IMPACTING HEALTH

The impact of walkable community design on the health of Mueller, Texas residents

Xuemei Zhu, Ph.D.
Zhipeng Lu, Ph.D
Chanam Lee, Ph.D.
George Mann
Chia-Yuan Yu, Ph.D.

Authors

Xuemei Zhu, Ph.D., Associate Professor

Zhipeng Lu, Ph.D., Lecturer

Chanam Lee, Ph.D., Professor

George Mann, Professor

Chia-Yuan Yu, Ph.D.

College of Architecture
Center for Health Systems & Design
Design Research for Active Living Group
Texas A&M University
3137 TAMU
College Station, TX 77843, USA

CONSULTANTS

Jim Adams, AIA, LEED AP, Principal, McCann Adams Studio, Austin, Texas

Jessica Reynolds, Mueller Marketing, Catellus

Pamela Hefner, RLA, ASLA, Project Manager, Economic Growth & Redevelopment Services, City of Austin, Texas

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Introduction

Health has been and continues to be one of the main concerns in people's everyday lives. It is closely related to the physical environment, especially the community we live in. However, finding and living in a "healthy community" are not easy tasks. Today's communities have been increasingly designed around automobiles instead of pedestrians, featuring segregated land uses, low density, disconnected street networks, and insufficient pedestrian, bicyclist, and transit infrastructure. Such communities have been questioned and criticized for their impacts on residents' physical and social health.

In terms of *physical health*, a substantial body of evidence has linked automobile-dependent communities with reduced physical activities in people's daily routines, while walkable communities with contrasting features showed reversed associations.[1-5] Leaders in public health, urban planning, and architecture now share this belief about environment–physical activity relationships, as evidenced by the City of New York's *Active Design Guidelines*.[6] This is especially important in the context that obesity has become a leading public health problem, and that physical inactivity is a significant contributing factor.[7-9]

Concerning *social health*, limited studies have suggested that automobile-centered communities discourage walking and other outdoor activities that in turn reduce opportunities for social interactions.[10-14] In contrast, walkable communities promote social interactions through pedestrian-friendly community layout and site design, rich and diverse natural features and open spaces, and mixed land uses providing diverse everyday destinations.[10-14]

Meanwhile, growing trends in community development, such as New Urbanism, Smart Growth, Transit Oriented Development, and Leadership in Energy and Environmental Design-Neighborhood Development (LEED-ND), all advocate walkability as a guiding principle for its benefits on not only health but also sustainability, economy, and equity. Recent market studies have shown growing acceptance and demands for walkable communities.[15-17] In practice, an increasing number of communities are using "walkable design" as a means to promote residents' health.

However, very few studies have examined the actual health impacts of moving into walkable communities.[18-21] In the traditional urban planning and land development process, relevant health benefits are not sufficiently considered either. As a result, these types of projects may still face market resistance and regulatory barriers.[22,23] More confirmatory evidence is needed to support the growing number of local governments that recognize benefits of walkable communities, and to inform evidence-based interventions.[23-25]

> "We ought to plan the ideal of our city with an eye to four considerations. The first, as being the most indispensable, is health." —Aristotle, *Politics* (ca. 350 B.C.)

Study Design

This research addresses these gaps of knowledge by conducting a case study of a walkable community named Mueller in Austin, TX, to examine walkability's impacts on adult residents' physical and social health. Based on the literature, a conceptual framework (Figure 1) was proposed for the hypothesized mechanisms of such impacts: 1) the increase in community walkability promotes residents' physical activities, social interactions, and neighborhood cohesion both directly and indirectly (by improving relevant personal attitudes and social support), and 2) the resulting increases in physical activities and improvements of social interactions and neighborhood cohesion reinforce each other.

Guided by this framework, this study examined 1) whether Mueller residents increased their physical activities, social interactions, and neighborhood cohesion after moving to Mueller; 2) if yes, how their physical and social activities changed in terms of types, locations, and frequencies; and 3) whether populations at higher risk of obesity (those who were previously less active and lived in less-walkable communities) had more increases in these activities.

Study Setting

Mueller is an exemplary project by the city to use a series of innovative policies to create a walkable, sustainable, and equitable community. As a pilot LEED-ND project developed on the former airport site (711 acres) near downtown, Mueller is planned to house about 10,000 residents and 10,000 employees. It features activity-friendly design approaches such as high density, mixed land uses, well-connected street networks with complete sidewalks, and rich and diverse natural resources and open spaces distributed throughout the community (Table 1 and Figure 2). Within this mixed-income community, over 25% of the housing units are affordable homes that are indistinguishably incorporated into the community with market-rate units.

FIGURE 1. Conceptual framework for the mechanisms through which environmental changes influence physical activities, social interactions, and perceived neighborhood cohesion

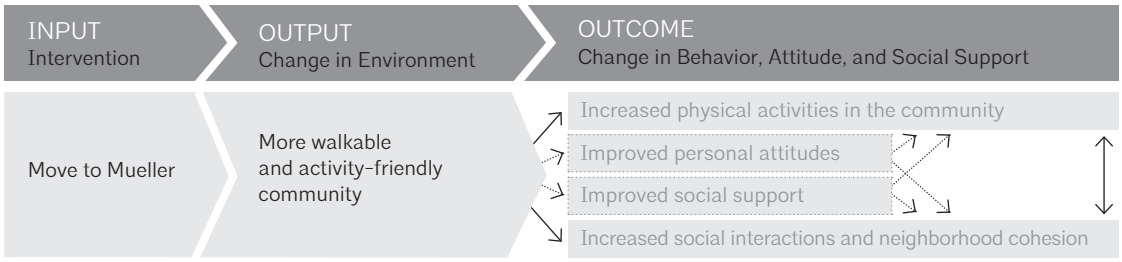


TABLE 1. Mueller's Activity-friendly Environmental Features Including Location, Neighborhood Pattern and Housing (Source of images: Catellus, 2004)

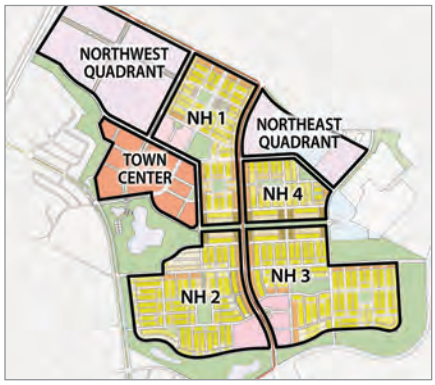
LOCATION: A central urban location with easy access to public transit and other urban amenities.

NEIGHBORHOOD PATTERN

High density: 14 residents/acre
Mixed land uses: civic/institutional buildings, offices, commercial areas, town center, parks, open spaces, and diverse housing within walkable distance

Parks and open space: Easily accessible, well-connected, and evenly distributed park systems (140 acres) with 13 miles of hike/bike paths/lanes

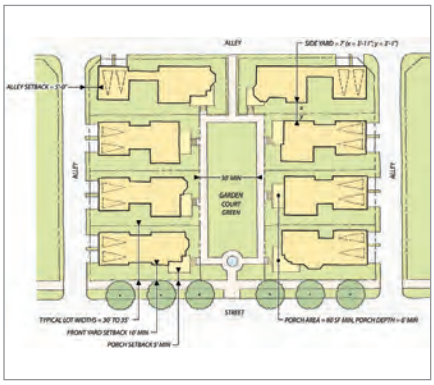
Streets: Grid-like, hierarchical, and connected systems with complete sidewalks, buffers between sidewalks and streets, traffic calming, and good maintenance, visual quality, and surveillance



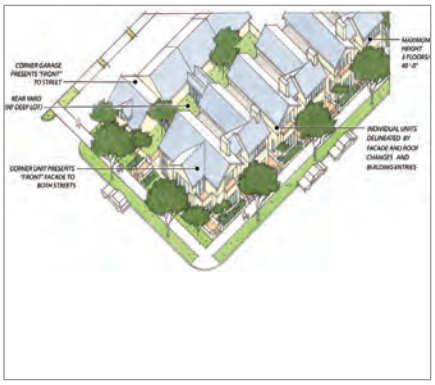
HOUSING: E.g., front porches and rear garages; garden courtyards; vertical mixed use with offices/shops at street level and living units above; access to parks and open spaces; various types of housing

1. Yard houses

2. Garden courts

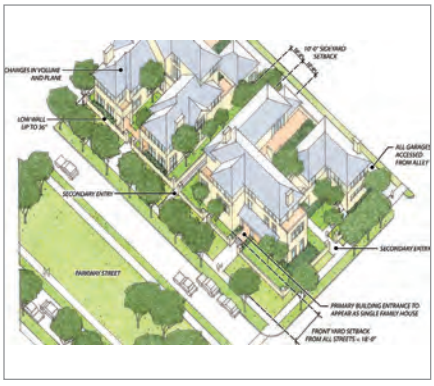


3. Row houses



4. Shop houses

5. Mueller houses



6. Apartments in mixed-use buildings

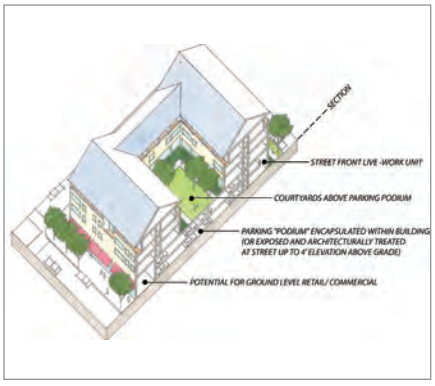


TABLE 2. Physical environment and population characteristics of Mueller Community and City of Austin

	FEATURES	OTHER COMMUNITIES IN THE CITY OF AUSTIN	MUELLER COMMUNITY
Physical environment[a] (Mueller's environment represents a departure from typical community developments in other parts of the city.)	Population density (persons/acre)	Mean: 6.8 (SD[b]: 3.7)	14
	Land use mix	Mean: 0.45 (SD: 0.24) (range: 0–1)[c]	10,000 employees, 100,000 residents, and 366,000 square feet of retail space on the 711-acre site
	Street connectivity (intersections/100 acres)	Mean: 19.7 (SD: 11.3)	66
	Sidewalk coverage (%)	Mean: 23.7 (SD: 13.7)	Close to 100
	Parks and open space coverage (%)	Mean: 8.9 (SD: 9.6)	20 (Each household has green space within 600 feet.)
Population[d] (Mueller's population is representative of the Austin population.)	Hispanic or Latino (of any race)	31.4%	35.1%
	White (one race)	68.3%	71.4%
	Population under the age of 18	22.1%	21.9%
	Mean household income	$68,659	$66,923

[a] Physical environmental measures for the City of Austin were based on the authors' previous measures of 74 communities (defined as public elementary schools' attendance areas) in Austin.[26]

[b] SD: Standard deviation.

[c] The land-use mix measure describes the evenness of land use distribution based on square footage of residential, commercial, and office land uses.[27] The value ranges from 0 (single land use) to 1 (a perfectly even mix).

[d] The population information was obtained from the 2010 Census and the 2005–2009 American Community Survey.[28]

As shown in Table 2, Mueller's physical environment represents a departure from typical automobile-centered developments in the city, but its population is representative of the city population. This makes it a unique research opportunity. When this study was started in 2013, Mueller had approximately 40% of its property developed, housing about 3,500 employees and 900 single-family homes.

Data Collection and Analysis

FOCUS GROUP A focus group discussion was conducted first to obtain information regarding Mueller residents' physical activities, social interactions, and neighborhood cohesion before and after the move, and to gain in-depth understanding about reasons for relevant changes, if any. Participants for the focus group were recruited at a Mueller Neighborhood Association meeting. They were also asked to use a map of Mueller to identify locations for their physical and social activities and places that caused concerns. Content analysis was used to analyze results from the focus group.

FIGURE 2. Land use map and developed areas of the Mueller Community features activity-friendly design approaches including high density and mixed land uses. (Source: Catellus)

SURVEYS Online surveys were used to collect information about Mueller residents' pre- and post-move conditions, including the outcomes (physical activities, social interactions, and neighborhood cohesion) and personal, social, and physical environmental factors that might have influenced these outcomes. Most of the survey items were adopted from previously validated questionnaires.[29-31] A few minor revisions or additions were made to validated items in order to reflect some unique features of Mueller, based on results from the focus group and a pilot test (N = 6). Survey participants were recruited using online messages on the Mueller Community online forum (N unknown) and mail invitations for a stratified random sample (N = 532) selected to be spatially representative of the community.

Survey results were analyzed using statistical software SPSS 19. Descriptive statistics was examined first, and then *t*-tests were used to examine the pre-post move differences in the outcomes. Pearson correlation matrix was used to examine correlations between changes in physical activities and changes in social interactions and neighborhood cohesion. For residents moving to Mueller from other cities, the changes of the cities and likely their jobs might have had significant impacts on their lifestyle changes. Therefore, additional analyses were limited to Mueller residents who moved from other neighborhoods in Austin. This sub-sample was further divided into subgroups based on their previous communities' walkability and pre-move physical activity (i.e., whether they met the public health guidelines of 5+ days per week with 30+ daily minutes of moderate physical activities). Each subgroup's pre-post differences in the outcome variables were examined by *t*-tests; between-group differences in changes of the outcomes were tested by analysis of variance (for 3-group comparisons) or *t*-tests (for 2-group comparisons).

The walkability of residents' previous communities were measured by Walk Score (range: 0-100).[32] This measure captures important aspects of neighborhood walkability such as density of retail destinations, recreational open spaces, street intersections, and residential land uses. It has been shown to be a valid measure linked to walking behavior.[33-35] This project categorized residents' pre-move communities into 5 levels of walkability using the Walk Score categories: 1) very low (0-24, car-dependent with almost all errands requiring a car); 2) low (25-49, car-dependent with most errands requiring a car); 3) medium (50-69, somewhat walkable and some errands can be accomplished on foot); 4) high (70-89, very walkable and most errands can be accomplished on foot); and 5) very high (90-100, walkers' paradise with daily errands not requiring a car).[32]

Results

Focus Group Results

Thirteen subjects (eight women and five men) with diverse ages, ethnicities, and lengths of living in Mueller (range: 1 month to 4 years) participated in the focus group in March, 2013. Two participants had young children living in their household. Content analysis showed increases in residents' physical activities, social interactions, and neighborhood cohesions after the move, and roles of some environmental factors in facilitating such changes.

PHYSICAL ACTIVITIES Most participants increased their physical activities after the move. Several participants reported walking more to diverse destinations such as parks, greenways, business areas, friends' homes, block parties, mailboxes, and the hospital in the community. One participant worked in the community and walked to and from work. Two residents liked bicycling and one biked to/from work. Several other residents used public transportation or private cars (including carpool) to travel to work, and their commute distances were much shorter. Two participants reported a "no driving in Mueller" rule in their household. Another participant reported a yearly saving of about $1,200 in gasoline. They also reported that environmental features such as complete and well-connected sidewalks, various parks and open spaces, convenient bike routes, diverse destinations, and safety (e.g., good street lighting for jogging early in the morning) supported diverse outdoor activities such as walking, bicycling, jogging, golfing (at a golf course nearby), and kite flying (Figure 3). The back alleys (see the upper right photo in Figure 3) were highlighted as popular shared spaces among a small group of neighbors and safe places for children to play in. A young father proudly reported that his 4-year-old son learned how to ride a two-wheel bicycle in the back alley where there was very little through traffic.

SOCIAL INTERACTIONS AND PERCEIVED NEIGHBORHOOD COHESION Participants also reported increases in social interactions and neighborhood cohesion after the move. Communal facilities such as community mailboxes were popular places for them to meet neighbors, make friends, and learn about news in and around the community. Several participants reported that smaller backyards encouraged them to use front porches and outdoor spaces more often, and therefore have more opportunities to interact with neighbors. Back alleys became semi-public areas for diverse social activities such as block parties and children's play. Overall, Mueller became a close-knit community even in its partially-completed development status. One participant called it "a sun city with diversity," welcoming people of all ages, ethnicities, income levels, and religions. More importantly, people in Mueller knew and helped each other. They frequently shared news and exchanged favors (e.g., borrowing tools) with neighbors, paid attention to what was happening in the community, and reported concerns, whenever there were any. All of these helped to build a safer community.

MAP OF ACTIVITIES AND CONCERNS Popular places for activities included parks, trails, walking paths, sidewalks, waterfront, swimming pool, restaurants, friends' homes, and central activity areas (e.g., the hangar used for the weekly farmers' market). The business area with both big-box retail stores and small shops received

FIGURE 3. Focus group participants reported environmental features supportive of physical and social activities (e.g., sidewalks, parks and open space, bike routes, diverse destinations, communal facilities, front porches, back alleys) (Source of images: Tom McConnell Photography [left]; Xuemei Zhu [others])

mixed opinions, including traffic safety concerns for the large surface parking area and expectations for more local businesses instead of big-box retail chains. Commonly mentioned places of concerns were mostly traffic related. Participants identified locations that needed safer walking paths and crosswalks (especially for children), more traffic lights, and better speed control and visibility for drivers. Another resident thought the community park should be better maintained.

Survey Results

A total of 229 valid responses were collected as of January 2014, yielding a response rate of 25%. The sample was 66% women and 14% of Hispanic, Latino, or Spanish origin, with a mean age of 44 years. Levels of education and income were diverse. Compared to the 2010 Census information for Mueller, female and non-Hispanic populations were somewhat overrepresented in this sample. Among 229 valid respondents, 167 moved to Mueller from Austin, including 15, 35, 72, 42, and 3 residents from neighborhoods with very low, low, medium, high, and very high level of walkability, respectively. The subgroups with "very low" and "very high" walkability had small samples and therefore, were excluded from the sub-group analysis. In addition, among these 167 residents, 51 were sufficiently active before the move and 116 were not.

PHYSICAL ACTIVITIES Among 229 responses, the percentage of residents meeting physical activity guidelines increased from 34% to 49% after the move. Meanwhile, 69% reported higher levels of physical activities and

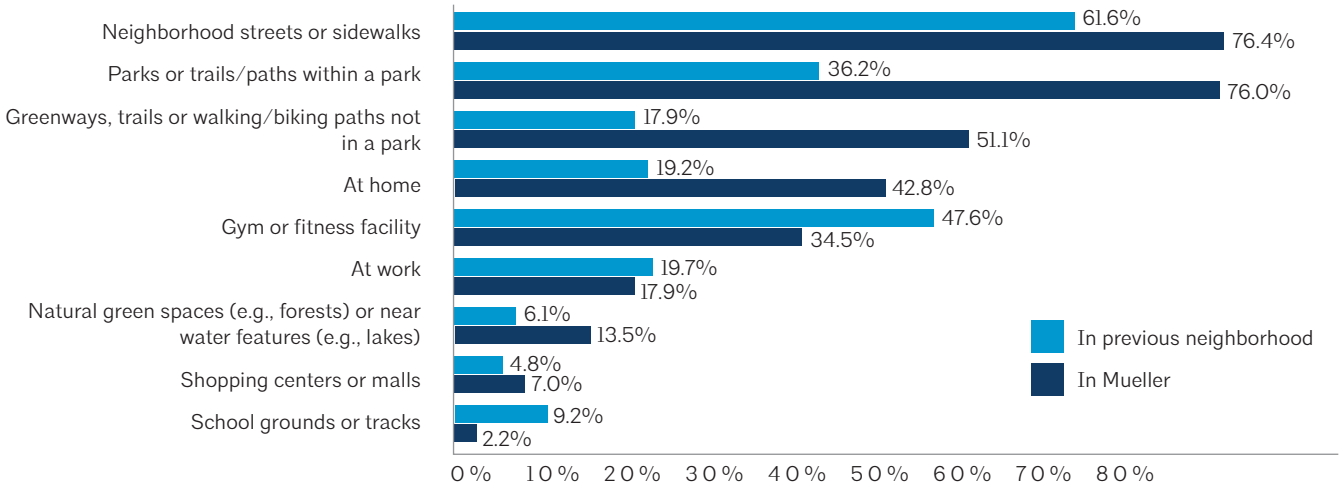


FIGURE 4. Percentages of respondents reporting using certain locations for physical activities

51% reported better health conditions. Results about specific types of activities are listed in Table 3. Moreover, the mean for days with 30+ minutes of physical activities increased by 0.7 day/week (p<0.001). Total bicycling, total walking, and walking in the community increased by 14, 40, and 46 minutes/week, respectively (p<0.001). Time spent traveling in a private car was reduced by 84 minutes/week (p<0.001). After the move, the time spent on total walking had a mean of 140 minutes/week. This is already very close to the public health guideline for the level of physical activities needed for an adult to obtain significant health benefits: at least 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity aerobic physical activity per week, or a combination.[36] For the sub-sample of those moving from Austin (N=167), very similar changes were observed.

Sub-group comparisons revealed some between-group differences. For sub-groups based on pre-move neighborhood walkability, those from high-walkability neighborhoods did not show significant increases in their physical activities, while those from medium- and low-walkability neighborhoods did (Table 3). Analysis of variance showed that residents from low-walkability neighborhoods had significantly more increases in the number of days/week with 30+ minutes of physical activities, compared to those from high-walkability neighborhoods (mean difference=1 day/week, p<0.05). However, no significant differences were identified for increases in specific types of physical activities (i.e., walking, bicycling) across these sub-groups.

For sub-group comparison based on pre-move physical activity, the previously insufficiently active sub-group had significant increases in not only total activities, but also specific types of physical activities. In contrast, the previously sufficiently active group showed a significant reduction in the total number of days/week with 30+ minutes of physical activities and insignificant increases in walking and biking. Further, compared to their more active counterparts, those who were previously insufficiently active had 46 and 42 more weekly minutes of increases in total walking and walking in the neighborhood, respectively (p<0.5).

TABLE 3. Descriptive statistics and *t*-test results for pre-post differences in physical and social activities

Variables	Descriptive statistics		*T*-test results: Mean pre-post differences (Post-move value – pre-move value)							*T*-test results: Between group difference in pre-post changes (Insufficiently active – sufficiently active)
	All survey respondents (N=229)		All survey respondents (N=229)	Survey respondents moving to Mueller from Austin (N=167)						
	Pre-move Mean (SD[a])	Post-move Mean (SD)		Whole sample (N=167)	Subgroups by pre-move neighborhood's walkability[b]			Subgroups by pre-move physical activity		
					High (N=35)	Medium (N=72)	Low (N=42)	Insufficiently active[c] (N=116)	Sufficiently active (N=51)	
Physical activities										
Days/week with 30+ minutes of physical activities	3.6 (1.9)	4.3 (1.7)	0.7***	0.7***	0.0	0.8**	1.0***	1.3***	-0.8**	2.1***
Bicycling (minutes/week[d])	14.6 (35.9)	28.1 (57.7)	13.5***	16.0***	4.1	12.8**	28.0**	18.4***	10.3	8.1
Total walking (minutes/week)	99.2 (106.3)	139.5 (114.9)	40.4***	40.3***	22.3	39.9**	48.3**	54.1***	8.2	45.9*
Walking in community (minutes/week)	70.8 (89.9)	116.5 (105.1)	45.7***	42.2***	5.7	49.4***	57.1**	54.9***	12.7	42.3*
Traveling in private car (minutes/week)	263.5 (193.3)	179.3 (138.7)	-84.2***	-68.6***	-3.6	-65.9**	-83.3**	-87.4***	-28.0	-59.3*
Social interactions (days/month)										
Say hello to neighbors	10.3 (9.0)	19.8 (9.8)	9.6***	10.3***	8.7***	11.4***	10.0***	11.1***	8.3***	2.8
Stop and talk to neighbors	5.5 (7.0)	12.3 (9.2)	6.9***	7.8***	6.6***	8.5***	7.1***	8.0***	7.5***	0.5
Socialize with neighbors	1.9 (4.0)	4.5 (5.6)	2.6***	2.8***	3.1*	2.7***	3.1***	2.6***	3.2***	-0.6
Seek help from and exchange favor with neighbors	1.5 (2.6)	3.8 (5.0)	2.3***	2.6***	2.7*	2.8***	2.7***	2.8***	2.1**	0.7
Neighborhood cohesion[e]										
Neighbors can be counted to help in case of need.	3.0 (1.2)	4.3 (1.0)	1.3***	1.5***	1.3***	1.6***	1.6***	1.7***	1.2***	0.5*
This is a close-knit neighborhood.	2.4 (1.3)	4.2 (1.0)	1.8***	2.6***	1.5***	2.1***	4.4	2.1***	3.6	0.5

[a] SD: Standard deviation

[b] High walkability: Walk Score: 70–89; medium walkability: Walk Score: 50–69; low walkability: Walk Score: 25–49.

[c] Insufficiently active is defined as not meeting the public health guideline for adults to get at least 30 minutes/day of moderate physical activities on at least 5 days/week.

[d] 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.

[e] 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).

*** $p < 0.001$; **: $0.001 \leq p < 0.01$; *: $0.01 \leq p < 0.05$

Different locations of physical activities were examined for their percentages of use and the corresponding pre-post move differences (Figure 4). Neighborhood streets and sidewalks were the most popular places for physical activities in both pre-move neighborhoods and Mueller. Compared to the pre-move condition, percentages of Mueller residents using neighborhood streets and sidewalks, parks or trails/paths in a park, greenways/trails/paths not in a park, and homes for physical activities were higher by 14.8%, 39.8%, 33.2%, and 23.6% respectively. In contrast, the percentage of residents using gyms or fitness facilities was lower by 13.1%, likely because of the rich outdoor venues available in Mueller.

SOCIAL INTERACTIONS AND PERCEIVED NEIGHBORHOOD COHESION Results (Table 3) also showed significant increases in social interactions and neighborhood cohesion after the move. The respondents (N=229) "said hello to neighbors," "stopped and talked to neighbors," "socialized with neighbors in home or restaurant," and "asked for help from or exchanged favors with neighbors" on 10, 7, 3, and 2 more days per month, respectively. Similar increases of social interactions were observed among those residents who moved from Austin and all subgroups. Neighborhood cohesion was measured using a 5-point Likert scale, by asking the respondent how much he/she agreed or disagreed with each statement. For all valid respondents, their perceptions of being in "a close-knit neighborhood" and being able to count on neighbors for help in case of need were 1.8 and 1.3 points higher, respectively, on a 5-point scale. Referring back to focus group results, this change was likely facilitated by denser community environments with diverse everyday destinations within a walkable distance. Similar increases in neighborhood cohesion were observed among the sub-sample moving from Austin and all subgroups, with the exception that perception of a "close-knit neighborhood" did not show significant change among those from low-walkability neighborhoods and those who were previously sufficiently active.

CORRELATIONS BETWEEN INCREASES IN PHYSICAL ACTIVITIES AND IMPROVEMENT OF SOCIAL INTERACTIONS AND NEIGHBORHOOD COHESION The increase of walking in the community was significantly correlated with the improved ratings for being able to count on neighbors for help in case of need (correlation=0.214, $p<0.01$) and being in a "close-knit neighborhood" (correlation=0.209, $p<0.01$), and the increased frequency of "saying hello to neighbors" (correlation=0.284, $p<0.001$). This warrants the need for additional analyses on complex mechanisms for changes in physical activities, social interactions and neighborhood cohesion.

Conclusion and Next Step

This study has several limitations. First, current analyses did not address the possible self-selection bias—those who were interested in improving their physical and social activities intentionally chose to live in Mueller. Second, for the older or lower-income residents in Mueller, Internet access may not be as convenient and may prevent them from responding to the online survey. Third, the sample size for the reported analysis was relatively small and subject to non-response bias. Female and non-Hispanic populations and those who were more interested in this topic may be overrepresented. Fourth, the pre-move data were collected retrospectively and subject to possible recall errors. Further, the reported analysis was limited to bivariate tests and did not explore the impacts of multilevel factors on changes in the outcome variables. Additional data collection and analyses will address some of these limitations by collecting more survey responses, conducting more detailed measures for physical environments using geographic information systems (GIS), and testing a series of structural equation models to examine the hypothesized mechanisms about environmental intervention-behavior change relationships.

Meanwhile, despite these limitations, this study provided promising evidence about the potential impacts of walkable communities on improving people's physical and social activities. Increased walking in community was shown to be correlated with improved social interactions and neighborhood cohesion. Findings also showed significant reduction in residents' driving, suggesting important environmental benefits that walkable communities can bring by reducing fuel consumption and environmental pollution. These are important yet understudied topics with significant policy implications.

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