Rural Versus Urban Comparison: Physical Activity and Functioning Following Coronary Artery Bypass Surgery

Lani M Zimmerman, PhD, RN, FAAN, FAHA [1]
Susan Barnason, PhD, APRN-CNS, CEN, CCRN, FAHA [2]
Paula Schulz, PhD, RN [3]
Janet Nieveen, PhD, RN [4]
Chunhao Tu, PhD [5]

[1] Professor, College of Nursing-Lincoln Division, University of Nebraska Medical Center, lzimmerm@unmc.edu
[2] Professor, College of Nursing-Lincoln Division, University of Nebraska Medical Center, sbarnaso@unmc.edu
[3] Assistant Professor, College of Nursing-Lincoln Division, University of Nebraska Medical Center, pschulz@unmc.edu
[4] Assistant Professor, College of Nursing-Lincoln Division, University of Nebraska Medical Center, jlnievee@unmc.edu
[5] Chunhao Tu, Assistant Professor; College of Pharmacy, University of New England, ctu@une.edu

Abstract

Purpose: The purpose of this sub-analysis was to compare the early recovery of elderly patients following coronary artery bypass surgery (CABS) by geographic location (urban/rural) on physical functioning and physical activity.
Methods: The sample was 124 subjects who had been in the usual care group (or control group) of a randomized controlled trial. Subjects were categorized into geographic locales using Rural Urban Commuting Area (RUCA) codes: urban n=35, large rural n=17, small rural n=23 and isolated rural n=33. Measures included the Medical Outcomes Study Short-Form 36 and the RT3® accelerometer. Mixed linear models were used to analyze the data.
Results: No significant differences were found for physical functioning by RUCA group. However, there was a statistically significant difference for physical activity, for average kcals/kg/ per day ($F = 3.01$, $p < .05$) and average daily activity counts ($F = 3.95$, $p <.01$), with the subjects in large rural communities having significantly ($p < 0.05$) more average kcals/kg per day than urban subjects ($M = 29.04$ and $M = 27.25$ respectively). Subjects in the large rural also had significantly ($p < .005$) more average daily activity counts than urban ($M = 216635$ and $M = 161221$ respectively).
Conclusions: This is the first study to compare early recovery functioning and activity outcomes of CABS subjects by rural/urban locations. Additional study is warranted to evaluate why these differences exist and the potential need to tailor interventions for CABS based on geographic location.

Keywords: Rural Urban Comparison, Cardiovascular Surgery, Physical Activity, Physical Functioning.

Rural Versus Urban Comparison: Physical Activity and Functioning Following Coronary Artery Bypass Surgery

Health disparities exist in our society and have been associated with geographic place of residence in various chronic diseases, including heart disease. These disparities most often are in reference to access to care as numerous studies (Bray et al., 2005; Coughlin et al., 2006; Larson & Fleishman, 2003; Rao et al., 2007) have shown that rural patients are less likely to receive optimal treatment and thus have inferior outcomes. Other disparities associated with rural geographic location have included rural residents' presentation for healthcare with more severe disease, and generally poorer health habits e.g. high prevalence of smoking and obesity, lower levels of physical activity (Jones, Parker, Ahearn, Mishra, & Variyam, 2009). Furthermore, there is conflicting data between rural residence and health outcomes (Vanderboom & Madigan, 2008; Wu et al., 2010). It is important for clinicians to understand if geographic locale of patients influences their ability to recover and rehabilitate following a significant cardiac event such as coronary artery bypass surgery (CABS). Therefore, this sub-analysis study was undertaken to compare the recovery period of elderly patients following CABS by geographic location (rural, urban) on physical functioning and physical activity (at baseline, 6-weeks, and 3-months after CABS).

Although, health disparities between urban and rural patients usually favor outcomes for patients in urban areas; the incongruences from study reports reflect the unique variables and definitions of rural and urban. For example, one study (McConnell et al., 2010) reported unique differences between rural and urban residents that had an impact on reducing cardiovascular (CV) risk; although there were no group differences. For example, they reported the reason for no differences may be due to environmental factors such as in urban areas, factors such as sidewalk conditions, facilities and equipment available may influence a person's willingness to increase physical activity. McConnell (2010) also reported those who decreased CVD risk, regardless of rural or urban, had better outcomes related to factors such as walking distance and CVD risk score ($p < .05$). Additionally, there were differences between those with decreased risk versus those who did not decrease risk within the rural and urban groups. Triglycerides, C-reactive protein, diabetes knowledge, risk perception, and outcome expectations were greater for the rural group who decreased their CVD risk versus those who did not (all $p < .05$). For the urban group, for those who decreased CVD risk ($p < .05$), their locus of control was from more powerful others versus internal control or happening by chance (McConnell et al., 2010).

Although there are known disparities in healthcare for rural-dwelling populations (e.g. access to care), only a few studies (K. M. King, Thomlinson, Sanguins, & LeBlanc, 2006; McConnell et al., 2010; Saleh, Alameddine, Hill, Darney-Beuhler, & Morgan, 2010) have been conducted to examine the impact of rurality on cardiovascular (CV) outcomes such as physical activity; and of those the majority are related to heart failure (HF) populations. Specifically related to physical activity, perceptions of patients (N = 42) managing coronary artery disease (CAD) differed by urban versus rural dwellers in a qualitative study by King (K. M. King et al., 2006). Rural-living participants were more vulnerable to summer heat and winter cold as barriers to exercise as opposed to urban participants having more alternatives to exercise. Rural participants, both men and women, viewed work on the farm as exercise and urban participants reported walking the stairs at work or going to a mall to walk as a form of exercise. These findings are similar to what was reported in one study (McConnell et al., 2010). Another study examined the effectiveness and cost-effectiveness of six rural employer-based, wellness programs (which included an exercise and physical activity component) with varying degrees of intervention intensities (Saleh et al., 2010). They concluded the highest intensity group had the most favorable outcomes in several wellness areas and in percentage of employees with good health indicators compared to the control and lower-intensity intervention groups. However, the lower group had more favorable cost-effectiveness ratios. Regardless of the intensity of the wellness program, employers and employees could still benefit from these types of programs. This literature review supports the notion that future intervention studies should be tailored by geographic location (rural and urban) factors that promote exercise since we believe they are different.

Methods

Design and Sample

Data for this sub-analysis were from a parent study which tested the effect of a symptom management (SM) home communication nursing intervention designed to improve functioning (physical and psychosocial), decrease postoperative problems, decrease health care utilization, and improve patient satisfaction through early symptom evaluation and management, and enhanced self-efficacy in the early discharge period of the elderly patient after CABS.

The symptom management (SM) intervention used a device called the health buddy (HB) that was attached to the telephone line. The study used a randomized (assigned by using a previously generated randomization schedule), two-group (N = 284) repeated measures design with measurements at time of discharge, 3 and 6 weeks, and 3 and 6 months postoperatively in elderly patients (65 years or older). One group received usual care (UC) combined with the SM intervention, and the control group received UC.

For this paper, only the 124 participants who were assigned to the UC group were included for this sub-analysis. Participants in the SM group were excluded because the SM intervention delivered some strategies for increasing physical activity. Participants in the UC group were categorized as urban or one of three rural groups (large, small or isolated). There were 43 participants (35%) who resided in an urban area. Within the rural subgroup, participants resided in large rural cities/towns (n = 20, 16%), small rural towns (n = 25, 20%), and isolated small rural towns (n = 36, 29%). Rural classifications were based on the Rural Urban Commuting Area Codes (RUCA) created in part by the US Department of Agriculture's Economic Research Service (Hart, Larson, & Lishner, 2005). The RUCA defines urban ($\geq$ 50,000 residents), large rural (10,000-49,000 residents), small rural (2500- 9999 residents), or isolated (< 2499 residents) based on the US Census Bureau's definitions of urbanized areas and urban clusters, which in turn rely on complex criteria, including population density and population work commuting patterns(Hart et al., 2005). Participants were recruited from four Midwestern tertiary hospitals. Participants were aged 65 years or older and had undergone CABS, oriented to persons, places, and time; able to hear, see, speak, and read English; been discharged within 7 days after surgery; and had no physical impairments that would limit their physical functioning.

Variables and Measures

Physical activity. The *Modified 7-Day Activity Interview* (Hellman, Williams, & Thalken, 1996a) was used for reported baseline physical activity measures. Participants were asked to recall their activity levels before surgery. Specific measures used from the Modified 7-Day Activity Interview were total kilocalories/day expended, average kilocalories/kilogram/day expended, and average minutes/day spent in moderate or greater activity (Hellman, Williams, &

Thalken, 1996b). Psychometric properties of this measure have been reported in the literature (Barnason, Zimmerman, Schulz, & Tu, 2009; Hellman, Williams, & Thalken, 1996a).

For this study, activity and estimated energy expenditure (EEE) will be measured physiologically using the RT3 accelerometer (by Stayhealthy, Inc.) which was originally the TriTrac-R3D (by Hermokinetics, Madison, WI) used in research since 1992. In addition, a self-report Activity Diary of activity/exercise was used to average minutes spent in exercising per day and Average kcals/kg/day (a measure of daily EEE). These data will be collected for three consecutive days (two week days and one weekend day) at each of the following postoperative time periods: 3 weeks, 6 weeks, 3 months, and 6 months.

The RT3 accelerometer, is a triaxial accelerometer which uses advanced microcomputers to register body motion (specifically, the electrical energy of acceleration and deceleration) during activities that involve energy cost. In this study, mean daily total activity counts and mean daily activity kcals expended were measured physiologically using the RT3 accelerometer at each of the following postoperative time periods: 3 and 6 weeks and 3 and 6 months. The RT3 combines three independent sensors in orthogonal axes to detect acceleration in the three-dimensional space (a strength over uniaxial accelerometers which tended to be inaccurate in measuring many different types of activities). The three dimensions are: x (anteroposterior axis), y (medial-lateral axis), and z (vertical axis). Within the RT3, counts of accelerations in the three-dimensional axes are sampled every second, stored in a buffer, then the average for each axis is calculated and logged once a minute. This produces “activity counts” (similar to the output produced by the actigraph) and thereby produces a measure of amount of activity. For this study, average daily activities were calculated as follows: Activity counts will be summed for each of the three consecutive daytime periods. Then a mean daily total activity counts variable were calculated by obtaining a mean of the three days. A subject’s physical characteristics (i.e. gender, age, height, and weight) are entered upon initializing the RT3 monitor. This information is used within the RT3 to calculate the subject’s resting EEE in kilocalories (kcals) per minute based on established predictive equations for men and women. The RT3 prediction of the EEE of physical activity (EEE) in kcals is calculated internally every second and logged every minute using an unpublished proprietary regression equation with the use of the vector magnitude of the acceleration registrations from the x, y, and z axes. These measures are then converted into kcals. The RT3 calculates activity kcals expended using the formula (total kcals - resting kcals) for each minute. For this study, estimated EEE (activity kcals) will be calculated as follows: Activity kcals will be summed for each of the three consecutive daytime periods. Then a variable of mean daily activity kilocalories expended will be calculated by obtaining a mean of the three days.

A teaching booklet was provided that explained and illustrated how to wear the RT3, and a demonstration was done at discharge from the hospital. Triaxial accelerometers have established validity with indirect calorimetry resulting in correlations ranging from .48 - .92 (Baranowski et al., 1999; Campbell, Crocker, & McKenzie, 2002; Hendelman, Miller, Baggett, Debold, & Freedson, 2000). Reliability has been demonstrated with correlation values of .85 reported between RT3 activity counts and mixed venous oxygen saturation (SVO_2), (Rowlands, Thomas, Eston, & Topping, 2004) .51 for activity counts and heart rate (DeVoe & Gotshall, 2003)and .32 - .91 for energy expenditure with indirect calorimetry (DeVoe & Gotshall, 2003; G. A. King, Torres, Potter, Brooks, & Coleman, 2004). Generalizability coefficients for the RT3 with 3 days of data at three data collection points were high (.85 - .97).(Hertzog et al., 2007) A 3-day diary was also used to correlate with the RT3 data. The reliability estimates (interclass correlations) for 3 days of self-reported, recorded data collection of minutes of moderate or higher physical activity in a diary and RT3 ranged from .76 to .84 at 3 weeks, 6 weeks, and 3 months after CABS(Hertzog et al., 2007).

Physical functioning. The MOS SF-36 is a multidimensional scale measuring eight health concepts: general health, physical, role-physical, role emotional, social, bodily pain, mental health, and vitality functioning (A. M. Jette, 2003). In this study, four subscales (physical, role-physical, bodily pain, and vitality) were used separately to evaluate physical functioning. Standardized response choices were utilized. Each of the concepts is scored on a scale of 0 to 100, with a higher score indicating better health. Reliability has been satisfactorily estimated by Cronbach's alpha. In studies of job strain and quality of life, Cronbach's alphas on the subscales ranged from .76 -.93, (Lerner, Levine, Malspeis, & D'Agostino, 1994) and in cardiac rehabilitation programs from .72 - .85 (D. Jette & Downing, 1994). These studies all refer to work by Stewart et al. (Stewart, Rand, Muldoon, & Kamarck, 2009) that showed an internal consistency reliability alpha range of .67 - .88. Cronbach's alphas for this sub-sample ranged from .69 – .91 at 6 weeks and 3 months for all subscales.

Procedures

Approval from the Institutional Review Committees at the facilities was received. Every day the research nurse would approach the unit charge nurses to identify patients who met study criteria. The charge nurses then approached patients and if they agreed to talk to the research nurse about the study, the research nurse would then explain the study, invite them to participate, and obtain written, informed consent. Each potential subject was randomly assigned to the intervention or usual care group using a previously generated randomization schedule. The research nurse completed the Demographic and Patient Characteristic tool, and at baseline, verbally administered the MOS SF-36 and Modified 7-Day Activity Recall by asking participants to reflect on their responses to these measures before undergoing cardiac surgery. A demonstration on how to wear and care for the RT3 accelerometer, along with a teaching booklet, was given to the patients. Participants were contacted by telephone at 3 and 6 weeks, and 3 and 6 months, after discharge, at which times the MOS SF-36 tool was completed by interview. Participants were mailed the RT3 to wear and diary to complete at each time frame.

Data Analysis

The statistical package, SAS version 9.2, was used to analyze the data. Data were entered into a secure data base with random data entry checks by the project director. Data analyses in this study were conducted using descriptive and repeated-measures analysis of covariance, with the baseline (before CABS) measures of the physical activity and functioning variables as the covariates. The classification variable treated like an independent variable was urban and rural groups (by RUCA code).

Results

The sample was composed of 124 participants (83% men and 17% women), and 86% of the sample were married. Participants had a mean age of 71.2 (SD 4.7) years. The majority of participants had an average of 13 or more years of formal education, and approximately 80% of participants participated in cardiac rehabilitation (CR) after hospital discharge. There were no statistically or clinically significant group differences on demographic (e.g. age, length of stay, race, and marital status) or baseline clinical variables (e.g. comorbidities, body mass index, discharge hemoglobin, and CR participation) by urban/rural groups. Table 1 provides an overview of the participants' clinical and demographic characteristics.

Table 1
Demographic and Clinical Characteristics of Study Participants by Rural group (N=124)

		Urban		Large Rural		Small Rural		Isolated Rural	
Demographic Variables		**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
Marital Status	Married	35	(81.4)	17	(85)	23	(92)	33	(91.7)
	Single	0	(0)	1	(5)	0	(0)	0	(0)
	Widowed	6	(14)	2	(10)	2	(8)	3	(8.33)
	Divorced	2	(4.7)	0	(0)	0	(0)	0	(0)
Gender	Men	36	(29)	19	(15)	19	(15)	29	(23)
	Women	10	(8)	1	(1)	3	(2)	7	(23)
Currently Working	Yes	17	(39.6)	10	(50)	18	(72)	18	(50)
Type of Procedure	CABS	29	(67.4)	15	(75)	20	(80)	31	(86.1)
	OPCAB	13	(30.2)	5	(25)	5	(20)	5	(13.9)
Clinical Variables		**n**	**(%)**	**n**	**(%)**	**n**	**(%)**	**n**	**(%)**
NYHA Classification	I	26	(60.5)	8	(40)	8	(32)	20	(55.6)
	II	15	(34.9)	9	(45)	14	(56)	11	(30.6)
	III	2	(4.65)	3	(15)	3	(12)	5	(13.9)
	IV	0	(0)	0	(0)	0	(0)	0	(0)
Ejection Fraction	< 50%	12	(27.9)	4	(20)	6	(25)	6	(16.7)
	≥ 50%	31	(72.1)	16	(80)	18	(75)	30	(83.3)
Participation in Cardiac Rehabilitation	Yes	29	(16)	9	(5)	17	(10)	20	(11)
	No	14	(8)	10	(6)	8	(5)	18	(10)
Risk Factors									
Previous MI	Yes	1	(2.33)	1	(5)	4	(16)	6	(16.7)
Diabetes	Yes	12	(27.9)	2	(10)	5	(20)	8	(22.2)
Hypertension	Yes	31	(72.1)	15	(75)	21	(84)	27	(75)
High Cholesterol	Yes	12	(41.4)	6	(42.9)	10	(53)	9	(30)
History of Tobacco Use	Yes	22	(51.2)	10	(50)	15	(60)	17	(47.2)
History of Smokeless Tobacco	Yes	1	(2.33)	1	(5)	0	(0)	3	(8.3)
Family History of CAD	Yes	30	(69.8)	11	(55)	19	(76)	22	(61.1)
PVD	Yes	5	(11.6)	1	(5)	1	(4)	8	(22.2)
Continuous Demographic and Clinical Variables									
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Length of Stay		5.3	1.1	5.8	1.2	5.6	0.9	5.3	0.9
Age		71.1	5.9	70.1	5.8	70.2	4.9	71.7	5.4
Education Level		13.7	3.1	12.5	2.5	13.2	3.7	12.6	2.4
Discharge Hemoglobin		10.6	0.9	10.7	1.4	10.4	1.5	10.4	1.0
Body Mass Index		28.1	4.8	28.5	4.1	29.5	5.3	29.3	5.9

Physical Functioning. No significant differences were found between rural and urban patients on physical functioning by urban/rural groups (see Table 2 for results of RM-ANCOVA). The mean scores for physical, role physical and vitality showed some slight variations over time in scores (see Figures 1-3).

Table 2
RM-ANCOVA for Physical Functioning and Physical Activity with SAS Mixed Procedure.

	Location		Location * Time		
Variables	F	P	F	P	Den d.f.
<u>**Physical Functioning (SF-36 subscales)**</u>					
Physical	1.65	0.18	0.82	0.56	153
Role-Physical	1.24	0.30	1.84	0.10	149
Vitality	0.70	0.56	0.70	0.65	151
Bodily Pain	1.19	0.32	0.73	0.63	148
<u>**Physical Activity**</u>					
Average kcal/kg/Day EEE (RT3)	**3.01**	**0.03**	0.75	0.66	414
Average Daily Activity Counts (RT3)	**3.95**	**0.009**	0.77	0.65	414
Average kcal/kg/Day EEE (Diary)	1.22	0.30	0.55	0.84	429
Average Total kcal/kg/Day EEE (Diary)	**2.91**	**0.03**	0.45	0.91	429
Average Daily Minutes in Moderate or Greater Activity (Diary)	2.53	0.06	0.91	0.51	429

P = p-value, Den d.f.= denominator of degree of freedom

Figure 1. Physical Functioning

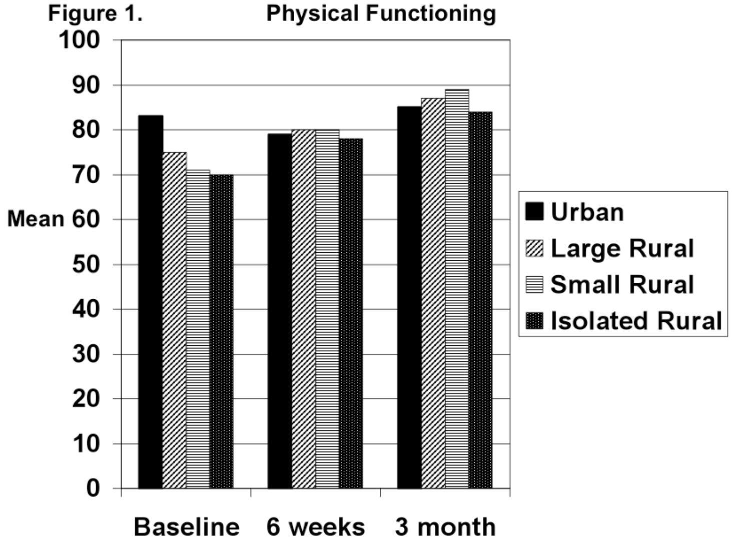


Figure 2.

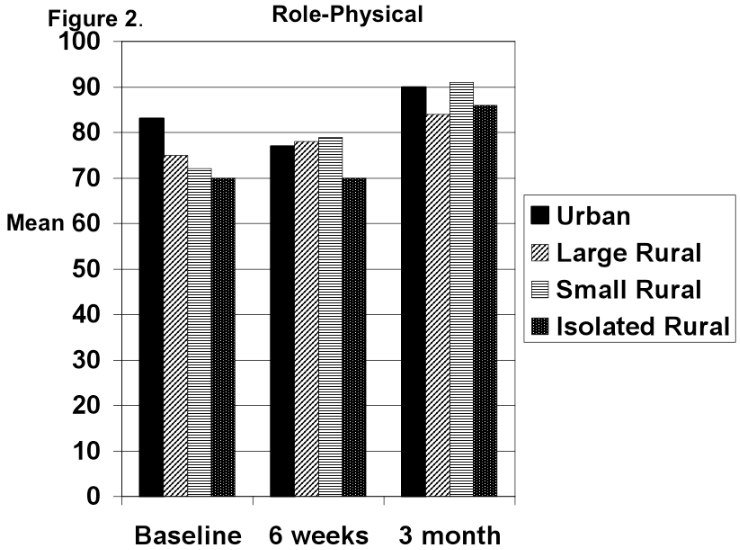
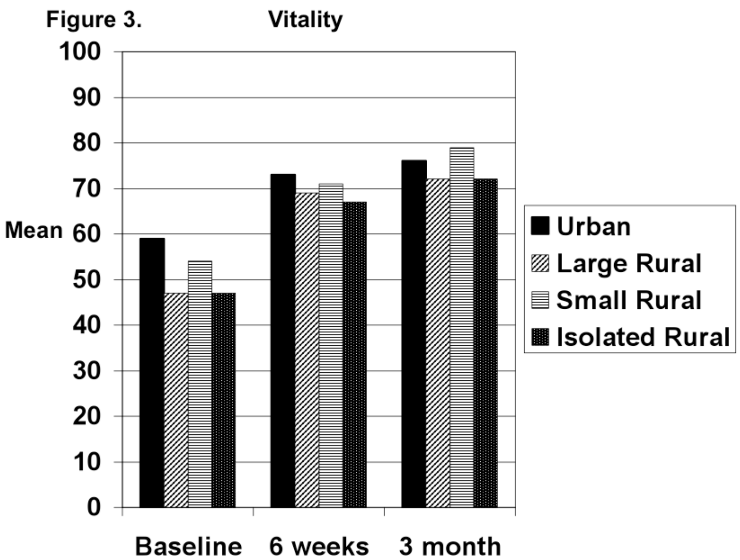


Figure 3.



Physical Activity. In relation to physical activity, there were significant differences between urban/rural groups for average kcals/kg/day (F = 3.01, P < .03), and average daily activity counts (F = 3.95, *p* < .01) . Specifically for RT3 data, post Bonferroni tests showed large rural (M= 29.04) had significantly (*p* <.05) more average kcals/kg/ day (a measure of daily energy expenditure) than urban (27.25); and large rural (*M*= 216635) had significantly (p < .005) more average daily activity counts than large urban (*M*=161221). In relation to diary measures, small rural (*M*=2462) had more average kcals/kg/ day than urban participants (*M*=2219). See table 2 for results of RM-ANCOVA by groups.

Figure 4. Post hoc Bonferroni Mean Scores for Average kcals/kg/Day: an estimate of estimated energy expenditure (RT3)

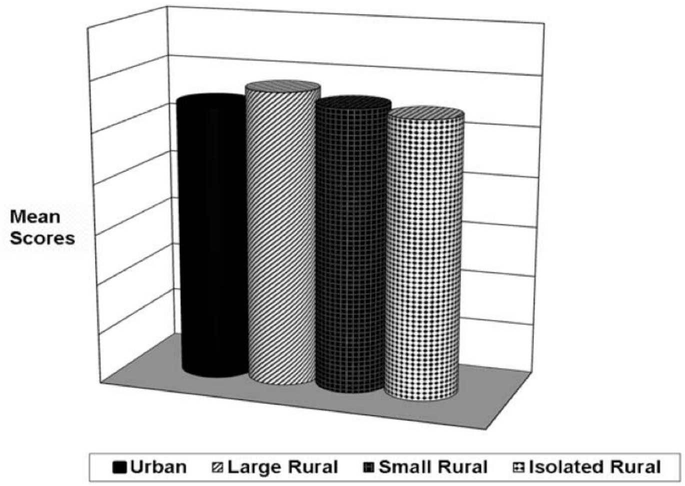
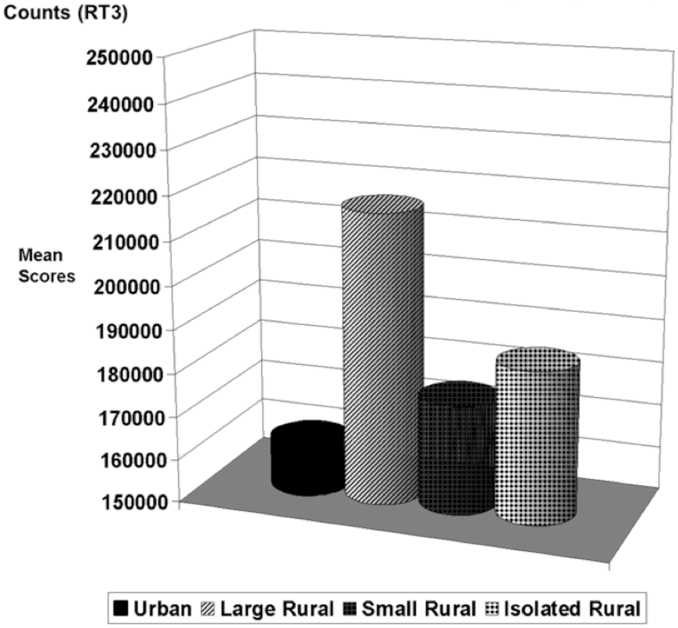


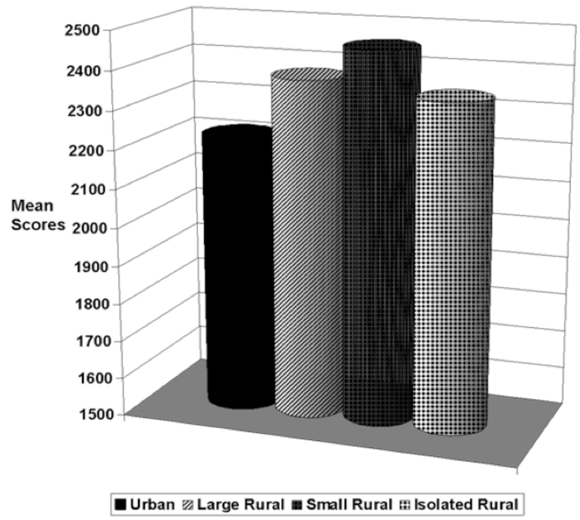
Figure 5. Post hoc Bonferroni Mean Scores for Average Daily Activity Counts (RT3)



Discussion

There have not been any other direct comparisons in the literature to examine outcomes in the early recovery period after cardiac surgery based on patients' geographic residence. Although, poorer health outcomes in rural areas are not consistently observed across studies, this may be due largely in part to a lack of standardization of definitions of urban/rural geographic locale. There are even fewer research-based articles that have stratified samples based on urban/rural residence. Additionally, there were a few studies that were cardiac focused reporting some differences for urban/rural location making it difficult to compare our findings to other studies.

Figure 6. Post hoc Bonferroni Mean Scores for Average kcals/kg/Day: an estimate of estimated energy expenditure (Diary)



The results of the sub-analyses did not support the frequently reported conclusion that rural patients have inferior outcomes to urban participants. In fact, this study found that some aspects of physical activity (estimated energy expenditure and average daily activity counts for one large rural participants were superior to those participants in the urban setting. However, not significant, large rural participants had higher physical functioning scores compared to urban participants at six weeks and three months. These findings are not entirely surprising, as age and gender may have influenced the results. A large proportion of the sample were from rural and were men who reported that they were very often still working (even though 65 or older), particularly in their occupation as farmers, and as reported by McConnell (McConnell et al., 2010)both men and women rural participants viewed work on the farm as exercise. The incidence of less physical activity in some of the smaller rural locations might further be explained by King (K. M. King et al., 2006) and McConnell(McConnell et al., 2010) who reported rural individuals were more affected by weather for exercising as compared to urban individuals who had more options for exercise (out of the inclement weather); and urban residents may also be more concerned about walking late at night or sidewalk conditions.

Limitations

Although we had sufficient power to demonstrate significant differences, a larger and more heterogeneous CV sample is needed for a more thorough investigation of possible mechanisms explaining differences in rural and urban patients. For example, would there be similar results when comparing different CV interventions. The original study was not designed to test differences between urban and rural participants. The study also used self-report measures for physical functioning and one of the measures of physical activity (diary). The small sample size limits the generalizability of the findings and requires caution in the interpretation of the findings. Since this was a sub-analysis, our study did not include all possible factors that might be related to rurality and outcomes such as gender differences, age, and occupation. A larger sample would also allow determining the influence of other demographic and environmental factors on physical activity in urban and rural participants.

Conclusions

The findings from this study warrant further research to help determine how rurality may influence the types of interventions that can promote and facilitate physical functioning and physical activity following significant cardiac events such as CABS. Studying additional surgical populations with a goal of increasing physical functioning and physical activity would contribute to the knowledge of providing different strategies based on urban/rural location. Increasing physical functioning and activity after a major surgical event is a goal of most discharge planning activities. This would have a major impact on nursing interventions and health care providers caring for patients in different geographic locations. Clinicians could then consider how to address alternative behavioral strategies to increase physical activity within the constraints of the rural and urban environment.

These limited findings regarding the differences in CV outcomes, based on urban versus rural location, warrant further study to determine if differences in outcomes extend to other CV outcome differences. Several reports indicated that rural patients have inferior outcomes to urban patients; yet very few studies actually stratify and power the sample to really test these differences. It should also be considered that there may not be group differences found; but within each group (urban and rural) different strategies were used to enhance outcomes. This too is important for future studies. There may also be different strategies between rural and urban among different age groups and by gender. A mixed method design would allow the researcher to gather some qualitative data that may help explain why sometimes group difference are not found or what unique strategies work to increase physical activity or functioning in urban versus different rural subgroups and what works or does not work in both areas. This is the first study to compare outcomes of CABS participants (physical functioning and physical activity after CABS) by rural/urban locations. Many people assume that urban CABS patients would have better functioning compared to rural populations; however this study did not support that premise. We also believe, from the literature reviewed and findings from this study, the belief that tailoring certain strategies based on urban/rural location is important when planning future studies; however, additional research is needed in this area to better assist nursing when planning activities such as increasing physical activity to reduce CV risk in the cardiac population.

Acknowledgements

This study was funded by the National Institute of Nursing Research of the National Institutes of Health (grant R01 NR07759; L.Z., principal investigator) and (grant 1P20NR011404-01; C Pullen principal investigator and L Zimmerman, co –Investigator).

References

Baranowski, T., Smith, M., Thompson, W. O., Baranowski, J., Hebert, D., & de Moor, C. (1999). Intraindividual variability and reliability in a 7-day exercise record. *Medicine & Science in Sports & Exercise, 31*(11), 1619-1622. [MEDLINE]

Barnason, S., Zimmerman, L., Schulz, P., & Tu, C. (2009). Influence of an early recovery telehealth intervention on physical activity and functioning after coronary artery bypass surgery among older adults with high disease burden. *Heart & Lung : The Journal of Critical Care, 38*(6), 459-468. [MEDLINE]

Bray, P., Roupe, M., Young, S., Harrell, J., Cummings, D. M., & Whetstone, L. M. (2005). Feasibility and effectiveness of system redesign for diabetes care management in rural areas:

The eastern North Carolina experience. *The Diabetes Educator, 31*(5), 712-718. [MEDLINE]
Campbell, K. L., Crocker, P. R. E., & McKenzie, D. C. (2002). Field evaluation of energy expenditure in women using tritrac accelerometers. *Medicine & Science in Sports & Exercise, 34*, 1667-1674. [MEDLINE]
Coughlin, S. S., Richards, T. B., Thompson, T., Miller, B. A., VanEenwyk, J., Goodman, M. T., & Sherman, R.L. (2006). Rural/nonrural differences in colorectal cancer incidence in the united states, 1998-2001. *Cancer, 107*(5 Suppl), 1181-1188. [MEDLINE]
DeVoe, D., & Gotshall, R. (2003). Comparison of the RT3 research tracker and Tritrac RT3 accelerometers. *Perceptual and Motor Skills, 99*(2), 545-546. [MEDLINE]
Hart, L. G., Larson, E. H., & Lishner, D. M. (2005). Rural definitions for health policy and research. *American Journal of Public Health, 95*(7), 1149-1155. [MEDLINE]
Hellman, E. A., Williams, M. A., & Thalken, L. (1996a). Construct validity of the modified 7-day activity interview used with older adults with cardiac problems. *Rehabilitation Nursing Research, 5*(4), 126-133.
Hellman, E. A., Williams, M. A., & Thalken, L. (1996b). Modifications of the 7-day activity interview for use among older adults. *Journal of Applied Gerontology, 15*(1), 116-132.
Hendelman, D., Miller, K., Baggett, C., Debold, E., & Freedson, P. (2000). Validity of accelerometry for the assessment of moderate intensity physical activity in the field. *Medicine & Science in Sports & Exercise, 32*(9, Suppl), S442-S449.
Hertzog, M. A., Nieveen, J. L., Zimmerman, L. M., Barnason, S. A., Schulz, P. M., Miller, C. L., & Rasmussen, D.A (2007). Longitudinal field comparison of the RT3 and an activity diary with cardiac patients. *Journal of Nursing Measurement, 15*(2), 105-120. [MEDLINE]
Jette, D. U., & Downing, J. (1994). Health status of individuals entering a cardiac rehabilitation program as measured by the medical outcomes study 36-item short-form study (SF-36). *Physical Therapy, 74*(6), 521-527. [MEDLINE]
Jette, A. M. (2003). Assessing disability in studies on physical activity. *American Journal of Preventive Medicine, 25*(3, Supplement 2), 122-128. [MEDLINE]
Jones, C. A., Parker, T. S., Ahearn, M., Mishra, A. K., & Variyam, J. N. (2009). Health status and health care access of farm and rural populations. *Economic Evaluation Bulletin, 57*
King, G. A., Torres, N., Potter, C., Brooks, T. J., & Coleman, K. J. (2004). Comparison of activity monitors to estimate energy cost of treadmill exercise. *Medicine & Science in Sports & Exercise, 36* (7), 1244-1251. [MEDLINE]
King, K. M., Thomlinson, E., Sanguins, J., & LeBlanc, P. (2006). Men and women managing coronary artery disease risk: Urban-rural contrasts. *Social Science & Medicine, 62*(5), 1091-1102. [MEDLINE]
Larson, S. L., & Fleishman, J. A. (2003). Rural-urban differences in usual source of care and ambulatory service use: Analyses of national data using urban influence codes. *Medical Care, 41*(7 Suppl), III65-III74. [MEDLINE]
Lerner, D., Levine, S., Malspeis, S., & D'Agostino, R. (1994). Job strain & health-related quality of life in a national sample. *American Journal of Public Health, 84*(10), 1580-1585. [MEDLINE]
McConnell, T. R., Santamore, W. P., Larson, S. L., Homko, C. J., Kashem, M., Cross, R. C., et al. (2010). Rural and urban characteristics impact cardiovascular risk reduction. *Journal of Cardiopulmonary Rehabilitation and Prevention, 30*(5), 299-308. [MEDLINE]

Rao, K., Darrington, D. L., Schumacher, J. J., Devetten, M., Vose, J. M., & Loberiza, F. R., Jr. (2007). Disparity in survival outcome after hematopoietic stem cell transplantation for hematologic malignancies according to area of primary residence. *Biology of Blood and Marrow Transplantation : Journal of the American Society for Blood and Marrow Transplantation, 13*(12), 1508-1514. [MEDLINE]

Rowlands, A. V., Thomas, P. W., Eston, R. G., & Topping, R. (2004). Validation of the RT3 triaxial accelerometer for the assessment of physical activity. *Medicine and Science in Sports and Exercise, 36*(3), 518-524. [MEDLINE]

Saleh, S. S., Alameddine, M. S., Hill, D., Darney-Beuhler, J., & Morgan, A. (2010). The effectiveness and cost-effectiveness of a rural employer-based wellness program. *The Journal of Rural Health : Official Journal of the American Rural Health Association and the National Rural Health Care Association, 26*(3), 259-265. [MEDLINE]

Stewart, J. C., Rand, K. L., Muldoon, M. F., & Kamarck, T. W. (2009). A prospective evaluation of the directionality of the depression-inflammation relationship. *Brain, Behavior, and Immunity, 23*(7), 936-944. [MEDLINE]

Vanderboom, C. P., & Madigan, E. A. (2008). Relationships of rurality, home health care use, and outcomes. *Western Journal of Nursing Research, 30*(3), 365-78; discussion 379-84. [MEDLINE]

Wu, J., Moser, D. K., Rayens, M. K., De Jong, M., Chung, M. L., Riegel, B., et al. (2010). Rurality and event-free survival in patients with heart failure. *Heart & Lung, 39*(6), 512-520. [MEDLINE]