ABSTRACT
The purpose of this secondary analysis was to determine whether age affects women’s and men’s exercise adherence after a cardiac event. In a convenience sample of 248 adults ages 38 to 86 who had a cardiac event, exercise adherence (three exercise sessions per week) was compared between men and women in three age groups (younger than 60, 61 to 70, and older than 70). Exercise patterns were recorded by heart rate monitors worn during exercise. No differences were found in adherence between the age groups for women; older men were nonadherent sooner than younger men when controlling for fitness level, pain, comorbidity, self-efficacy, depressed mood, and social support. Exercise adherence after a cardiac event was higher for younger men compared with older men. For all age groups, less than 37% of the total sample adhered to a three-times-per-week exercise regimen after 1 year, suggesting that interventions to maintain exercise adherence are needed.

An important component of recovery from a cardiac event is lifestyle modification that includes exercise. After a cardiac event, many older adults participate in an outpatient cardiac rehabilitation program (CRP) to assist with the adoption of exercise. Outpatient CRPs consist of medically supervised exercise three times per week for 12 weeks (American Association of Cardiovascular and Pulmonary Rehabilitation, 2004). The benefits of adopting a 12-week cardiac rehabilitation exercise program are a 20% to 31% reduction in mortality from heart disease, improved functional capacity, reduction in cardiac risk factors, improvement in emotional health and quality of life, improvement in cognitive function (Gunstad et al., 2005; Jolliffe et al., 2000, 2001; Taylor et al., 2004), and improvement in lower extremity function (Dolansky & Moore, 2004). To maintain these benefits, exercise must continue for life. Participants who complete a CRP are recommended to...
continue to exercise a minimum of three times per week as established during the CRP.

Continuation of the exercise regimen is difficult, and only 15% to 50% of participants continue to exercise 6 months after completion of a CRP (Ades, Maloney, Savage, & Carhart, 1999; Bock et al., 1997; Moore, Ruland, Pashkow, & Blackburn, 1998). Gender differences exist: Women are more vulnerable to not adhering to the exercise regimen compared with men (Moore et al., 2006), even among older adults (Lee, 2005). Although community-dwelling older adults have been reported to be less active than younger adults (Federal Interagency Forum on Aging-Related Statistics, 2008; O’Brien Cousins, 1998), it is not known whether this trend exists for CRP participants. Thus, the purpose of this secondary analysis was to determine whether age affects women’s and men’s exercise adherence after a cardiac event and completion of a CRP. Understanding differences between younger and older adults will help tailor interventions to help cardiac patients continue to exercise for life.

BACKGROUND
As a disease management strategy following hospitalization for a cardiac event, outpatient CRPs offer a comprehensive approach to the integration of healthy lifestyle practices. Although CRP services are not offered under all private insurance plans, they are covered for older adults under Medicare. The Centers for Disease Control and Prevention (2008) noted that participation in a CRP by patients following a cardiac event is a key strategy for reducing further disability. The goals of CRPs are to improve functional capacity, alleviate activity-related symptoms, reduce disability, and modify coronary risk factors in an attempt to reduce subsequent morbidity and mortality (Balady et al., 2000). The focus on exercise and the requirement of a cardiac stress test prior to CRP enrollment results in participants who are generally more fit, physically able, and motivated to exercise. In addition to being physically able, CRP participants are predominantly men and have a physician who recommends use of these services (Ades, Waldmann, McCann, & Weaver, 1992; Ades, Waldmann, Polk, & Coflesky, 1992; Harlan, Sandler, Lee, Lam, & Mark, 1995; Husak et al., 2004; Lieberman, Meana, & Stewart, 1998).

Factors related to adherence to an exercise program include comorbidity (Ades et al., 1999; O’Brien Cousins, 1998), fitness level (McAuley et al., 1999; Newson & Kemps, 2007), muscle and joint pain (Moore, Dolansky, Ruland, Pashkow, & Blackburn, 2003), self-efficacy (Bock et al., 1997; Clark, 1999; McAuley, 1993; McAuley, Lox, & Duncan, 1993; Oman & King, 1998), depression (Blumenthal et al., 2004; Milani, Littman, & Lavie, 1993), social support (Lieberman et al., 1998), and race (Crespo, Smit, Andersen, Carter-Pokras, & Ainsworth, 2000). Older cardiac patients are particularly vulnerable to not participating in a CRP because they tend to have decreased physical fitness, reduced muscle strength, and higher levels of depression (Ades, 1999; Ades et al., 2002). In addition, older adults have more comorbidity than younger adults, including a higher incidence of arthritis that may interfere with exercise (Schoenberg, Kim, Edwards, & Fleming, 2007). Given that community-dwelling older adults tend to be less physically active and that older adults have more comorbid illnesses, less social support, and greater disability and depression that is associated with lower exercise adherence, it is possible that differences exist in adherence to exercise guidelines between older and younger adults. Thus, this secondary analysis addressed the following research questions:

- During the year following completion of a CRP, what are the trends in adherence to exercise three times per week for men and women in three age groups: younger than 60, 61 to 70, and older than 70?
- Are there differences between women and men in adherence to exercise three times per week for each of these age groups?
- Do these differences remain when controlling for race, comorbidity, physical fitness, pain, self-efficacy, depression, and social support?

METHOD
Sample
A convenience sample was recruited for a prospective longitudinal intervention study between November 2000 and December 2002 from three Phase II CRP locations in Cleveland, Ohio (Moore et al., 2006). These individuals started the CRP after a hospitalization for myocardial infarction, cardiac bypass surgery, and/or angioplasty. Individuals were approached as they neared the end of their 12-week outpatient CRP. Every woman and person of minority race was approached, whereas every other Caucasian man was approached to obtain sufficient numbers of these subpopulations. Regardless of intervention group assigned by the parent study, all participants were included in the current secondary analysis because no differences were found between the intervention and control groups in the outcome variables for the current study.

To ensure safe exercise after a cardiac event, exclusion criteria included: ejection fraction lower than 30%, a decrease in systolic blood pressure greater than 15 mmHg with exercise, serious arrhythmias at rest or with exercise or ischemia with exercise indicated by angina, and greater than 2 mm
ST segment depression on electrocardiogram. A total of 546 individuals met the study enrollment criteria. Of these, 273 were enrolled into the study. This refusal rate is consistent with other cardiac studies (Moore, 1996; Moore & Dolansky, 2001). Fourteen participants withdrew prior to assessment of baseline measures, while 9 withdrew between baseline measurement and completion of the CRP. Two individuals were deemed outliers for having reported several hours of walking daily and were dropped from the analysis to yield a final sample of 248. Individuals who withdrew during the study period after baseline measurements were included in the analysis because the statistics used in the analysis (Kaplan-Meier and Cox regression) appropriately censure these cases.

Measures

Dependent Variable. Exercise sessions were recorded using a portable wristwatch heart rate monitor worn by the participant (Polar Vantage NV™, Polar Electro, Kempele, Finland), and data were aggregated to determine the number of exercise sessions performed each week. Although adherence to exercise is currently defined by the American Heart Association as a minimum of five 30-minute sessions per week at a moderate intensity (Haskell et al., 2007), this analysis is based on a more liberal definition of exercising three times per week as recommended by the American Heart Association at the time of participant enrollment into the study. A nonadherence event was calculated as occurring the week after the last time a participant did not meet the guideline of three exercise sessions per week. The duration of the individual exercise sessions (N = 12,527) ranged from 8 to 62 minutes. Of these 12,527 recorded exercise sessions, 95% were at least 20 minutes in length, and 86% were at least 30 minutes in length.

Candidate Predictor Variables. A candidate set of predictor variables was based on Ewart’s (1990) conceptual model (Social Problem Solving Model), which describes how component processes interact to influence health behavior. Demographic, physical, and psychosocial variables that were postulated to affect exercise adherence were assessed during the baseline interview (Week 6 to 8 of the CRP). Demographic variables included age, gender, and race. Physical variables were fitness, muscle and joint pain, and comorbidity. Fitness was measured by the 6-Minute Walk Test (Guyatt et al., 1984). Muscle and joint pain was measured by the question, “How much muscle or joint pain do you experience while exercising?” Responses range from no discomfort (1) to severe discomfort (4). Comorbidity was assessed using the Charlson Comorbidity Index (Charlson, Pompei, Ales, & MacKenzie, 1987), which measures the impact of comorbid illnesses using a weighted scale. The higher the score, the greater the comorbidity.

Psychosocial variables were self-efficacy, depressed mood, and social support. Self-efficacy was measured using the Barriers to Exercise Self-Efficacy Scale (McAuley, 1993), which assesses participants’ perceived confidence to overcome commonly identified barriers to exercise for at least 40 minutes three times per week over the subsequent 2 months. Higher scores indicate greater self-efficacy to adhere to an exercise program. Depressed mood was measured using the Depression/Dejection scale of the Profile of Mood States (McNair, Lorr, & Droppleman, 1981). Participants were asked about psychological and emotional responses to stressors during the previous week using a Likert-type scale. Higher scores reflect greater mood disturbance. Social support was measured using the family subscale of the Social Support for Exercise Scale (Sallis, Grossman, Pinski, Patterson, & Nader, 1987); higher scores reflect greater perception of social support from family members.

Procedures and Data Analysis

Individuals who met study inclusion criteria during Weeks 6 to 8 of the CRP were recruited by trained clinicians. Written informed consent was obtained from participants prior to baseline data collection. The baseline measures included all candidate predictor variables. Each participant was given a heart rate monitor and an exercise diary. Participants were directed to return by mail both the monitor and diary each month upon receipt of a new monitor and diary for the next 12 months. Individuals were given exercise prescriptions from the CRP that included a target heart rate and were counseled to exercise at least three times per week for 30 minutes at that rate.

Survival analysis was used to determine the relationships between age group, gender, and time to cessation of exercise. Time was measured in weeks. A nonadherence event was defined as exercising less than three times per week and was recorded as the week after the last week during which the participant exercised fewer than three times. Participants who reported no exercise throughout the study were recorded as having an event at Week 1. Participants who withdrew from the study were censored in the week they withdrew if they met the adherence guideline in the last week of participation.

Kaplan-Meier plots of survival distributions were examined by age group for women and men. The log rank test was used to compare differences in the survival distributions. The Cox proportional hazards regression model was used to test the relationship of the candidate predictor variables with adherence to exercise. The confidence interval for significant predictors was set at 95%. Demographic variables (age group, race), physical variables (fitness, muscle and
joint pain, comorbidity), and psychosocial variables (self-efficacy, depressed mood, social support) were included in the final model.

RESULTS
Demographic Variables
The sample consisted of 38.3% women and 61.7% men. The mean age of the sample was 62.4 (SD = 11.1 years), and the mean years of education was 14.1 (SD = 2.6). Eighty-one percent were Caucasian, 17% were African American, and 2% were neither Caucasian nor African American. Cardiac events included hospitalization for a myocardial infarction (51.6%), coronary artery bypass surgery (55.2%), and/or angioplasty (58.9%). The data were examined for natural break points in age groups, and the following were used: younger than 60, 61 to 70, and older than 70. The demographic information for each age group is shown in Table 1. The mean age for each of the three groups was 51.8 (SD = 5.4 years), 65.5 (SD = 3 years), and 76 (SD = 4.5 years), respectively.

Research Questions
The means and standard deviations of the physical and psychosocial variables by gender within the age groups are listed in Table 1. The oldest age group had significantly lower scores on the 6-Minute Walk Test, greater comorbidity compared with the youngest age group, and lower reported family

<table>
<thead>
<tr>
<th>Variable</th>
<th>Younger than 60 (n = 108)</th>
<th>61 to 70 (n = 73)</th>
<th>Older than 70 (n = 67)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women (n = 37)</td>
<td>Men (n = 71)</td>
<td>Women (n = 29)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>21 (56.8)</td>
<td>65 (91.5)</td>
<td>21 (72.4)</td>
</tr>
<tr>
<td>African American</td>
<td>14 (37.8)</td>
<td>5 (7)</td>
<td>7 (24.1)</td>
</tr>
<tr>
<td>Other</td>
<td>2 (5.4)</td>
<td>1 (1.4)</td>
<td>1 (3.4)</td>
</tr>
<tr>
<td>Married or separated**</td>
<td>18 (48.6)</td>
<td>58 (81.7)</td>
<td>18 (62.1)</td>
</tr>
<tr>
<td>Retired**</td>
<td>3 (8.1)</td>
<td>6 (8.5)</td>
<td>15 (51.7)</td>
</tr>
<tr>
<td>Comorbid illness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>13 (35.1)</td>
<td>12 (16.9)</td>
<td>8 (27.6)</td>
</tr>
<tr>
<td>Arthritis*</td>
<td>19 (51.4)</td>
<td>18 (25.4)</td>
<td>21 (72.4)</td>
</tr>
<tr>
<td>Years of school attended</td>
<td>13.2 (1.9)</td>
<td>15.3 (2.5)</td>
<td>13.6 (2)</td>
</tr>
<tr>
<td>Physical factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-Minute Walk Test (ft)</td>
<td>1,067 (353)</td>
<td>1,338 (265)</td>
<td>1,000 (279)</td>
</tr>
<tr>
<td>Muscle and joint pain*</td>
<td>1.92 (1)</td>
<td>1.46 (0.77)</td>
<td>1.83 (0.97)</td>
</tr>
<tr>
<td>Comorbidity**</td>
<td>1.46 (1.2)</td>
<td>1.32 (1.5)</td>
<td>1.29 (0.75)</td>
</tr>
<tr>
<td>Psychosocial factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy*</td>
<td>66.9 (21.7)</td>
<td>73.7 (17.1)</td>
<td>69.7 (22.7)</td>
</tr>
<tr>
<td>Depressed mood*</td>
<td>8 (10.29)</td>
<td>6.45 (8.6)</td>
<td>4.76 (9.9)</td>
</tr>
<tr>
<td>Social support*</td>
<td>23.1 (10.1)</td>
<td>23.2 (9.6)</td>
<td>22.7 (10.1)</td>
</tr>
</tbody>
</table>

Note. Percentages may not equal 100 due to rounding.

* Measured by the question, “How much muscle or joint pain do you experience while exercising?” Responses range from no discomfort (1) to severe discomfort (4).

** Measured using the Charlson Comorbidity Index (Charlson, Pompei, Ales, & MacKenzie, 1987).

† Measured using the Barriers to Exercise Self-efficacy Scale (McAuley, 1993).

‡ Measured using the Depression/Dejection scale of the Profile of Mood States (POMS) (McNair, Lorr, & Droppleman, 1981).

§ Measured using the family subscale of the Social Support for Exercise Scale (Sallis, Grossman, Pinski, Patterson, & Nader, 1987).

* Significant difference between age groups, p < 0.05.

** Significant difference between age groups, p < 0.01.
social support. The older groups (61 to 70 and older than 70) had significantly more reported arthritis than the youngest group. Although not significantly different, men older than 70 had the highest self-efficacy for barriers scores, and the youngest women had the highest levels of depressed mood.

Figure 1 shows the trends in adherence to exercise three times per week. The percentage of women and men who adhered to the guideline at Weeks 1, 12, 24, 36, and 48 are displayed. All age groups experienced a downward trend in exercise over time. For the oldest age group (older than 70), women had higher rates of meeting the exercise guidelines than older men. For both men and women in all age groups, the greatest decline in exercise adherence was between 9 and 12 months.
For both men and women, age group comparisons for time to discontinuation of exercise three times per week were examined using Kaplan-Meier plots. For women, no significant differences were found among age groups in adherence to exercise in the 48 weeks following the CRP (log rank test = 3.5, \( p = 0.18 \)). Significant differences were found for men (Figure 2). Men older than 70 stopped exercising sooner than younger men (younger than 60, mean = 32.6 weeks; 61 to 70, mean = 34.3 weeks; older than 70, mean = 24.9 weeks; log rank test = 6.4, \( p = 0.04 \)).

The Cox proportional hazards regression model was used to identify the effect of age while controlling for covariates. The Cox regression results confirmed the results of the Kaplan-Meier plots. For women, age was not a predictor of exercise; the only significant predictor was race (Wald = 11.26, Hazard Ratio = 0.35, \( p = 0.001 \)), indicating that Caucasian women continued to exercise after a CRP longer than women of other races. Table 2 displays the Cox regression results for men. Older men were more likely to stop exercise adherence sooner than younger men, even when controlling for all other factors. In addition to age differences in exercise adherence, other covariates were significant (self-efficacy: Wald = 8.00, Hazard Ratio = 0.98, \( p = 0.01 \); depressed mood: Wald = 11.08, Hazard Ratio = 1.04, \( p = 0.001 \)). Men with higher self-efficacy were more likely to continue exercising, whereas men reporting depressed mood were more likely to stop exercising.

DISCUSSION
Women

The analysis revealed that age group differences in exercise adherence following a cardiac event were gender specific. In contrast to men, age was not a factor in exercise adherence for women. Older women did not exercise less than younger women. Although not statistically significant, there was a trend indicating that older women continued to exercise longer than younger women. This is in contrast to studies of community-dwelling adults, in which older women were found to exercise less than younger women (Conn, 1998; Nies & Kershaw, 2002), but consistent with studies of women after a cardiac event and completion of a CRP, in which older women adhered to the exercise prescription longer than younger women (Moore et al., 1998). Women who have a cardiac event and complete a CRP may be more functionally fit than older women of the same age in the community and may be more motivated to continue with the exercise routine established during the CRP. In addition, previous studies identified that younger women have more competing work and family obligations than older women and therefore exercise less (Moore et al., 1998).

The only predictor of exercise adherence in women was race. After further exploration, it was noted that the age group in which exercise adherence declined the fastest was the youngest group. This group (younger than 60) had the greatest percentage of African American women (38%). A downward decline in exercise adherence for African American women has been noted in other exercise studies (Crespo et al., 2000; Wilbur, Vassalo, Chandler, McDevitt, & Miller, 2005). There is a pressing need to understand and develop exercise maintenance strategies that are culturally sensitive and meaningful to African American women.

It was surprising that pain was not related to exercise adherence in women, especially because a large proportion of the women across the age groups reported having arthritis. The measure of pain in this study was investigator developed, and it is possible it did not adequately capture the pain experience for these women. In addition, baseline levels of pain were used as predictors in this
Men

Age was a factor in exercise adherence for men. Older men stopped adhering to exercise guidelines sooner than younger men, even when controlling for self-efficacy, depressed mood, comorbidity, physical fitness, and social support. In addition to age, other significant predictors of non-adherence to exercise guidelines were depressed mood and lower self-efficacy. This was consistent with other studies on adherence to exercise after a structured exercise program (Bock et al., 1997; McAuley, 1993). Although no significant differences were found at baseline for self-efficacy among the age groups, at 48 weeks, older men had the lowest level of self-efficacy compared with the other age groups of men. This difference in confidence to exercise among the age groups may indicate that older men had experienced more barriers to exercise compared with younger men. These findings also suggest that participants should be screened for depression at the completion of a CRP to identify those at risk for not adhering to exercise guidelines. Similarly, assessment of self-efficacy in relation to barriers and counseling during a CRP about ways to overcome barriers may help older men maintain long-term exercise.

Women and Men

A downward trend of exercise adherence was found for all age groups in both men and women over time. At 1 year, 78% of participants were not adhering to the exercise guidelines of three sessions per week. This is particularly concerning, given that the current guideline recommendation is for exercise five times per week. This low rate of exercise adherence is consistent with other studies reporting that adults have difficulty maintaining exercise after completion of a structured exercise program (Bock et al., 1997; McAuley, 1993; Wilbur et al., 2005). More information is needed about the factors influencing maintenance of exercise adherence, as the factors associated with maintenance of exercise are thought to be different than those influencing exercise initiation (Rothman, 2000). New models of exercise adherence behavior are needed that explain the underlying mechanisms of transition from exercise initiation to maintenance (Orleans, 2000). Understanding of these CRP transitions (program initiation, program adherence, exercise maintenance) is important, as lifestyle exercise is a dynamic process that requires attention and intervention (Wing, 2000). The CRP environment may be a valuable opportunity to address the dynamic nature of exercise adherence and teach the skills necessary to continue to exercise for life.

Self-efficacy declined over time for both men and women in all age groups. It may be that soon after completion of a structured CRP, participants are optimistic and have unrealistically high confidence regarding their ability to overcome barriers to exercise. As time passes, the reality of the difficulty in adhering to an exercise regimen becomes apparent. This initial overly optimistic outlook has been noted to be a barrier to maintenance in other studies on long-term weight loss in both men and women (Sbrocco, Nedegaard, Stone, & Lewis, 1999).

An unexpected finding of this study was that at 48 weeks after completion of the CRP, older women had better adherence.
to exercise guidelines than older men. This is in contrast to the findings of other studies that women in the general population have lower levels of exercise adherence than men. Participation in a CRP after a cardiac event may be especially important for older women as a way to increase lifestyle exercise.

It is interesting to note that although the oldest participants had lower fitness and higher comorbidity than the youngest participants, fitness and comorbidity did not contribute to the explanation of nonadherence in men or women. This may be because most people who enter a CRP are generally more physically fit than those who do not participate in a CRP (Dolansky & Moore, 2008). It is also possible that the measurement of physical fitness obtained during the last weeks of the CRP in this study provided time for all participants to increase their physical fitness levels and thus reduced the differences between age groups.

LIMITATIONS

We recognize that understanding exercise adherence, as presented in this report, may be limited by the decision to dichotomize exercise as adherent or nonadherent. Further examination of exercise using total amount of exercise and other exercise patterns is reported elsewhere (Moore et al., 2006). Another possible limitation of this study is the difficulty of measuring exercise in field studies. However, we feel relatively confident in our measure because an objective measure (the heart rate monitor) and two other measures were used to capture lifestyle exercise over time.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future recommendations include the need for more prospective descriptive studies that examine the reasons people stop adhering to exercise guidelines after completion of a CRP. A national CRP registry that follows participants after a CRP may be a valuable resource for understanding adherence to exercise guidelines. This registry could be Web based, including the tracking of lapses and relapses and collecting information related to potential predictors of these situations. Given that only a small percentage of participants adhered to the exercise regimen at 1 year, intervention studies are needed that consider age and gender issues. In addition, given the consistent finding in the literature regarding the influence of self-efficacy on exercise, studies that offer booster interventions to enhance self-efficacy are needed. Other variables to include in studies of exercise adherence are perceived satisfaction with the outcomes of exercise, enjoyment of exercise, and incorporating exercise into daily recreational activities, as these factors have been identified as important in adherence with to long-term exercise (Hagberg, Lindahl, Nyberg, & Hellenius, 2008; Rothman, 2000).

CONCLUSION

The effect of age on adherence to exercise guidelines after a cardiac event was gender specific. Age was a factor for men but not for women. During the year after participation in a CRP, younger men adhered to routine exercise longer than older men. Interventions for exercise adherence will help cardiac patients continue with exercise for life so the benefits achieved from participating in a CRP after a cardiac event can be maintained.

REFERENCES

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Dolansky et al.


