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Neighbourhood Deprivation, Social Capital and Regular Exercise during Adulthood: A Multilevel Study in Chicago

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Summary. This multilevel research examines the contextual effects of neighbourhood SES and social capital indicators on physical activity over and above individual socio-demographic background. Using 1990 census data and two social surveys, the hypotheses are tested among 907 Chicagoans in 242 neighbourhoods in 1996. Significant interaction effects are found with gender and both neighbourhood SES and social capital; women's physical activity level is more responsive to neighbourhood context. Controlling for socio-demographic factors at the individual level and the interaction effects between neighbourhood variables and gender, social capital and neighbourhood SES appear to be significant correlates of individual physical activity. Moreover, contrary to most findings in the neighbourhood effects research on health, the data show that the effects of neighbourhood SES are stronger than the effects of household income. Interventions promoting physical activity should incorporate local environmental features into their designs.

Introduction

Regular physical activity has been consistently demonstrated to reduce morbidity and mortality, increase physical functioning and independence, and promote longevity and psychological well-being (US Department of Health and Human Services, 1996). However, in the US, physical inactivity remains a serious public health concern and temporal trends showed little improvement over the past decade (Centers for Disease Control and Prevention, 2001). This in part reflects the inability of interventions to increase effectively

physical activity levels in the long run (Eyler *et al.*, 2003). In recent years, recognition of the impact of the built environment on active living has grown; researchers postulate that it holds the promise of creating long-term change in physical activity (Robinson and Sirard, 2005; Saelens *et al.*, 2003).

The urban planning, transport and public health literatures have demonstrated that accessibility of facilities (such as the presence of recreational facilities and the distance to them), opportunities for activity (such as

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awareness of facilities and perceived 'neighbourhood walkability'), aesthetics (such as landscaping and views), mixed land use design and street connectivity (connected streets versus cul-de-sacs) are important environmental correlates of physical activity in adults (Ewing and Cervero, 2001; Giles-Corti and Donovan, 2003; Handy *et al.*, 2002; Humpel *et al.*, 2002). Despite this burgeoning literature, little is known about the influence of neighbourhood social-structural factors on the chances of maintaining an active lifestyle. Indeed, it is possible that the impact of the social environment on physical activity is as important as, if not more so than, that of the built physical environment. For example, crime or fear of crime may play a bigger role than the existence of high-quality sidewalks or parks in determining the likelihood of individuals' physical activity in the neighbourhood. As an initial step, analyses guided by theoretical and empirical developments in urban sociology, health services research and social epidemiology can complement the literature focusing on physical environmental factors and provide additional insight into neighbourhood context and its impact on physical activity.

This study examines the effect of neighbourhood structural characteristics (i.e. indicators of socioeconomic status (SES)) and social environment (i.e. indicators of social capital) on physical activity in adulthood over and above individual socio-demographic background. We focus on several prominent and theoretically relevant domains of neighbourhood deprivation and social capital. We investigate the effects of these factors separately and then assess their relative contribution to physical activity. The main purpose of this study is to disentangle area effects on physical activity, a domain gaining significance in explaining socioeconomic differences in health (Lindström *et al.*, 2001).

Background

The Significance of Neighbourhood

The neighbourhood constitutes an important dimension of our social environment. Not

only is it important to where and when we carry out our daily routine activities, but it also facilitates making connections to others. It fosters attachment and belonging, demonstrates or reflects one's own values and identity, signifies status and culture, and provides or inhibits opportunities that can be capitalised on to achieve better life circumstances (Kearns and Parkinson, 2001). As Forrest and Kearns argue

In a sense, the neighbourhood becomes an extension of the home for social purposes and hence extremely important in identity terms: 'location matters' and the neighbourhood becomes part of our statement about who we are (Forrest and Kearns, 2001, p. 2130).

Indeed, the neighbourhood is likely to be the site for many daily routines, particularly for people who spend large amounts of time at home. For example, young people in disadvantaged neighbourhoods seem extremely territorial in their behaviour—this may be because their activity space is largely restricted to the area around their homes (Kearns and Parkinson, 2001). Neighbourhood also may be an important arena for consumption—that is, an integral component of a class-based *habitus* described in Bourdieu's framework of class reproduction via social capital and cultural capital transmitted across certain social ecologies (Bourdieu, 1986). Given the prominent role the neighbourhood plays in our lives, it is not surprising to find growing evidence that consistently points to area effects on a wide range of individual-level outcomes (Sampson *et al.*, 2002).

Area effects have been defined as the net change in the contribution to life-chances made by living in one area rather than another (Atkinson and Kintrea, 2001). It also has been defined specifically as an independent effect of area over and above individual-level risk factors (Diez-Roux, 2001; Macintyre and Ellaway, 2003). A myriad of spatial scales have been used in empirical investigations, ranging from postal divisions (such as zip codes) (Veugelaers and Fitzgerald, 2005; Wen and Christakis, 2005), public

administration (such as local government areas in Scotland and villages and towns in China) (Croombie *et al.*, 1989; Luo and Wen, 2002), to census geographical units in the US (such as block groups, census tracts, counties) (Cagney *et al.*, 2005; Ewing, 2005; Powell *et al.*, 2004). Recently, the literature on the built environment and physical activity has increasingly relied on geographical information system (GIS) techniques to create individualised 'neighbourhoods' using buffers with varying radii depending on specific situations (Duncan and Mummery, 2005; Maas *et al.*, 2006). An alternative approach is to use community-based definitions of neighbourhood (meaning the way residents define them) (Sampson and Raudenbush, 2004; Wen *et al.*, 2006). Despite these definitional and operational variations, the general focus is on characterising areas around one's residence. By far, evidence indicates that one of the strongest identified area effects is on health (Kearns and Parkinson, 2001).

The mechanisms underlying these area effects are complex and dynamically intertwined. Neighbourhood context is relevant for physical activity because it reflects social ecological features of local neighbourhoods that promote or inhibit physical activity, particularly in terms of regular exercise to maintain health, appearance or overall well-being. Presumably, a structurally deprived neighbourhood, characterised by high poverty, low educational attainment, a high concentration of female-headed households and a high prevalence of households on public assistance, is likely to have visible signs of physical disorder such as air pollution, noise, dilapidated housing, few recreational options, more vacant houses, more litter and broken glass on the ground and more *graffiti* on buildings (Sampson and Raudenbush, 2004). Conceivably, poorly maintained areas with unambiguous cues of disorder and little vegetation and greenery may discourage recreational activities within the neighbourhood. For example, data from eight European countries show that residents of neighbourhoods that contain high levels of greenery are significantly more physically active; conversely, residents of neighbourhoods characterised by high levels of incivilities (such as *graffiti*,

litter and dog waste) are about 50 per cent less likely to be physically active (Ellaway *et al.*, 2005; Maas *et al.*, 2006). Perhaps the deterring effect of physical disorder is partly due to fear of being victimised in the neighbourhood and partly due to the inhibiting effect of an unfriendly *ambience* with little open space and aesthetic features that encourage outdoor activities.

Aggregate educational resources in a neighbourhood may be linked with more exercise via other pathways. Neighbourhoods with a high proportion of college-educated adults are more likely to have a culture of leisure-time physical activity and such a culture may encourage other people to adopt the same active lifestyle (Crane, 1991; Ross and Mirowsky, 2001). In other words, neighbourhoods with few college-educated residents may lack the normative climate that promotes healthful lifestyles, including leisure-time physical activity.

Neighbourhoods deprived of economic and educational resources also tend to be deficient in health-promoting social resources. Neighbourhood poverty has been routinely linked with local social disorganisation which typically manifests in a lack of social cohesion and informal social control, interpersonal mistrust and crime (Sampson *et al.*, 1997; Shaw and McKay, 1969; Wilson, 1996). These aspects of neighbourhood social context embody several core elements of social capital. While the downside of social capital is not negligible (Caughy *et al.*, 2003; Forrest and Kearns, 2001), as for example, in risk behavioural contagion among adolescent gang members, a growing number of researchers agree that social capital generally has positive health consequences (Kawachi and Berkman, 2000; Leyden, 2003; Lindström *et al.*, 2001; Lomas, 1998).

The mechanisms linking social capital and physical activity can be found in processes such as social relationships and social support, social participation, information diffusion, healthy norms of behaviour, social control of deviant behaviour (and thus possibly improved safety) and local services that promote physical activity. Quantitative and qualitative evidence supports these pathways.

For example, lack of community support and social participation and problems of neighbourhood safety are found to be contextual barriers to physical activity (Eyler *et al.*, 1998; Lindström *et al.*, 2001). Lack of social support from family and friends also is related to physical inactivity (Amesty, 2003; Eyler *et al.*, 1998). Evidence from criminology further indicates that residents in communities with low stocks of social capital are less willing to exert social control over deviant behaviours such as violence and crime (Kawachi *et al.*, 1999; Sampson *et al.*, 1997). Such communities tend to have higher levels of social and physical disorder, deterring outdoor activity. Social capital also has been linked to information exchange—innovative messages and behaviours may be diffused more rapidly in a cohesive community in which members know, trust and help one another (Coleman, 1988; Rogers, 1983). Healthy norms of behaviour are therefore more readily adopted in such communities (Kawachi and Berkman, 2000). Moreover, neighbours in a cohesive community are presumably more easily united to address collective concerns such as the availability of safe and comfortable places to exercise. Indeed, parks, well-lit walking trails and recreation centres have been shown to be strong predictors of physical activity (Eyler *et al.*, 2002).

In sum, one's recreational preferences are reinforced by both the physical characteristics of the built environment and the sociocultural system prevailing in local neighbourhoods (Ferriss, 1970). Neighbourhood SES is linked to neighbourhood physical conditions and social capital, both of which are expected to have direct and indirect effects on physical activity. It is noteworthy that neighbourhood social factors may have less impact on the total amount of physical activity than on regular exercise because people in poorer or environmentally less friendly neighbourhoods still may have to keep physically active (for example, walking to meet their transport needs). However, as the research reviewed in the next section indicates, social environmental factors can affect non-leisure time physical activity as well.

Previous Work on Neighbourhood Context, Health and Physical Activity

The past decade has witnessed renewed interest in how the neighbourhood social and structural ecology contextually affects health and illness. Although the ecologically clustered pattern of neighbourhood social, economic and health problems was documented long ago (for example, Faris and Dunham, 1960), the major interdisciplinary endeavour in conceptualising and testing neighbourhood effects on health is relatively new (Kawachi and Berkman, 2003). The resurgence of scholarly interest in neighbourhood effects on health has generated a considerable literature pointing to the independent effects of residential areas on health. An impressive number of contextual studies have shown that residence in low-SES neighbourhoods has negative effects on a range of health-related outcomes including health behaviours (Pickett and Pearl, 2001). Evidence that local social organisations are beneficial to health has also emerged. Several studies have demonstrated that neighbourhood collective efficacy, subcultural orientation, safety, physical disorder, perceived violence and crime are important social environmental factors affecting health status, health behaviour and mortality (Browning and Cagney, 2003; Grzywacz and Marks, 2001; Ross and Mirowsky, 2001; Wen *et al.*, 2005; Wen and Christakis, 2006). Community trust and norms of reciprocity—as integral components of community social capital—also have been examined, with some evidence supporting a positive relationship between norms of trust and reciprocity at the community or state level and health status and behaviour (Franzini *et al.*, 2005; Kawachi *et al.*, 1997; Lochner *et al.*, 2003; Subramanian *et al.*, 2002; Wen *et al.*, 2007).

With a few exceptions (Duncan *et al.*, 2002; Lee and Cubbin, 2002; Ross, 2000; Yen and Kaplan, 1998), many of these contextually oriented studies have not directly focused on the extent to which neighbourhood affects physical activity. While a growing literature documents the association between physical features of the built environment and physical activity (such as travel and exercise) (Ewing,

2005), few studies have directly examined the contextual effects of neighbourhood SES and social capital. Indeed, as Sallis and Owen (1999) noted, researchers in physical activity are just beginning to study the neighbourhood.

Safety and crime, as markers of social-environmental facilitators or hazards, have received relatively more attention than other social ecological factors. Yet empirical results are mixed about whether or not neighbourhood safety and perceived or actual crime have an impact on physical activity (despite the *a priori* expectation that safety issues should matter). For example, in a study of 285 Latino women in Spain, safety from crime was not significantly linked with meeting physical activity recommendations based on total amount of weekly physical activity (including both leisure time and purposeful physical activity such as transport) (Voorhees and Young, 2003). Similarly, safety did not prove to be an important influence on walking for exercise in a sample of 399 adults aged 40 or over in Australia (Humpel *et al.*, 2004). A longitudinal study focusing on adolescent girls demonstrated that neighbourhood safety did not exhibit cross-sectional or longitudinal effects on total physical activity (Motl *et al.*, 2005). On the other hand, a national study in the US revealed that residents in less safe neighbourhoods had lower levels of participation in regular vigorous exercise (Grzywacz and Marks, 2001). Data from the Behavioral Risk Factor Surveillance System (BRFSS) also revealed that perceived safety was significantly associated with leisure-time physical activity (Centers for Disease Control and Prevention, 2005). In addition, a recent pan-European study found a significant association between perceived safety and exercise (Shenassa *et al.*, 2006). These discrepancies may have been due to different study populations and study sites.

Another aspect of neighbourhood context concerns neighbourhood structural arrangements, routinely measured by neighbourhood poverty or other aggregate SES indicators. For example, using data from the Alameda County Study, Yen and Kaplan (1998) examined the impact of residential area on trajectories of leisure-time physical activity measured with a

summative score based on responses to a question about frequency of participating in active sports, swimming or taking long walks, working in the garden and engaging in physical exercise. The key finding from this study was that area-level poverty was associated with a decline in physical activity, adjusting for individual characteristics. Using data from Sweden, Sundquist *et al.* (1999) also found that neighbourhood deprivation was negatively associated with regular physical activity including both purposeful and leisure-time physical activity. Ross (2000), in contrast, found that people walked more in poor rental neighbourhoods despite the fact that living in a disadvantaged neighbourhood was associated with fear of being attacked and being afraid of leaving the house. Thus, using an umbrella measure of neighbourhood SES may mask variation in the effects of different aspects of neighbourhood structure. In addition, another study found that neighbourhood SES and social disorganisation based on census variables such as proportion of families headed by women and proportion of persons 5 years and younger and residential instability had no contextual effect on participation in sports or exercise (Lee and Cubbin, 2002). Thus, the extent to which neighbourhood SES has an effect on individual physical activity over and above personal risk factors remains a question.

Despite research documenting the link between neighbourhood social capital and health (Islam *et al.*, 2006), there is inadequate evidence of the association between neighbourhood social capital and physical activity (Li *et al.*, 2005). However, a small body of research suggests that social capital is a relevant concept for physical activity. For example, using multiple data sources, Duncan *et al.* (2002) conducted a multilevel study and found that appealing features of the physical environment, perceived neighbourhood social cohesion and the absence of neighbourhood problems were all positively linked to residents' physical activity level. In this study, physical activity was measured by responses to an item asking "Compared with others of your same age and sex, how much physical activity do you get?". Such measures

were intended to capture the overall levels of physical activity regardless of its purpose. Another multilevel study confirmed that independently measured neighbourhood social cohesion promoted overall levels of walking in the neighbourhood after controlling for individual-level covariates (Fisher *et al.*, 2004). More recently, data from England showed that positive perceptions of the social environment (i.e. social support and social capital) were associated with higher levels of physical activity where physical activity is measured by sports activity, walking and people's overall physical activity (Poortinga, 2006). Findings from these three studies suggest that the neighbourhood social environment may have an impact not only on physical activity for recreational purposes but also on the total amount of physical activity (including activities for instrumental purposes such as housework, home repair and walking for travel purposes).

A handful of studies have addressed the extent to which neighbourhood social and structural contexts affect physical activity, but the body of literature is still relatively small. In addition to the dearth of efforts to test the link between neighbourhood social environment and physical activity, we have little knowledge about the relative importance of these aspects of neighbourhood context for physical activity, or their relative position in the pathway from neighbourhood social ecology to individual physical activity. For example, it is conceivable that neighbourhood SES indirectly affects physical activity through its role in promoting social capital and/or controlling crime and violence. In fact, previous evidence has shown that the effect of neighbourhood affluence on self-rated health is substantially mediated by a composite social index combining collective efficacy, social networks and neighbourly reciprocity (Wen *et al.*, 2003). Yet it is also possible that the effects of social-environmental resources and hazards can be confounded or explained by neighbourhood SES because local social organisations may also impact physical, service and structural dimensions of local neighbourhoods.

In summary, the existing literature indicates that neighbourhood social factors affect a variety of health outcomes including health behaviours. Research that examines neighbourhood effects on physical activity, however, is inadequate. Although violence and crime have been theoretically proposed as salient environmental factors deterring physical activity, evidence is mixed regarding the role of neighbourhood safety in contributing to physical activity. Moreover, the relationships among different aspects of environmental context as they affect physical activity have not been well examined. Consequently, from a policy perspective, it is not clear which aspects of neighbourhood environment should be prioritised to promote physical activity.

Objectives and Hypotheses

The aim of this research is to investigate neighbourhood SES and three aspects of neighbourhood social capital as they affect physical activity. We focus on both positive and negative markers of neighbourhood social capital, including neighbourhood trust, norms of reciprocity, perceived violence and violent crime. We further examine whether the effects of neighbourhood SES on physical activity can be explained by the social resources (such as trust) or social hazards (such as crime) present in the neighbourhood, or conversely, whether the effects of these neighbourhood social factors are mediated or confounded by neighbourhood SES.

We hypothesise that neighbourhood educational and economic resources, perceived neighbourhood trust and norms of reciprocity have positive effects on physical activity, whereas indicators of neighbourhood concentrated disadvantage and perceived violence and crime have negative effects. We hypothesise that these relationships exist in the presence of controls for individual predictors of physical activity. We do not have an *a priori* expectation about the relative position of neighbourhood SES versus social capital on the pathway between neighbourhood and physical activity. Theoretically, the effect of neighbourhood SES can be confounded or mediated by

social capital and vice versa. Whether deprivation or social capital has a more direct effect is an empirical question.

Methods

Data

We use several sources to construct the multilevel data necessary to examine our hypotheses. Neighbourhood-level data are constructed from the 1990 US Census and the Project on Human Development in Chicago Neighborhoods—Community Survey (PHDCN—CS). Individual data are from the Metropolitan Chicago Information Center—Metro Survey (MCIC—MS). The three datasets are linked using neighbourhood identifiers (Sampson *et al.*, 1997).¹

The dependent variable and individual-level covariates are drawn or constructed from the MCIC—MS. The MCIC—MS is a random probability serial cross-section of adults aged 18 and older who reside in the six counties of the metropolitan Chicago area. We confine our sample to the residents of the City of Chicago. The survey incorporated an array of individual-level measures of health, health behaviour and socio-demographic background characteristics. The response rate for the MCIC—MS was approximately 55 per cent across the 10 cross-sectional samples. The physical activity question used in this study was asked only in the 1993, 1994 and 1996 waves of the MCIC—CS. Considering that the PHDCN—CS was primarily collected in 1995 and our crime data covered homicide rates from 1991 to 1993, we only include the 1996 sample of the MCIC—MS. This strategy allows a temporal sequence from the proposed environmental predictors (such as trust) to the outcome variable (i.e. physical activity).

Measures of neighbourhood SES are obtained or derived from the 1990 US Census. We include neighbourhood-level affluence, poverty, education, percentage of female-headed households, percentage on public assistance and a composite index of concentrated disadvantage (defined below).

Measures of neighbourhood social environment are constructed from the PHDCN—CS (Sampson *et al.*, 1997). The PHDCN—CS asked questions about the community in which respondents lived. It is a probability sample of 8782 residents of Chicago, age 18 and older. The study combined 847 census tracts into 343 larger, ecologically meaningful ‘neighbourhood clusters’ (NCs). The response rate was 75 per cent. A detailed description of the PHDCN—CS and how these neighbourhood clusters were constructed has appeared elsewhere (Sampson *et al.*, 1997).

Because the MCIC—MS did not achieve as high a response rate as the PHDCN—CS, we compared the latter with combined 1993–96 MCIC—MS samples. The distributions across demographic characteristics such as gender, age and race in the MCIC—MS data were similar, indicating that the lower response rate in the MCIC—MS did not yield a non-comparable sample.

Dependent Variable

Our dependent variable is individual-level *physical activity* (dichotomised). In the MCIC—MS, respondents were asked “In the past year to stay healthy or improve your fitness did you exercise regularly?”. In this sample, about 63 per cent reported having exercised regularly. This measure is a self-reported assessment of exercise and self-defined regular exercise does not necessarily coincide with the officially recommended amount of weekly physical activity.² However, this form of measure is valuable in that it captures perceived regular exercise over a longer period of time rather than just one or two weeks as typically used to assess physical activity (Lee and Cubbin, 2002; Ross, 2000). Moreover, this measure is likely to capture all forms of exercise including minor, moderate and vigorous leisure-time physical activity (which is implied in the concept of exercise). While numerous studies have focused on vigorous exercise, even a small amount of exercise is believed to be better than a sedentary lifestyle (US Department of Health and Human Services, 1996).

Therefore, our measure of regular exercise may be a more informative indicator of regular physical activity as it pertains to general health.

Independent Variables

At the individual level, we control for *age*, *gender*, *race/ethnicity* (White, Black, and Latino), *marital status* (married/cohabitating versus other), *education* (6 levels), and *annual household income* (10 levels). Table 1 illustrates the descriptive statistics for these individual-level variables.

Neighbourhood SES is measured by several variables. Neighbourhood *affluence* is operationalised as the percentage of neighbourhood residents with household annual incomes of

\$50 000 and over. Neighbourhood *poverty* is indicated by the percentage of households in a neighbourhood that were below the Federal Poverty Threshold (the average poverty threshold for a household of 4 persons was \$13 359 in 1990). Neighbourhood *education* is represented by the percentage of college-educated residents. In order to capture the prevalence of welfare dependency and the prevalence of households likely to be in social and economic distress, we also include *the percentage of households on public assistance* and *the percentage of female-headed households* in the study. The five census-based variables are highly correlated and are thus combined into a composite index labelled *deprivation index*, weighted by

Table 1. Descriptive statistics for individual-level variables (MCIC—MS: 1996)

Variables	Proportions/mean	Standard deviation
<i>Dependent variable (physical activity)</i>		
Exercise regularly	0.63	0.48
<i>Independent variables (socio-demographic background)</i>		
Age	43.92	15.69
Male	0.37	0.48
<i>Race</i>		
White/Other	0.44	0.50
Black	0.43	0.49
Latino	0.13	0.34
Married/Cohabiting	0.40	0.49
<i>Annual household income (\$)</i>		
<10 000	0.10	0.30
≥10 000—<15 000	0.07	0.26
≥15 000—<20 000	0.08	0.28
≥20 000—<25 000	0.08	0.28
≥25 000—<30 000	0.10	0.30
≥30 000—<40 000	0.17	0.38
≥40 000—<50 000	0.14	0.35
≥50 000—<70 000	0.11	0.32
≥70 000—<90 000	0.06	0.24
≥90 000	0.08	0.27
<i>Education</i>		
8th grade or less	0.05	0.22
9–12th grade, no diploma	0.11	0.32
High school graduate	0.17	0.38
Some college	0.32	0.47
College graduate	0.20	0.40
Graduate study or degree	0.15	0.40

Note: N = 907 individuals.

factor loadings that in absolute value range from 0.67 (percentage of college-educated residents) to 0.96 (percentage on public assistance), based on principal component factor analysis. The coefficient alpha is 0.92.

Other aspects of the neighbourhood social environment are measured by survey-based variables (PHDCN—CS). The level of *trust* and *norms of reciprocity* among residents are measured respectively, by single items asking respondents' levels of agreement to the statements "People in this neighbourhood can be trusted" and "People around here are willing to help their neighbours". We specifically test these two components of social capital because we posit that they are the most theoretically relevant constructs among social capital indicators for physical activity.

The *perceived violence* scale is created to reflect the perceived prevalence of armed fights, violent arguments between neighbours, gang fights, sexual assault or rape and robbery or mugging.

The *homicide rate* per 10 000 persons between 1991 and 1993 is included to tap crime exposure within the neighbourhood. The measure of the homicide rate is the empirical Bayes residuals from a two-level Poisson model of the count of homicides between 1991 and 1993 (Bryk and Raudenbush, 1992). Homicide is one of the most reliably measured crimes and signals the potential for victimisation and environmental stress resulting from perceived threats to personal safety (Sampson *et al.*, 1997). Using principal components factor analysis, we construct a composite neighbourhood *social capital index* combining neighbourhood trust, norms of reciprocity, perceived violence and homicide exposure. The factor loadings in absolute value range from 0.75 (perceived violence) to 0.92 (trust). The coefficient alpha is 0.83. All neighbourhood variables are standardised in the statistical analysis.

Analytical Strategy

To construct the perceived violence scale from the PHDCN—CS we used the econometric method. This aggregation process of assessing

ecological properties of neighbourhoods based on survey data employs a three-level item response model correcting for measurement error, missing data and response bias. A detailed description of this method has appeared elsewhere (Browning and Cagney, 2002; Sampson *et al.*, 1997). In addition to this approach, we used factor analyses to construct the deprivation index and the social capital index.

After data construction, we fit a series of random effect logit models to test our hypotheses. The number of duplicate cases within each neighbourhood ranges from 1 to 17 with an average of 4. We also ran logit models without random effects. Although the results from the two approaches were similar due to a low within-neighbourhood correlation, we decided to report findings based on the more conservative random effects models.

Results

Table 2 is a matrix that illustrates zero-order correlations among the neighbourhood-level variables, all of which are standardised. All the correlation coefficients have p-values smaller than 0.0001 (two-tailed test) and are consistent with theoretical expectations. Neighbourhood affluence and education are positively associated with neighbourhood trust and norms of reciprocity. They are negatively linked to perceived violence and homicide rates and other neighbourhood disadvantage indicators such as poverty and percentage of households on public assistance.

Table 3 presents the results testing the associations between neighbourhood SES indicators and physical activity. Controlling for individual socio-demographic factors, neighbourhood affluence (p-value <0.05) and education (p-value <0.05) have positive influences on physical activity, whereas poverty (p-value <0.05), percentage of households on public assistance (p-value <0.05), prevalence of female-headed households (p-value <0.01) and the deprivation index (p-value <0.01) are negatively correlated with physical activity. For example, a one standard deviation (SD) increase in the

Table 2. Correlation matrix of neighbourhood-level variables

	1	2	3	4	5	6	7	8	9
1. Neighbourhood affluence ^a	1.00								
2. Neighbourhood poverty ^b	-0.76	1.00							
3. Neighbourhood education ^c	0.65	-0.47	1.00						
4. Percentage of female-headed households (HHs)	-0.63	0.81	-0.62	1.00					
5. Percentage of HHs on public assistance	-0.69	0.93	-0.55	0.93	1.00				
6. Neighbourhood trust ^d	0.73	-0.71	0.39	-0.60	-0.65	1.00			
7. Norms of reciprocity ^d	0.63	-0.58	0.31	-0.47	-0.52	0.82	1.00		
8. Perceived violence ^d	-0.64	0.72	-0.36	0.63	0.69	-0.71	-0.60	1.00	
9. Homicide rate (1991–93) ^d	-0.66	0.78	-0.50	0.81	0.82	-0.68	-0.48	0.72	1.00

^aNeighbourhood affluence was measured by the percentage of household with annual family income over \$50 000.

^bNeighbourhood poverty was measured by the percentage of households in poverty in a neighbourhood.

^cNeighbourhood education was measured by the percentage of college-educated people.

^dHigher scores in neighbourhood trust, norms of reciprocity, perceived violence and homicide rate indicate higher stock in these social resources or hazards at the neighborhood level.

Notes: *N* = 242 neighbourhoods. All correlation coefficients have *p*-values smaller than 0.0001 (two-tailed test).

percentage of affluent families is associated with a 23 per cent higher likelihood of exercising regularly at the individual level (Table 3, model 3), whereas a one SD decrease in the deprivation index is associated with a 35 per cent higher likelihood of exercising regularly (Table 3, model 8). Moreover, the effects of neighbourhood SES indicators seem to be greater than the effect of individual annual household income. For example, the odds ratio for household income and the neighbourhood deprivation index are 1.08 and 0.74 respectively (Table 3, model 8) and the probability of this difference being not different from zero is only 0.0002 according to the Wald test. We then test interaction effects of neighbourhood deprivation with age, gender, race/ethnicity, education and household income. We find an interaction effect of neighbourhood deprivation with gender (*p*-value <0.01) and present this result in model 9 (Table 3). Apparently, the negative effect of neighbourhood deprivation is remarkably stronger for women than for men and controlling for this interaction effect renders the deprivation index's main effect even greater. No other interaction effects that have *p*-values smaller than 0.05 are found.

Table 4 illustrates the results of examining the impact of neighbourhood social context

on physical activity. Two sub-components of social capital—neighbourhood trust and norms of reciprocity—have positive effects on physical activity and the probability of these effects not being different from zero is smaller than 10 per cent. The effect sizes of the two variables are comparable, with a 39 per cent and 45 per cent increase in the likelihood of exercising regularly associated with a one SD increase in neighbourhood trust and norms of reciprocity respectively (Table 4, models 3 and 4). As for social hazards, here captured by violence and crime, the data show that the homicide rate between three to five years ago has a negative effect (*p*-value <0.05) on individual physical activity. A one SD increase in the homicide rate corresponds to a 27 per cent decrease in the likelihood of exercising regularly (Table 4, model 6). Interestingly, perceived violence in the neighbourhood does not have an impact that has a *p*-value smaller than 0.05, although the effect is in a negative direction, as expected. Overall, the social capital index effect appears positive (*p*-value <0.05), suggesting that residents of neighbourhoods characterised by high levels of trust and norms of reciprocity and low levels of violent crime are more likely to engage in regular exercise (Table 4, model 7). We then test interaction effects of

Table 3. Multilevel logistic model of neighbourhood SES indicators on regular exercise

	Baseline model (1)	Individual SES (2)	Neighbourhood affluence (3)	Neighbourhood poverty (4)	Neighbourhood education (5)	Female- headed HHs (6)	HHs on public assistance (7)	Deprivation index (8)	Interaction with gender (9)
Age	0.99**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Male	1.72***	1.66***	1.67***	1.62***	1.67***	1.61***	1.61***	1.62***	1.66***
Black	0.88	1.35*	1.58**	1.64***	1.62**	2.00***	1.80***	1.89***	1.86***
Hispanic	0.75	1.44	1.59*	1.46	1.63*	1.48	1.44	1.52*	1.45
Married	1.36**	1.21	1.20	1.17	1.29	1.21	1.19	1.20	1.18
Education		1.43***	1.38***	1.38***	1.37***	1.37***	1.37***	1.36***	1.36***
Annual household income		1.11***	1.09**	1.09**	1.10***	1.09**	1.09**	1.08**	1.08**
Neighbourhood affluence			1.23**						
Neighbourhood poverty				0.80**					
Neighbourhood education					1.25**				
Percentage of female-headed households (HHs)						0.74***			
Percentage of HHs on public assistance							0.77**		
Deprivation index ^a								0.74***	0.66***
Deprivation X gender ^b									1.58**

^aDeprivation index is a factor score based on neighbourhood affluence, poverty, education, per cent of female-headed HHs, and per cent of HHs on public assistance.

^bDeprivation X gender is the interaction effect between the deprivation index and gender coded 1 for male.

Notes: *N* = 907 individuals located in 242 neighbourhoods. Odds ratios are presented with 95 per cent confidence intervals in parentheses. * significant at 10 per cent; ** significant at 5 per cent; *** significant at 1 per cent.

Table 4. Multilevel logistic model of neighbourhood social capital indicators on regular exercise

	Baseline model (1)	Individual SES (2)	Neighbourhood trust (3)	Norms of reciprocity (4)	Perceived violence (5)	Homicide rate (6)	Social capital index (7)	Interaction with gender (8)	Add deprivation effects (9)
Age	0.99**	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Male	1.72***	1.66***	1.69***	1.69***	1.65***	1.66***	1.68***	1.68***	1.66***
Black	0.88	1.35*	1.57**	1.47**	1.51**	1.90***	1.66**	1.68***	1.89***
Hispanic	0.75	1.44	1.52*	1.52*	1.49	1.57*	1.55*	1.48	1.46
Married	1.36**	1.21	1.18	1.18	1.20	1.19	1.17	1.16	1.17
Education		1.43***	1.41***	1.41***	1.41***	1.40***	1.41***	1.40***	1.36***
Annual household income		1.11***	1.10***	1.10***	1.10***	1.10***	1.09***	1.09***	1.08**
Neighbourhood trust			1.39*						
Norms of reciprocity				1.45*					
Perceived violence					0.89				
Homicide rate (1991–93)						0.79**			
Social capital index ^a							1.20**	1.37***	1.10
Social capital X gender ^b								0.67***	0.85
Deprivation index ^c									0.71**
Deprivation X gender ^d									1.37

^aSocial capital index is a factor score based on neighbourhood trust, norms of reciprocity, perceived violence and homicide rate.

^bSocial capital X gender is the interaction effect between the social capital index and gender.

^cDeprivation index is a factor score based on neighbourhood affluence, poverty, education, per cent of female-headed HHs, and per cent of HHs on public assistance.

^dDeprivation X gender is the interaction effect between the deprivation index and gender coded 1 for male.

Notes: *N* = 907 individuals located in 242 neighbourhoods. Odds ratios are presented with 95 per cent confidence intervals in parentheses. ** significant at 10 per cent; *** significant at 5 per cent; **** significant at 1 per cent.

neighbourhood social capital with age, gender, race/ethnicity, education and household income. Again, only the interaction with gender has a p-value smaller than 0.05, as reported in model 8 (Table 4). The protective effect of neighbourhood social capital is considerably stronger for women; controlling for this interaction term renders the main effect of neighbourhood social capital even stronger. In separate analyses (data not shown), we included an interaction term with gender for every single measure of neighbourhood social capital. When we controlled for the interaction with gender, the probability that the effects of neighbourhood trust and norms of reciprocity are not different than zero is smaller than 0.05 and the probability that the coefficient of the homicide rate is different from zero increases. The last model in Table 4 examines the social capital effect controlling for neighbourhood deprivation and its interaction with gender. The effect of neighbourhood deprivation remains negative, with a p-value smaller than 0.05, while the effect of social context (as captured by neighbourhood trust, norms of reciprocity and crime) is rendered insignificant. The Odds Ratio of the social capital index is reduced 20 per cent in magnitude when the deprivation index and its interaction effect with gender are simultaneously examined in the model (Table 4, from model 8 to model 9).

Individual-level effects are fairly consistent across models. As expected, male sex, education and household income are positively associated with physical activity. The race effect, however, is somewhat surprising. Several models indicate that African Americans have higher levels of regular physical activity than Whites, a finding inconsistent with previous evidence (Ahmed *et al.*, 2005). However, without controlling for SES variables (model 1 in Tables 3 and 4), the effect of Black race is negative, although the probability of this effect being different from zero is not smaller than 0.05. As we add individual-level SES covariates to the model, the effect of Black race becomes positive. Further, the protective effect of Black race is

strengthened when neighbourhood variables are subsequently added to the models. For example, model 8 in Table 3 shows that, after controlling for SES at both the individual and neighbourhood levels, Black Chicagoans are 89 per cent more likely than Whites to participate in regular exercise. This may suggest that the observed pattern where African Americans are less physically active can be explained, in part, by their on average lower levels of educational attainment, household income and residence in more deprived neighbourhoods. On the other hand, this race effect should be interpreted with caution. As in all self-reported measures, it is possible that a systematic bias exists in self-reported physical activity across racial and ethnic groups. The possibility that African Americans systematically over- or under-report physical activity in comparison with Whites due to a social desirability concern warrants investigation; both objective and subjective measures of physical activity should be examined in future work.

Discussion

This study explores whether and how the neighbourhood social and economic environment contextually affects individual physical activity (i.e. regular exercise) in adulthood. In general, the research supports our hypotheses that both neighbourhood SES and other non-SES social constructs are important environmental correlates of physical activity, over and above individual characteristics. These neighbourhood effects are more influential for women's physical activity behaviour than for men's. Moreover, the effects of non-SES social factors seem to be either mediated through or confounded by neighbourhood SES, suggesting that neighbourhood SES may be the key contextual force promoting physical activity.

Because this study focuses on exercise, the reported effects of social environmental factors may be stronger than those for total amount of physical activity including activities for both recreational and instrumental purposes. Research should be conducted to evaluate whether similar patterns hold for

activities that are not meant to increase well-being but simply to meet transport needs. Nonetheless, recreational physical activity is an important outcome because it is typically more structured and more intensive than instrumental physical activity (such as home-based manual work) and thus more beneficial for maintaining muscular strength, cardiovascular and bone health and mental well-being. A better understanding of how social environmental factors contextually affect exercise can facilitate the imperative to increase physical activity, reduce obesity, and improve population health.

As to the impact of neighbourhood socioeconomic resources, our study did not find opposing effects of economic disadvantage and educational disadvantage. As expected, positive aspects of neighbourhood structure, such as concentration of education and affluence, contribute to a higher level of regular exercise, whereas poverty, proportion of female-headed households and prevalence of households on public assistance are all consistently associated with lower levels of regular exercise. Consistent with previous work (for example, Lee and Cubbin, 2002; Yen and Kaplan, 1998), these results suggest that people exercise more in affluent neighbourhoods because of a more desirable environment. However, this pattern was not borne out in Ross' study (2000) where neighbourhood economic disadvantage was positively linked with walking. This discrepancy might be partly due to the different measures of physical activity used in these studies. We need additional evidence and further theoretical development to investigate fully the positive link between neighbourhood poverty and physical activity.

The protective effect of educational resources on health and mortality is fairly consistent. Although the health effect of education may differ across different stages of life, most recent evidence indicates that, controlling for cohort and period effects, the protective effect of education on health is consistent throughout the life-course (Lauderdale, 2001). In fact, education has been viewed as the strongest predictor among SES indicators of individual health practices (Mirowsky

et al., 2000). It is thus plausible that an important pathway underlying the effect of educational resources on health is via healthful lifestyles. Previous work has found that aggregate education had a strong contextual impact on self-rated health (Wen *et al.*, 2003). Unlike the effects of economic resources, this effect could not be explained by local social and service resources. Thus, the question remains as to why educational resources had such a strong effect on health. Based on this research and previous evidence on the health impact of community sub-cultural orientation (Wen and Christakis, 2006), a viable hypothesis is that educational resources promote a healthful lifestyle sub-culture which in turn benefits health. However, the positive effects of educational attainment either at the individual level or at the neighbourhood level are not necessarily apparent in the effects of educationally oriented community-based interventions. For instance, a recent report documented that in a two-year community intervention trial in Eindhoven, The Netherlands, more than 40 intervention activities were implemented yet none had an impact on physical activity among adults aged 18–65 years living in deprived neighbourhoods (Kloek *et al.*, 2006). This case study suggests that knowledge of healthful lifestyles is not easily transferable to behavioural modification. Thus, the routinely observed health impact of educational attainment should not be confused with the effects of educational programmes disseminating health-related information. In fact, despite overwhelming evidence of the impact of education, the explanation for the beneficial effect of formal education, particularly at the aggregate level, remains elusive. The differential pathways linking various aspects of neighbourhood SES to health and health behaviours are worthy of attention in future studies.

Another important finding is that neighbourhood SES has a stronger effect than individual-level income. Most neighbourhood-based research finds stronger effects for individual-level SES variables and smaller effects for

neighbourhood-level SES indicators (Pickett and Pearl, 2001; Robert, 1998). These studies have generally focused on other health outcomes, however. It is possible that individual factors are more proximate in the pathway from social conditions to health, thereby exhibiting a stronger effect. However, for physical activity, a health behaviour determined by multiple and multilevel social environmental forces, the pattern is reversed such that neighbourhood SES exerts a stronger impact than individual income. Certainly, this result simply may be due to statistical artifact. If substantiated by other studies, this finding would have important implications for informing initiatives aimed at enhancing health and well-being.

Previous literature has routinely shown that the long-term effects of behaviour-based or education-based interventions targeted towards improving physical activity are modest (Resnicow and Robinson, 1997). Given this circumstance, considerable attention has turned to physical environmental factors in understanding and tackling physical inactivity, with some promising yet preliminary results showing the importance of the environment. Our research provides further evidence that neighbourhood environment does matter, not only in terms of the design of the built environment (as suggested by previous work in physical activity (for example, Huston *et al.*, 2003), but also via its invisible but palpable social and economic context.

We also found that neighbourhood safety, neighbourly trust and norms of reciprocity were important dimensions of neighbourhood context that affected regular exercise. Although these social capital effects were rendered insignificant in the presence of the neighbourhood deprivation index, these effects should not necessarily be considered spurious or entirely confounded by neighbourhood structure. An alternative explanation is that neighbourhoods where people do not trust or help one another and where violent crimes are prevalent tend to push people with means away—a process directly resulting in a further downward trend of neighbourhood SES and deterioration of neighbourhood conditions. Only longitudinal studies can sort out these causal and

dynamic issues for neighbourhood effects on leisure-time physical activity. That said, social capital does appear to influence an active living lifestyle even if the effect is manifest in an indirect way.

We acknowledge that the effect of neighbourhood social capital on individual health status and behaviour may be complex. For example, the contagion theory and the sub-cultural orientation perspectives contend that one pathway linking place to health is through anomic attitudes and deviant behaviour that may prevail in structurally distressed yet well-integrated communities (Crane, 1991; Fitzpatrick and Lagory, 2000; Wen and Christakis, 2006; Wilson, 1996). Limited evidence has shown an interaction effect between social capital and neighbourhood deprivation (Caughy *et al.*, 2003).

The extent to which neighbourhood constructs interact with individual-level factors merits attention. Despite a voluminous literature on neighbourhood and its relationship to health, we have little consistent evidence to show how neighbourhood effects vary across different sub-groups with different socio-demographic profiles. Conceptually, different sub-groups may have different degrees of exposure to their residential environment. For example, children, older adults and women may spend more time in their local communities due to, for instance, lower rates of labour force participation and stronger attachment to residential areas, so they may be more sensitive to neighbourhood context (Robert, 1999). The effect of neighbourhood characteristics, including neighbourhood SES, may also depend on individual-level SES. Only a handful of studies have examined how neighbourhood effects vary according to individual characteristics, with mixed results (Anderson *et al.*, 1997; Collins *et al.*, 1997; Maas *et al.*, 2006; Merkin *et al.*, 2002; Wen and Christakis, 2005). In this study, we tested a series of interaction effects between key neighbourhood constructs (i.e. deprivation and social capital) and five individual sociodemographic factors: age, gender, race/ethnicity, household income and education. Only the interaction effects with gender have p-values smaller than 0.05, indicating that neighbourhood effects are stronger for

women. While this finding is consistent with our theoretical expectation that women may be more responsive to the neighbourhood environment, additional research is needed to confirm that neighbourhood social and structural environment indeed has stronger influences on women's leisure-time physical activity.

So, taken together, how do these results speak to the active living literature, given its focus on the role of the built environment in physical activity and its reliance on research in urban planning, transport and geography (Humpel *et al.*, 2002; McNeill *et al.*, 2006)? Consistent with a handful of previous studies (Duncan *et al.*, 2002; McNeill *et al.*, 2006; Sundquist *et al.*, 1999), our research suggests that social environmental factors are not negligible but instead vital to the physical activity of adults. However, we do not know the relative role of these factors as compared with those of the built environment. Presumably, the built and social environments are constantly reinforcing and reacting to one another. Evidence suggests that inviting environmental characteristics such as commercial physical activity facilities and public parks or open spaces are less likely to be present in lower-income neighbourhoods, whereas environmental barriers such as crime and signs of disorder (for example, *graffiti* and broken glass) are more likely to be present in deprived neighbourhoods (Powell *et al.*, 2006; Sampson and Raudenbush, 2004; Wen *et al.*, 2005, 2006). How community social capital affects physical features of the built environment is less known. One study showed that persons living in walkable, mixed-use neighbourhoods share higher levels of social capital compared with those living in car-oriented suburbs (Leyden, 2003). We need additional research to reach a better understanding of the ecological relationship between neighbourhood physical design and neighbourhood social organisation. Moreover, perhaps due to the paucity of comprehensive environmental data linked to epidemiological information, little work has been done to evaluate the unique, relative and interactive influences of the built environment and the social

environment on active living. In fact, it would be an exciting elaboration of the current research if the built environment and the social environment could be simultaneously examined.

One policy implication of the research is that the neighbourhood may be a fruitful place to intervene. Neighbourhood deprivation appears to be a key source of neighbourhood effects on physical activity, although other social aspects should not be neglected in the design of interventions. Previous work has reported that economic heterogeneity is beneficial to self-rated health due to the visible presence of affluence in the neighbourhood (Wen *et al.*, 2003). Thus, one tangible strategy is to encourage mixed-income communities in planning, housing and urban policy (Blackman, 2006). Other studies have shown that adult physical activity is significantly predicted not only by SES, but also by physical activity in early life (Yang *et al.*, 1999). Government support of community programmes aimed at monitoring crime and deviant behaviour, promoting an active living lifestyle and supporting youth sports organisations are all examples of public health policies to increase physical activity. This applies not only to children and adolescents but also to adult residents due to a contagion effect.

Three limitations of this study are noteworthy. First, our study is based in Chicago. Our findings are not necessarily generalisable to other areas. Research is needed in other settings, including rural and suburban areas. Further, most research on the environment–physical-activity link has been conducted in Western settings. It is critical to examine environmental correlates of physical activity in other parts of the world. Secondly, while our data allow a temporal sequence from neighbourhood measures to physical activity, our study is cross-sectional. This is a major limitation in the physical activity literature in general. Longitudinal studies are rare and much needed to provide stronger evidence of a causal effect of neighbourhood environment on physical activity. That said, the causality issue is very hard to determine in any observational study design which is limited by problems of omitted variables and selection issues.

Experimental or quasi-experimental studies are thus advantaged in determining how changes in environmental characteristics may lead to changes in physical activity. Thirdly, we used a self-reported item to capture regular exercise. Although self-reported measures of physical activity have been routinely used in the literature (Grzywacz and Marks, 2001; Lindström *et al.*, 2001; Motl *et al.*, 2005; Ross, 2000; Ross and Mirowsky, 2001; Yen and Kaplan, 1998), subjective assessments could impair the accuracy of measured physical activity. However, our measure of regular exercise was based on a one-year time-frame. It is essentially infeasible to use pedometer-based objective measures of physical activity to assess regular exercise during a year. Moreover, the external validity of this measure is ensured to some extent by the fact that our study replicates and extends other findings. Future research should explore whether these social environmental factors are also influential for other types of physical activity.

In conclusion, this research provides preliminary evidence that the neighbourhood social context has an important effect on adult physical activity, particularly among women. It also reveals that neighbourhood SES exerts a stronger effect on physical activity than individual income. This suggests that, to enhance the physical activity level and to help check the obesity epidemic in the US, a joint effort is necessary. That is, it may be necessary to promote individual recognition of the importance of active living while concurrently enhancing the built environment and social structural context to make residential areas more amenable to physical activity. Such interventions are likely to be more rewarding in the long run than those purely focused on changing individual behaviours.

Notes

1. As neighbourhood identifiers, we used the 'neighbourhood clusters' (NCs) provided by the PHDCN—CS as the spatial scale in the analysis. By neighbourhood, the survey protocol stated

We mean the area around where you live and around your house. It may include places

you shop, religious or public institutions, or a local business district. It is the general area around your house where you might perform routine tasks, such as shopping, going to the park, or visiting with neighbors (Morenoff *et al.*, 2001, footnote 3).

As noted in Sampson *et al.*'s work (1997, p. 919), the overriding consideration in the formation of neighbourhoods was that they should be as ecologically meaningful as possible, composed of geographically contiguous census tracts (typically two or three) and internally homogeneous on key census indicators (i.e. SES and racial composition). Cluster analyses of census data also helped to guide the construction of internally homogeneous NCs and the internal homogeneity of NCs has been verified by random-effect analyses of variance producing intracluster correlation coefficients (Sampson *et al.*, 1997).

2. No other data are available to evaluate this prevalence rate of regular exercise obtained from the MCIC—CS in 1996 in the City of Chicago. The only available data on physical activity in Illinois are from the Behavioral Risk Factor Surveillance System (BRFSS) collected by the Centers for Disease Control and Prevention in the US (available at <http://apps.nccd.cdc.gov/brfss>). It showed that 44 per cent of adults in 2003 in Illinois had 30+ minutes of moderate physical activity 5 or more days per week or vigorous physical activity for 20+ minutes 3 or more days per week. Our results show that 63 per cent of Chicago residents in 1996 reported that they exercised regularly in the past year. The discrepancy in the prevalence of physical activity may stem from two sources. First, our data assessed regular exercise in the City of Chicago, whereas the BRFSS focused on the entire State of Illinois. It is possible that leisure-time physical activity is more prevalent in a big city than in less urban areas. Secondly, the exercise question asked in the MCIC—CS loosely referred to all recreational exercises without a strict specification of how many minutes of exercise and for how many times per week. Without such a specification, the concept of 'regular' is likely to capture all minor, moderate and vigorous leisure-time physical activity. It should not be surprising, then, that the prevalence rate of exercise reported in the MCIC—CS is higher than that of the BRFSS in Illinois. In addition, our study replicates previous findings in important ways as shown in the results, suggesting that this measure of leisure-time physical activity has some external validity.

References

- AHMED, N. U., SMITH, G. L., FLORES, A. M. ET AL. (2005) Racial/ethnic disparity and predictors of leisure-time physical activity among U.S. men, *Ethnicity & Disease*, 15(1), pp. 40–52.
- AMESTY, S. C. (2003) Barriers to physical activity in the Hispanic community, *Journal of Public Health Policy*, 24(1), pp. 41–58.
- ANDERSON, R. T., SORLIE, P., BACKLUND, E. ET AL. (1997) Mortality effects of community socioeconomic status, *Epidemiology*, 8, pp. 42–47.
- ATKINSON, R. and KINTREA, K. (2001) Disentangling area effects: evidence of deprived and non-deprived neighbourhoods, *Urban Studies*, 38(12), pp. 2277–2298.
- BLACKMAN, T. (2006) *Placing Health*. Bristol: Policy Press.
- BOURDIEU, P. (1986) The forms of capital, in: J. RICHARDSON (Ed.) *Handbook of Theory and Research for the Sociology of Education*, pp. 241–258. New York: Macmillan.
- BROWNING, C. R. and CAGNEY, K. A. (2002) Collective efficacy and health: neighborhood social capital and self-rated physical functioning in an urban setting, *Journal of Health and Social Behaviors*, 43(4), pp. 383–399.
- BROWNING, C. R. and CAGNEY, K. A. (2003) Moving beyond poverty: neighborhood structure, social processes, and health, *Journal of Social and Health Behavior*, 44(4), pp. 552–571.
- BRYK, A. S. and RAUDENBUSH, S. W. (1992) *Hierarchical Linear Models*. London: Sage.
- CAGNEY, K. A., BROWNING, C. R. and WEN, M. (2005) Race and self-rated health at older ages: what difference does the neighborhood make?, *Journal of Gerontology: Social Sciences*, 60B(4), pp. S193–S194.
- CAUGHY, M. O. B., O'CAMPO, P. J. and MUNTANER, C. (2003) When being alone might be better: neighborhood poverty, social capital, and child mental health, *Social Science and Medicine*, 57, pp. 227–237.
- CENTERS FOR DISEASE CONTROL AND PREVENTION (2001) Physical activity trends—United States, 1990–1998, *Morbidity and Mortality Weekly Report*, 50, pp. 166–169.
- CENTERS FOR DISEASE CONTROL AND PREVENTION (2005) Perceptions of neighborhood characteristics and leisure-time physical inactivity—Austin/Travis County, Texas, 2004, *Morbidity and Mortality Weekly Report*, 54(37), pp. 926–928.
- COLEMAN, J. S. (1988) Social capital in the creation of human capital, *American Journal of Sociology*, 94(Supplement: Organizations and Institutions), pp. S95–S120.
- COLLINS, J. W., HERMAN, A. A. and DAVID, R. J. (1997) Very-low-birthweight infants and income incongruity among African American and White parents in Chicago, *American Journal of Public Health*, 87(3), pp. 414–417.
- CRANE, J. (1991) The epidemic theory of ghettos and neighborhood effects on dropping out and teenage childbearing, *American Journal of Sociology*, 96, pp. 1236–1259.
- CROOMBIE, I. K., KENICER, M. B., SMITH, W. C. and TUNSTALL-PEDOE, H. D. (1989) Unemployment, socioenvironmental factors, and coronary heart disease in Scotland, *British Heart Journal*, 61(2), pp. 172–177.
- DIEZ-ROUX, A. V. (2001) Investigating neighborhood and area effects on health (letter; comment), *American Journal of Public Health*, 91(9), pp. 1487–1493.
- DUNCAN, M. and MUMMERY, K. (2005) Psychosocial and environmental factors associated with physical activity among city dwellers in regional Queensland, *Preventive Medicine*, 40(4), pp. 363–372.
- DUNCAN, S. C., DUNCAN, T. E. and STRYCKER, L. A. (2002) A multilevel analysis of neighborhood context and youth alcohol and drug problems, *Prevention Science*, 3(2), pp. 125–133.
- ELLAWAY, A., MACINTYRE, S. and BONNEFOY, X. (2005) Graffiti, greenery, and obesity in adults: secondary analysis of European cross sectional survey, *British Medical Journal*, 331, pp. 611–612.
- EWING, R. (2005) Can the physical environment determine physical activity levels?, *Exercise and Sport Sciences Reviews*, 33(2), pp. 69–75.
- EWING, R. and CERVERO, R. (2001) Travel and the built environment: a synthesis, *Transportation Research Record*, 1780, pp. 87–114.
- EYLER, A. A., BAKER, E., CROMER, L. ET AL. (1998) Physical activity and minority women: a qualitative study, *Health Education and Behavior*, 25, pp. 640–652.
- EYLER, A. A., MATSON-KOFFMAN, D., VEST, J. R. ET AL. (2002) Environmental policy, and cultural factors related to physical activity in a diverse sample of women: the women's cardiovascular health network project-summary and discussion, *Women and Health*, 36(2), pp. 123–134.
- EYLER, A. A., MATSON-KOFFMAN, D., YOUNG, D. R. ET AL. (2003) Quantitative study of correlates of physical activity in women from diverse racial/ethnic groups, *American Journal of Preventive Medicine*, 25(3, Supp. 1), pp. 93–103.
- FARIS, R. E. and DUNHAM, H. W. (1960) *Mental Disorders in Urban Areas: An Ecological Study of Schizophrenia and Other Psychoses*, 2nd edn. New York: Hafner.
- FERRISS, A. L. (1970) The social and personality correlates of outdoor recreation, *Annals of the American Academy of Political and Social Science*, 389, pp. 46–55.
- FISHER, K. J., LI, F., MICHAEL, Y. and CLEVELAND, M. (2004) Neighborhood-level influences on

- physical activity among older adults: a multilevel analysis, *Journal of Aging and Physical Activity*, 11, pp. 45–63.
- FITZPATRICK, K. and LAGORY, M. (2000) *Unhealthy Places: The Ecology of Risk in the Urban Landscape*. New York: Routledge.
- FORREST, R. and KEARNS, A. (2001) Social cohesion, social capital and the neighbourhood, *Urban Studies*, 38(12), pp. 2125–2143.
- FRANZINI, L., CAUGHY, M., SPEARS, W. and ESQUER, M. E. F. (2005) Neighborhood economic conditions, social processes, and self-rated health in low-income neighborhoods in Texas: a multilevel latent variables model, *Social Science and Medicine*, 61, pp. 1135–1150.
- GILES-CORTI, B. and DONOVAN, R. J. (2003) Relative influences of individual, social environmental, and physical environmental correlates of walking, *American Journal of Public Health*, 93(9), pp. 1583–1589.
- GRZYWACZ, J. G. and MARKS, N. F. (2001) Social inequalities and exercise during adulthood: toward an ecological perspective, *Journal of Health and Social Behavior*, 42(2), pp. 202–220.
- HANDY, S. L., BOARNET, M. G., EWING, R. and KILLINGSWORTH, R. E. (2002) How the built environment affects physical activity: views from urban planning, *American Journal of Preventive Medicine*, 23, pp. 64–73.
- HUMPEL, N., OWEN, N. and LESLIE, E. (2002) Environmental factors associated with adults' participation in physical activity: a review, *American Journal of Preventive Medicine*, 22, pp. 188–199.
- HUMPEL, N., OWEN, N., IVERSON, D. ET AL. (2004) Perceived environment attributes, residential location, and walking for particular purposes, *American Journal of Preventive Medicine*, 26(2), pp. 119–125.
- HUSTON, S. L., EVENSON, K. R., BORS, P. and GIZLICE, Z. (2003) Neighborhood environment, access to places for activity, and leisure-time physical activity in a diverse North Carolina population, *American Journal of Health Promotion*, 18, pp. 58–69.
- ISLAM, M. K., MERLO, J., KAWACHI, I. ET AL. (2006) Social capital and health: does egalitarianism matter? A literature review, *International Journal for Equity in Health*, 5(3), pp. 1–28.
- KAWACHI, I. and BERKMAN, L. F. (2000) Social cohesion, social capital, and health. in: L. F. BERKMAN and I. KAWACHI (Eds) *Social Epidemiology*, pp. 174–190. New York: Oxford University Press.
- KAWACHI, I. and BERKMAN, L. F. (2003) Introduction, in: I. KAWACHI and L. F. BERKMAN (Eds) *Neighborhoods and Health*, pp. 1–19. New York: Oxford University Press.
- KAWACHI, I., KENNEDY, B. P. and WILKINSON, R. G. (1999) Crime: social disorganization and relative deprivation, *Social Science and Medicine*, 48, pp. 719–731.
- KAWACHI, I., KENNEDY, B. P., LOCHNER, K. and PROTHROW-STITH, D. (1997) Social capital, income inequality, and mortality, *American Journal of Public Health*, 87, pp. 1491–1498.
- KEARNS, A. and PARKINSON, M. (2001) The significance of neighbourhood, *Urban Studies*, 38(12), pp. 2103–2110.
- KLOEK, G. C., LENTHE, F. J. VAN, NIEROP, P. W. VAN ET AL. (2006) Impact evaluation of a Dutch community intervention to improve health-related behavior in deprived neighbourhoods, *Health and Place*, 12, pp. 665–677.
- LAUDERDALE, D. S. (2001) Education and survival: birth cohort, period, and age effects, *Demography*, 38(4), pp. 551–561.
- LEE, R. E. and CUBBIN, C. (2002) Neighborhood context and youth cardiovascular health behaviors, *American Journal of Public Health*, 92(3), pp. 428–436.
- LEYDEN, K. M. (2003) Social capital and the built environment: the importance of walkable neighborhoods, *American Journal of Public Health*, 93(9), pp. 1546–1551.
- LI, F., FISHER, K. J., BAUMAN, A. ET AL. (2005) Neighborhood influences on physical activity in middle-aged and older adults: a multilevel perspective, *Journal of Aging and Physical Activity*, 13(1), pp. 87–114.
- LINDSTRÖM, M., HANSON, B. S. and ÖSTERGREN, P.-O. (2001) Socioeconomic differences in leisure-time physical activity: the role of social participation and social capital in shaping health related behaviour, *Social Science and Medicine*, 52, pp. 441–451.
- LOCHNER, K. A., KAWACHI, I., BRENNAN, R. T. and BUKA, S. L. (2003) Social capital and neighborhood mortality rates in Chicago, *Social Science and Medicine*, 56, pp. 1797–1805.
- LOMAS, J. (1998) Social capital and its relevance to health and family policy, *Australian and New Zealand Journal of Public Health*, 23, pp. 424–429.
- LUO, Y. and WEN, M. (2002) Can we afford better health? A study of the health differentials in China, *Health: An Interdisciplinary Journal for the Social Study of Health, Illness and Medicine*, 6(4), pp. 471–500.
- MAAS, J., VERHEIJ, R. A., GROENEWEGEN, P. P. ET AL. (2006) Green space, urbanity, and health: how strong is the relation?, *Journal of Epidemiology and Community Health*, 60, pp. 587–592.
- MACINTYRE, S. and ELLAWAY, A. (2003) Neighborhoods and health: an overview, in: I. KAWACHI and L. F. BERKMAN (Eds)

- Neighborhoods and Health*, pp. 20–42. New York: Oxford University Press.
- MCNEILL, L. H., KREUTER, M. W. and SUBRAMANIAN, S. V. (2006) Social environment and physical activity: a review of concepts and evidence, *Social Science and Medicine*, 63, pp. 1011–1022.
- MERKIN, S. S., STEVENSON, L. and POWE, N. (2002) Geographic socioeconomic status, race, and advanced-stage breast cancer in New York City, *American Journal of Public Health*, 92(1), pp. 64–70.
- MIROWSKY, J., ROSS, C. E. and REYNOLDS, J. (2000) Links between social status and health status, in: C. E. BIRD, P. CONRAD and A. M. FREMONT (Eds) *Handbook of Medical Sociology*, 5th edn, pp. 47–67. Upper Saddle River, NJ: Prentice Hall.
- MORENOFF, J. D., SAMPSON, R. J. and RAUDENBUSH, S. W. (2001) Neighborhood inequality, collective efficacy, and the spatial dynamics of urban violence, *Criminology*, 39(3), pp. 517–560.
- MOTL, R. W., DISHMAN, R. K., WARD, D. S. ET AL. (2005) Perceived physical environment and physical activity across one year among adolescent girls: self-efficacy as a possible mediator?, *Journal of Adolescent Health*, 37(5), pp. 403–408.
- PICKETT, K. E. and PEARL, M. (2001) Multi-level analyses of neighborhood socioeconomic context and health outcomes: a critical review, *Journal of Epidemiology and Community Health*, 55, pp. 111–122.
- POORTINGA, W. (2006) Perceptions of the environment, physical activity, and obesity, *Social Science and Medicine*, 63, pp. 2835–2846.
- POWELL, L. M., SLATER, S. and CHALOUPKA, F. (2004) The relationship between community physical activity settings and race, ethnicity and socioeconomic status, *Evidence-based Preventive Medicine*, 1(2), pp. 135–144.
- POWELL, L. M., SLATER, S., CHALOUPKA, F. J. and HARPER, D. (2006) Availability of physical activity-related facilities and neighborhood demographic and socioeconomic characteristics: a national study, *American Journal of Public Health*, 96(9), pp. 1676–1680.
- RESNICOW, K. and ROBINSON, T. N. (1997) School-based cardiovascular disease prevention studies: review and synthesis, *Annals of Epidemiology*, 7(Suppl.7), pp. S14–S31.
- ROBERT, S. A. (1998) Community-level socioeconomic status effects on adult health, *Journal of Health and Social Behavior*, 39(March), pp. 18–37.
- ROBERT, S. A. (1999) Socioeconomic position and health: the independent contribution of community socioeconomic context, *Annual Review of Sociology*, 25, pp. 489–516.
- ROBINSON, T. N. and SIRARD, J. R. (2005) Preventing childhood obesity: a solution-oriented research paradigm, *American Journal of Preventive Medicine*, 28(Suppl. 2), pp. 194–201.
- ROGERS, E. (1983) *Diffusion of Innovations*. New York: Free Press.
- ROSS, C. E. (2000) Walking, exercising, and smoking: does neighborhood matter?, *Social Science and Medicine*, 51(2), pp. 265–274.
- ROSS, C. E. and MIROWSKY, J. (2001) Neighborhood disadvantage, disorder, and health, *Journal of Health and Social Behavior*, 42(3), pp. 258–276.
- SAELEN, B. E., SALLIS, J. F., BLACK, J. B. and CHEN, D. (2003) Neighborhood-based differences in physical activity: an environment scale evaluation, *American Journal of Public Health*, 93(9), pp. 1552–1558.
- SALLIS, J. F. and OWEN, N. (1999) *Physical Activity and Behavioral Medicine*. Thousand Oaks, CA: Sage.
- SAMPSON, R. J. and RAUDENBUSH, S. W. (2004) Seeing disorder: neighborhood stigma and the social construction of ‘broken windows’, *Social Psychology Quarterly*, 67(4), pp. 319–342.
- SAMPSON, R. J., MORENOFF, J. D. and GANNON-ROWLEY, T. (2002) Assessing ‘neighborhood effects’: social processes and new directions in research, *Annual Review of Sociology*, 28, pp. 443–478.
- SAMPSON, R. J., RAUDENBUSH, S. W. and EARLS, F. (1997) Neighborhoods and violent crime: a multilevel study of collective efficacy, *Science*, 227, pp. 918–923.
- SHAW, C. R. and MCKAY, H. D. (1969) *Juvenile Delinquency and Urban Areas: A Study of Rates of Delinquents in Relation to Differential Characteristics of Local Communities in American Cities*. Chicago, IL: University of Chicago Press.
- SHENASSA, E. D., LIEBHABER, A. and EZEAMAM, A. (2006) Perceived safety of area of residence and exercise: a pan-European study, *American Journal of Epidemiology*, 163(11), pp. 1012–1017.
- SUBRAMANIAN, S., KIM, D. J. and KAWACHI, I. (2002) Social trust and self-rated health in US communities: a multilevel analysis, *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, 79(4, Suppl. 1), pp. S21–S34.
- SUNDQUIST, J., MALMSTROM, M. and JOHANSSON, S. E. (1999) Cardiovascular risk factors and the neighborhood environment: a multilevel analysis, *International Journal of Epidemiology*, 28(5), pp. 841–845.
- US DEPARTMENT OF HEALTH AND HUMAN SERVICES (1996) *Trends in the well-being of America's children & youth: 1996*. Office of

- the Assistant Secretary for Planning and Evaluation, HHS (<http://aspe.hhs.gov/hsp/trends/TOC.HTM>).
- VEUGELERS, P. J. and FITZGERALD, A. L. (2005) Prevalence of and risk factors for childhood overweight and obesity, *Canadian Medical Association Journal*, 173(6), pp. 607–613.
- VOORHEES, C. C. and YOUNG, D. R. (2003) Personal, social, and physical environmental correlates of physical activity levels in urban Latinas, *American Journal of Preventive Medicine*, 25(3, Supp. 1), pp. 61–68.
- WEN, M. and CHRISTAKIS, N. A. (2005) Neighborhood effects on post-hospitalization mortality: a population-based cohort study of the elderly in Chicago, *Health Services Research*, 40(4), pp. 1108–1127.
- WEN, M. and CHRISTAKIS, N. A. (2006) Prospective effect of community distress and subcultural orientation on mortality following life-threatening diseases in later life, *Sociology of Health and Illness*, 28(5), pp. 558–582.
- WEN, M., BROWNING, C. R. and CAGNEY, K. A. (2003) Poverty, affluence, and income inequality: neighborhood economic structure and its implications for health, *Social Science and Medicine*, 57(5), pp. 843–860.
- WEN, M., CAGNEY, K. A. and CHRISTAKIS, N. A. (2005) Effect of specific aspects of community social environment on the mortality of individuals diagnosed with serious illness, *Social Science and Medicine*, 61, pp. 1119–1134.
- WEN, M., HAWKLEY, L. C. and CACIOPPO, J. T. (2006) Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: an analysis of older adults in Cook County, Illinois, *Social Science and Medicine*, 63(10), pp. 2575–2590.
- WEN, M., KANDULA, N. and LAUDERDALE, D. S. (2007) Leisure-time walking in a multiethnic population: what difference does the neighborhood make?, *Journal of General Internal Medicine*, 12.
- WILSON, W. J. (1996) *When Work Disappears*. Chicago, IL: University of Chicago Press.
- YANG, X., TELANA, R., LEINO, M. and VIIKARI, J. (1999) Factors explaining the physical activity of young adults: the importance of early socialization, *Scandinavian Journal of Medicine and Science in Sports*, 9, pp. 120–127.
- YEN, I. H. and KAPLAN, G. A. (1998) Poverty area residence and changes in physical activity level: evidence from the Alameda County study, *American Journal of Public Health*, 88, pp. 1709–1712.