HBCU and 40 were at the PWI. Of the 18 participants at the HBCU, all self-identified as Black or African American. This sample is representative of all the Short Course attendees in terms of their relative proportions by institution and academic title.

Preliminary data analysis

There were no significant differences (at the $p < .05$ level) on demographic characteristics for the three study groups. Specifically, no statistically significant differences emerged in age, academic title, or research productivity among study groups. Notably, 49 of the 58 participants had conducted or helped to conduct a research study prior to this study and 43 of them were currently conducting research. There was a significant positive correlation between participants' research self-efficacy scores (pre-intervention or pre-Short Course) and level of interest at baseline ($r_{\text{rho}} = .310$, $p = .019$, two-tailed). The four most frequently reported career outcome expectations by the participants were (1) personal/life

Table 3 Number of participants in sample broken down by institution, race and study group

Institution	Study group	Race				N
		Asian	Black or African American	White	Mixed race	
HBCU	Male control	0	3	0	0	3
	Female control	0	8	0	0	8
	Female intervention	0	7	0	0	7
	Subtotal	0	18	0	0	18
PWI	Male control	0	0	12	0	12
	Female control	1	0	12	1	14
	Female intervention	1	1	11	1	14
	Subtotal	2	1	35	2	40
	Total	2	19	35	2	58

satisfaction (78%), (2) expertise for patient care or disease management (66%), (3) prestige or professional recognition (52%) and (4) improved ability to provide clinical care (51%).

Primary data analysis

Results of within group differences in median research self-efficacy scores before and after the intervention workshop and Short Course are shown in Table 4. Research self-efficacy scores significantly increased from pre- to post-intervention for women who participated in the self-efficacy workshop ($z = -2.782$, $p = .002$, one-tailed). Median CRAI scores also significantly increased within each group following the Short Course (Table 4), but a comparison of the difference in pre- and post-Short Course self-efficacy scores across the three groups was not significant ($\chi^2 = .949$, $df = 2$, $p = .622$, two-tailed).

Table 4 Median self-efficacy scores and within group comparisons for each study group

Comparison group	N	Intervention pretest	Intervention posttest	Short Course pretest	Short Course posttest	Z	Effect size estimate (r)[a]	p-value[b] one-tailed
Male control	15	Nt[c]	Nt[c]	6.8	7.8	−3.408	−.622	<.001
Female control	22	Nt[c]	Nt[c]	6.3	8.1	−4.074	−.614	<.001
Female intervention	21	6.3	6.7	6.6	7.6	−2.782[d], −3.875[e]	−.429[d], −.598[e]	.002[d], <.001[e]

[a] Estimated effect size was calculated from the test statistic Z (the Wilcoxon signed rank test statistic) divided by the square root of the total number of observations within each group ($N \times 2$). Cohen's criteria: $r = 1.0$ (small effect), $r = .30$ (medium effect), $r = .50$ (large effect)

[b] The calculated p-value using the Wilcoxon signed rank test

[c] Nt = not tested

[d] Refers to comparison of pre- and post-intervention research self-efficacy scores

[e] Refers to comparison of pre- and post-Short Course research self-efficacy scores

Table 5 Median self-efficacy scores and within group statistical comparisons by race for each female study group

Comparison group	N	Intervention pretest	Intervention posttest	Short Course pretest	Short Course posttest	Z	Effect size estimate (r)[a]	p-value[b] one-tailed
Female control[c]								
White	12	Nt[d]	Nt[d]	5.9	7.4	−3.059	−.624	.001
Other races	9	Nt[d]	Nt[d]	6.6	9.2	−2.547	−.600	.005
Female intervention								
White	11	6.3	6.9	6.6	7.3	−2.244[e], −2.934[f]	−.478[e], −.626[f]	.012[e], .002[f]
Other races	10	6.4	6.7	6.7	8.3	−1.682[e], −2.701[f]	−.376[e], −.604[f]	.046[e], .004[f]

[a] Estimated effect size was calculated from the test statistic Z (the Wilcoxon signed rank test statistic) divided by the square root of the total number of observations within each group (N x 2). Cohen's criteria: $r = 1.0$ (small effect), $r = .30$ (medium effect), $r = .50$ (large effect)

[b] The calculated p-value using the Wilcoxon signed ranks test

[c] Two participants did not indicate their racial origin

[d] Nt = not tested

[e] Refers to comparison of pre- and post-intervention research self-efficacy scores

[f] Refers to comparison of pre- and post-Short Course research self-efficacy scores

Consequently, the analyses did not support our first hypothesis that women in the intervention group would have greater increases in their self-efficacy scores following the Short Course than women in the control group. Furthermore, there were no significant differences in self-efficacy scores when women who participated in the intervention or control group were compared with men in the control group. Thus, our results also do not support our second hypothesis that increases in men's and women's self-efficacy scores would differ from each other as a result of their Short Course participation.

To test our third hypothesis that there would be no significant differences by race in women's pre- to post-Short Course self-efficacy scores, we created two racial groups defined as "White Participants" and "Participants of Color." Table 5 presents the median research self-efficacy scores by racial group for women in the two study groups (intervention and control).

Interestingly, increases in pre- to post-Short Course research self-efficacy scores appeared greater for women of color than for White women and a significant main effect for race was found across treatment groups ($z = -1.719$, $p = .043$, one-tailed) when these scores were compared. Analyses of differences in pre- and post-Short Course research self-efficacy scores between racial categories and within each of the female study groups, however, were not significant ($z = -1.066$, $p = .155$, one-tailed for the control group; $z = -1.409$, $p = .086$, one-tailed for the intervention group). Overall, our analyses supported our third hypothesis that changes in research self-efficacy scores would not differ across racial groups. However, caution must be taken when interpreting these results since we found a small but statistically significant difference between changes in research self-efficacy scores when White participants and participants of color were compared. Our small sample size may subject this interpretation to Type II error.

Discussion

Learning experiences are derived from a person's interactions with his or her environment and situated within both time and place. Experiences result in changes in a person's knowledge, attitudes, skills and sometimes, behaviors (Dewey 1938; Bandura 1986). According to SCCT (Lent et al. 1994), educational activities, such as the Short Course in Clinical Research, and efficacy enhancing interventions, such as the one tested in this study, should provide structured learning experiences that stimulate and support one's confidence to perform and interests in biomedical research. Self-efficacy as a mediator of the relationship between learning experiences and career-related interests has been theorized (Lent et al. 1994) and subsequently, supported (Kahn 2001; Kahn and Scott 1997; Saks 1995); however, little is known about the nature of learning experiences that lead to career outcomes (Schaub and Tokar 2004; Williams and Subich 2006). The purpose of this study was to test the effect of an intervention using theoretically-derived learning experiences on the research self-efficacy beliefs of early career biomedical scientists. This study is, to the best of our knowledge, the first to investigate the effects of an intervention to increase research self-efficacy in early career female clinician-scientists who have some level of interest in biomedical research.

Our results suggest that a research self-efficacy workshop intervention had a statistically significant effect on increasing self-efficacy scores prior to a short-term research training program for the women who were studied. Although the workshop had a positive effect, it did not significantly alter research efficacy beliefs between the intervention and control groups when these women participated in the Short Course. Alternatively, it appears that the workshop served to boost base-line self-efficacy scores for the women who participated in it. This observation makes sense in terms of social cognition and learning theory. Bandura (1997) states that "self-referent thought activates cognitive, motivational and affective processes that govern the translation of knowledge and abilities into proficient action" (p. 37). The intervention workshop focused on reinforcing self-efficacy through its four primary sources (i.e., vicarious learning experiences, physiological and affective states, verbal persuasion, and master experiences) which, in terms of learning, primarily speak to affective processes and to a lesser extent, cognitive and motivational processes. The Short Course, on the other hand, was designed to strengthen cognition and motivation and to a lesser extent, affective processes. Since the items in our measure of self-efficacy (the CRAI), like other efficacy measures, are largely focused on one's confidence in their knowledge and skills (reflecting cognitive and motivational processes) regarding research, our results could suggest that the CRAI is less sensitive to learning derived through affective processes. If this were true, one would expect a gain in self-efficacy to be greater for the Short Course and less for the intervention workshop. Furthermore, one would expect incremental or cumulative gains in self-efficacy scores (as we observed in our results) with learning experiences (e.g., intervention and Short Course) that address multiple processes. This rationale is supported by the work of Saks (1995) and Gist et al. (1991) who provide evidence that cognitive and motivational training activities along with socialization tactics that enhance self-efficacy and reinforce learning transfer and positive attitudes are needed for job satisfaction, performance, and commitment.

The learning experience provided by the two-day Short Course was also effective at increasing research self-efficacy for both men and women. This later finding is consistent with our previous study suggesting that short-term research training programs can provide learning experiences that positively affect research self-efficacy (Bakken et al. 2003). Saks

(1995) found that brief training interventions not only serve to increase self-efficacy related to job satisfaction and performance (opposed to training outcomes), but for trainees who have low self-efficacy prior to training, training interventions serve to reduce anxiety which, in turn, increases self-efficacy and enhances socialization and adjustment in the workplace. Since research self-efficacy is a significant predictor of scholarly activity (Kahn 2001), we extrapolate that scholarly activity may be enhanced through short-term training programs, such as the Short Course described in this study.

These results, however, also conflicted with our previous finding that a gender difference in research self-efficacy was exacerbated following a short-term clinical research training program (Bakken et al. 2003). Several factors may explain this contradiction. First, in this study we used a carefully developed and psychometrically-sound scale to assess research self-efficacy that was not used in our previous study (Mullikin et al. 2007). This more valid assessment of research self-efficacy may have provided a more accurate understanding of the effects of the short-term research training program on research self-efficacy for the women and men in the present study than was assessed in the prior study.

Second, since 2003, we have made deliberate attempts to select instructors for the Short Course who can serve as role models for participants, giving close attention to gender and race. Role models are important for reinforcing vicarious learning; thereby, strengthening one's efficacy beliefs (Bandura 1986). However, a recent study by Williams and Subich (2006) found that vicarious learning failed to be a significant predictor of career self-efficacy. Instead, performance accomplishments had the greatest effect on self-efficacy for men and women. This finding would suggest that perhaps the Short Course is more effective at reinforcing the research accomplishments of the men and women who participated in it. Additional studies are needed to ascertain the sources of self-efficacy that are enhanced through the Short Course.

Research training environments comprise the day-to-day interactions that researchers have with mentors, colleagues, peers and others who help to shape their self-efficacy beliefs (Gelso and Lent 2000). Since academic medical environments continue to be dominated by men, especially those in higher ranking positions, women are less likely to receive the types of vicarious experiences, verbal persuasion, performance awards, and anxiety reducers that provide ongoing support for research efficacy beliefs (see Ragins and Cotton 1999). Indeed, other authors have reported lack of mentors and other social enforcements, such as that provided by multiple-member research teams (Manson 2009), which are needed to support women in their academic pursuits to become researchers (Love et al. 2007; Watt et al. 2005). Recent studies by Schaub and Tokar (2004) and Williams and Subich (2006) have supported the positive relationship between learning experiences and self-efficacy and suggest that prior learning experiences may be the sources of previously observed gender differences between men and women. If so, it is imperative that educational interventions be designed to offset potential detrimental effects of research environments on efficacy beliefs.

One way to accomplish this is through participatory approaches, such as that described by Manson (2009), when designing educational programs that promote equity and support researchers in their career development. Another way to counteract the potential negative effects of research environments on women's or men's self-efficacy is for organizations to utilize "socialization tactics" (Saks 1995), such as the "conceptual roadmap" described by Manson (2009) that provides an effective self-management technique (Gist et al. 1991) for benchmarking performance accomplishments and assessing job fit; thereby, enhancing self-efficacy beliefs. Moreover, welcoming and supportive "communities of practice"

(Wenger 1998) are critical in preventing social isolation that can erode research self-efficacy (Wang 2005).

Interestingly, the results of this study indicated a greater gain in research self-efficacy scores for participants of color compared to White participants for both the female intervention and control groups. These differences may be due to the facilitative effect of culturally-relevant learning experiences and role models that comprised both the intervention and Short Course for all participants. When members of historically marginalized groups are validated for their scholarly contributions and their professional potential is affirmed, prevailing stereotype threats (Steele and Aronson 1995) that can undermine their perceived intellectual capabilities and create efficacy-depleting anxiety may be counteracted. Thus, the significant gain in research self-efficacy scores for participants of color may have indirectly captured the facilitative effect of vicarious learning in the form of culturally-validating role models within the intervention that also took place in a culturally-affirming HBCU context. Indeed, in a study of African American students' math course intentions, Gainor and Lent (1998) found that vicarious learning was the largest source of self-efficacy predicting their intentions; not performance accomplishments.

These findings underscore the need for continued development and implementation of conceptually-sound and culturally-relevant interventions to attract and retain emerging clinical researchers. Dick et al. (2007) provide an excellent example of how this can be done using participatory approaches. Additional studies are needed to determine the means by which educational interventions and learning activities are addressing cultural differences related to research self-efficacy.

Implications

This study suggests several practical implications for educational efforts aimed at increasing research self-efficacy and career interests. As suggested by Manson (2009) and the findings from this study, inclusive approaches to educational programming efforts are more likely to result in equitable and culturally-relevant research learning experiences. Moreover, short-term training programs, such as the intervention workshops and Short Course, are necessary for increasing self-efficacy which is essential to one's job satisfaction and performance and career success (Saks 1995). Training programs, however, constitute only one type of organizational/environmental means for supporting self-efficacy and they may, as suggested by this study, tend to favor cognitive or motivational processes. In order to address affective processes that promote self-efficacy and lead to satisfying and productive research careers, three- or four-member mentoring teams (Carnes et al. 2006; Manson 2009) and organizational supports to reduce researcher anxiety, such as women's mentoring programs or multiple years of financial commitment (Carnes et al. 2006; Ragins and Cotton 1999), should be incorporated into training efforts. Finally, this study suggests that measures of self-efficacy might not be assessing all learning processes (cognitive, motivational and affective) that promote efficacy beliefs. Our findings suggest a need for studies that separately assess sources of self-efficacy and their associations with learning experiences. Quasi-experimental studies, such as this one, could be strengthened using measures of the four sources of self-efficacy, rigorous recruitment efforts across multiple sites, and integrated, but separately assessed, training interventions that address all types of learning approaches (cognitive, motivational and affective).

Limitations

The major limitations of this study were our small sample size and related inability to control for variables, such as age or academic title, in our group comparisons that may also have influenced our results. Overall, it appears from our independent analyses of the demographic variables, that our study groups had similar characteristics; thus, it is unlikely that these results are confounded by differences in any of those variables. Moreover, our power to detect significant differences across each of the three study groups was modest (observed power $= .154$, $df = 2$, $p = .05$) thus, limiting our ability to detect actual differences among the men and women studied.

Conclusions

In spite of these limitations, our findings provide initial evidence that efficacy enhancing interventions are indeed effective at increasing female scientists' confidence in their abilities to perform biomedical research. The impact of such interventions may be especially important for women of color in biomedical research careers. These findings suggest several future directions for research and directions for stimulating more interest in biomedical research career pathways. First, it is important to determine the efficacy of interventions in sustaining efficacy beliefs in order to positively affect eventual career-related behaviors and outcomes. Second, additional studies are needed to determine the specific learning experiences and sources of research self-efficacy that are most effective at enhancing these beliefs. If we can successfully enhance research efficacy beliefs through educational interventions, then we are more likely to stimulate biomedical scientists' interests in research careers and increase the amount of research that is translated into clinical applications that improve human health.

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References

Andrews, N. C. (2002). The other physician-scientist problem: Where have all the young girls gone? *Nature Medicine, 8*, 439–441.

Bakken, L., Sheridan, J., & Carnes, M. (2003). Gender differences among physician-scientists in self-assessed abilities to perform clinical research. *Academic Medicine, 78*, 1281–1286.

Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bickel, J., Wara, D., Atkinson, B., Cohen, L., Dunn, M., Hostler, S., et al. (2002). Increasing women's leadership in academic medicine: Report of the AAMC Project Implementation Committee. *Academic Medicine, 77*, 1043–1061.

Bierema, L. (2001). Women, work, and learning. *New Directions for Adult and Continuing Education, 92*, 53–62.

Bieschke, K. J. (2006). Research self-efficacy beliefs and research outcome expectations: Implications for developing scientifically minded psychologists. *Journal of Career Assessment, 14*, 77–91.

Blustein, D. L. (1989). The role of goal instability and career self-efficacy in the career exploration process. *Journal of Vocational Behavior, 35*, 194–203.

Buckley, L., Sanders, K., Shih, M., & Hampton, C. (2000a). Attitudes of clinical faculty about career progress, career success and recognition, and commitment to academic medicine. *Archives of Internal Medicine, 160*, 2625–2629.

Buckley, L., Sanders, K., Shih, M., Kallar, S., & Hampton, C. (2000b). Obstacles to promotion? Values of women faculty about career success and recognition. *Academic Medicine, 75*, 283–288.

Carnes, M., Schuler, L., Sarto, G. E., Lent, S. J., & Bakken, L. (2006). Increasing sex and ethnic/racial diversity of researchers in aging: Some promising strategies at the postdoctoral level. *Journal of the American Geriatric Society, 54*, 980–985.

Dewey, J. (1938). *Experience and education*. New York: The MacMillan Company.

Dick, R. W., Manson, S. M., Hansen, A. L., Huggins, A., & Trullinger, L. (2007). The native telehealth outreach and technical assistance program: A community-based approach to the development of multimedia-focused health care information. *American Indian and Alaska Native Mental Health Research: The Journal of the National Center, 14*, 49–66.

FACTS: Applicants, matriculants and graduates. (2007). Retrieved July 19, 2007, from www.aamc.org/data/facts/2006/grads4table21.htm.

Final Report of the NAGMS Council MORE Division Working Group. (2006). Retrieved March 29, 2006, from www.nigms.nih.gov/News/Reports/MORECouncil_Jan2006.htm.

Flores, L., & O'Brien, K. (2002). The career development of Mexican–American adolescent women: A test of Social Cognitive Career Theory. *Journal of Counseling Psychology, 49*, 14–27.

Gainor, K. A., & Lent, R. W. (1998). Social cognitive expectations and racial identity attitudes in predicting the math choice intentions of Black college students. *Journal of Counseling Psychology, 45*, 403–413.

Gelso, C. J., & Lent, R. (2000). Scientific training and scholarly productivity: The person, the training environment, and their interaction. In S. Brown & R. Lent (Eds.), *Handbook of counseling psychology* (3rd ed., pp. 109–139). New York: John Wiley & Sons.

Gist, M. E., Stevens, C. K., & Bavetta, A. G. (1991). Effects of self-efficacy and post-training intervention on the acquisition and maintenance of complex interpersonal skills. *Personnel Psychology, 44*, 837–861.

Guelich, J. M., Singer, B. H., Castro, M. C., & Rosenberg, L. E. (2002). A gender gap in the next generation of physician-scientists: Medical student interest and participation in research. *Journal of Investigative Medicine, 50*, 412–418.

Hollingsworth, M. A., & Fassinger, R. E. (2002). The role of faculty mentors in the research training of counseling psychology doctoral students. *Journal of Counseling Psychology, 49*, 324–330.

Jagsi, R., Guancial, E., Worobey, C., Henault, L., Chang, Y., & Starr, R. (2006). The "gender gap" in authorship of academic medical literature—A 35-year perspective. *New England Journal of Medicine, 355*, 281–287.

Kahn, J. H. (2001). Predicting the scholarly activity of counseling psychology students: A refinement and extension. *Journal of Counseling Psychology, 48*, 344–354.

Kahn, J. H., & Scott, N. A. (1997). Predictors of research productivity and science-related career goals among counseling psychology doctoral students. *The Counseling Psychologist, 25*, 38–67.

Kelley, W. N., & Randolph, M. A. (Eds.). (1994). *Careers in clinical research: Obstacles and opportunities*. Washington, DC: National Academy Press.

Lent, R., Brown, S., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice and performance. *Journal of Vocational Behavior, 45*, 79–122.

Love, K. M., Bahner, A. D., Jones, L. N., & Nilsson, J. E. (2007). An invitation of early research experience and research self-efficacy. *Professional Psychology: Research and Practice, 38*, 314–320.

Luzzo, D., Funk, D., & Strang, J. (1996). Attributional retraining increases career decision-making self-efficacy. *Career Development Quarterly, 44*, 378–386.

Luzzo, D., & McWhirter, E. (2001). Sex and ethnic differences in the perception of educational and career-related barriers and levels of coping efficacy. *Journal of Counseling & Development, 79*, 61–67.

Manson, S. M. (2009). Personal journeys, professional paths: persistence in navigating the crossroads of a research career. *American Journal of Public Health, 99*, S20–S25.

Mullikin, E. A., Bakken, L. L., & Betz, N. E. (2007). Assessing research self-efficacy in physician-scientists: The Clinical Research Appraisal Inventory. *Journal of Career Assessment, 15*, 367–387.

Multon, K., Brown, S., & Lent, R. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of Counseling Psychology, 38*, 30–38.

Nathan, D., & Varmus, H. (2000). The National Institutes of Health and clinical research: A progress report. *Nature Medicine, 6*, 1201–1203.

Pett, M. A. (1997). *Nonparametric statistics for health care research*. Thousand Oaks: Sage Publications.

Promoting Translational and Clinical Science: The critical role of medical schools and teaching hospitals. (2006). Retrieved August 14, 2008, from http://www.aamc.org/research/clinicalresearch/start.htm.

Ragins, B., & Cotton, J. (1999). Mentor functions and outcomes: A comparison of men and women in formal and informal mentoring relationships. *Journal of Applied Psychology, 84*, 529–550.

Reck, S. J., Stratman, E. J., Vogel, C., & Mukesh, B. N. (2006). Assessment of residents' loss of interest in academic careers and identification of correctable factors. *Archives of Dermatology, 142*, 855–858.

Ross-Gordon, J., & Brown-Haywood, F. (2000). Keys to college success as seen through the eyes of African American adult students. *Journal of Continuing Higher Education, 48*, 14–23.

Saks, A. M. (1995). Longitudinal field investigation of the moderating and mediating effects of self-efficacy on the relationship between training and newcomer adjustment. *Journal of Applied Psychology, 80*, 211–225.

Schaub, M., & Tokar, D. M. (2004). The role of personality and learning experiences in Social Cognitive Career Theory. *Journal of Vocational Behavior, 66*, 304–325.

Stalker, J. (1994). Athene in academe: Women mentoring women in the academy. *International Journal of Lifelong Education, 13*, 361–372.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology, 69*, 797–811.

Sullivan, K., & Mahalik, J. (2000). Increasing career self-efficacy for women: Evaluating a group intervention. *Journal of Counseling & Development, 78*, 54–62.

Tabachnick, B. G., & Fidell, L. S. (2001). *Using multivariate statistics* (4th ed.). Needham Heights, MA: Allyn & Bacon.

Taylor, K., & Betz, N. (1983). Applications of self-efficacy theory to the understanding and treatment of career indecision. *Journal of Vocational Behavior, 22*, 63–81.

Valian, V. (2000). Evaluating women and men. In *Why So Slow?* (pp. 125–144). Cambridge, MA: MIT Press.

Wang, M. (2005). *Physician-scientists' learning in communities of practice*. Doctoral unpublished dissertation, University of Wisconsin, Madison, WI.

Watt, C. D., Greeley, S. A. W., Shea, J. A., & Ahn, J. (2005). Educational views and attitudes, and career goals of MD–PhD students at the University of Pennsylvania School of Medicine. *Academic Medicine, 80*, 193–198.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York, NY: Cambridge University Press.

Williams, C. M., & Subich, L. M. (2006). The gendered nature of career related learning experiences: A Social Cognitive Career Theory perspective. *Journal of Vocational Behavior, 69*, 262–275.

Wong, E., Bigby, J., Kleinpeter, M., Mitchell, J., Camacho, D., Dan, A., et al. (2001). Promoting the advancement of minority women faculty in academic medicine: The National Centers of Excellence in Women's Health. *Journal of Women's Health & Gender-Based Medicine, 10*, 541–549.