Examining the associations of and interactions between intrapersonal and perceived environmental factors with objectively assessed physical activity among rural Midwestern adults, USA

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Abstract

Purpose: We investigated associations of intrapersonal and environmental factors with objectively assessed weekly moderate to vigorous physical activity (MVPA) minutes, and their interactions in rural adults.

Design: Cross-sectional.

Setting: 14 rural towns participating in a multilevel intervention to promote physical activity.

Sample: Baseline data from 241 rural community members (19% losses due to missing data).

Measures: Self-reported demographics, behavioral factors, and neighborhood environment perceptions. Weekly MVPA minutes were assessed using accelerometry data.

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Analysis: Generalized linear models using a negative binomial distribution examined associations of and interactions between intrapersonal and environmental correlates with weekly MVPA.

Results: Older age (β= −1.37; p= 0.025) and identifying as a woman (β= −0.71; p= <0.001) were inversely associated with MVPA. Self-efficacy (β= 0.34; p= <0.001) and trail use (β= 0.44; p-value= 0.003) were directly associated with MVPA. Further, among women, perceived safety from traffic was inversely associated with MVPA (β= −0.37; p = 0.003), while indoor recreational facility access was directly associated with MVPA (β= 0.24; p = 0.045).

Conclusions: Rural residents, especially women, face disproportionately lower MVPA levels. Improving recreational access and self-efficacy may be effective strategies for increasing MVPA.

Keywords

Purpose

Rural communities in the US have significantly higher morbidity and mortality rates of chronic diseases such as obesity and cardiovascular disease, when compared to urban communities.[1] Adopting adequate physical activity (PA) levels can reduce the risk of chronic disease morbidity and mortality,[2] however, people in rural communities are less active than urban residents.[3] In order to alleviate these disparities, there is a need to understand PA contextual factors in rural communities to help inform and advance PA interventions.[4]

Interventions working at scale are informed by evidence on PA correlates.[5] To better understand the correlates of weekly MVPA in rural Midwestern communities, the aims of the present study were to (1) identify intrapersonal and environmental factors associated with weekly MVPA among rural adults; and (2) test effect measure modification between intrapersonal and environmental factors in relation to weekly MVPA.

Methods

Participants and procedures

The analyses used baseline data collected between Fall of 2019 and Spring of 2020 from a sample of rural adults participating in a multilevel PA intervention.[6] Specifically, data were used from a sub-sample who agreed to wear an accelerometer device, in addition to the main telephone survey. Prior to data collection, research staff obtained informed consent from participants, with the sponsoring Institutional Review Board's approval.

Measures

Objectively assessed PA.—Participants wore an accelerometer device for at least 12 hours per day for seven days.[7] From this, we computed the primary outcome of interest, total weekly MVPA minutes.[8] Additionally, in order to describe the sample, meeting the 2018 PA guidelines were dichotomized as meeting 150 minutes or more per week of

moderate-intensity, or 75 minutes or more per week of vigorous-intensity physical activity or an equivalent combination of aggregate moderate to vigorous physical activity.[9]

Intrapersonal characteristics.—Demographic information collected included age, gender, education, race/ethnicity, and income. Gender was dichotomized by identifying as a man or woman, with age categorized as 18–33 years, 34–48 years, 49–64 years, 65–78 years, and 79+ years of age. Education was dichotomized by having a high school education or not. Race was dichotomized by identifying as white or non-white, and annual household income was dichotomized by using a median split of $50,000. Information on PA behavioral factors, included trail use and self-efficacy for PA, with the latter measured by Bandura's Exercise self-efficacy scale.[10]

Perceived neighborhood environment.—Three perceived neighborhood environment subscales were used from the abbreviated Neighborhood Environment Walkability Scale (NEWS), along with the Rural Active Living Perceived Environment Support Scale (RALPESS).[11,12] The NEWS subscale used characterizes Safety from traffic (five items, Cronbach's $\alpha = 0.74$). Response options for each item ranged on a four-point Likert scale (1= "strongly disagree" to 4= "strongly agree"). Utilizing the same Likert scale, RALPESS subscales used included indoor recreational access (six items, Cronbach's $\alpha = 0.91$), as well as the area around the home (five items, Cronbach's $\alpha = 0.78$). Higher scores of these variables indicate neighborhood that are more favorable for physical activity.

Analysis

Descriptive statistics were conducted for all variables. Generalized linear models were used for the main outcome (weekly MVPA minutes), to examine associations with the intrapersonal and perceived neighborhood environment factors. All continuous independent variables were standardized to have a mean of zero and standard deviation of 1. Models used negative binomial distributions and were controlled for wear time and town. Regression coefficients (betas) represent the log of weekly MVPA minutes estimated to be gained or lost in association with a one unit increase in continuous independent variables, or when contrasting a given category to a referent one for categorical independent variables. Further, expected percent change of weekly MVPA minutes associated with the given independent variable were also estimated. Effect measure modification was examined by testing two-way interactions between the significant intrapersonal factors and all perceived environmental factors. Analyses were conducted using STATA software Version 15.1.

Results

Sample Characteristics

The final sample included 241 participants (See Table 1 for participant characteristics), with 19% losses due to missing data. Participants (mean age (SD) = 54.2 years (15.5)) were predominantly White (87%) and identified as a woman (71%). On average, participants engaged in 94.6 (SD=116.6) minutes per week of MVPA, with 22% of participants meeting recommended guidelines for PA. Furthermore, 63.9% of participants reported using walking trails.

Intrapersonal and Environmental Correlates

Belonging to the older age group of 79+ years, relative to the younger age group of 18–33 years, was inversely associated with weekly MVPA (β= 1.37, p-value= 0.025, SE= 0.61). Identifying as a woman, relative to identifying as a man was inversely associated with weekly MVPA (β=0.71, p-value = <0.001, SE= 0.15). Additionally, reporting trail use, relative to reporting non-use was positively associated with weekly MVPA (β=0.44, p-value = 0.003, SE=0.14). Finally, every unit increase in more favorable self-efficacy for physical activity was positively associated with weekly MVPA (β=0.34, p-value = <0.001, SE= 0.07).

No environmental correlates were statistically significant, with more favorable indoor recreational access being inversely associated with weekly MVPA when accounting for interactions (β=−0.27; p-value= 0.004, SE=0.09); See Table 2 for intrapersonal and environmental associations).

Effect measure modification

Table 2 shows significant effect measure modification. For women, more favorable perceived safety from traffic was inversely associated with weekly MVPA; whereas in men more favorable perceived safety from traffic was positively associated with weekly MVPA (β= −0.37; p-value= 0.003, SE= 0.12; Illustrated in Supplementary Figure 1). Additionally, in women, more favorable indoor recreational access was positively associated with weekly MVPA; whereas in men more favorable indoor recreational access was inversely associated with weekly MVPA (β= 0.24; p-value= 0.045, SE= 0.12); Illustrated in Supplementary Figure 2).

Discussion

This is one of the first studies to examine multilevel correlates of objectively-assessed PA in rural US adults. When examining gender, there is a concerning disparity in weekly MVPA among women. Gender norms in rural communities, including roles such as caregiving and not being employed outside of the home, may help to explain the wide disparity in PA levels.[13] As expected, rural residents who used trails and those reporting higher self-efficacy for PA had higher PA levels. Promoting trail use may be an effective strategy for PA promotion in rural communities. In addition to trail use, interventions utilizing social cognitive theory[14] may be effective in promoting PA when considering self-efficacy; a strategy utilized in several PA interventions in rural communities.[15]

Insignificant associations between environmental correlates and weekly MVPA minutes, may be due to the lack of specificity as to where PA was occurring. Interestingly, gender significantly moderated the relationship between perceived safety from traffic and indoor recreational access with weekly MVPA minutes. This difference among men and women further suggests gender norms and roles may be contributing to patterns of PA.

Limitations and Strengths

Our focus on rural communities in southeastern Missouri, and participants being predominantly White and Female limits the generalizability of study findings. Additionally,

there is the potential for the Hawthorne effect (alteration of behavior due to being observed) stemming from the requirement to wear an accelerometer device for one week. Future studies should focus on a nationally representative sample of rural residents. The cross-sectional nature of the current study limits our ability to test causality. Additionally, important social-cultural factors (e.g., gender norms) were not measured, and further qualitative research may be beneficial to explain drivers of PA. A key strength of this study is the use of objectively-assessed PA data. Objectively assessing PA behaviors consist of a more valid approach towards examining correlates of overall PA.

Conclusion

Given the public health importance of PA, there is a need to better understand correlates in rural communities. Results indicate significantly lower levels of PA in women. Targeting self-efficacy for PA and recreational access (e.g., walking trails) may be an effective strategy to promote PA in rural communities. Prospective studies are needed to examine how PA promotion strategies (e.g., use of walking trails) can increase PA in rural communities, especially in women. Understanding contextual factors in rural settings can help progress PA promotion strategies.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements:

References

1. Whitfield GP, Carlson SA, Ussery EN, Fulton JE, Galuska DA, Petersen R. Trends in Meeting Physical Activity Guidelines Among Urban and Rural Dwelling Adults — United States, 2008–2017. MMWR Morb Mortal Wkly Rep. 2019;68(23):513–518. doi:10.15585/mmwr.mm6823a1 [PubMed: 31194722]

2. Lee IM, Shiroma EJ, Lobelo F, et al. Effect of physical inactivity on major non-communicable diseases worldwide: An analysis of burden of disease and life expectancy. Lancet. 2012;380(9838):219–229. doi:10.1016/S0140-6736(12)61031-9 [PubMed: 22818936]

3. Parks SE, Housemann RA, Brownson RC. Differential correlates of physical activity in urban and rural adults of various socioeconomic backgrounds in the United States. J Epidemiol Community Health. 2003;57(1):29–35. Accessed September 30, 2016. http://www.ncbi.nlm.nih.gov/pubmed/12490645 [PubMed: 12490645]

4. Bhuiyan N, Singh P, Harden SM, Mama SK. Rural physical activity interventions in the United States: A systematic review and RE-AIM evaluation. Int J Behav Nutr Phys Act. 2019;16(1):1–11. doi:10.1186/S12966-019-0903-5/TABLES/3 [PubMed: 30606197]

5. Reis RS, Salvo D, Ogilvie D, et al. Scaling up physical activity interventions worldwide: stepping up to larger and smarter approaches to get people moving. Lancet. 2016;388(10051):1337–1348. doi:10.1016/S0140-6736(16)30728-0 [PubMed: 27475273]

6. Beck AM, Eyler AA, Aaron Hipp J, et al. A multilevel approach for promoting physical activity in rural communities: a cluster randomized controlled trial. BMC Public Health. 2019;19(1):126. doi:10.1186/s12889-019-6443-8 [PubMed: 30700262]

7. ActiGraph wGT3X-BT | ActiGraph. Accessed April 2, 2020. https://actigraphcorp.com/actigraph-wgt3x-bt/

8. Watson KB, Carlson SA, Carroll DD, Fulton JE. Comparison of accelerometer cut points to estimate physical activity in US adults. J Sports Sci. 2014;32(7):660–669. doi:10.1080/02640414.2013.847278 [PubMed: 24188163]

9. Piercy KL, Troiano RP, Ballard RM, et al. The Physical Activity Guidelines for Americans. JAMA. 2018;320(19):2020. doi:10.1001/jama.2018.14854 [PubMed: 30418471]

10. Bandura A. Self-efficacy: Toward a unifying theory of behavioral change. Psychol Rev. 1977;84(2):191–215. doi:10.1037/0033-295X.84.2.191 [PubMed: 847061]

11. Adams MA, Ryan S, Kerr J, et al. Validation of the Neighborhood Environment Walkability Scale (NEWS) items using geographic information systems. J Phys Act Health. 2009;6 Suppl 1:S113–23. Accessed August 12, 2015. http://www.ncbi.nlm.nih.gov/pubmed/19998857 [PubMed: 19998857]

12. Rural Active Living Perceived Environment Support Scale (RALPESS) | Active Living Research. Accessed April 2, 2020. https://activelivingresearch.org/rural-active-living-perceived-environment-support-scale-ralpess

13. Gender roles and opportunities for women in urban environments - GSDRC. Accessed April 27, 2021. https://gsdrc.org/publications/gender-roles-and-opportunities-for-women-in-urban-environments/

14. Beauchamp MR, Crawford KL, Jackson B. Social cognitive theory and physical activity: Mechanisms of behavior change, critique, and legacy. Psychol Sport Exerc Published online November 16, 2018. doi:10.1016/J.PSYCHSPORT.2018.11.009

15. Walsh S, Meyer MRU, Gamble A, Patterson M, Moore J. A Systematic Review of Rural, Theory-based Physical Activity Interventions. Am J Health Behav. 2017;41(3):248–258. doi:10.5993/AJHB.41.3.4 [PubMed: 28376969]

So What?

What is already known on this topic?

People in rural communities in the United States face higher rates of physical inactivity and chronic disease compared to urban/suburban individuals.

What does this article add?

This study confirms the low levels of PA in rural settings, and highlights a wider disparity seen in women. However, there is some potential for strategies that increase self-efficacy for PA and improve recreational access.

What are the implications for health promotion practice or research?

Creating policies and allocating funding towards public spaces and recreational facilities is imperative for the health of rural communities, including rural women. Understanding contextual factors that impact PA is vital in rural communities, and further work around socio-cultural factors is needed.

Table 1.

Characteristics of rural Midwestern adults (N=241)

Characteristic	Mean (SD) or (%)
Intrapersonal	
Demographics	
Age, %	
18 – 33 years of age	12.5
34 – 48 years of age	22.4
49 – 64 years of age	34.9
65 – 78 years of age	26.1
79+ years of age	4.2
Gender (Women), %	71.4
Education (High School Degree), %	21.6
Race (White), %	87.1
Annual Income ($50,000), %	51.5
Physical Activity Behavioral Factors	
Self-efficacy for physical activity, mean (SD)	2.3 (0.9)
Trail Use, %	63.9
Perceived Neighborhood Environment	
Indoor Recreational Access, mean (SD)	3.3 (0.6)
Area Around Home, mean (SD)	2.3 (0.6)
Safety From Traffic, mean (SD)	2.5 (0.4)
Physical Activity	
Weekly MVPA, mean (SD)	94.6 (116.6)
Meet PA Guidelines, %	22

Table 2.

Negative binomial model of the multivariate associations of intrapersonal and perceived environmental level factors with weekly MVPA minutes in rural Midwestern adults (N=241)

	Model 1 (Main Effects)				Model 2 (Effect Measure Modification)			
	Beta[a]	Standard Error	% Change[b]	p-value	Beta[a]	Standard Error	% Change[b]	p-value
Intrapersonal factors								
Demographics								
Age (Ref: 18–33 years)								
34 – 48 years of age	0.00	0.18	0.3	0.984	0.12	0.17	1.2	0.943
49 – 64 years of age	−0.08	0.19	−7.9	0.657	−0.15	0.19	−13.7	0.434
65 – 78 years of age	−0.23	0.20	−20.3	0.258	−0.25	0.20	−22.0	0.220
79+ years of age	**−1.37**	**0.61**	**−74.5**	**0.025**	**−1.50**	**0.60**	**−77.6**	**0.012**
Annual Income (<$50,000 vs. $50,000)	−0.11	0.13	−10.8	0.397	−0.09	0.14	−8.8	0.497
Gender (Female vs. Male)	**−0.71**	**0.15**	**−51.0**	**<0.001**	**−0.66**	**0.14**	**−48.4**	**<0.001**
Physical Activity Behavioral Factors								
Self-efficacy for physical activity	**0.34**	**0.07**	**40.7**	**<0.001**	**0.35**	**0.07**	**41.7**	**<0.001**
Trail Use (vs. non Trail Use)	**0.44**	**0.14**	**54.5**	**0.003**	**0.44**	**0.14**	**54.7**	**0.002**
Perceived environmental factors								
Indoor recreational access	−0.12	0.06	−11.2	0.056	**−0.27**	**0.09**	**−23.8**	**0.004**
Safety from traffic	−0.07	0.07	−6.7	0.304	0.17	0.10	19.0	0.071
Area around home	0.17	0.07	1.7	0.801	0.01	0.07	1.0	0.880
Significant Interactions								
Gender (Female) × Safety from traffic	-	-			**−0.37**	**0.12**	**−30.9**	**0.003**
Gender (Female) × Indoor Recreational Access	-	-			**0.24**	**0.12**	**27.5**	**0.045**

Model 1 examines main effects of intrapersonal and environmental factors with weekly MVPA minutes, while Model 2 tests interactions. Both models control for wear time and town. Bold indicates a significant association (i.e., p-value < 0.05).

[a]Estimates represent log minutes of weekly MVPA gained or lost in association with the given independent variable.

[b]Indicates the expected percent change in weekly minutes of MVPA associated with the given independent variable.