seeking readmission. He was told that admissions had been frozen because of the impending closure of the hospital and that therefore his request could not be honored. Nine days later he died of a drug overdose.

We dedicate this article to that veteran. His tragic death underscores the importance of providing continuing treatment and hope to that vulnerable population.

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Distance Between Homes and Exercise Facilities Related To Frequency of Exercise Among San Diego Residents

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Synopsis

Although personal determinants of exercise behavior have been studied extensively, few investigators have examined the influence of the physical environment on exercise habits. A random sample of 2,053 residents of San Diego, CA, were surveyed regarding exercise habits and other variables. A total of 385 exercise facilities in San Diego were classified into categories of either free or pay. After the addresses of respondents

and facilities were located on a grid-map and coded, the density of exercise facilities around each respondent's home address was computed. Subjects who reported engaging in three or more exercise sessions per week reported a statistically greater density of pay facilities near their homes than did those who reported no exercise sessions, after controlling for age, education, and income. The finding suggests an association between proximity of exercise facilities and frequency of exercise.

REGULAR PHYSICAL ACTIVITY provides numerous health benefits (*1, 2*), yet less than 1 in 10 adults in this country engages in regular vigorous physical activity (*3*). Many researchers have attempted to identify the determinants of physical activity habits (*4–6*). Most have examined personal characteristics, such as demographics, knowledge, attitudes, personality traits, and various health behaviors. Environmental influences have been studied less frequently.

Winett (*7*) has described several types of environmental supports and constraints that may be related to health behaviors. Among these environmental contexts are the interpersonal environment, the informational environment, the environment of the city, economic influences, and governmental political influences. Access to exercise facilities is an environmental characteristic that is presumably a factor in a person's decision to exercise or not.

Access to facilities has been studied in relation to exercise, but results have been mixed. For supervised programs, most studies showed that participants who lived closer to the facility were less likely to drop out (*4, 6*). Teraslinna and coworkers (*8*) found that proximity to a facility was the best predictor of subjects' volunteering for a program. In population studies, access to facilities was usually unrelated to exercise habits (*5*). However, no population studies used methodologies that adequately addressed the question.

A facility-rich environment could encourage physical activity in at least two ways. First, exercise facilities serve as visual stimuli that could cue exercise behavior. Facilities close to one's home will be seen often and may repeatedly bring exercise to one's attention. People in and around the facility who appear to be exercisers may strengthen the impact of the stimulus by making exercise appear to be the social norm. Thus, proximal facilities can provide numerous role models for exercise.

Second, subjects frequently cite perceived inconvenience and travel problems as reasons for dropping out of programs (*9*). Nearby facilities reduce some of the barriers associated with exercise. Travel time and traffic-related stress also are reduced; in some cases, subjects can walk to nearby facilities. Thus, physical proximity could reduce psychological and physical barriers to exercise.

We sought to examine the nature of the association between proximity to exercise facilities and participation in regular vigorous activity. We used a research design that overcame several methodological weaknesses of previous studies. First, we studied a large, randomly selected sample of persons who reported their exercise habits. Second, we surveyed exercise facilities of all types, since we were interested in any general stimulus that the environment might provide for exercising. Third, we objectively determined the proximity of facilities to subjects by calculating the actual density of facilities within varying distances of the subjects' homes. These procedures allowed us to assess, at a community level, the apparent impact of nearby exercise-related facilities on physical activity habits.

Methods

Subjects. Of a random sample of 6,000 adults drawn from a commercial, cross-indexed directory for San Diego, CA, 4,729 potential subjects were located within the city. They were mailed a 7-page questionnaire designed to solicit information on the determinants of physical activity.

Several incentives were used to increase the number of responses; after three mailings, 2,053 persons (43 percent) had responded. When compared with 1980 census data, the sample somewhat over-represented affluent, educated whites. The mean age was 47.8 years (SD = 16.5), the mean years of education was 14.9 (SD = 2.8), 42 percent of the respondents were women, 22 percent were smokers, and 39 percent reported exercising vigorously at least three times per week. Additional subject characteristics are available (*10*).

Assessment of exercise habits. Only responses to selected items in the questionnaire were used in the study. Vigorous physical activity was assessed from responses to "During a usual week, about how often do you do physical exercise in your free time, for at least **20 minutes** without stopping, **hard** enough to make your heart rate and breathing increase a large amount?" The responses to the question were scored as frequency per week. Comparison to other exercise self-reports in the questionnaire revealed that subjects were relatively consistent in their reporting (*10*). Subjects were grouped by their exercise habits according to the Amer-

ican College of Sports Medicine recommendations for conditioning exercises (*11*). The 938 subjects who reported no sessions of vigorous activity per week were classified as sedentary; the 800 who reported 3 or more sessions per week were termed exercisers. The remaining 315 subjects were excluded from the analysis.

Assessment of proximity to facilities. An exhaustive list of exercise facilities in the City of San Diego was compiled from the telephone classified directory, local sports and exercise publications, and other commonly available sources (*12*). We intended to identify places where people can exercise that are open to the public. Thus, sporting goods stores and other sources of exercise-related items were not inventoried. Facilities unlikely to provide aerobic exercise, like yoga and martial arts centers, were omitted. We could not collect data on facilities such as bicycle trails, walking trails, private tennis courts, and private swimming pools.

Facilities were classified as either free or pay. Free facilities included public parks and sports fields (identified through the city parks department), public recreation centers, colleges and universities, and public schools (because they all have large, accessible athletic fields). Pay facilities included tennis and racquet clubs, aerobic and dance studios, membership swimming pools, health or fitness clubs, YMCAs and YWCAs, and skating rinks.

We used a methodology based on city blocks to compute distances between each respondent's home and each of the catalogued exercise facilities. A grid of coordinates was overlaid on a street map of San Diego, on which were located the residences of each respondent, and the athletic facilities that we identified. The distance between each respondent's residence and each facility was computed as the sum of the differences between the coordinates. This method was believed to be more representative of urban walking patterns than straight line distances. We computed the number of free, pay, and total exercise-related facilities within 5 km of each subject's home, in 1 km increments. We referred to the variable of the concentration of exercise facilities around a subject's home as the density of exercise facilities.

Results

We catalogued a total of 385 facilities within the city and determined the mean number of each type of facility located within 1 km and within 5 km of the subjects' homes (table 1). Skating rinks and membership swimming pools were the least common, and public schools were the most common.

Almost half of the sample reported exercising at home. One-quarter of the sample reported exercising outside, using no special facilities (table 2). Neither of these categories considered sites located in the facilities survey. Fifty-one percent of the sample reported exercising at facilities that were represented in the survey. Although schools and other institutions were the most widely available type of facility, they were used the least frequently. As expected, exercisers were more likely than sedentary subjects to use every type of facility.

Table 1. Total exercise facilities and mean number within specified distances from homes of 2,053 subjects, San Diego, 1986

Type of facility	Total in city	Number within 1 km	Number within 5 km
Free facilities, total	311	1.11	13.10
Parks and sports fields	66	0.2	2.4
Public recreation centers	26	0.1	1.2
Colleges and universities	6	0.01	0.2
Public schools	213	0.8	9.3
Pay facilities, total	74	0.38	3.28
Tennis and racquet clubs	12	0.1	0.7
Aerobic and dance studios	14	0.1	0.6
Swimming pools	3	0.04	0.3
Health and fitness clubs	34	0.1	1.3
YMCA and YWCA	9	0.03	0.3
Skating rinks	2	0.01	0.08
Total all facilities	385	1.49	16.38

Table 2. Percentage of subjects reporting use of specific exercise sites, San Diego, 1986 [1]

Type of facility	Total (N = 2,053)	Exerciser group[2] (N = 800)	Sedentary group[3] (N = 938)
Home	48	49	46
Outside, using no special facility	25	40	16
Commercial facility or private club	22	35	14
Park	15	21	11
Work	10	12	8
Free facility	9	13	7
School, church, college, or university	5	7	3

[1] Subjects could indicate use of more than 1 facility.
[2] Respondents who reported 3 or more sessions of vigorous exercise per week.
[3] Respondents who reported zero sessions per week of vigorous exercise. Respondents reported where they exercise on those occasions when they exercise, which may include gardening.

Facility density and exercise habits. The primary analysis was designed to detect any association between vigorous exercise habits and the density of exercise facilities. Preliminary analyses indicated that demo-

Table 3. Differences in density of exercise facilities near subjects' homes between exerciser and sedentary groups, San Diego, 1986

Type of facility	Exerciser group[1]	Sedentary group[2]	F[3]
Free facilities within:			
1 km	1.1	1.0	0.6
2 km	3.1	3.2	0.2
3 km	5.8	5.8	0.1
4 km	8.7	8.8	0.1
5 km	12.2	12.5	0.2
Pay facilities within:			
1 km	0.4	0.3	[4]7.8
2 km	1.0	0.8	[5]6.0
3 km	1.7	1.4	[5]6.0
4 km	2.5	2.2	[4]7.1
5 km	3.5	3.1	[4]7.9
Total facilities within:			
1 km	1.5	1.3	[5]4.5
2 km	4.0	3.9	0.5
3 km	7.4	7.1	1.1
4 km	10.8	10.7	0.3
5 km	15.0	15.2	0.1

[1]Exerciser group reporting 3 or more sessions of vigorous exercise per week (N = 800).
[2]Sedentary group reporting zero sessions per week of vigorous exercise (N = 938).
[3]Analysis of covariance, adjusting for age, education, and income.
[4]*P* less than 0.01.
[5]*P* less than 0.05.

graphic variables, such as age, education, and income, were significantly associated with density of facilities ($P < 0.05$). We therefore conducted analyses of covariance to adjust for age, education, and income (table 3).

The density of total facilities within 1 km was significantly different for the sedentary and exerciser groups ($P < 0.05$). No other significant differences were found for the density of total facilities or free facilities. However, at all distances studied, the density of pay exercise facilities was significantly associated with exercise habits ($P < 0.05$ to $P < 0.01$), even when important covariates were controlled. The association was neither strengthened nor weakened as the distance increased between facilities and subjects' homes.

The total sample included many subjects who did not engage in activity at facilities, and it is possible that the inclusion of these subjects weakens the observed associations. To verify this, the analyses comparing density of facilities by exercise status were repeated after deleting all subjects who reported exercising at home but at no other facilities. The findings from this subset analysis paralleled the previous finding, and the mean density scores were very similar in both analyses. In the subset analysis, exercisers were significantly more likely to live near pay facilities than were sedentary subjects, and this association was significant at four of the five distances. There were no significant differences for free facilities or for total facilities. The F values were smaller in subset analyses because of the smaller sample size. There was no evidence that the association between exercise and proximity to facilities depended on where subjects did their physical activity.

Perceived convenience and barriers. We conducted several analyses to test hypotheses about possible mechanisms of the relationship between exercise habits and density of facilities. One posited a correlation between rated convenience and the density of total facilities, because psychological distance was expected to be associated with physical distance. Subjects reported the subjective convenience of 15 types of exercise facilities listed in the questionnaire. We summed the responses to create a score for convenience of facilities. However, we found no significant correlations between the convenience variable and the density of facilities. Convenience may have reflected such considerations as perceived accessibility (that is, cost and social requirements) as well as perceived proximity.

A second hypothesis suggested a negative correlation between perceived barriers to exercise and the density of facilities, because nearby facilities would be expected to reduce the psychological costs of attending those facilities. Barriers to exercise were assessed from subjects rating how often any of 15 items prevented them from exercising. These items included lack of time, lack of enjoyment from exercise, and lack of facilities or space. We found, for all distances, significant negative correlations between barriers and the density of pay facilities ($r = -0.07$ to -0.05; $P < 0.05$). However, the associations were very weak, and we found no associations with free facilities or the total of facilities.

Type of activity and type of facility. A final set of analyses concerned the perceived convenience and actual physical convenience of specific exercise facilities for those who do and those who do not perform specific types of activities. Subjects reported whether they had performed any of 24 activities during the preceding 2 weeks. We then constructed activity groups by selecting subjects who reported any participation in common activities that often required facilities during the previous 2 weeks. The groups and the number of subjects in each were aerobic dance (164), jogging (375), tennis (149), swimming (490), weight lifting (219), basketball (54), soccer (24), and racquetball (56). Each group was compared with subjects who reported no vigorous physical activities (938).

Table 4 displays the relationship between participation in a specific activity and the perceived convenience of closely related specific facilities. In all analyses, the group that exercised also rated specific facilities as sig-

Table 4. Perceived convenience of specific facilities associated with specific activities, San Diego, 1986

Type of activity	Sedentary group[1]	Exerciser group[2]	Number of exercisers	F[3]	P
Aerobics	7.08	8.13	184	27.4	0.001
Jogging	7.30	8.27	375	30.9	0.001
Tennis	4.82	5.60	149	29.3	0.001
Swimming	4.81	[4]5.60	490	81.7	0.001
Weight lifting	4.88	5.48	219	9.5	0.002
Basketball	4.62	5.56	54	9.6	0.002
Soccer	2.22	2.88	24	8.8	0.003
Racquet sports	2.14	2.91	56	36.7	0.001

[1]Reported zero sessions per week of vigorous exercise (N = 938).
[2]Reported any participation in the specific activity during the previous 2 weeks. Subjects could report multiple activities.
[3]Analysis of covariance, adjusting for age, education, and income.
[4]Because swimming was undefined and was assessed during the summer, it is likely that most of these are not regular swimmers.

Table 5. Geographic density of specific facilities within 1 km of residence of subjects who reported specific activities, San Diego, 1986

Type of activity[1]	Sedentary group[2]	Exerciser group[3]	Number of exercisers	F[4]	P[5]
Aerobics	0.30	0.29	184	0.15	[5]NS
Jogging	1.11	1.22	375	1.68	NS
Tennis	0.22	0.19	149	0.33	NS
Swimming	0.18	0.23	490	3.42	NS
Weight lifting	0.24	0.32	219	10.42	0.001
Basketball	1.24	1.21	54	0.05	NS
Soccer	1.13	1.13	24	0.07	NS
Racquet sports	0.15	0.16	56	0.92	NS

[1]Several types of facilities were combined for most categories.
[2]Zero sessions per week of vigorous exercise (N = 938).
[3]Reported any participation in the specific activity during the preceding 2 weeks. Subjects could report multiple activities.
[4]Analysis of covariance, adjusting for age, education, and income.
[5]NS = no significance found.

nificantly more convenient than did the sedentary group.

Table 5 shows the relationship between participation in the same activities and the actual density of specific, related exercise facilities. Several types of facilities were combined to construct most facility categories. For example, aerobic facilities included aerobic or dance studios, health or fitness clubs, YMCAs or YWCAs, and recreation centers, because all of these are likely to sponsor aerobic dance classes. Only the 1-km results are presented, since associations at other distances were similar. In general, we found no relationship between participation in specific exercise activities and proximity to related facilities. The exception was weight lifting, with weight lifters being more likely than nonexercisers to live closer to those facilities.

Discussion

We found that the density of exercise facilities around one's home was associated with exercise habits. Several factors increased our confidence in this finding. First, the association was found consistently across all five distances from subjects' homes. Second, the density of facilities was objectively measured, independently of the exercise report. Third, the confounding variables of age, education, and income were controlled in the analyses. Fourth, similar results were found with the total sample and with the subsample who exercised at facilities. Fifth, most limitations of the study biased against finding an association. For example, not all facilities were assessed, such as walk-jog-bike paths, private tennis courts, private swimming pools, and worksite exercise facilities. Also, not everyone uses facilities to exercise. Many people jog or cycle on public streets or exercise in their own homes. Some people may exercise at a facility near work or at a facility not near home but on a commonly traveled route.

Because an association appears to exist between the density of facilities and exercise behavior, any mechanisms that might underlie the relationship merit consideration. Our study tested several hypotheses regarding these mechanisms. The hypothesis that actual proximity enhances perceived convenience of facilities received no support. The second hypothesis, that nearby facilities reduce psychological barriers to exercise, was weakly supported by low but significant correlations between density of facilities and perceived barriers. Because previous analyses revealed perceived barriers to be highly related to exercise habits (*10*), this apparent mechanism deserves further study.

'... this study provides evidence that objectively assessed proximity to facilities is associated with exercise behavior, independent of demographic variables.'

With few exceptions, participants in specific activities perceived that facilities of direct relevance to their activity were relatively convenient. However, we found very little evidence that these relevant facilities were in fact more proximal to subjects who participated in specific activities than to sedentary subjects. These results and the analysis of the subset who exercised away from home lead to the interpretation that exercise facilities may prompt activity in general. That is, proximal facilities do not seem to stimulate the specific activities that are done at those facilities.

There is a sharp distinction between subjective and objective assessments of convenience. While both measures may be important, the current findings imply that each must be measured separately. As noted earlier, many people do not exercise in special facilities, or the facilities they use may be more proximal to their place of work than to their home. This pattern of use could have weakened the association between specific activities and the density of specific facilities.

In this study, measures of perceived convenience and geographic proximity were crude because they did not consider the complex nature of both constructs. While distance seems like a simple variable, 2 km in a residential neighborhood can be very different from 2 km across several busy commercial streets. Our measure of density could not include consideration of these complex factors. A nearby facility may be desirable in some respects, but it may have inadequate parking, or have other undesirable characteristics so that it is seldom or never used. Thus, it is expected that proximity is only one variable that would influence one's perception of the convenience of a facility and one's decision about whether to use a facility.

The present study dealt only with participation in vigorous exercise, but it should not be implied that this is the only type of exercise that we recommend as a public health intervention. There is mounting evidence of the significant health benefits of regular moderate-intensity physical activity (*14–16*), and activities such as walking may be more appropriate for many segments of the population (*17*). Given the nature of moderate-intensity activities, they are less likely to be performed in exercise facilities than vigorous exercises. Therefore, we considered it more appropriate to examine the relationship between access to facilities and vigorous exercise.

It is important to consider the cross-sectional nature of this research. Although one may postulate that proximity to exercise facilities encourages exercise, it is also possible that some exercisers move to be near facilities or that proprietors of facilities build them in neighborhoods with a high proportion of persons likely to be regular exercisers. Thus, the relationship observed in this study could develop because market forces influence the location of pay facilities.

The association between the density of exercise facilities around one's home and exercise habits was statistically significant for pay facilities but not for free, public facilities. An association between pay facilities and exercise is expected because both variables are positively associated with socioeconomic status. Surprisingly, the present study found that such a relationship remained significant even after the effects of age, education, and income were controlled through analysis of covariance. This finding implies that either the proximity of pay exercise facilities encourages exercise behavior or that pay facilities are built in the proximity of already exercising populations. Another explanation is that people who exercise in pay facilities may have a more clearly defined pattern of exercise than people who do not belong to pay facilities. For equal amounts of exercise, the ones who belong to a pay facility may be more likely to classify themselves as exercisers.

The absence of an association between exercise habits and public facilities may be due to several factors. Schools constituted 68 percent of public facilities and were used by only 5 percent of the respondents. Therefore, the lack of an association between public facilities and exercise habits is largely because of the reported lack of use of school facilities. Public schools in San Diego all have accessible fields, and in many cases, basketball courts, tennis courts, and running tracks. However, schools also are frequently in use by students, making them relatively unavailable to the general public. In some locales their use by the public is discouraged, and some adults may not perceive them to be relevant to their exercise practices. On the other hand, it appears that schools may be an important and underutilized type of exercise facility. Since our study was limited to adults, we cannot comment about the use of schools or other public facilities by children.

One might suggest, based on the results of our study, that numerous pay facilities scattered throughout the community would be more effective at increasing exercise in the population than would be a few centrally located facilities or more public facilities. Although the need for increased exercise participation is great in low-income communities, low-income residents are least

able to pay for the use of facilities and it seems unlikely that more pay facilities in their neighborhoods is the answer. It might be more useful to examine the differences between public and pay facilities. To the extent that public exercise facilities can be improved by the addition of features normally available only in pay facilities, their impact on vigorous activity might be increased. For example, public facilities might be improved by providing exercise trainers or leaders, adding special equipment (such as weight lifting equipment), ensuring physical safety (such as with more outside lighting), and enhancing conveniences (such as providing showers).

The relationships between exercise and density of facilities were not large. Therefore, if policy changes were to alter the actual or perceived availability of facilities, we would not expect a powerful effect on exercise participation. It is clear that exercise behavior results from a complex interplay of multiple determinants (*5, 10*) and that current understanding of these determinants is limited. However, this study provides evidence that objectively assessed proximity to facilities is associated with exercise behavior, independent of demographic variables. The observed associations are probably underestimates of the true associations, because exercise was measured with error, not all facilities were assessed, and many people do not exercise at any facility.

Although the association is weak, any effect of exercise facilities is pervasive in the community. Therefore, interventions that increase the availability of appropriate exercise facilities would likely have small effects on particular individuals while having a substantial cumulative effect on the community. Because such population-wide interventions (*13*) are the essence of public health approaches to health promotion, public health professionals should consider the potential positive effects of altering policies related to the distribution of exercise facilities in the community.

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