Locating Ambulatory Medical Care Facilities for the Elderly

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The importance of effective planning strategies for the location of primary medical services for the independently living elderly increases as their absolute number and proportion in the general population increases. Current spatial planning strategies focus on providing services in centralized locations or decentralized at the level of the somewhat problematic residential "neighborhood" or catchment area. An alternative or supplemental strategy based on the actual use of community space by the elderly is presented in this article. Aggregate activity spaces are identified and illustrated using activity location data obtained for a sample of elderly urban residents. Subsequently, the aggregate spaces are used as a basis for suggesting the location of ambulatory care facilities. It is believed that the aggregate activity space represents a dynamic and more functional approach to spatial planning strategies than current approaches and, therefore, that it can be used more effectively to locate services for the elderly.

In the United States the importance of health planning for the elderly increases apace with the relatively rapid expansion in their already large number and the accompanying upward spiral in costs of providing care for them. Within the next 15 years, the total number of elderly, those aged 65 years and over, is expected to exceed 32 million or 20 percent of the total population [1,2]. It is important to remember, however, that of this large and growing number, only an estimated 25 percent will ever receive care in an institutional setting and only 5 percent reside in institutions at any given time [3]. Also important is the fact that an estimated 80 percent of the elderly suffer from chronic disease conditions requiring relatively frequent and continuous medical care [4,2]. These conditions result in an average of five physician

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visits per year for the elderly compared with three visits per year for those persons under age 65 [5,2]. This increased need for and use of ambulatory medical care services among older people is, unfortunately, commonly accompanied by decreased mobility due to physical limitations, reduced income, and problems coping with an often complex and rigid public transportation environment [6–8]. An important contribution to the ability of the noninstitutionalized elderly to maintain a high-quality and independent lifestyle would appear to be the provision of accessible ambulatory medical care services. Presented here is an approach to planning the physical location of these services for the elderly, which we consider to be a viable alternative to existing spatial planning strategies.

The method proposed here involves determining individual and aggregate activity or "life spaces" of the elderly. As such, it requires identification of what might be termed the "dynamic" neighborhood of the elderly based on manifest travel rather than the traditional, elusive, and perhaps illusive "static" neighborhood based on some ill-defined relationship between residence and geographic and social proximity. The activity-space approach is based on determining the general spatial interaction patterns of the elderly as manifest in their demonstrated and existing capacities for movement to activity sites within the community. It emphasizes locating ambulatory medical care services and facilities within the area(s) of the community regularly visited and traversed by older persons.

This approach contrasts with the spatial planning strategies generally currently employed in planning medical care for the elderly—home-based services, central facility–based services, and institution-based services [9]. Each of these strategies is clearly tied to the home location or residential distribution of the target elderly population. Of course, delivery of medical care to homebound elderly, while relatively expensive, is necessary and important in many instances. And, in residences and institutions for the elderly, provision of medical services at the residential site provides for effective and efficient coverage when properly administrated. When medical services are provided at "centralized" facilities, however, the distribution of service sites is frequently based on minimizing the average distance of the facility from residences of the elderly [10–12], even though this location may be completely unfamiliar to many among the target population. The activity-space approach proposed and demonstrated in this article would seem to be appropriate for any elderly person who is not homebound or institutionalized, and the approach is considered particularly

appropriate for use in planning the delivery of services in large urban areas.

This article presents the concept of the activity space and its relevance as the basis for an alternative strategy of ambulatory medical care facility location for the noninstitutionalized elderly. In addition, one methodology for analyzing individual and community activity spaces is demonstrated for a sample of older persons residing in the city of Flint, Michigan. Finally, the health planning implications of the specific activity-space analysis are discussed as well as the possible generalizations and alternative methodologies.

MOBILITY AND THE ACTIVITY SPACE

The issue of mobility, long dormant, has emerged within the past decade or so as one of the major concerns of research and planning for the elderly [6]. A substantial body of literature now exists, for example, identifying the elderly as "transportation disadvantaged." Despite increased information on trip frequency, travel distances, travel modes, travel times, and differences in mobility patterns in different environments, we do not yet have adequate information on the actual spatial and temporal patterns of environmental use by the elderly, that is, their activity spaces.

Generally defined, an individual's activity space is comprised of the set of locations regularly visited in the course of conducting the business of daily living, and paths to and from these locations. The activity space, thus characterized, includes: (1) a home base; (2) other locations visited on a frequent and regular basis such as grocery stores, shopping centers, religious and recreational facilities, the homes of friends and relatives, and so forth; and (3) the paths connecting the home base and activity sites or one activity site with another.

The notion that the older person's activity space is potentially important to understanding the aging process itself was suggested as early as 1970 [13]. Specifically related to the provision and use of medical care services, it has been suggested that the activity space may function in effect as a "territory," reflecting on the part of an individual or group a relatively efficient spatial organization of resources and their use. In addition, frequent contact with a set of locations imparts to the individual or group advantages derived from a sense of familiarity and attachment. The possible disadvantages of such territorial behavior derive from the possibility of its reducing "exploratory"

behavior and, perhaps, use of opportunities situated beyond the area of familiar locations [14].

While various aspects of older persons' travel behavior and mobility patterns have been explored [15–17], to date there has been no systematic collection of travel data appropriate and sufficient to permit the construction, interpretation, and possible use of derived activity spaces for medical services planning. One attempt to examine the activity spaces of population groups within a large urban community relative to their medical-care spaces has been conducted [18], but the sample was limited to families with small children. This study did demonstrate, however, that a wide range of activity spaces may exist among members of a small, racially and socioeconomically homogeneous subcommunity.

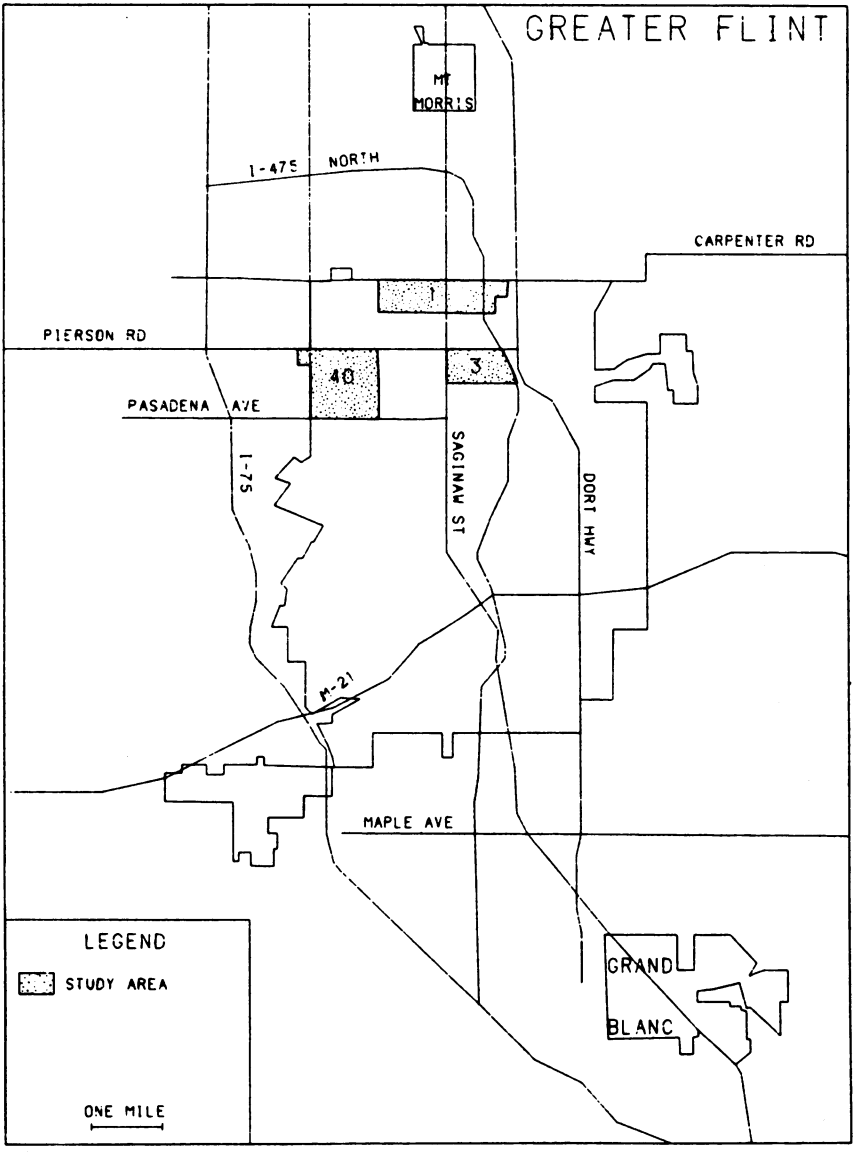
That use of the activity space has merit as a basis for medical services planning also derives indirectly from some observations made in studies of the use and barriers to use of mental health clinics and the development of catchment areas for these clinics in large urban areas. In a study of a New York City mental health clinic, for example, the appropriateness and effectiveness of "official" areas assigned to each community mental health clinic were called into question [19]. It was suggested that there might be, in fact, "natural" catchment areas more appropriate for locations of the centers and, further, that the present catchment area boundaries should be reconsidered in this light. In another study it was determined that some patients were reluctant to attend mental health clinics because of their reluctance to travel through "hostile" or "strange" territory [20]. The activity-space approach proposed here would seem to satisfy the observed need to create "natural" catchment areas which would incorporate the concern of individuals for avoiding hostile or strange territories while, at the same time, capitalizing on the positive aspects of locating clinics in areas familiar to the target populations in order to increase utilization.

STUDY AREA AND SURVEY

Data used here derive from a household survey conducted during the summer of 1982 among an areally stratified random sample of individuals 60 years of age or older residing in three census tracts in northern Flint (Figure 1). A total of 131 interviews were completed, representing approximately 10 percent of the elderly households in the study area [21].

Three major types of data were collected through personal inter-

Figure 1: Greater Flint, Michigan Elderly Activity Study Areas



views. First, basic sociodemographic information was obtained. Second, a set of questions was directed specifically toward obtaining information regarding respondents' activities, including the frequency of use, mode of travel, and travel time to as well as location of activity sites. Finally, a number of questions were designed to elicit information pertaining to respondents' health status, attitudes, and patterns of health care utilization; among these questions were those directed toward identifying the locations of physicians, dentists, hospitals, and pharmacies used by the respondents.

METHODOLOGY

Identification of sufficiently large groups of elderly respondents traveling in distinctive subareas of the larger urban environment was basic to the premise that the activity space is a viable spatial strategy for planning medical care facility location. This necessitated developing a multistage procedure to analyze the reported travel and related activity-space data. The first stage involved the determination and mapping of each respondent's activity space. A measure of pairwise comparison for determining the similarity of individual activity spaces was then developed and applied to the total set of activity spaces. The resulting similarity values were used to group respondents on the basis of the spatial congruence of these manifest life spaces. Finally, the "aggregate" or community activity spaces of the respondents were constructed and their characteristics assessed for their pertinence to locating medical care services for the sample population.

INDIVIDUAL ACTIVITY SPACES

From the range of activities for which use and locational information was collected, those activities and associated sites especially relevant to medical care delivery were determined. This necessitated eliminating some activity sites from consideration. For example, the workplace was excluded because only six of the respondents were employed. Locations of visits with friends and relatives were determined to be inappropriate since a high proportion of these visits occurred in the respondents' homes. Moreover, the residential nature of the areas in which such visits occurred, for all practical purposes, precluded the location of medical care facilities in these areas. Given the goal of identifying potential sites for the older population in the aggregate, the activity

sites deemed most appropriate and therefore selected for inclusion in activity-space construction were the locations within the Flint metropolitan area reported for grocery and other types of shopping, voluntary association meetings, and places of recreation and entertainment.

A final criterion was applied in the selection of activity locations to be included. If the activity spaces were to represent places frequently visited by the sample population, it was decided that destinations to be considered must be visited a minimum of once a month by a respondent. Deleting the infrequently visited destinations reduced the total number of reported destinations by 18 percent (Table 1).

The addresses of activity destinations for each respondent were assigned an x,y coordinate pair from a grid overlay on a large-scale street map of Flint. Subsequently, the coordinate locations for each respondent's destinations were converted to cell locations based on dividing the Flint urban area into one-quarter-mile grid cells. Separate plots of grid cell locations visited by each respondent thus represented their individual activity spaces. In this method of operationalizing the activity-space concept, paths were generally disregarded. In part, this decision was based on the almost inordinate variability in individual travel paths for both single and multipurpose trips and by varying travel modes reflecting interaction at different scales within the environment. The activity nodes visited by respondents rather than the paths linking the nodes with the activity space were believed to be the most important consideration here.

Table 1: Number of Reported Destinations for Four Selected Activities by Frequency

	Number of Reported Destinations										
Frequency	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*Total*
Daily	0	0	2	0	1	3	0	0	0	0	6
Several times/week	0	1	9	9	9	9	7	3	1	0	48
Weekly	0	3	13	19	24	29	16	3	1	5	113
Several times/month	0	2	15	16	14	5	5	0	1	0	58
Monthly	0	1	14	15	29	33	4	0	1	3	100
Less than once/month*	0	3	15	15	21	14	2	1	3	1	75
Not ascertained	0	21	0	4	2	2	2	0	1	0	13
Total destinations	0	12	68	78	100	95	36	7	8	9	413
Destinations included in analysis	0	9	53	63	79	81	34	6	5	8	338

*Eliminated from analysis as noted in text.

ASSESSING ACTIVITY SPACE SIMILARITY

Groups of older persons traveling to the same activity sites within Flint were identified by first evaluating the similarity in the destination patterns for respondent pairs through applying a variation of Cole's Index of Association [22]:

$$I - 2ab/(a + b) \quad (1)$$

where: I = similarity index value.
a = total number of grid cells traveled to by respondent A.
b = total number of grid cells traveled to by respondent B.
ab = total number of grid cells traveled to by both A and B.

The values derived for the similarity index (I) vary linearly from 0.0 to 1.0 when a and b are constant as the number of common destinations increases. High index values identify respondent pairs using similar activity locations within the urban space. The calculated similarity values for each respondent pair were recorded in a symmetric matrix for similarities.

GROUPING ACTIVITY SPACES

Based on the derived matrix of similarities, nonmetric multidimensional scaling (MDS) was used to "map" individuals by converting the "distances" between similarities—that is, the dissimilarities—in the matrix into explicit distances [23]. Subsequently, a hierarchical grouping procedure was used to group individuals based on their locations in the MDS output [24,25].

To facilitate interpretation of the MDS output, respondents whose activity spaces exhibited no similarity with any other activity space, including those who were homebound, were eliminated and similarities data converted to dissimilarities data by subtracting each of the remaining matrix cell values from 1.0 [26]. Based on a conventional analysis of stress (goodness-of-fit) values associated with MDS solutions of varying dimensionality, a plot of scaled observations in two dimensions were selected for further analysis [27].

AGGREGATE ACTIVITY SPACES

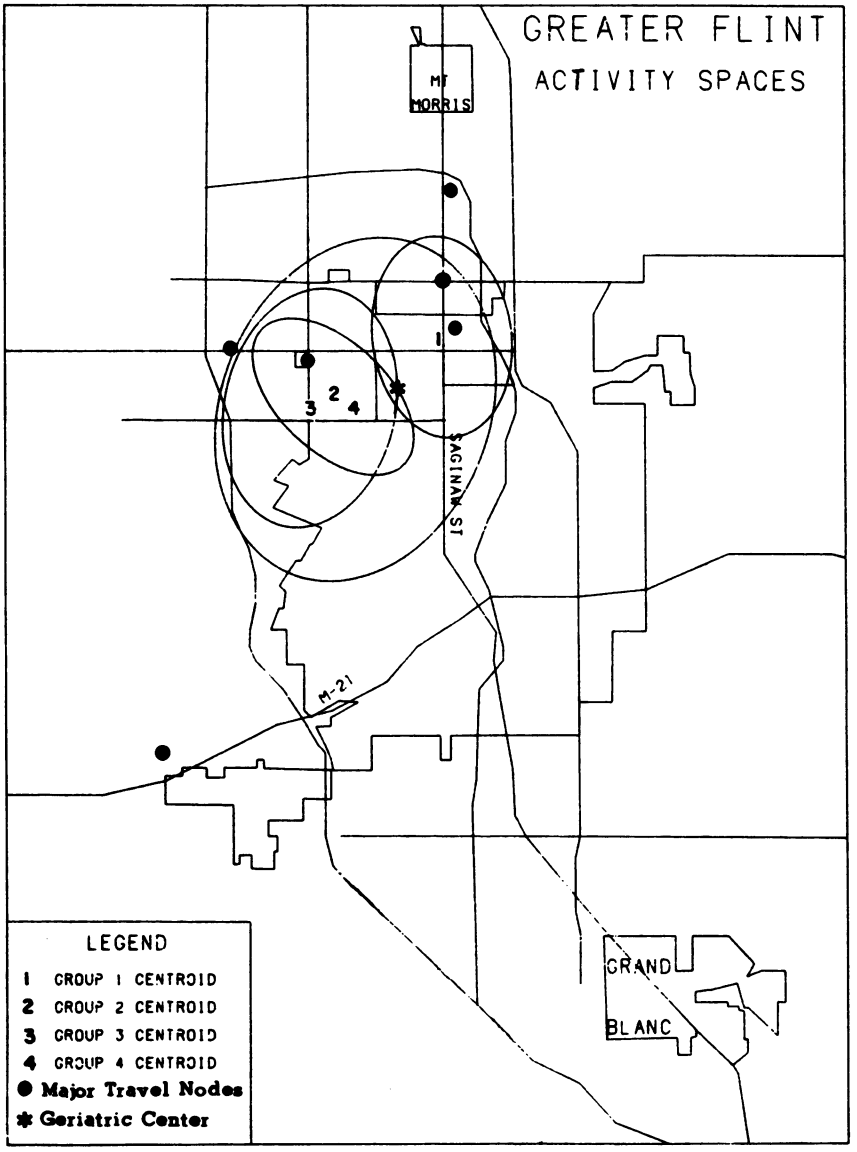
Analysis of individual activity spaces indicated that the total sample of respondents could be divided into five groups: those having activity spaces with no similarity to any of the others, including eight homebound individuals plus four respondents who had unique travel patterns; and four larger groups of respondents exhibiting distinct aggregate travel patterns. It is important to note here that travel of the four groups, while geographically diverse in terms of the total locations visited, was focused on six major activity nodes (Figure 2) and 80 percent of the respondents reported traveling to at least one of them. With the exception of the large regional shopping center in southwest Flint, the travel "nodes" were located in the northwest section of the city.

The spatial characteristics of each group's aggregate activity space was summarized by means of the standard deviational ellipse (SDE), a two-dimensional centrographic measure [28,29]. The SDE provides information on the spatial extent of the distribution of activity locations, the directional orientation or "trend" of the distribution as determined by the inclination of the major axis away from the horizontal, and the central tendency of the activity locations reflected in the mean center value or location of the centroid for each distribution of locations. Additionally, the sizes of the activity spaces were measured by the number of reported grid cell destinations. These values are presented in Table 2 and the SDE for each group is illustrated in Figure 2.

Table 2: Characteristics of Standard Deviational Ellipses

Characteristic	*Group 1*	*Group 2*	*Group 3*	*Group 4*
Centroid location	x = 633 y = 1,148	x = 474 y = 1,063	x = 440 y = 1,047	x = 507 y = 1,046
Angle of orientation (degrees of counterclockwise rotation of major axis from horizontal)	98 degrees	138 degrees	76 degrees	67 degrees
Standard deviation in x and y (length of axes)	x = 101 y = 144	x = 141 y = 79	x = 124 y = 172	x = 195 y = 251
Number of grid cell locations	*N* = 41	*N* = 8	*N* = 37	*N* = 39
Number of respondents	44	18	26	31

Figure 2: Greater Flint, Michigan Activity Spaces of the Study Group Elderly



Group 1 members traveled to activities located in a total of 41 different cells. The distribution of the cells was principally in a north-south direction along Saginaw Street, as indicated by the almost 98-degree inclination of the major axis of the SDE (Table 2). Of the total cells visited, about 75 percent of the group traveled to three activity nodes comprised of a shopping center, a grocery store, and an intersection of Saginaw Street with a drugstore and grocery store. Travel along Saginaw Street would appear to be common for this group, and the mean center of the locations of activities is located here.

In contrast to the large number of locations visited frequently and regularly by Group 1 members, those of Group 2 traveled to activities in only eight grid cells. Moreover, there was only one dominant focus of travel for this group, a major shopping center. Every member of Group 2 reported traveling to this center. Of all groups, Group 2 members demonstrated the highest degree of local travel, indicated by the relatively small size of the SDE summarizing their activity-site distribution. Orientation of their travel was in a northwest-southeasterly direction (138 degrees).

Although Group 3 respondents traveled to more destinations (37) over a wider area than Group 2, they shared a dominant travel focus in the shopping center. However, a second focus of travel for Group 3 was a grocery-discount store complex located to the west at the intersection of an interstate highway and a major arterial. A minor focus of travel for this group was a shopping mall in southwestern Flint. The resultant "pull" of the activity foci contributed to the slightly northeast-southwest north-south orientation to their travel pattern (76 degrees).

Group 4 members reported travel to activities located in 39 different grid cells and two of their major travel nodes corresponded to those mentioned earlier for other groups, namely, the grocery-discount store complex and the minor shopping center to the north of the city. Travel patterns of this group were the most diffuse in terms of distribution, resulting in the largest SDE. The major directional trend of Group 4 was northeast-southwest as indicated by the inclination of the major axis of the summary SDE (67 degrees).

Analysis of the residential distribution of the various group members according to residential location revealed that elderly respondents having similar travel patterns were not necessarily from the same residential area (Table 3). Comparison of individual activity spaces further supported the conclusion that the activity spaces of individuals living virtually next door to one another could vary considerably in both the number and location of activities. Both the nodal character of respondents' travel patterns and lack of direct association between home loca-

Table 3: Residential Area Distribution of Activity Group Members

	Residential Area			
Group	*Census Tract 01*	*Census Tract 02*	*Census Tract 03*	*Total*
Group 1	23	17	4	44
Group 2	2	2	14	18
Group 3	2	3	21	26
Group 4	13	7	11	31
Total	40	29	50	119

tion and activity-space characteristics suggest that the activity-space strategy may, indeed, be a more precise measure of what might be construed to constitute each individual's "neighborhood," at least with regard to travel for regular and frequent activities. (That this might be the case was further supported by the extreme difficulty and imprecision with which the respondents were able to identify the limits of their "neighborhood" when asked directly.)

HEALTH PLANNING IMPLICATIONS

The activity-space analysis presented here identified several focal points and travel "territories" in respondents' travel patterns, both of which would be of interest to those responsible for medical care facility planning. Although the four aggregate activity spaces derived from grouping individual activity patterns were distinct, there are some important similarities. Of particular interest is the considerable overlap of the aggregate activity spaces of Groups 2, 3, and 4. While varying considerably in the spatial and numerical distribution as well as the directional trend of activity locations, when summarized by the SDE they formed almost a "nested hierarchy" of spaces. Moreover, the centroids of these aggregate activity spaces were located quite close together. At the same time, the aggregate activity space and centroid location of Group 1 are quite spatially distinct.

From the planning perspective, therefore, it would seem practicable to reduce the number of possible ambulatory facility catchment areas from four to two in this instance. Certainly one facility might be located within the nested activity spaces of Groups 2, 3, and 4, and another, perhaps smaller, facility might be located within Group 1's aggregate activity space. As a further indicator of just where to locate

each of these facilities, reference could be made to the focal or "nodal" locations identified in the preceding analysis. As mentioned, several shopping center and grocery store complexes were identified as being frequented by relatively large numbers of the respondents. Insofar as these "real world" locations reflect the central tendencies of elderly travel and lie within a single activity space or a nested hierarchy of aggregate activity spaces, their immediate areas would appear to be appropriate for locating specific ambulatory medical care facility sites. Locating facilities here would perhaps truly "maximize" geographical access to ambulatory medical care providers for the elderly residing in this section of the city.

That this might be the case is further indicated by the respondents reporting traveling too far for ambulatory medical care. Of the 104 respondents visiting physicians regularly, only 8 percent reported their physicians to be in the same grid cell as one of their regular activity destinations. None of these respondents reported traveling too far for care. However, of those traveling to physicians outside of their regular activity spaces, 23 percent perceived the travel distance as being "too far." And, while certainly other factors must be considered, at the time of the study the only ambulatory care center in the area, perceived to be severely underutilized by its administrators, was centrally located within the study area but at the periphery of the aggregate activity spaces developed and summarized here (Figure 2). It might be added that, although the clinic had been open for over two years, fewer than 25 percent of the respondents had any knowledge of its existence or location. This was particularly notable, since the majority of respondents lived within a 2-mile radius of the facility.

The activity-space strategy proposed and demonstrated in this article preserves some of the positive advantages of the other major spatial strategies for providing medical care to the elderly while eliminating some of the associated disadvantages. Like home or residential-institution care, it places the medical care delivery site within the activity space of the individual. Insofar as the elderly are already moving to and from these sites in the course of their other activities, transportation requirements are already met. And, like centralized facility strategies, the activity-space strategy reduces the number of sites at which care is provided and encourages the continued movement of the elderly and their interaction within the community. A particular advantage here, however, is that the activity-space strategy incorporates the individual's and group's preference for use of particular sections of the city, in this way eliminating problems related to travel in "strange" or "hostile" territory. Finally, the activity-space strategy may

contribute to determination of more "natural" catchment area delineation, a problem alluded to in studies of mental health clinics, but most likely associated with any type of medical facility clinic.

ALTERNATIVE METHODOLOGY

Although the present analysis employed multidimensional scaling and relied heavily on computer-assisted procedures for analyzing individual and group activity spaces as well as assessing their dimensions, a modified approach may be used in situations where such resources and skills are not readily available. The fact that particular foci or nodes of travel emerge as important dimensions differentiating activity spaces suggests the possibility of a heuristic alternative for applying the activity-space strategy. It may be sufficient for health planners, through individual surveys or review of secondary data sources, to identify locations of major retail facilities, organizations, or public places in urban areas utilized by large numbers of older persons and the residential distribution of each facility's clientele. Given this information, the planners may make evaluations similar to those made in this study regarding locational strategies. However, in planning for other population groups it must not be assumed that the selected activities forming the basis of this analysis will be relevant. For each population group considered, data collection procedures must be designed to identify those activities most appropriate for inclusion in the activity-space strategy. Among middle-aged adults, for example, unlike the elderly, the workplace would likely emerge as an important element of their activity space. The point here is that the spatial distribution of facilities to which people travel may differ from place to place and from group to group within the same area, with potentially important implications on the geometry of both the individual and aggregate activity spaces derived.

The activity-space strategy is perhaps most appropriate for the provision of ambulatory medical services to the elderly and other "disenfranchised" segments of the population. Locating medical care facilities within the activity-space patterns of groups like the elderly or the poor might reduce both their financial and psychological travel costs for this type of care and, consequently, encourage their use of the services offered.

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