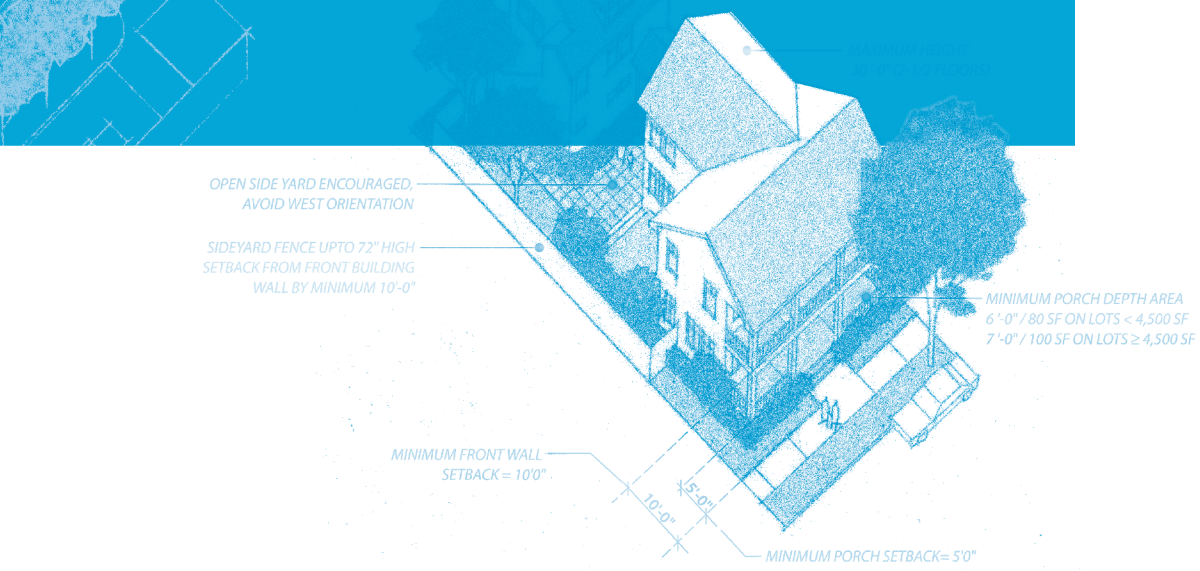
WALKABLE COMMUNITIES

Evaluating Impacts of a Walkable Community on Residents' Physical and Social Health

College of Architecture
Center for Health Systems & Design
Design Research for Active Living
Texas A&M University
College Station, Texas



Acknowledgment

This project was supported by the American Institute of Architects (AIA) and the Association of Collegiate Schools of Architecture (ACSA) through *Decade of Design,* a Clinton Global Initiative commitment. It was also made possible by additional funding from the Global Obesity Prevention Center at Johns Hopkins University, and the tremendous support from residents, developers, and designers of the Mueller Community in Austin, Texas.

PROJECT PERIOD: July 1, 2012–December 31, 2013

Project Team

Xuemei Zhu, Ph.D., Associate Professor
(Principal Investigator)

Zhipeng Lu, Ph.D., Lecturer
(Co-Principal Investigator)

Chanam Lee, Ph.D., Professor
(Co-Principal Investigator)

George Mann, Professor (Co-Principal Investigator)

Chia-Yuan Yu, Ph.D
(Graduate Research Assistant)

College of Architecture
Center for Health Systems & Design
Texas A&M University
3137 TAMU, College Station,
TX 77843-3137
Tel: (979) 845-7009
Fax: (979) 862-2735
Email: xuemeizhu@tamu.edu

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

NOTE: Some components of this report were first published by the International Academy for Design & Health in the July 2013 issue of *World Health Design,* Volume 6, Issue 3, pp 68–75. Updated results from this study, including additional analyses based on a larger sample, are published in Preventive Medicine and can be accessed at http://authors.elsevier.com/sd/article/S0091743514003041

cover image source: Catellus, 2004

Contents

“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.)

Executive Summary

Living in a "healthy community" is everyone's dream. However, today's communities have been increasingly designed around automobiles instead of pedestrians, which may compromise residents' physical and social health. In terms of physical health, a substantial body of evidence has shown that "walkable communities" with mixed land uses, higher density, connected street networks, rich physical activity resources, and pedestrian-friendly designs are associated with increased physical activities among residents.[1-4] Leaders in public health, urban planning, and architecture now share this belief, as evidenced by the City of New York's "Active Design Guidelines."[5] This is especially important in the context that the obesity epidemic has become one of the leading public health problems and that physical inactivity is a significant contributing factor.[6-9] On the other hand, limited studies suggested that walkable communities may promote social health by encouraging outdoor activities and social interactions among neighbors, which will in turn increase neighborhood cohesion.[10-14]

Meanwhile, growing trends in community development, such as New Urbanism, Smart Growth, and Transit Oriented Development, share walkability as a guiding principle for its benefits on not only health but also sustainability, economy, and equity. The nation's first rating system for green neighborhoods, Leadership in Energy and Environmental Design-Neighborhood Development (LEED-ND), also addresses walkability as a key principle in creating sustainable neighborhoods. In addition, recent market studies have shown growing acceptance and demands for walkable communities.[15-17] In practice, an increasing number of communities are targeting these potential health benefits through design. However, the actual health impacts of such design interventions are understudied. Walkable community projects may still face market resistance and regulatory barriers because such health benefits are not sufficiently considered in the traditional urban planning and land development process.[18,19] More confirmatory evidence is needed to support the growing number of local governments that recognize health and other benefits of walkable communities and to inform evidence-based interventions.[19-21]

Project Aims and Goals

This project addressed these knowledge gaps by (1) evaluating the impacts of moving into a walkable community—Mueller in Austin, Texas—on improving adult residents' physical activities, social interactions, and neighborhood cohesion; and (2) using relevant knowledge and evidence to inform two class projects on the design and planning of another mixed-use Austin community—Colony Park. Results from this project contribute to building stronger empirical evidence to support the development of walkable communities, which will in turn promote population-level behavior changes toward more physically active and socially integrated lifestyles.

Methods

This project was conducted between July 1, 2012, and December 31, 2013. It consisted of two components that corresponded to the two project aims.

COMPONENT 1 is a research project that examined (1) whether moving to Mueller increased residents' physical activities, social interactions, and perceived neighborhood cohesion; (2) if yes, how these behaviors changed in terms of types, frequencies, and locations, and what design characteristics contributed to such changes; and (3) whether populations at higher risk of obesity (those who were physically insufficiently active or lived in less-walkable neighborhoods) had significantly greater increases in their physical and social activities. A focus group and online surveys were conducted to collect information about Mueller residents' physical and social activities before and after the move, as well as other personal, social, and physical environmental factors that might have had an impact on these activities. Content analysis was used to analyze the qualitative data from the focus group. Quantitative data from the survey were analyzed using *t*-tests or analysis of variance to examine pre-post differences in residents' activities or differences in such changes across sub-groups.

COMPONENT 2 integrated research into teaching by using relevant knowledge to inform two class projects on the Colony Park community project. Supported by a $3 million grant from the Department of Housing and Urban Development, Colony Park is being developed by the city of Austin as a sustainable and livable mixed-use, mixed-income community. Undergraduate students from a landscape design studio produced a master plan toward these goals; graduate students from a seminar course proposed design guidelines for promoting physical and social health through the design and planning of the Colony Park community.

Results

COMPONENT 1 The research project showed a significant increase in residents' physical and social activities after the move. The percentage of adult residents meeting physical activity guidelines (i.e., being moderately active for at least 30 minutes/day on at least 5 days/week) increased from 34% to 49%; 51% reported better health conditions. Time spent on total walking, walking in the community, and bicycling increased by 40, 46, and 13 minutes/week, respectively. Time spent on walking in Mueller had a mean of 140 minutes/week. This accounts for 93% of the level of physical activities needed for adults to obtain significant health benefits as suggested by public health guidelines.[6] Meanwhile, time spent in a car was reduced by 84 minutes/week. Neighborhood streets, parks, greenways, walking and biking trails/paths, and homes were used more often for physical activities after the move. In terms of social health, residents "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/month, respectively. Their perceptions of being in a "close-knit neighborhood" and being able to count on neighbors for help were 1.8 and 1.3 points higher, respectively, on a 5-point scale. Sub-group comparisons showed that residents who were previously insufficiently active (or lived in less-walkable neighborhoods) had significantly more increases in their physical and social activities after the move, compared to their counterparts who were previously sufficiently active (or lived in more-walkable neighborhoods). Further, the increase of walking in the community was significantly correlated with the increase of social interactions and perceived neighborhood cohesion. Details of Component 1 are explained in this report.

COMPONENT 2 Class products from the undergraduate landscape design studio and the graduate seminar class were presented to the city's planning team for the Colony Park project and will be used as a reference for the master plan of the community. Products of these class projects are not included in this report.

Future Activities

This *Decade of Design* funded project, with a focus on adults, was conducted in parallel with another research project on Mueller, which focused on children and was funded by the Global Obesity Prevention Center at Johns Hopkins University. The latter was completed on June 30, 2014 and is not included in this report. Follow-up analyses will identify the specific environmental factors contributing to residents' changes in physical and social activities. The research team is also working on a research proposal for the National Institutes of Health, using the pilot data from this project, to further examine the long-term health impacts of the Mueller community in promoting physical activities.

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, which has been questioned and criticized for their impacts on residents' physical and social health.

In terms of *physical health,* a substantial body of evidence has shown that automobile-dependent communities with segregated land uses, low density, disconnected street networks, and insufficient pedestrian and bicyclist infrastructure are associated with reduced physical activities such as walking or exercise in outdoor spaces.[1-4, 22] In contrast, walkable communities with mixed land uses, higher density, connected street networks, rich physical activity resources, and pedestrian-friendly designs have been linked to increased physical activities in daily routines (Figures 1 and 2).[1-4]

This environment–physical activity relationship is especially important in the context that the obesity epidemic has become one of the leading public health problems

FIGURE 1. Comparison of walkable and automobile-dependent communities (Source: Zhu & Sallis, 2011[22])

An example of walkable community patterns, featuring high density, grid-like street systems with high connectivity, and mixed land uses.

An example of automobile-dependent community patterns, featuring low density, cul-de-sac street systems with low connectivity, and segregated land uses.

FIGURE 2. Comparison of walkable and automobile-dependent streets (Source: Zhu & Sallis, 2011[22])

Examples of walkable streets which accommodate pedestrians, bicyclists, transit, and cars.

Examples of automobile-dependent streets which accommodate cars yet discourage walking and bicycling.

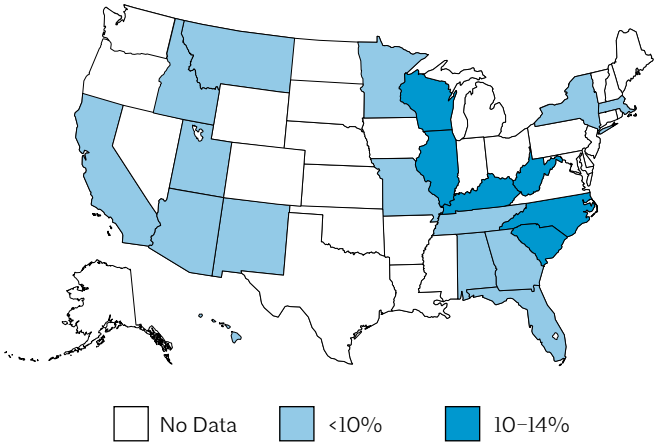
(Figure 3) and that physical inactivity is a significant contributing factor.[6-9] Traditional approaches of promoting physical activities focused on personal factors and have not been very successful.[23] Recent trends have shifted to a more comprehensive approach targeting a complex system of factors on personal, social, and built environmental levels.[23] This shift was built on the socioecological theory, which considers human behavior to be influenced by interactive factors on intrapersonal, interpersonal, institutional, community, and public policy levels.[24] Community environments, in particular, have been increasingly recognized as important intervention venues to promote sustainable population-level changes.

On the other hand, in terms of *social health,* automobile-centered communities tend to make everyday life dependent on automobiles and ignore the needs of pedestrians, reducing opportunities for social interactions. Limited studies suggest that walkable communities promote social health by encouraging walking and other outdoor activities, thereby facilitating social interactions among neighbors.[10-14] Specific environmental features identified in previous studies include 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] A U.S. study reported a greater sense of community in Kentlands—a prototypic New Urbanism community with walkable environmental features, compared to a suburban, automobile-oriented development.[12] Another U.S. study in Portland, Oregon, found that residents' sense of community was greater in a pedestrian-oriented neighborhood than in an auto-oriented counterpart, and the perception of pedestrian environment was the most significant predictor for sense of community.[10] Similar results were also found in Galway, Ireland.[14] However, some inconsistencies have been reported on the impacts of certain design features on the sense of community. For example, a study in Atlanta, Georgia reported a negative association between land-use mix and the sense of community.[25]

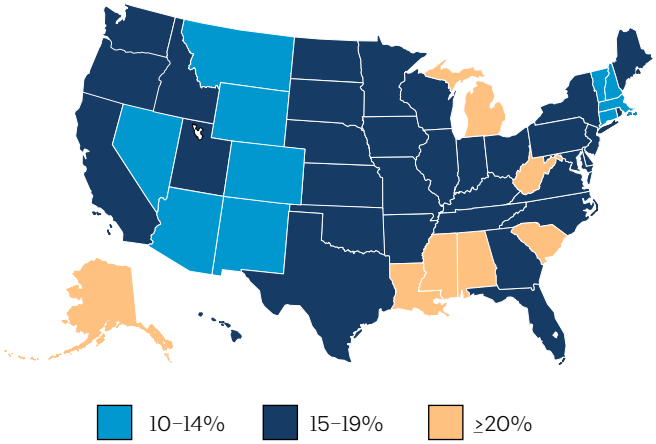
Meanwhile, growing trends in community development, such as New Urbanism, Smart Growth, and Transit Oriented Development, all advocate walkability as a guiding principle for its benefits on not only health but also sustainability, economy, and equity. In the U.S., the first rating system for green neighborhoods, Leadership in Energy and Environmental Design-Neighborhood Development (LEED-ND), also addresses walkability as a key principle in creating sustainable neighborhoods. The City of New York developed "Active Design Guidelines" for promoting physical activities through design.[5] Recent market studies have also shown growing acceptance and demands for walkable communities.[15-17]

In practice, an increasing number of communities are using "design" as a means to promote physical and social health. However, health impacts of such design interventions are understudied. Walkable community projects may still face market resistance and regulatory barriers because such health benefits are not sufficiently considered in the traditional urban planning and land development process.[18,19] More confirmatory evidence is needed to support the growing number of local governments that recognize health and other benefits of walkable communities and to inform evidence-based interventions.[19-21]

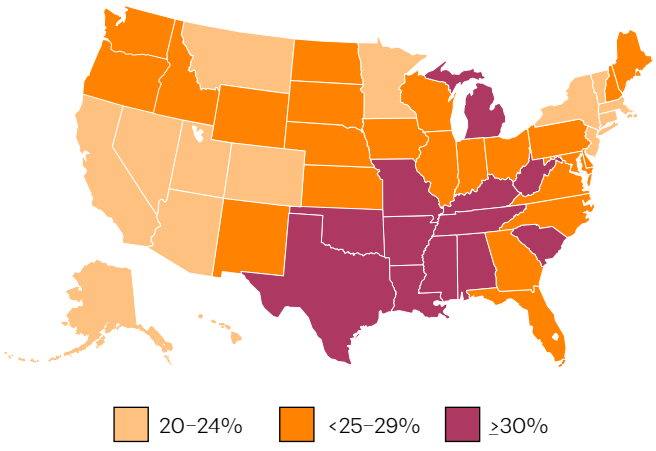
FIGURE 3. Increase of obesity rates among U.S. adults between 1986 and 2010 (Source: Behavioral Risk Factor Surveillance System, Centers for Disease Control and Prevention)



1986



1998



2010

Methods

This study addresses these gaps of knowledge by conducting a case study of the Mueller Community in Austin, Texas, U.S., to examine its impacts on adult residents' physical and social health. Mueller is a LEED-ND–certified, mixed-use community designed to support walking and other outdoor activities. Based on the literature, a conceptual framework (Figure 4) was developed for the hypothesized mechanisms of such impacts: (1) the increase in community walkability will promote residents' physical activities, social interactions, and perceived neighborhood cohesion both directly and indirectly (by improving relevant personal attitudes and social support—the mediators), and (2) the resulting increases in physical and social interactions and neighborhood cohesion will reinforce each other.

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

Study Setting

Mueller is the first exemplary project by the City of Austin to use a series of innovative policies to create a model for walkable, sustainable, and equitable communities. Developed on the former airport site (711 acres) near downtown, Mueller is planned to house 10,000 residents and 10,000 employees. It features many activity-friendly design strategies (Table 1), 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. It is also a mixed-income community with over 25% of the housing units being affordable and indistinguishably incorporated into the community with market-rate units.

FIGURE 4. Conceptual framework for the mechanisms through which environmental changes influence physical activities, social interactions, and perceived neighborhood cohesion

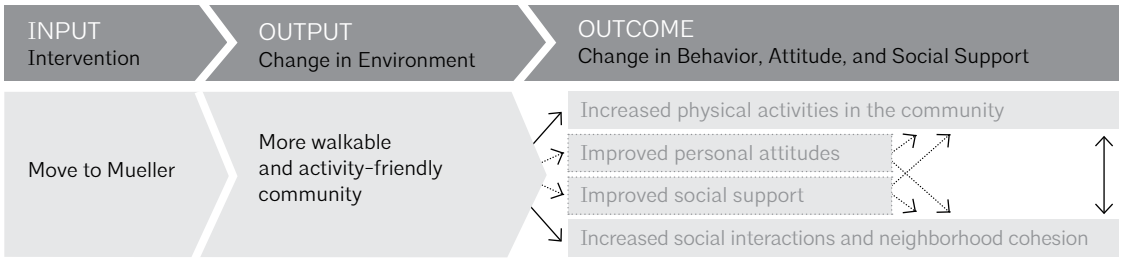


TABLE 1. Mueller's Activity-friendly Environmental Features Including Location, Neighborhood Pattern and Housing (Source of images: Catellus, 2004)

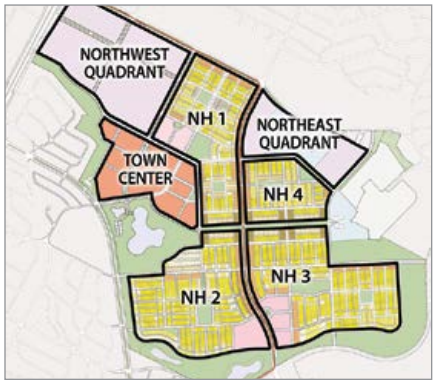
LOCATION: A central urban location with easy access to public transit and other urban amenities.

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

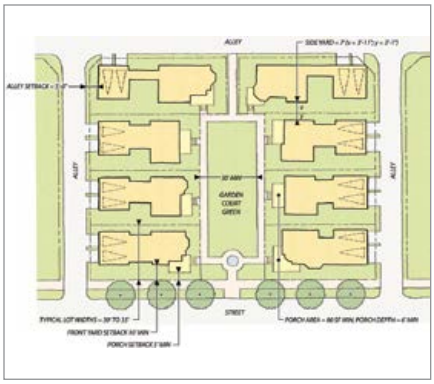
Streets: Grid-like, hierarchical, and connected systems with complete sidewalks, buffers between sidewalks and streets, traffic calming, and good maintenance, visual quality, and surveillance



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 communities in 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.[15]

[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.[16] 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.[26]

Table 2 illustrates Mueller's environmental and sociodemographic characteristics, compared to those of the City of Austin. Although the physical environment in Mueller represents a departure from typical community developments in the city, Mueller's population is representative of the city population. This makes Mueller an especially unique research opportunity to study the impact of environmental changes on residents' activities. As of 2013 when this study was conducted, Mueller had approximately 40% of its property developed, with about 3,500 employees and about 900 single-family households.

Data Collection and Analysis

This study, with a focus on adults, was conducted parallel with another study, with a focus on children, that was funded by the Global Obesity Prevention Center at Johns Hopkins University and concluded on June 30, 2014. Data collection efforts for these two projects were combined for improved efficiency, and used mixed methods, including focus groups and online surveys. In this report for the *Decade of Design* funded project, only those completed research activities, completed as of January 2014 including one focus group (N = 13) and the online survey (N = 229 as of January 2014), and corresponding results are reported. Additional data collection for the project supported by the Johns Hopkins University was completed in June 2014. Additional analyses are currently being conducted.

The focus group was conducted first to obtain information about Mueller residents' physical activities, social interactions, and perceptions of neighborhood cohesion before and after moving to Mueller and to gain in-depth understanding about reasons that led to changes in these behaviors and perceptions. Results from this focus group were also used to guide the development of the survey instrument. Thirteen participants for the focus group were recruited at a Mueller Neighborhood Association meeting. The participants first discussed a series of topics raised by the moderator, including reasons for moving to Mueller and comparisons of community environments and their behaviors before and after the move. After the discussion, the participants were given a map of Mueller to identify destinations they went to for physical and social activities and places that caused concerns. Content analysis was used to analyze results from this focus group.

The online survey was designed for one adult from each household to answer questions about himself/herself and the oldest child in the household, if there was one. It asked about the respondent's physical activities, social interactions, and perceived neighborhood cohesion (i.e., the outcome variables) and the child's physical activities (which were collected for the project funded by the Johns Hopkins university and not included in this report), as well as personal, social, and built environmental factors that might have influenced these outcomes, before and after moving to Mueller. Most of the survey items were retrieved from previously validated questionnaires, including the International Physical Activity Questionnaire, the Twin Cities Walking Survey, and the Active Where Survey.[27-29] Several new questions were added based on the focus group results. Pilot tests (N = 6) were conducted for the draft survey instrument, and led to a few minor revisions for a better clarity and logic flow. The finalized survey took 20 to 30 minutes to complete.

Survey participants were recruited using online messages posted on the Mueller Community online forum (N unknown) and mail invitations sent to a stratified random sample of residents (N = 532) that was selected to be spatially representative of the community. For the online recruitment, two reminder messages were posted on the online forum 1 and 2 weeks after the initial invitation, respectively. For mailed survey invitations, a reminder mail was sent 1.5 months after the initial invitation.

After the survey results were collected, valid and complete surveys were included in the analyses 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 outcome and mediator variables. Pearson correlation matrix was examined to see if there was any significant correlation between changes in physical activities and changes in social interactions and perceived neighborhood cohesion.

For residents moving to Mueller from places other than Austin, the changes in the larger context (the city) and likely their job as well might have a significant impact on their lifestyle changes. Therefore, additional analyses were limited to Mueller residents who lived in other Austin neighborhoods before the move (N = 167) for a better understanding of the impact of neighborhood environmental changes on their activities. Sub-group analyses were conducted to examine whether populations who were previously insufficiently active (or lived in less-walkable neighborhoods) had more changes in their activities than their more active counterparts (or counterparts who lived in more-walkable neighborhoods before the move). First, the pre-post move differences in physical and social activities for each sub-group were tested using *t*-tests. Second, the between-group differences in changes of physical and social activities were tested using analysis of variance (for 3-group comparisons) or *t*-tests (for 2-group comparisons).

The walkability for residents' pre-move neighborhoods were measured using the Walk Score, which is publicly available online.[30] This score captures certain important aspects of neighborhood walkability (e.g., density of retail destinations, recreational open space, street intersection, and residential land uses) and in previous studies has been shown to be an effective measure related to walking.[31-33] This project categorized residents' pre-move neighborhoods into 5 levels of walkability based on their Walk Score categories: including (1) very low (score = 0–24, car-dependent with almost all errands requiring a car); (2) low (score = 25–49, car-dependent with most errands requiring a car); (3) medium (score = 50–69, somewhat walkable and some errands can be accomplished on foot); (4) high (score = 70–89, very walkable and most errands can be accomplished on foot); and (5) very high (score = 90–100, walkers' paradise with daily errands not requiring a car).[30]

Results

Focus Group Results

Thirteen subjects (eight women and five men) participated in the focus group session in March 2013. Three participants were over 65 years of age; two were in the 50–64 age group; seven were in the 30–49 age group; and one was in the 20–29 range. In terms of ethnicity, there were one African American, one Asian, and eleven White participants. Two participants had young children living with them. Residents' durations of living in Mueller ranged from 1 month to 4 years. Content analysis showed increases in residents' physical activities, social interactions, and perceived neighborhood cohesions after they moved to Mueller, as well as roles of some environmental factors in facilitating such changes.

PHYSICAL ACTIVITIES The majority of the participants had increased physical activities after moving to Mueller. They 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, among many others (Figure 6).

Several participants reported walking more since moving to Mueller, and one older woman mentioned walking 2 or 3 times more after the move. These walking trips had diverse destinations, including 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 to travel to work, with much shorter commute distances after the move and some carpooling with neighbors. Two participants reported a "no driving in Mueller" rule in their household, and another participant reported a yearly saving of about $1,200 in gasoline for vehicles after moving to Mueller. Most of the residents were looking forward to the opening of HEB (a chain supermarket) in Mueller and planned to do grocery shopping without driving. In addition, the back alleys (see the upper right photo in Figure 6) were highlighted as 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 ACTIVITIES AND PERCEIVED NEIGHBORHOOD COHESION Participants also reported increased social interactions and perceived neighborhood cohesion due to changes in community environments. Communal facilities such as community mailboxes were reported by several participants as popular places for social interactions. One resident's parents liked to go to the mailbox every day and often came back with stories about new friends they made and news in and around the community. A woman enjoyed the location of her house being close to mailboxes, because that was how she got to know her neighbors. Several participants reported that smaller backyards encouraged them to use front porches and community outdoor spaces more often, and therefore have more opportunities to interact with

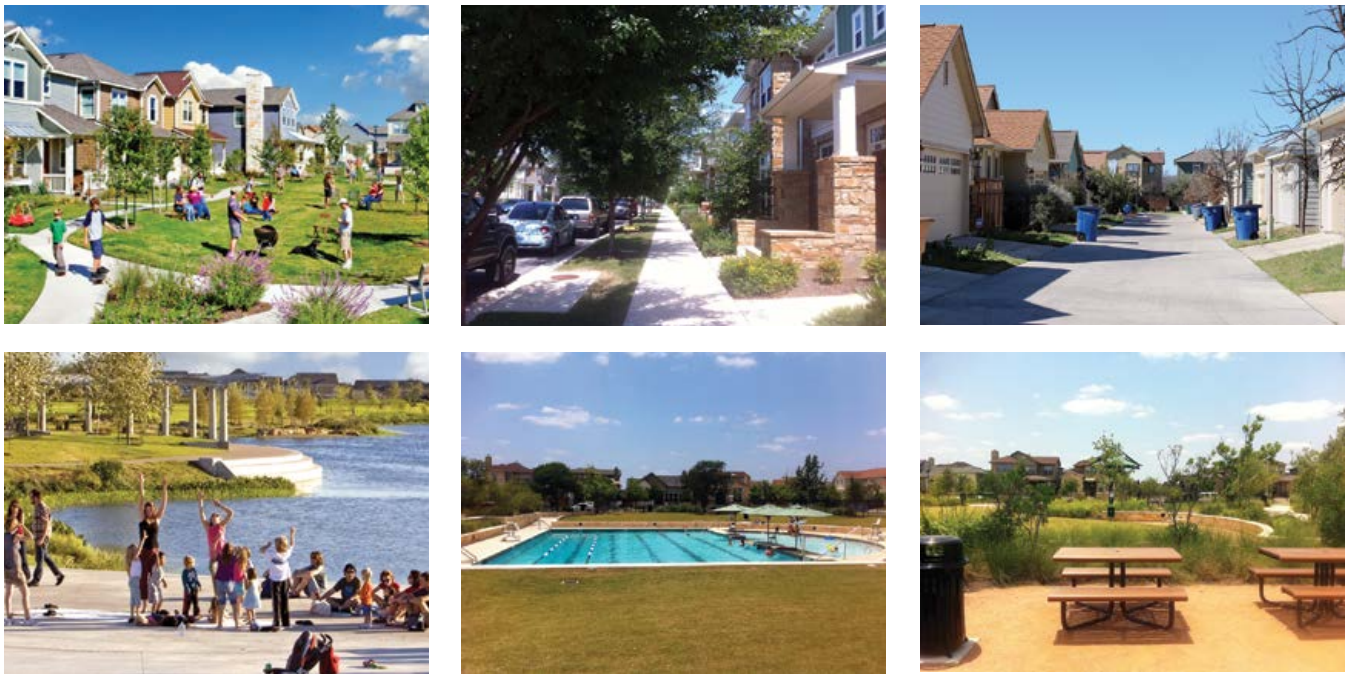


FIGURE 6. Focus group participants reported environmental features supportive of physical and social activities (e.g., sidewalks, parks and open space, bike routes, diverse destinations, communal facilities, front porches, back alleys) (Source of images: Tom McConnell Photography [left]; Xuemei Zhu [others])

neighbors. Back alleys also played an important role, as they had become semi-public areas for diverse social activities such as residents' block parties and children's play. The discussions revealed that Mueller had become a close-knit community even with the current, 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, which helped to build a safer community.

MAP OF ACTIVITIES AND CONCERNS Eleven participants used the provided maps and color stickers to identify their homes, most-liked places for physical activities, and places of concerns. Popular places for physical activities included parks, trails, walking paths, waterfront, swimming pool, restaurants, bank, 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 mixed opinions. Commonly mentioned places of concerns were mostly related to traffic safety issues (Figure 7). Participants identified places that needed safer walking paths and crosswalks (especially for children), more traffic lights, and better speed control and visibility for drivers. A resident was concerned about traffic safety

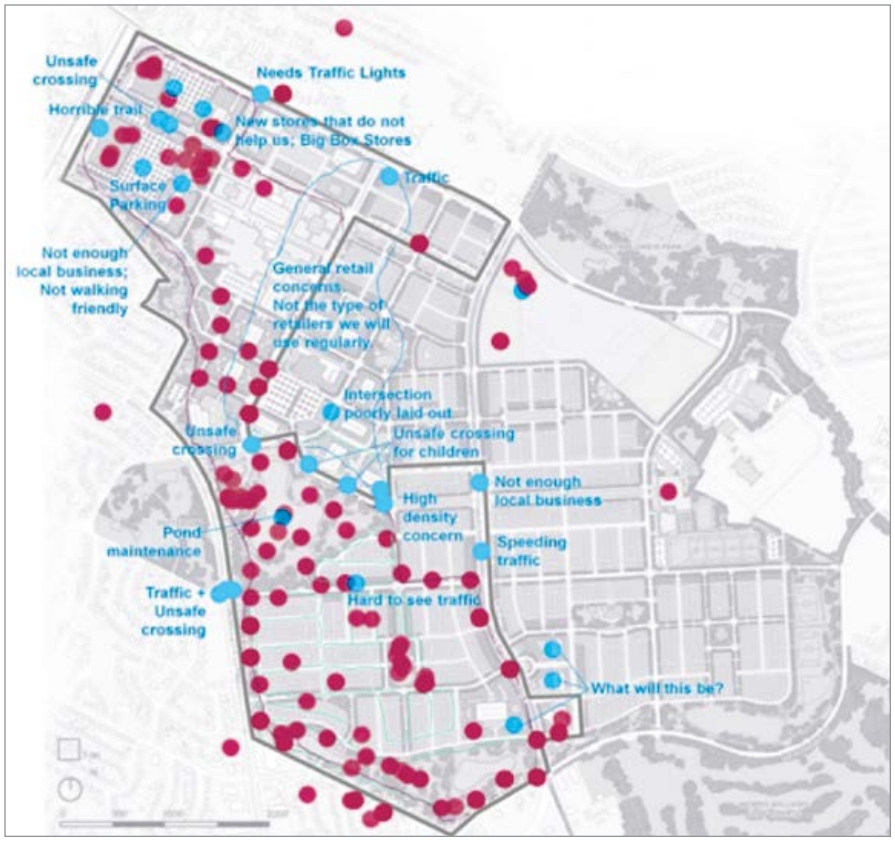


FIGURE 7. Despite the overall positive comments about the community, focus group results also revealed places of concerns

in the large surface parking area for the retail district. One mentioned that big-box retails might not be the type of business they needed in Mueller. Another resident thought the community park, Lake Park, should be better maintained.

Survey Results

A total of 229 valid responses were collected from the online survey 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. In terms of the level of education, 5%, 7%, 30%, 48%, 2%, 5%, and 1% of the respondents had a doctoral degree, professional degree, master's degree, bachelor's degree, associate's degree, some college education, and high school diploma/GED, respectively. The level of household income is diverse, with 8%, 13%, 29%, 9%, 12%, 20%, 8%, and 1% reporting an income of $200K or more, $150–199K, $100–149K, $80–99K, $60–79K, $40–59K, $20–39K, and less than $20K, respectively. Compared to the 2010 Census information for Mueller, female and non-Hispanic populations were somewhat overrepresented in this study sample.

Among 229 valid survey respondents, 167 moved to Mueller from other Austin neighborhoods, including 15, 35, 72, 42, and 3 residents from neighborhoods with a very low, low, medium, high, and very high level of walkability, respectively. Since the sample sizes for the "very low" and "very high" categories were small, we excluded them from the analysis. Three other categories (low-, medium-, and high-walkability) were included for the sub-group analyses based on pre-move neighborhood's walk score. In addition, among these 167 residents, 51 were physically sufficiently active (meeting the public health guideline of being moderately sufficiently active for at least 30 minutes/day on at least 5 days/week) before the move and 116 were not. Corresponding sub-group analyses were conducted.

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 suvey 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] Inactive 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).

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

Descriptive Statistics and *T*-Test Results

PHYSICAL ACTIVITIES Among the total of 229 residents, the percentage of adult residents meeting physical activity guidelines increased from 34% to 49% after the move. Meanwhile, 69% reported higher levels of physical activities and 51% perceived their health conditions to be better. Descriptive statistics and *t*-test results about specific types of physical and social activities before and after the move are listed in Table 3. Among 229 valid respondents, 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 ($p < 0.001$). It is worth noting that the time spent on walking per week after moving to Mueller 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 adults 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.[6]

Among 167 respondents who moved to Mueller from other Austin neighborhoods, very similar patterns were observed for increases in all types of physical activities and reduction in time spent in a private car (Table 3). Meanwhile, sub-group comparisons revealed some between group differences. For sub-groups with different levels of pre-move neighborhood walkability, those who moved from high-walkability neighborhoods did not show significant increases in their physical activities after the move, while those from medium- and low-walkability neighborhoods showed significant increases (Table 3). Results from analysis of variance showed that residents from low-walkability neighborhoods had significantly more post-move 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 in terms of increases for specific types of physical activities (i.e., walking, bicycling) across sub-groups based on pre-move neighborhood walkability.

For sub-group comparison based on pre-move physical activity, the previously insufficiently active sub-group had significant increases in not only total activities (days/week with 30+ minutes of physical activities), but also in 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. Additional *t*-tests were conducted to examine if there were significant differences in pre-post changes in physical activities between previously insufficiently active and sufficiently active sub-groups (Table 3). Compared to their active counterparts, those who were previously insufficiently active had 46 and 42 more minutes of increases in total minutes of total walking and walking in the neighborhood, respectively ($p < 0.5$).

Different locations of physical activities were examined for their percentages of use and the corresponding pre-post move differences (Figure 9). Neighborhood streets and sidewalks were the most popular places for physical activities in both pre-move neighborhoods and Mueller. About 76.4% of Mueller residents used them for physical activities. 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, homes, natural green spaces or places near water features, and shopping centers or malls for physical activities were higher by 14.8%, 39.8%, 30.2%, 23.6%, 7.4%, and 2.2%, respectively. In contrast, the percentage of residents using gyms or fitness facilities for physical activities were lower by 13.1%, likely because of the rich outdoor venues that were freely available in Mueller.

SOCIAL INTERACTIONS AND PERCEIVED NEIGHBORHOOD COHESION Results (Table 3) also showed that social interactions and perceived neighborhood cohesion increased significantly after the participants moved to Mueller. For all valid respondents (N = 229), they "said

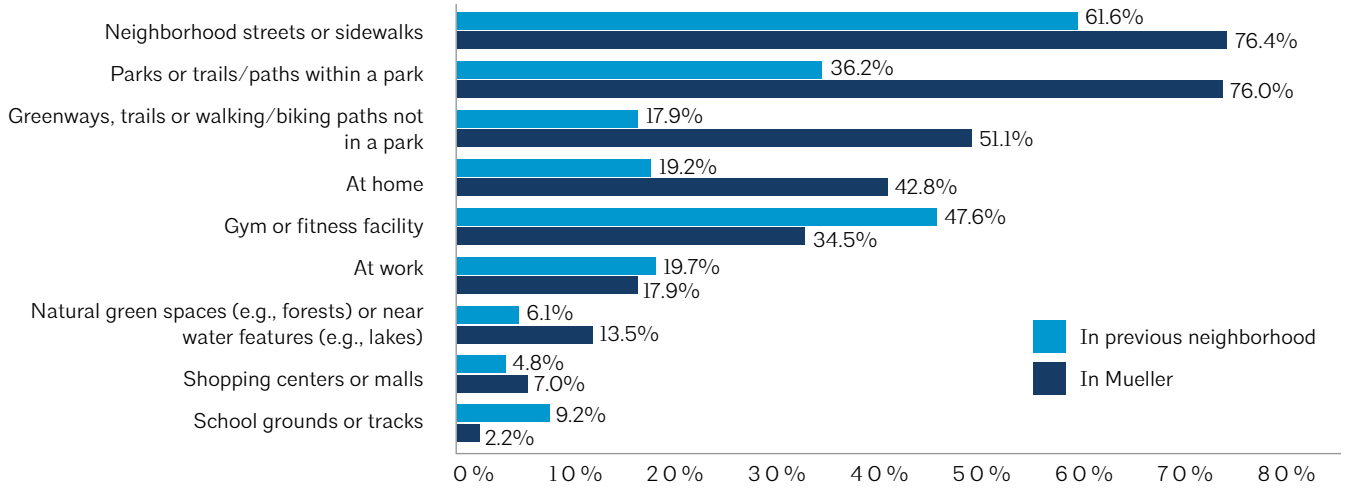


FIGURE 8. Percentages of respondents reporting using certain locations for physical activities

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/month, respectively. Similar increases of social interactions were also observed among those residents who lived in Austin before the move, as well as all subgroups. There was no significant between group differences in increases of social interactions.

Perceived neighborhood cohesion was measured using 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). 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, it is likely that this change was facilitated by denser community environments with diverse everyday destinations (e.g., parks, trails and greenways, grouped mail boxes) within a walkable distance. Similar increases of perceived neighborhood cohesion were also observed among those residents who lived in Austin before the move, as well as all subgroups, with the exception that perception of being in a "close-knit neighborhood" did not show significant change among the subgroup from low-walkability neighborhood, and the previously sufficiently active subgroups.

CORRELATIONS BETWEEN INCREASES IN PHYSICAL ACTIVITIES AND IMPROVEMENT OF SOCIAL INTERACTIONS AND NEIGHBORHOOD COHESION The increase in walking in community was significantly correlated with the improved ratings for being able to count on neighbors for help in case of need (correlation = 0.214, $p < 0.01$), the improved ratings for 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 further warrants the needs for additional analyses to explore specific and complex mechanisms for changes in physical activities and social interactions and neighborhood cohesion.

Conclusion and Next Step

This study has several limitations. First, 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. Second, the sample size for the reported analysis was relatively small and subject to non-response bias (e.g., female and non-Hispanic populations being overrepresented; residents who were more interested in this topic being more likely to respond to the survey). Third, the pre-move data were collected retrospectively and were limited to possible recall errors. Further, the analysis reported in this report was limited to bivariate tests and did not explore the impacts of multilevel factors on changes in physical activities, social interactions, and perceived neighborhood cohesion. As explained earlier, additional data collection and analyses will address some of these limitations.

Meanwhile, despite these limitations, this study contributed important knowledge about the actual health impacts of moving to a walkable community on residents' physical and social health. This is an important yet understudied area with significant policy implications. The results from this study provided promising evidence that residents did improve their physical activities, social interactions, and perceived neighborhood cohesion after moving to more walkable environments in Mueller. Increased walking in community was correlated with improved social interactions and neighborhood cohesion. Findings also showed significant reductions in driving among residents, suggesting important environmental benefits that walkable communities can bring by reducing fuel consumption and environmental pollution.

These findings also provided preliminary results that will guide future research in this community. In addition to collecting more survey responses, a GIS analysis will also be conducted to analyze survey respondents' previous and current living environments. A series of structural equation models will be conducted to test the hypothesized mechanisms about how environmental changes influence physical activities, social interactions, and perceived neighborhood cohesion, while also considering impacts of personal and social factors. They will examine not only the direct impacts of this environmental intervention (moving to Mueller), but also its indirect impacts through improving relevant personal attitudes and social support. The mutual influence between increases in physical activities and changes in social interactions and neighborhood cohesion will also be examined. Results from these models will help us better understand the impacts of specific design strategies.

References

1. Saelens BE, Handy SL. Built environment correlates of walking: a review. *Med Sci Sports Exerc.* Jul 2008;40(7 Suppl):S550-566.
2. Durand CP, Andalib M, Dunton GF, Wolch J, Pentz MA. A systematic review of built environment factors related to physical activity and obesity risk: implications for smart growth urban planning. *Obes Rev.* May 2011;12(5):e173-182.
3. Humpel N, Owen N, Leslie E. Environmental factors associated with adults' participation in physical activity: a review. *Am J Prev Med.* Apr 2002;22(3):188-199.
4. Dannenberg A, Frumkin H, Jackson R. *Making Healthy Places: Designing and Building for Health, Well-being, and Sustainability.* Washington, DC: Island Press; 2011.
5. New York City Department of Design + Construction. Active design guidelines. http://www.nyc.gov/html/ddc/html/design/active_design.shtml. Accessed June 15, 2013.
6. U.S. Department of Health and Human Services. *Physical Activity Guidelines for Americans.* Washington, DC: U.S. Department of Health and Human Services; 2008.
7. Centers for Disease Control and Prevention. *State Indicator Report on Physical Activity, 2010.* Atlanta, GA: U.S. Department of Health and Human Services; 2010.
8. Ding D, Gebel K. Built environment, physical activity, and obesity: What have we learned from reviewing the literature? *Health & Place.* 2012;18(1):100-105.
9. World Health Organization. Obesity and overweight. 2013; http://www.who.int/mediacentre/factsheets/fs311/en/. Accessed June 15, 2013.
10. Lund H. Pedestrian environments and sense of community. *J Plan Educ Res.* Spr 2002;21(3):301-312.
11. Nasar JL, Julian DA. The Psychological Sense of Community in the Neighborhood. *J Am Plann Assoc.* Spr 1995;61(2):178-184.
12. Kim J, Kaplan R. Physical and psychological factors in sense of community—New urbanist Kentlands and nearby orchard village. *Environ Behav.* May 2004;36(3):313-340.
13. Kuo FE, Sullivan WC, Coley RL, Brunson L. Fertile ground for community: Inner-city neighborhood common spaces. *Am J Commun Psychol.* Dec 1998;26(6):823-851.
14. Leyden K. Social capital and the built environment: the importance of walkable neighbourhoods. *American Journal of Public Health,* 2003;93(9):1546–1551.
15. Sobel LS, Anderson W, Shipman J. Market Acceptance of Smart Growth: U.S. Environmental Protection Agency; 2011.
16. Handy SL, Sallis JF, Weber D, Maibach E, Hollander M. Is support for traditionally designed communities growing? Evidence from two national surveys. *Journal of American Planning Association.* 2008;74(2):209-221.
17. Levine J, Inam A. The Market for Transportation-land Use Integration: Do Developers Want Smarter Growth than Regulations Allow? *Transportation.* 2004;31(4):409-427.
18. Nelson K, Doll A, Schroeer W, et al. *Essential smart growth fixes for urban and suburban zoning codes.* Washington, DC: U.S. Environmental Protection Agency;2009.
19. U.S. Green Building Council. Local Governments & LEED for Neighborhood Development. 2011; http://www.usgbc.org/DisplayPage.aspx?CMSPageID=2471. Accessed July 21, 2011.
20. American Planning Association. *Comprehensive planning for public health: results of the Planning and Community Health Research Center Survey.* Planning & Community Health Research Center, American Planning Association;2011.
21. Bogaerts M. Manager, Neighborhood Development, U.S. Green Building Council. Email communication ed2011.
22. Zhu X, Sallis J. Designing for healthy communities: Active living, healthy eating, and comprehensive community development. *Journal of the Institute for Comprehensive Community Development.* 2011;2(2):9-20.
23. Sallis JF, Cervero RB, Ascher W, Henderson KA, Kraft MK, Kerr J. An ecological approach to creating active living communities. *Annual Review of Public Health.* 2006;27:297-322.
24. McLeroy KR, Bibeau D, Steckler A, Glanz K. An ecological perspective on health promotion programs. *Health education quarterly.* Winter 1988;15(4):351-377.

25. Wood L, Frank LD, Giles-Corti B. Sense of community and its relationship with walking and neighborhood design. *Soc Sci Med.* May 2010;70(9):1381-1390.

26. American Fact Finder. 2011. http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml. Accessed July 21, 2011.

27. Forsyth A, Oakes JM, Schmitz KH. Test-retest reliability of the Twin Cities Walking Survey. *J Phys Act Health.* Jan 2009;6(1):119-131.

28. Bassett DR, Jr. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc.* Aug 2003;35(8):1396.

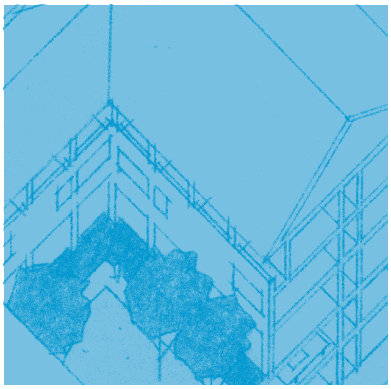
29. Durant N, Kerr J, Harris SK, Saelens BE, Norman GJ, Sallis JF. Environmental and safety barriers to youth physical activity in neighborhood parks and streets: reliability and validity. *Pediatr Exerc Sci.* Feb 2009;21(1):86-99.

30. WalkScore.com. Walkability, Real Estate and Public Health Data. 2014; http://www.walkscore.com/professional/research.php. Accessed January 15, 2014.

31. Carr LJ, Dunsiger SI, Marcus BH. Validation of Walk Score for estimating access to walkable amenities. *British Journal of Sports Medicine.* 2011;45(14):1144-1148.

32. Brown SC, Pantin H, Lombard J, et al. Walk Score®: Associations with Purposive Walking in Recent Cuban Immigrants. *American journal of preventive medicine.* 2013;45(2):202-206.

33. Hirsch JA, Diez Roux AV, Moore KA, Evenson KR, Rodriguez DA. Change in Walking and Body Mass Index Following Residential Relocation: The Multi-Ethnic Study of Atherosclerosis. *Am J Public Health.* 2014:e1-e8.



THE AMERICAN INSTITUTE
OF ARCHITECTS

Association of Collegiate
Schools of Architecture
www.acsa-arch.org

TEXAS A&M
UNIVERSITY

1735 New York Avenue, NW
Washington, DC 20006-5292
www.aia.org