Brief Original Report

A retrospective study on changes in residents' physical activities, social interactions, and neighborhood cohesion after moving to a walkable community ☆

Xuemei Zhu [a],*, Chia-Yuan Yu [b], Chanam Lee [b], Zhipeng Lu [a], George Mann [a]

[a] Department of Architecture, Center for Health Systems & Design, Texas A&M University, 3137 TAMU, College Station, TX 77843-3137, USA
[b] Department of Landscape Architecture and Urban Planning, Center for Health Systems & Design, Texas A&M University, 3137 TAMU, College Station, TX 77843-3137, USA

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ABSTRACT

Objective. This study is to examine changes in residents' physical activities, social interactions, and neighborhood cohesion after they moved to a walkable community in Austin, Texas.

Methods. Retrospective surveys (N = 449) were administered in 2013–2014 to collect pre- and post-move data about the outcome variables and relevant personal, social, and physical environmental factors. Walkability of each resident's pre-move community was measured using the Walk Score. *T* tests were used to examine the pre–post move differences in the outcomes in the whole sample and across sub-groups with different physical activity levels, neighborhood conditions, and neighborhood preferences before the move.

Results. After the move, total physical activity increased significantly in the whole sample and all sub-groups except those who were previously sufficiently active; lived in communities with high walkability, social interactions, or neighborhood cohesion; or had moderate preference for walkable neighborhoods. Walking in the community increased in the whole sample and all subgroups except those who were previously sufficiently active, moved from high-walkability communities, or had little to no preference for walkable neighborhoods. Social interactions and neighborhood cohesion increased significantly after the move in the whole sample and all sub-groups.

Conclusion. This study explored potential health benefits of a walkable community in promoting physically and socially active lifestyles, especially for populations at higher risk of obesity. The initial result is promising, suggesting the need for more work to further examine the relationships between health and community design using pre–post assessments.

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Introduction

Physical and social activities have important health benefits. Regular *physical activities* help prevent obesity and have many other benefits for physical and mental health (Strohle, 2009; U.S. Department of Health and Human Services, 2008). However, in 2014, 48.4% of American adults did not meet the public health guidelines recommending ≥150 min of moderate physical activities per week (Centers for Disease Control and Prevention, 2014). Positive *social interactions* help improve physical and mental health and trust among residents (Berkman et al., 2000; Kawachi and Berkman, 2001; Putnam, 2000). But such social interactions within the neighborhood have declined over the past few decades,

accompanied by a decrease in residents' attachment to the neighborhood (Guest and Wierzbicki, 1999).

The built environment has been identified as an important correlate of residents' physical and social activities. In contrast to automobile-dependent developments, walkable communities typically feature high density, mixed land uses, and sufficient pedestrian, bicycle, and transit facilities. They have been associated with higher levels of physical activities (Dannenberg et al., 2011; Frank et al., 2004; Ding and Gebel, 2012; Saelens and Handy, 2008; Durand et al., 2011; Humpel et al., 2002) and more social interactions (Lund, 2002; Nasar and Julian, 1995; Kim and Kaplan, 2004; Leyden, 2003). However, previous studies are mostly cross-sectional (Saelens and Handy, 2008; Ding and Gebel, 2012; Zhu and Sallis, 2011); only a few studies conducted a pre–post comparison to better isolate the impact of moving into walkable communities (Handy et al., 2008; Tudor-Locke et al., 2008; Wells and Yang, 2008; Giles-Corti et al., 2013).

This study addressed this knowledge gap by using a retrospective "pre–post" comparison to examine (1) if residents increased their

Table 1

Descriptive statistics and *t* test results for pre–post move differences in physical and social activities among the 2013–2014 survey respondents who moved to Mueller in Austin, Texas, U.S.A.

Variables	Descriptive statistics		*T* test results: mean pre–post differences (post-move–pre-move)					
	All respondents (N = 449)		All respondents (N = 449)	Respondents who moved from Austin (N = 284)	Subgroups by pre-move neighborhood's walkability[b]			
	Pre-move mean (SD[a])	Post-move mean (SD)			High (N = 60)	Medium (N = 99)	Low (N = 81)	Very low (N = 34)
Physical activities								
Days/week with ≥30 min of moderate physical activities	3.6 (2.0)	4.2 (1.8)	0.6[***]	0.6[***]	0.1	0.8[***]	0.7[**]	0.8[*]
Bicycling (min/week[e])	12.4 (35.9)	21.8 (54.8)	9.5[***]	10.9[**]	9.1	1.4	12.2[**]	40.5[*]
Total Walking (min/week)	110.9 (112.5)	142.4 (116.3)	32.1[***]	31.0[***]	2.3	39.8[***]	37.8[***]	53.3[***]
Walking in community (min/week)	80.5 (99.9)	118.0 (105.2)	37.8[***]	41.4[***]	10.0	49.8[***]	55.3[***]	54.1[**]
Traveling in private car (min/week)	249.5 (207.5)	181.1 (152.3)	−68.4[***]	−50.8[***]	24.6	−59.9[***]	−60.7[**]	−164.2[**]
Social interactions (days/month)								
Say hello to neighbors	10.9 (9.8)	17.9 (10.3)	7.0[***]	8.6[***]	7.4[***]	9.3[***]	8.1[***]	10.4[***]
Stop and talk to neighbors	6.2 (7.9)	11.2 (9.5)	4.9[***]	6.2[***]	5.2[***]	6.6[***]	5.8[***]	8.8[***]
Socialize with neighbors	2.7 (5.6)	4.9 (6.9)	2.1[***]	2.5[***]	1.7	3.3[***]	1.5[*]	4.4[**]
Seek help from and exchange favor with neighbors	2.2 (4.3)	3.4 (5.1)	1.2[***]	1.6[***]	1.4	2.1[***]	1.2	1.9[*]
Neighborhood cohesion[f]								
Neighbors can be counted to help in case of need	3.1 (1.4)	4.1 (1.1)	1.0[***]	1.4[***]	1.3[***]	1.3[***]	1.4[***]	1.8[***]
This is a close-knit neighborhood	2.5 (1.4)	3.9 (1.1)	1.4[***]	1.7[***]	1.6[***]	1.7[***]	1.7[***]	1.9[***]

[a] SD: Standard deviation.

[b] High walkability, Walk Score: 89-70; medium walkability, Walk Score: 69-50; low walkability, Walk Score: 49-25; very low walkability, Walk Score: 24-0.

[c] Sufficiently active is defined as obtaining ≥30 min/day of moderate physical activities on ≥5 days/week.

[d] Subgroups for social interactions and neighborhood cohesion were created based on the percentiles of the sum of all corresponding measures (high = 100–67 percentiles; medium = 66–34 percentiles; low = 33–1 percentiles).

[e] The survey collected information about the *number of days per week* (continuous variable) and the *number of minutes per day* (categorical variable with ranges of 1–10, 11–20, 21–30, 31–40, 41–50, 51–60, and 61+) spent on each type of physical activity or in a private car. The *number of minutes per week* was calculated by multiplying the number of days per week with the midpoint value of the time range (or a value of 65 for the "61+" category) for the number of minutes per day.

[f] Neighborhood cohesion variables were measured on a 5-point Likert scale, by asking the respondent how much he/she agreed or disagreed with each statement (1 = strongly disagree; 2 = somewhat disagree; 3 = neither disagree nor agree; 4 = somewhat agree; 5 = strongly agree).

[***] *p* < 0.001.

[**] 0.001 ≤ *p* < 0.01.

[*] 0.01 ≤ *p* < 0.05.

physical activities, social interactions, and neighborhood cohesion after moving to a walkable community and (2) whether such changes varied across sub-groups with different levels of physical activities, community walkability, social interactions, neighborhood cohesion, and neighborhood preferences before the move.

Methods

Study setting

The study setting is the 711-acre Mueller community in Austin, Texas, U.S.A. It will accommodate about 10,000 residents and 10,000 employees upon completion in 2018. About 25% of the housing units in Mueller are affordable homes reserved for households with incomes lower than the area's median. When this study began in May 2013, Mueller had approximately 40% of its construction completed. Mueller's activity-friendly environment features compact and mixed land uses, grid-like street networks, complete sidewalks, and rich green/open spaces. Based on the 2010 Census, its population characteristics are similar to the citywide average. This offers an advantageous opportunity to study the health impacts of moving into a walkable community. More details about Mueller's environment and population characteristics have been reported elsewhere (Zhu et al., 2013).

Variables and data collection

A self-report survey was administered to one adult (≥18 years) from each participating household, who had no physical impairment or disability preventing him/her from engaging in normal physical activities. The survey included post-move and pre-move sections. The recall period for the pre-move section, or the time the respondent had lived in Mueller, ranged from

1 month to 6.4 years, with a mean of 2.9 years. Study variables included the outcomes (physical activities, social interactions, and neighborhood cohesion) and personal, social, and physical environmental factors that might have influenced those outcomes. They were selected based on the social ecological theory (McLeroy et al., 1988) and previous literature (Saelens and Handy, 2008; Ding and Gebel, 2012; Durand et al., 2011). Most survey items were adopted and a few were adapted from existing validated questionnaires, including the International Physical Activity Questionnaire, the Twin Cities Walking Survey, and the Active Where Survey (Forsyth et al., 2009; Durant et al., 2009; Craig et al., 2003). The adaption was made based on the feedback from a focus group with Mueller residents (N = 13) and a pilot test (N = 6), to reflect Mueller's unique characteristics (e.g., adding "front porches" as a choice for physical activity locations).

Online surveys were the main method of data collection, but hard copies, as a more preferred format for older adults, were also mailed to the senior apartment residents. The recruitment process started with an online message posted at the community online forum in May 2013, followed by two online reminders. Between December 2013 and May 2014, mail invitations were sent to those residents who did not respond to the survey and were followed by two reminder mails.

Physical activities were captured by the number of days per week with ≥30 daily min of moderate physical activities and by frequencies (days/week and min/day) of specific activities (Table 1) (Craig et al., 2003). Positive social interactions were measured by the frequency of specific interactions; neighborhood cohesion was measured using a 5-point Likert scale, by asking the respondent how much he/she agreed or disagreed with relevant statements (Table 1) (Forsyth et al., 2009). Residential self-selection (neighborhood preference in relation to walkability) was captured by asking the respondent how important the "ease of walking" was in their relocation to Mueller (Boone-Heinonen et al., 2010; Forsyth et al., 2009). The walkability for each respondent's pre-move neighborhood was measured

Subgroups by pre-move physical activity		Subgroups by pre-move social interactions[d]			Subgroups by pre-move neighborhood cohesion[d]			Subgroups by importance of walkability in relocation to Mueller		
Sufficiently active (N = 95)[c]	Insufficiently active (N = 186)	High (N = 94)	Medium (N = 93)	Low (N = 92)	High (N = 120)	Medium (N = 76)	Low (N = 85)	Very important or important (N = 184)	Moderate (N = 62)	Little or no importance (N = 38)
−0.9***	1.3***	0.2	0.6**	0.9***	0.3	0.6**	0.9***	0.6***	0.5	0.5*
7.1	13.0**	11.7	7.9**	12.4	7.8	6.7	19.2*	16.4***	−4.8	10.1
−0.4	47.9***	25.1	24.5**	43.9***	29.8**	27.3*	37.3***	39.0***	11.3	27.7
9.8	58.2***	30.3**	55.4***	38.9***	27.2**	46.1***	58.3***	52.5***	36.9**	4.7
−17.8	−67.9***	−51.6**	−24.1	−72.8***	−17.3	−46.8*	−99.4***	−74.5***	−22.6	−21.7
5.7***	10.1***	3.2**	11.3***	11.2***	3.6***	10.8***	13.6***	9.9***	8.3***	4.0*
4.2***	7.4***	3.4**	8.8***	6.4***	2.7**	8.3***	9.5***	7.8***	5.1***	1.0
1.2	3.2***	0.7	4.5***	2.5***	1.2	2.7***	3.9***	3.2***	1.8	0.5
0.3	2.3***	0.02	2.8***	2.1***	0.7	1.5**	2.9***	2.2***	1.1	0.3
0.9***	1.6***	0.6***	1.6***	1.9***	0.1	1.7***	2.8***	1.5***	1.3***	0.8*
1.1***	2.0***	1.2***	2.0***	1.9***	0.5***	2.3***	2.9***	1.6***	1.6***	0.9**

using the publicly available Walk Score (WalkScore.com, 2014), which captures environmental factors such as density of retail destinations, street intersections, and residential land uses. It has been shown to be a valid measure of neighborhood walkability and has been linked with actual amounts of walking in previous studies (Brown et al., 2013; Hirsch et al., 2014; Carr et al., 2011; Duncan et al., 2011).

Statistical analysis

Statistical software SPSS 19 was used for data analyses. Descriptive analysis was performed for each variable to examine its distribution, missing values, outliers, etc., and to recode it as necessary. To examine the pre–post move differences of outcome variables, paired *t* tests were conducted first for the entire sample (N = 449) and then for a sub-sample (N = 284) for those who moved from the City of Austin to Mueller. Those moving from outside the city were excluded because additional factors (e.g., the city, weather, and job) outside the interest of this study might have significant confounding impacts. Within this sub-sample from Austin, paired *t* tests were conducted for subgroups to examine whether certain populations were more responsive to environmental changes. First, respondents were divided into those who were insufficiently active (<5 days/week with ≥30 daily min of moderate physical activities) and sufficiently active (≥5 days/week) before the move. Second, another set of sub-groups was created based on the Walk Scores of respondents' pre-move neighborhoods: very low (0–24, car-dependent with almost all errands requiring a car), low (25–49, car-dependent with most errands requiring a car), medium (50–69, somewhat walkable and some errands can be accomplished on foot), high (70–89, very walkable and most errands can be accomplished on foot), and very high (90–100, walkers' paradise with daily errands not requiring a car) (WalkScore.com, 2014). Third, sub-groups with different levels of pre-move social interactions and neighborhood cohesion were created based on the sums of respective measures (high: 100–67 percentiles,

medium: 66–34 percentiles, low: 33–1 percentiles). Finally, sub-groups were created based on how important the "ease of walking" was for residents' relocation to Mueller (Table 1).

Results

The total number of occupied housing units in Mueller was 1241. A response was considered valid if the respondent provided a valid Mueller address, and the number of questions with missing values or the answer "Do not know" was less than 15% of the total. Further, 12 female respondents who were pregnant or had a less than one year old baby at the time of survey were excluded. The valid response rate was 36.3% (N = 449). It is difficult to evaluate how representative the sample is because over half of the respondents moved in after the latest population data for Mueller were collected through Census 2010. A comparison with the sample from an earlier study in Mueller (Calise et al., 2013) showed similar sociodemographic characteristics. However, when referring to the Census 2010 data for Mueller, the sample appears to over-represent those who are female (66.1% in the sample vs. 49.2% in the population), white (82.4% in the sample vs. 61.1% in the population), or older (mean age of 48.3 for the sample vs. 37.2 for the population), with higher income (39.4% with ≥$100,000 annual household income in the sample vs. 21.8% in the population) and with higher education (83.7% with bachelor's degree and higher in the sample vs. 36.7% in the population).

Among 449 survey respondents, 284 moved to Mueller from Austin (Fig. 1). Within this sub-sample, sub-groups were generated based on pre-move physical activities, community conditions, and walkability
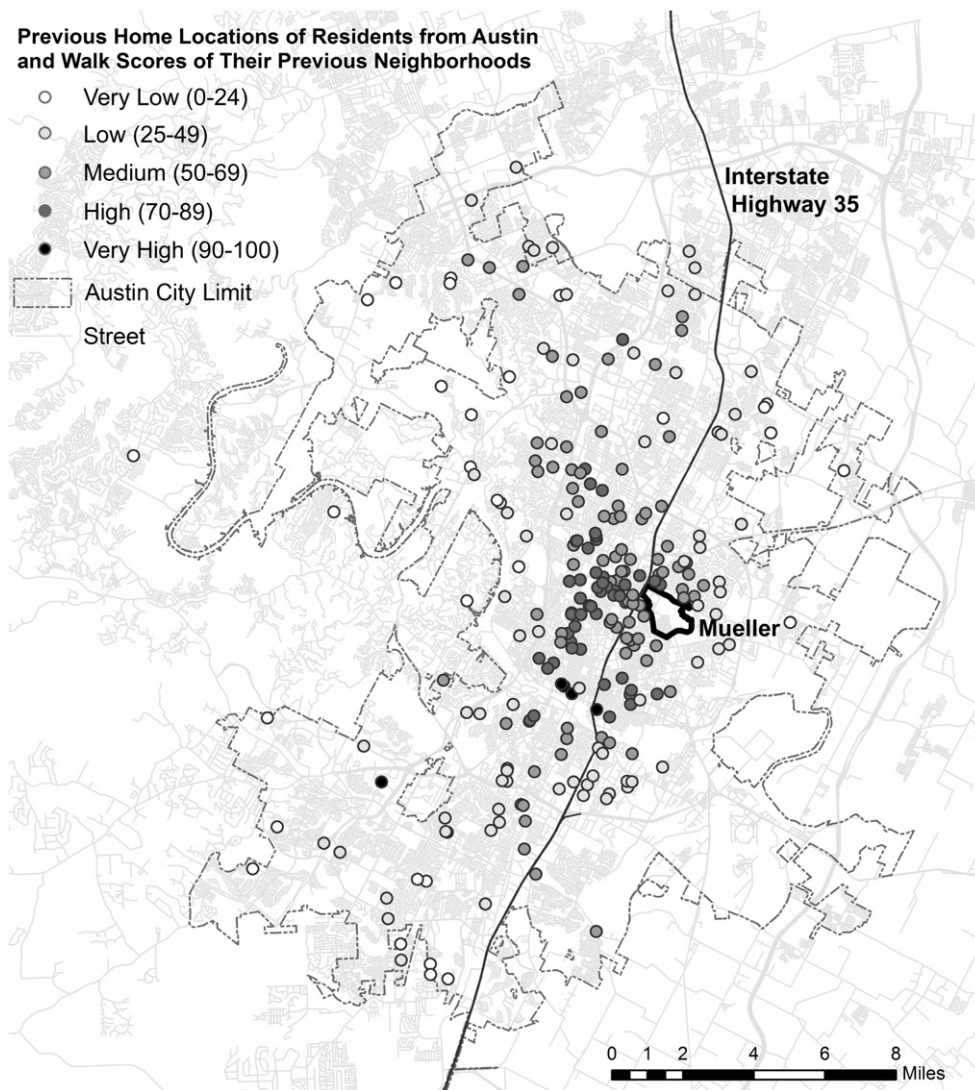
Fig. 1. Pre-move home locations of the 2013–2014 survey respondents who moved to Mueller from Austin, Texas, U.S.A. (N = 284) and Walk Scores of their pre-move neighborhoods.

preferences. The sub-group with "very high" pre-move walkability had a small sample size of 10 and was therefore excluded.

From the 449 respondents, the percentage of residents who had ≥5 days per week with ≥30 daily min of moderate physical activities increased from 34.4% to 45.8% after the move; 64.8% and 26.5% reported "higher" and "about the same" physical activity levels, respectively; 47.7% and 45.4% reported "better" and "about the same" health conditions, respectively. Results (Table 1) also showed significant increases in bicycling, total walking (in and outside the community), and walking in the community; and a significant reduction in time spent in an automobile. After the move, the weekly mean of total walking minutes was 142.4, which is close to the recommended 150 min of moderate physical activities (U.S. Department of Health and Human Services, 2008). For social interactions and neighborhood cohesion, the 449 respondents showed significant increases in all variables (Table 1). Among the 284 respondents who moved from Austin, very similar patterns were observed (Table 1).

Sub-group analyses revealed between-group differences in changes of physical activities. Those from less-walkable communities showed significant increases in their physical activities, while those from high-walkability communities did not (Table 1). For example, residents from medium-, low-, and very-low-walkability communities walked 49.8, 55.3, and 54.1 more min/week in the community ($p < 0.01$), respectively, after the move. In addition, the previously insufficiently

active sub-group showed significant increases in physical activities (e.g., 1.3 more days/week of being moderately active for ≥30 min/day, $p < 0.001$), while the previously sufficiently active sub-group did not. For sub-groups based on pre-move social interactions and neighborhood cohesion, all sub-groups showed some significant increases in physical activities, with the exception of a few variables. Sub-groups with different levels of neighborhood preferences all showed increases in some physical activity measures, and the impact was the strongest in the sub-group with strong preference for walkable neighborhoods. For social interactions and neighborhood cohesion, all sub-groups showed significant increases. The change was relatively stronger among those with lower levels of social interaction, neighborhood cohesion, community walkability, and physical activity; and stronger residential self-selection before the move.

Discussion and conclusion

Limitations should be acknowledged for this brief report. First, this retrospective, cross-sectional study may be subject to recall errors, measurement errors from self-report, "honeymoon effects" from the move, and residential self-selection bias (Cao et al., 2009; Boone-Heinonen et al., 2010). If more resources were available, longitudinal studies with control groups and multiple, objective post-move measures would have been a stronger design. Second, it is impossible to

accurately evaluate how representative the sample is, as no updated population information is available for this new community. It is possible that white, higher-income, and better-educated populations were over-represented, because only the online survey option was provided for potential participants except those senior apartment residents. Also, survey respondents may over-represent those who were more physically or socially active. Third, during the study period (May 2013 and December 2013–May 2014), seasonal effects might have had an impact on the outcomes, as reported by some previous studies (Tucker and Gilliland, 2007). Fourth, for a few survey items modified from validated instruments, original items' validity and reliability may not apply. The small sample size (N = 6) in the pilot test did not allow validity or reliability test either. Finally, the reported results are from bivariate tests and did not control for covariates. To address some of these limitations, follow-up analyses are being conducted, involving more detailed environmental assessments using Geographic Information Systems (GIS) and more rigorous, multivariate statistical modeling.

Despite these limitations, this study addressed some important knowledge gaps about health impacts of community design. It strengthens the typical cross-sectional design in this area of research by using the retrospective study on behavior changes after residents relocated to a walkable community. Compared to a 2009 study in Mueller (Calise et al., 2013), this project was conducted later when more walkable destinations and housing were constructed. It also revealed differences across sub-groups with different pre-move community conditions and expanded the range of health benefits by including social health indicators. The increase of physical activity after the move is consistent with results from limited previous studies on pre–post move differences (Handy et al., 2008; Giles-Corti et al., 2013). Even for residents who did not value walkability in their neighborhood selection, physical activities still showed significant increases. This is encouraging and consistent with some previous studies accounting for residential self-selection (Cao et al., 2009). This study and its follow-up analyses can help further understand the link between community design and health promotion. This is an important, yet understudied, area with significant implications for future planning and public health policies.

Conflict of interest statement

The authors declare that there are no conflicts of interest.

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