Inequalities in Social and Physical Contexts of Older Adults' Activity Spaces: Early Results from the CHART Study

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Abstract
A large literature points to the role of neighborhood conditions in the production of health disparities, but less is known about the relevance of other spaces of daily life. We draw on new data from the first wave of the *Chicago Health and Activity Space in Real Time (CHART)* study to describe older adults' activity spaces, or the locations of routine activities of daily life. In the study, 450 community-residing older adults from ten Chicago neighborhoods carried smartphones for GPS tracking and ecological momentary assessments (EMAs) over seven days. We use GPS and EMA data to assess how the span, characteristics, and experiences of activity spaces vary across socioeconomic status and racial/ethnic groups. We conclude by discussing how activity spaces -- and their potential downstream effects on health -- may be an underexplored source of inequalities in older adults' health and well-being.

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Theoretical advances in urban sociology have contributed to our understanding of neighborhood context and its impact on health and well-being. Attention to mechanisms linking neighborhood conditions to health has led scholars to reach beyond structural indicators of context (e.g., poverty) to consider features that emerge from social engagement (e.g., cohesion, trust) and the processes that link structural resources to outcomes. The ability to disentangle nested influences is fostered by analytic techniques that allow for multiple levels of analysis. However, ambiguities in the operationalization of neighborhoods have led to calls for more precise information on where residents spend their time – both inside and outside the residential neighborhood – and the relevance of non-residential areas for health and well-being (Cagney, Browning, Jackson, and Soller 2013; York Cornwell and Cagney 2017; Cagney and York Cornwell 2018).

We can extend our focus beyond individuals' residential neighborhoods by considering their *activity spaces*. Activity spaces are defined by locations of routine activities in everyday life (Golledge and Stimson 1997). Activity spaces may include individuals' residential neighborhoods, but they may also encompass areas beyond the residential neighborhood where older adults access services, organizations, and amenities, as well as places where they seek social contact and participate in social activities (Cagney, et al. 2013).

Physical and social conditions of activity spaces may be particularly important for older adults. Later life is often marked by social and physiological changes such as retirement, bereavement, and the development of functional impairments. These shape access to resources and social engagement, and render older adults especially vulnerable to – and dependent upon – characteristics of their social environments (Cagney & York Cornwell 2010; Robert & Li 2001). For example, physical features of everyday environments shape the feasibility of daily activities for older adults with limited mobility (Mendes de Leon, et al. 2009). At the same time, social network losses due to retirement or widowhood increase the importance of social integration through community-based institutions (e.g., senior centers) or informal social interactions.

Research on aging often assumes that later life, along with the advent of health problems and functional limitations, contributes to a shrinking of individuals' circumference of turf. However, an alternative possibility is that retirement may bring greater flexibility in structuring daily life. And, older adults may have unique opportunities and interest in moving beyond their residential areas to access services, organizations, and amenities, and to take part in social groups and activities (Cagney, Browning, Jackson, and Soller 2013). Examining older adults' movements—in, out of, and across their communities—will provide insight into their span of engagement, the contexts most relevant for their health and well-being, and their access to social and community resources.

Variation in activity spaces of older adults may shed new light on mechanisms of inequality in later life health and well-being. For example, those who have a greater span of mobility in their activity spaces have the potential to access more resources and find more varied opportunities for social participation. Those who stay close to home may have their needs met in the proximal space -- or they may be confined and socially isolated. Examining variation in patterns of

mobility, and adjudicating how they contribute to inequalities in health and well-being, is a key contribution of an activity space approach.

The characteristics of places that older adults visit may also be consequential. Recent research using survey-generated activity spaces from the Los Angeles Family and Neighborhood Study (LAFANS) finds that exposure to socioeconomic disadvantage outside of one's residential area is associated with worse self-rated health (Sharp, Denney, and Kimbro 2015) and may condition the relationship between residential neighborhood conditions and adult health (Inagami et al. 2007). However, little is known about how the span and characteristics of activity spaces vary across older adults.

Therefore, initial research questions for this paper include:

1. How does the span of activity spaces vary across older adults, particularly across levels of socioeconomic status (i.e., educational attainment, income) and across racial/ethnic groups?
2. How do characteristics, such as localized socioeconomic disadvantage and social cohesion, vary across older adults' socioeconomic status and racial/ethnic background?

Prior work suggests that social support and collective efficacy based in the residential neighborhood may be critical factors for trajectories of health and well-being among community-residing older adults (e.g., Cagney and York Cornwell 2010). Neighborhood social cohesion enables diffusion of health-relevant information and increases residents' sense of purpose (Kawachi and Berkman 2000). It has also been associated with fewer depressive symptoms among middle aged and older adults (Echeverría et al., 2008; Kim 2010).

Less is known about how older adults perceive or respond to the social contexts of non-residential spaces that they visit during their daily routines. An important possibility is that exposure to localized disadvantage and social disorganization can elicit real-time fluctuations in affect, perceived stress, and symptomology. Research on residential neighborhoods suggests that exposure to disadvantage and disorder leads, over time, to heightened vigilance, generalized distrust of others, fear, and stress (Perkins and Taylor 1996; Ross et al. 2001) -- and it may also increase the risk of psychological distress and depression (Kim 2010). In this paper, we examine variation in real-time reports of negative and positive affect as older adults go about their daily activities. Specifically, we ask:

3. Do real-time reports of negative and positive affect, while older adults move through their activity spaces, vary across socioeconomic status and racial/ethnic groups?

We also consider whether variations in negative and positive affect are mediated by particular characteristics of activity spaces, the presence of others, or individuals' activities in the moment.

This paper draws from unique data collected in the first of three waves of the Chicago Health and Aging in Real Time (CHART) study. The CHART study employs smartphone-based methods for observation of the characteristics of older adults' activity spaces, including geolocation of daily activities over a 7-day period and real-time respondent reports of a sample of these locations using ecological momentary assessment (EMA). The five daily EMAs are distributed on a randomized schedule, with the aim of capturing a representative sample of the indoor and outdoor, private and public spaces where respondents spend their time. The EMAs include questions asking older adults to describe the physical and social features of the location where they receive each EMA, as well as a number of aspects of positive and negative affect.

Data and Methods

The full-scale CHART Study will enroll 450 community-residing older adults, age 65 and over, sampled from ten Chicago neighborhoods (see Figure 1). Neighborhoods were purposively chosen to maximize racial/ethnic and socioeconomic variation within the sample and in respondents' residential areas. Respondents were selected via population-based sampling within each neighborhood. Following the first wave of data collection, activity space and EMA data will be collected in two more waves of data collection (seven days each) over a period of 18 months.

We currently have 376 completed cases and anticipate the full Wave 1 data collection effort to be completed within the next month. The study begins with a baseline in-person questionnaire, followed by one week of smartphone-based observation of respondents' activity spaces. Data collection for the first wave of the CHART study includes four components: 1) an in-person questionnaire which captures respondents' social network roster, social support, household composition, sociodemographic characteristics, physical health, and mental health (with the use of Item Response Theory (IRT) to assess depression and anxiety – see Table 1); 2) biomeasure data collection (blood spots, height, weight) during the in-person interview; 3) activity space assessment through smartphone-based GPS tracking for seven days; and 4) EMAs (five per day for seven days using the smartphone) assessing respondents' locations and their experience of physical symptoms and mental and emotional well-being.

Figure 2 illustrates the contribution of each data collection mode to the assessment of different levels of variation over this period. The inclusion of EMA and GPS tracking allows us to examine short-term variation and individual-level, daily fluctuation in older adults' physical health, emotional well-being, social connectedness, and interaction with the built environment.

Below we describe the data that we will use to examine each of the three research questions we outlined above.

Geographic Span of Activity Spaces

CHART is using the MetricWire app, installed on Android phones (Samsung Galaxy S7) carried by respondents for near-continuous location tracking with a geofenced radius of 20 meters. In effect, when a respondent travels beyond 20 meters from his or her prior location, the app records the new location. We chose to set the geofenced radius at 20 meters to limit the amount of data being collected while the respondent is moving around his or her home or other stable locations such as work, and to minimize battery drain.

Figure 4 shows sample results from passive tracking of a resident of one of Chicago's South Side neighborhoods over the course of several days, showing both the area covered and the paths taken (apparently from home to work). Note that the yellow and green circles include multiple geofenced data points, with the actual number provided inside the circle, while the larger blue circles represent an estimate of the accuracy of each location data point. This ability to see the full set of respondent "destinations" as well as the "paths taken" to each destination allows us to define an activity space as either the area covered or the distances traveled as the respondent goes about his or her week (Hirsch et al., 2014).

To address our first research question, we will use demographic characteristics collected on the baseline survey coupled with the GPS data. We will use the GPS data to calculate several measures of the geographic span of older adults' activity spaces such as the standard deviation ellipse and total path area. We will examine how these vary across respondents, with attention to differences across socioeconomic status and racial/ethnic groups. As Figure 1 indicates our

sample, by design, is characterized by variation in race/ethnicity and socioeconomic status at the neighborhood-level.

Physical and Social Characteristics of Activity Spaces

Ecological momentary assessments (EMAs), administered via the smartphones, ask respondents to report on the physical and social characteristics of the location where they were when the EMA was requested. Figure 3 shows a sample smartphone screen displaying an EMA item. Table 2 provides frequency distributions for several relevant EMA items, based on the initial 376 respondents.

To address our second research question – how physical and social characteristics of activity spaces vary across respondents – we will utilize demographic measures from the baseline data as well as the following EMA measures:

Localized disorder. Respondents are asked to indicate whether they observed any of a number of features of disorder, including broken windows, vacant buildings, trash or litter, graffiti, lack of cleanliness, crowded spaces, strong or unpleasant odor, noise, people hanging out, drug or alcohol use, and police using excessive force.

Localized social cohesion. Respondents who were not at home at the time of the EMA were asked to indicate their level of agreement with the following statements: 1) "This place felt close-knit;" 2) "This felt like a trustworthy place;" 3) "If I needed help in this place, someone would come to my aid;" 4) "I felt like people were watching what's happening around this place;" and 5) "If a fight broke out and someone was being beaten or threatened, people in this place would do something."

Localized social composition and activities. Respondents will also be asked to indicate whether they observed the presence of people of different ages, people of different races or ethnicities, people nodding and smiling, people helping each other, homeless people or panhandlers, and racial or ethnic tension.

Real-Time Positive and Negative Affect

Finally, to address our third research question, we will draw from reports of positive and negative affect on EMAs collected when respondents are away from home. To capture aspects of positive affect, respondents were asked whether they felt (at the time of the EMA ping): happy, safe, content, or energetic. To capture aspects of negative affect, they were asked whether they felt tired, stressed, lonely, or irritable. We will devote attention to whether the frequency of real-time reports of positive and negative affect vary across socioeconomic status and racial/ethnic groups and whether such variations are correlated with particular types of locations or types of activities.

Results

We will present results from the first wave of data collection. We will have data on our entire sample of 450 respondents over the one-week period, with continuous GPS data over the full week and approximately 5,700 EMA observations across all respondents (based on the current EMA response rate).

Discussion

To our knowledge, these will be the first results of this kind to examine the physical and social characteristics of activity spaces of urban, community-residing older adults. Socioeconomic status and race/ethnicity may be associated with the span of space older adults inhabit, and the spaces themselves may influence affect, with potential downstream effects on physical and emotional well-being.

We will conclude by considering strengths and weaknesses of our data, and highlight the unique potential to augment activity space data with other urban sensing projects, which provide opportunities to glean additional information about the characteristics of activity spaces. For example, the NSF-funded *Array of Things* (AoT) project has placed over 100 nodes throughout the City of Chicago which currently collect information on the social and physical environment (e.g., wind, rain, carbon monoxide, carbon dioxide, sound), as well as street activity and the use of public spaces via photographs analyzed in-situ. Smartphone-based activity space and EMA data, combined with the AoT data, will give us a fuller picture of the communities where older adults live, as well as the spaces that they visit and traverse in daily life.

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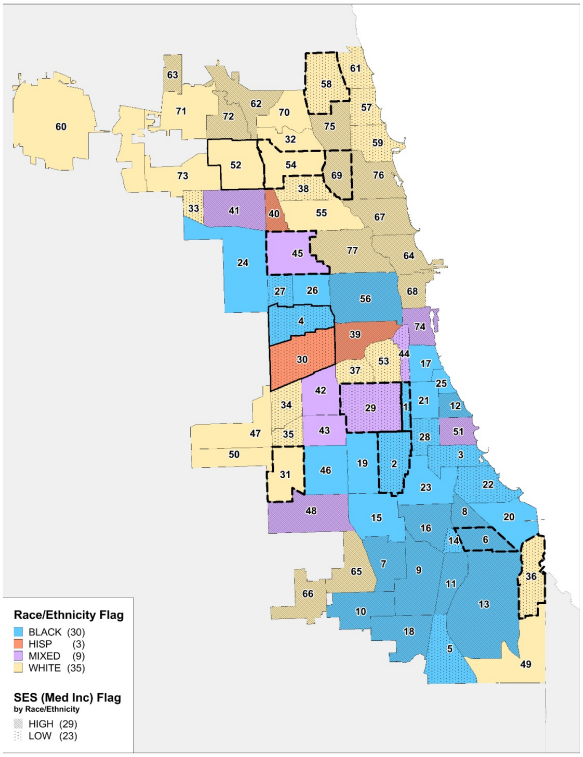
Figure 1. Chicago Neighborhoods Sampled for the CHART Study

Chicago Neighborhoods Selected



KEY: 1 = FULLER PARK; 2 = ENGLEWOOD; 6 = CALUMET HEIGHTS; 29 = NEW CITY; 36 = EAST SIDE; 39 = LOWER WEST SIDE; 45 = HUMBOLDT PARK; 54 = IRVING PARK; 58 = WEST RIDGE; 69 = NORTH CENTER

Neighborhood	Completed Cases
CALUMET HEIGHTS	47
EAST SIDE	26
ENGLEWOOD	40
FULLER PARK	50
HUMBOLDT PARK	30
IRVING PARK	26
LOWER WEST SIDE	37
NEW CITY	49
NORTH CENTER	36
WEST RIDGE	24
TOTAL	**365**

Figure 2. CHART Study Components

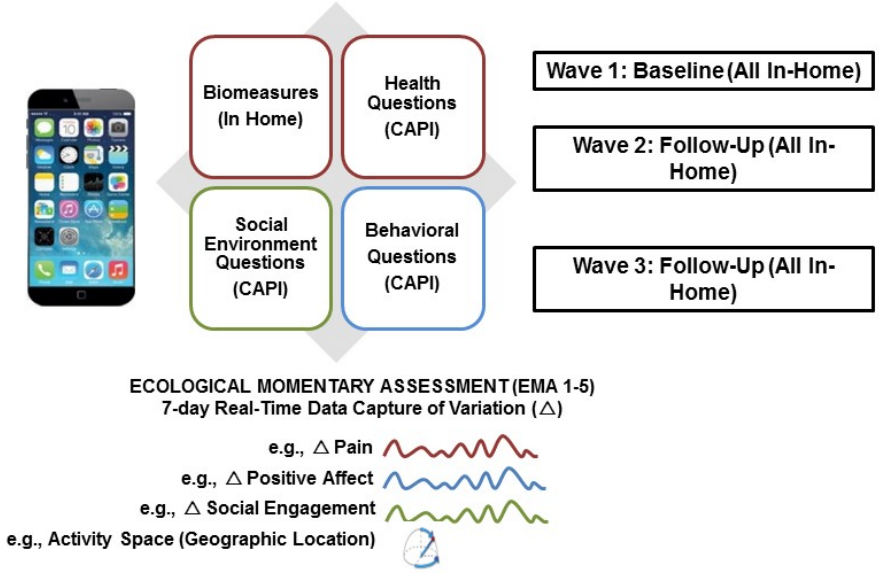


Figure 3. Sample Screenshot from EMA Administered on Smartphone

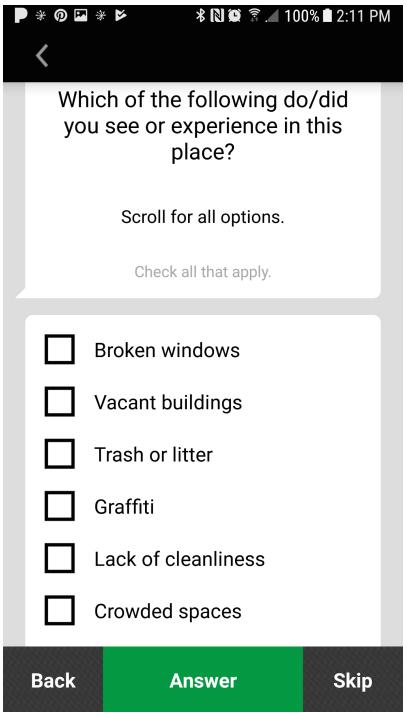


Figure 4. Passive Location Tracking for a Resident of Chicago's South Side

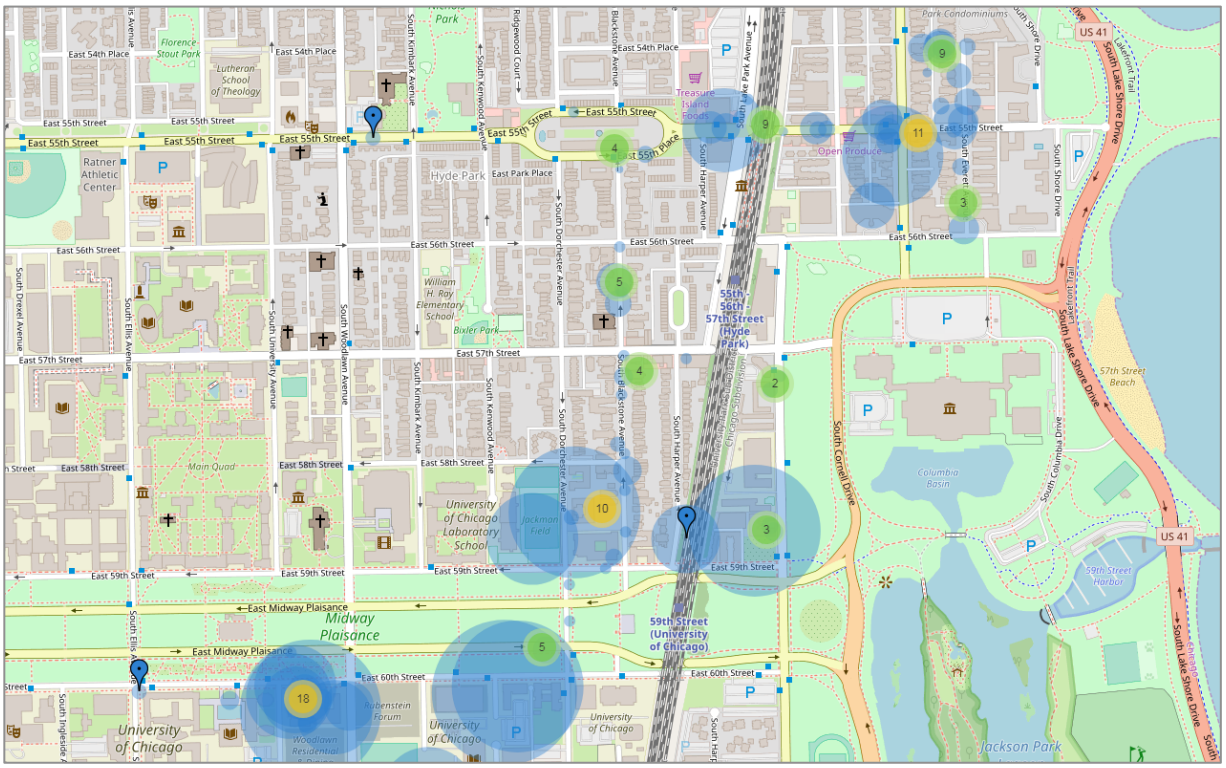


Table 1. Summary of Baseline Questionnaire Domains

Questionnaire Domains
Neighborhood Context
Neighborhood social ties and interaction
Perceptions of neighborhood physical/social environment
Norms and collective efficacy
Transportation access
Household Context
Household roster
Perceptions of household physical and social environment
Household order/disorder
Social Context
Social network roster
Social support
Social involvement and activities
Physical Health
Self-rated health and morbidity
Functional health and disablement (including mobility and assistive devices)
Health-related behaviors
Health care utilization
Well-being
Depression
Anxiety
Loneliness
Sociodemographic Characteristics
Age
Gender
Race/Ethnicity
Foreign-born status
Education
Income & employment status

Table 2. Descriptive Statistics for Selected EMA Items (n = 376 respondents)

	Percent	N
Current Location		
At home	73.00	3,493
At someone else's home	4.16	199
At work	3.76	180
In transit	6.62	317
Walking	2.24	107
Someplace else	10.22	489
Location Type		
Indoors	81.98	3,922
Outdoors	18.02	862
Who are you with?		
Nobody	44.60	2,139
1 person	47.60	2,280
2 people	6.90	331
3 or more people	0.85	41
This felt like a trustworthy place. (When R in a public place)		
Strongly agree	34.66	374
Agree	46.71	504
Neither agree nor disagree	16.96	183
Disagree	1.20	13
Strongly disagree	1.00	5
Do you feel safe?		
Not at all	1.19	57
Slightly	3.18	152
Moderately	13.51	645
Very	82.11	3,919
Do you feel happy?		
Not at all	3.12	147
Slightly	11.15	526
Moderately	42.91	2,024
Very	42.82	2,020
Do you feel stressed?		
Not at all	75.90	3,616
Slightly	17.34	826
Moderately	5.18	247
Very	1.57	75
Do you feel tired?		
Not at all	52.02	2,483
Slightly	13.71	1,401
Moderately	14.58	696
Very	4.04	193