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The anatomy of the safe and social suburb: An exploratory study of the built environment, social capital and residents' perceptions of safety

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Abstract

This study explored the relationship between social capital and aspects of the built environment, focusing in particular on the walkability of suburbs as determined by street network design and the mix of land uses. We measured social capital and feelings of personal safety in 335 residents of three suburbs in metropolitan Perth, WA, and collected objective and perceived data on the built environment. After adjustment for demographic factors, the built environment was found to have a significant but small effect on social capital and feelings of safety, particularly in relation to the number and perceived adequacy of destinations. A high level of neighbourhood upkeep was associated with both higher social capital and feelings of safety.

Keywords: Social capital; Safety; Built environment; Health; Walkability; Mixed use; Upkeep

Introduction

> In the absence of walkable public places—streets, squares, and parks, the *public realm*—people of diverse ages, races, and beliefs are unlikely to meet and talk. (Duany et al., 2001, p. 60)

Escalating research and policy attention to area variability in health has been paralleled by increasing interest in area variations in social capital. This research has been driven from a health perspective, and has encompassed studies of social capital variability between nations (Kennelly et al., 2003; Pollack and von dem Knesebeck, 2004), states (Holtgrave and Crosby, 2003), geographical regions (Veenstra, 2005), and neighbourhoods (Macintyre and Ellaway, 2000; Leyden, 2003; McCulloch, 2003; Altschuler et al., 2004). Social capital is characterized by a diverse array of definitions and research and policy applications, but is commonly described as the features of social life—networks, norms and trust—that enable participants to act together more effectively to pursue shared objectives (Putnam, 1996).

Although sometimes equivocal, a growing body of research indicates that neighbourhood differences

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in social capital remain after adjusting for individual factors such as age, sex, marital status, race and socioeconomic factors such as income and education (Hyyppä and Mäki, 2003; McCulloch, 2003; Subramanian et al., 2003; Sundquist and Yang, 2007). Beneath observed area and neighbourhood variations in social capital, however, are a multitude of environmental factors that might influence social capital formation or decomposition and, in turn, health.

Qualitative research has identified neighbourhood factors such as local resources and services, area history, opportunities for meeting others or for participation, as relevant to the development of trust, norms of cooperation and reciprocity and patterns of mutual aid and information exchange (Cattell, 2001; Baum and Palmer, 2002; Boneham and Sixsmith, 2006). Empirical studies of the nexus between social capital and specific physical attributes of neighbourhoods began to emerge in the literature in the late 1990s (Macintyre and Ellaway, 1998, 1999; and Saegert and Winkel, 1998), but were followed by a relative hiatus in uptake or publication by other researchers. Pertinent empirical studies published more recently include investigations of the relationship between social capital and neighbourhood walkability (Lund, 2002, 2003; Leyden, 2003), housing for seniors (Cannuscio et al., 2003) and social disorganization and physical neighbourhood characteristics (McCulloch, 2003). Providing aesthetic environments conducive to walking (Ball et al., 2001) and opportunities for social interaction (Altschuler et al., 2004) also appear relevant to social capital formation.

Physical environments can facilitate informal neighbouring through the availability of opportunities for casual interaction between neighbours (Baum and Palmer, 2002). There is empirical evidence that chance encounters between residents are explained most significantly by frequency of walking (Lund, 2003), and that walking behaviour is encouraged by positive perceptions of the physical environment (Handy et al., 2002; Lund, 2003; Foster et al., 2004). Other elements that facilitate interaction include meeting places (both formal and informal), mixed use planning and housing design (Cattell, 2001).

Perceptions of safety also affect perceptions of walkability (Baum and Palmer, 2002; Lund, 2002) and actual physical activity (Shenassa et al., 2006), and may therefore mediate the formation of social capital. Previous research has found that positive perceptions of suburb safety encouraged people to interact (Baum and Palmer, 2002), and that people who perceived the walking environment to be safe and interesting were more likely to rate their sense of community highly (Lund, 2002). If people are fearful they may be less likely to go out of their home, use local facilities, attend clubs or functions or interact with strangers or people they meet 'in the street', particularly at night. Moreover, as demonstrated in the fear of crime literature, perceptions can be a powerful and independent factor that may affect people through different pathways than actual experiences (Pain, 2000); hence, residents' perceptions of safety as conveyed by the built environment are also pertinent.

Together, these findings suggest that suburbs without attractive walking destinations, footpaths, or a safe and interesting walking environment, are less likely to provide opportunities for informal interaction. Yet conventional suburban development is characterized by highly segregated land uses, automobile dependence, low levels of street connectivity and a lack of footpaths. Described colloquially as 'urban sprawl', conventional development has been criticized for producing poor health outcomes, particularly regarding obesity (Frank et al., 2004; Lopez, 2004). Using a metropolitan sprawl index, sprawl has been shown to be a predictor of both chronic medical conditions (Sturm and Cohen, 2003) and obesity (Lopez, 2004). Moreover, sprawl has been associated with weaker social ties (Frumkin, 2002) and social isolation (Power, 2001).

Although not couched in the language of social capital *per se*, 'new urbanism' refers to an urban planning paradigm that seeks to promote community bonds (Bothwell et al., 1998), sense of community (Joongsub and Kaplan, 2004) and pedestrian-friendly neighbourhoods (Brown et al., 1998). The key design principles underpinning new urbanism include grid-style interconnected streets, mixed land use, well-designed public buildings and gathering places, high residential density and quality parks and conservation land areas (Deitrick and Ellis, 2004). Of particular interest to this study is the way in which street patterns can divide and connect suburban space, thereby influencing 'where residents can go and what they observe and interact with along the way' (Southworth and Owens, 1993, p. 273).

While developers of new residential developments and urban renewal initiatives often enthusiastically

market 'sense of community', healthy lifestyles and community well-being, there remains a need to better understand the precise mechanisms by which the built environment affects the social dynamics and interactions within neighbourhoods (Herbert and Smith, 1997; Leyden, 2003). Recent research suggests that grid street networks and mixed land use facilitate the formation of social capital (Leyden, 2003) and sense of community (Lund, 2002) because it provides a more 'walkable' environment, thereby facilitating casual interaction between neighbours. Another study by Lund (2003) found that positive environmental perceptions resulted in more walking, and therefore more chance encounters. However, strolling trips (i.e., recreational walking) were more conducive to neighbouring behaviour than were destination trips (Lund, 2003), raising the question as to whether neighbourhoods that encourage utilitarian trips hinder or facilitate the development of social capital.

Such findings also need to be viewed in the context of the measures used. Leyden's measure of walkability was based on the perceptions and ratings of both the researcher and residents of the degree to which neighbourhoods were pedestrian oriented and mixed use. By contrast, our study sought to assess whether the relationship between walkability and social capital holds when objectively measured elements of suburb design are used in the analysis. From our review of the literature, Lund's study published in 2003 (Lund, 2003) is the only other to have included an objective measure of walkability, which entailed simply indicating the presence or not of retail destinations and parks. Further research is required to learn how distinct aspects of the built environment, including the availability and number of key destinations, influence the formation of social capital.

The present exploratory study examined the association between specific, objectively measured aspects of the built environment on social capital and feelings of safety. It also explored the relationships between social capital, feelings of safety and participation in activities within the suburb. The study was conducted in three suburbs in Perth, WA. Perth is a low-density, highly automobile-dependent city (Newman, 1972), but with some traditional neighbourhoods in the inner suburbs. We hypothesized that the elements of the built environment that improve walkability—such as destinations, connectivity and upkeep—would be positively related to social capital and feelings of safety. We also hypothesized that feelings of safety and participation within the suburb would be related to social capital.

Methods

Aims

The main aims of the study were to explore the association between:

- Demographic factors and social capital, feelings of safety and participation in the local suburb.
- Objectively measured environmental variables at the individual level (e.g., walkable destinations proximate to home) and social capital, feelings of safety and participation in the local suburb.[1]
- Street network design and social capital, feelings of safety and participation in the local suburb.[1]
- Neighbourhood level upkeep (maintenance) and social capital, feelings of safety and participation in the local suburb.[1]

Suburbs

The selection of suburbs for inclusion in the study was based on their differentiated street network design and matched as closely as possible for area-based SES (Wood et al., 2005). We compared three suburbs of different street network design: traditional, conventional and hybrid. As depicted in Fig. 1, these suburbs varied on a number of street network characteristics and also in relation to the number of amenities and walkable destinations.

Of the three suburbs, the traditional suburb was the oldest and the closest to the Perth CBD. It features a grid street design, includes a variety of shops and other services and contains a mix of housing styles, including a high proportion of apartments. In the hybrid suburb, the street design is made up of both grid and cul-de-sacs elements. The conventional suburb has a cul-de-sac street network typical of urban sprawl and low residential density. It also contains several small shopping complexes rather than one large regional shopping mall complex as found in the hybrid suburb.

Data collection

This study involved four phases of data collection. *Phase one* entailed formative qualitative

[1]After adjusting for demographic variables.

Suburb	Conventional	Traditional	Hybrid
Suburb street network			
	cul-de-sac and curved layout	predominantly grid layout	mix of grid and cul-de-sacs
Suburb Area (km)	8.98	4.94	5.07
Period developed	1978 onwards through 1980's	1890's onwards	1970's
Number of Cul-de-sacs	304	39	119
Number of 3 way or greater intersections	448	134	267
Intersections per sq. km[1]	49.89	39.27	52.66
Density of cul-de-sacs per sq. km[2]	33.85	7.89	23.47
Shopping Centres	3	2	1
Parks	22	10	22
Daily needs	Bakeries, newsagents, delis	8	7
Food (take away and restaurants)	Restaurants, take-away outlets and food court shops	7	20
Food (suppliers and supermarkets)	Fish markets, butchers, supermarkets, greengrocers, Asian food markets	7	9
Useful amenities	Hairdressers, petrol stations, banks, police stations, vets, post office, child care centres, laundrettes/ dry cleaners	13	16
Retail outlets and other services	Real estate agents, shops, mechanics	15	57
Population	19,846	9786	8111

[1] Intersections per sq. km = number of ≥ 3 way intersections/ area

[2] Cul-de-sacs per sq. km = number of cul-de-sacs / area

Fig. 1. Characteristics of study suburbs.

research in the form of 4 focus groups (12 in total) conducted in each of the three suburbs in October 2000. *Phase two* entailed a random cross-sectional telephone survey of adults with a sample comprising of 113 residents from each suburb (total $n = 339$). The survey was undertaken in April 2002 and eligibility criteria required respondents to be over 18 yr and to have lived in the current suburb for at least 12 months. The survey was administered by telephone in the evening and on weekends to ensure a cross-section of eligible respondents and used a telephone survey sampling method that balances the chances of selecting a mix of gender and age groups (Lavrakas, 1993).

Phase three entailed the extraction of data on the physical environmental characteristics of the study area collected as part of the Study of Environmental and Individual Determinants of Physical Activity (known as SEID II), full details of which have been published elsewhere (Pikora et al., 2002, 2003, 2006). The SEID II study involved an audit of 400 m radii across Perth suburbs using the SPACES audit instrument to measure suburb characteristics at the street-segment level. Data for whole suburbs were not available from SEID II, thus data on three aspects relating to upkeep of the built environment were aggregated to the suburb level for the present study: garden maintenance, street maintenance and

level of cleanliness. Creating suburb-level scores was considered acceptable as there was low variability within each of the suburbs on the maintenance and cleanliness variables.

Phase four involved the collection of environmental data using Geographic Information Systems (GIS). GIS data sets for 2002 of park, reserves, schools, shops and bus stops were provided by the Western Australian Department for Planning and Infrastructure (DPI), while post box locations were provided by Australia Post. The variables extracted from this data are more fully described below.

Variables included in the analysis

Dependent variables

The social capital scale was formed through factor analysis and comprised of factors measuring trust, concern, reciprocity, civic engagement, friendliness and networks (Wood et al., 2005). Appendix A summarizes the items included in the factors making up the social capital scale and the respective reliability statistics. The social capital scale had an ICC of 0.934 in the test–retest reliability and in terms of internal reliability, a Cronbach's alpha of 0.682. While an alpha of 0.7 or higher is considered desirable (Nunnally, 1978; Abramson and Abramson, 1999), it is not uncommon to find published scales with alphas of less than 0.7 (DeVellis, 1991; Perkins et al., 1993; McGuire, 1997), and very few social capital scales published to date report any reliability data.

The participation scale measured participation (yes, no) in 13 community activities (e.g., volunteer work, school-related groups, action groups, religious groups, hobbies and sports) within the suburb of residence. The safety scale comprised of 5 items that measured feelings of safety in various situations within the suburb: within the home, walking alone or with another person during the day and at night, using parks and facilities, within the suburb generally. Respondents rated their agreement on a Likert scale (strongly disagree = 1, strongly agree = 5).

Demographic variables

The data analysis included and adjusted for a number of demographic variables including gender, annual income, whether or not the respondent had dependent children under 18 yr at home, length of residency in the suburb (years), age and dwelling type.

Built environment characteristics

The study included variables collected for individual respondents as well as variables aggregated to the suburb level as summarized in Table 1.

Variables used from the SEID II study included garden maintenance ($\geqslant 75\%$, 50–74% or $\leqslant 49\%$ of gardens well maintained), street maintenance ($\geqslant 75\%$, 50–74% or $\leqslant 49\%$ of verges well maintained) and general cleanliness (none or almost no rubbish, some rubbish or lots of rubbish). Factor analysis indicated that garden maintenance, street maintenance and level of cleanliness were a single construct. Therefore, they were combined into a single scale labelled 'upkeep' (low-level upkeep or high-level upkeep) (Cronbach's alpha = 0.95). A 'street network' variable (traditional, hybrid or conventional) was also included in the analysis given the suburbs were stratified by street design.

For the GIS variables, respondents' homes were geocoded using the street addresses provided in the telephone survey. Road network analysis was conducted using ArcView 3.3 and the ArcView extension 'identify features within distance' to determine the total number of destinations within an 800 m buffer of each respondent's home. The 800 m radius was chosen because it is the standard walkable catchment distance used in new urbanist planning. Finally, 'the multiple closest facilities' extension was used to find the network (by road) distance from each respondent's home to the nearest reserve, school, bus stop and post box. Only shops serving daily needs, i.e., delicatessens, newsagents, corner stores and bakeries, were included in the analysis.

Table 1
Built environment characteristics

Individual level	Suburb level
Dwelling type	Street pattern—traditional, conventional or hybrid
No. destinations <800 m	Garden maintenance
Perceived adequacy of facilities	Street maintenance
Distance to nearest school	Level of cleanliness
Distance to nearest bus stop	
Distance to nearest shop	
Distance to nearest park	
Distance to nearest post box	
Dwelling type	

Analysis

The data were analysed using SPSS version 12. The general linear model (GLM) was used to examine the association between the demographic variables, the characteristics of the physical environment and the dependent variables (i.e., social capital, feelings of safety and participation). The GLM model was chosen because it does not require the data to be normally distributed. It was essential to avoid multi-colinearity as many of the environmental variables were highly correlated. Therefore, each table presents the demographic factors first and then adds the built environment variables either individually or in groups. The GLM is a means comparison model, therefore the results were interpreted by comparing the mean social capital or feelings of safety score for each independent variable against the intercept (overall mean score). Our model assumed a normal distribution with an identity link function. A percentage increase or decrease in social capital or feelings of safety was then calculated to indicate the effect of each independent variable.

Results

Respondents

The study was designed to match the three suburbs as closely as possible by area-based measure of SES. The *socioeconomic indices for areas* (SEIFA) (ABS, 1998) were used to assess socioeconomic status (see Table 2). The SEIFA values for the hybrid and traditional suburbs were comparable and in the lowest quartile of disadvantage. The conventional suburb's indices were slightly higher and in the second lowest quartile, but it was included because it met the other neighbourhood design criteria, and it was difficult to find another suburb with a conventional design with SEIFA values in the lowest quartile only.

As shown in Table 2, there were some significant differences in respondent characteristics. The most significant difference between suburbs was the proportion of respondents who lived in apartments or flats, which was significantly higher in the traditional suburb (35.4%) ($p<0.000$). This suburb also displayed the highest density and a population that was more transient (i.e., 36.6% of respondents reported living in the suburb for only 1–3 yr). More respondents in the conventional suburb reported household incomes over $40,000 and were more likely to have children under 18 living at home. The hybrid suburb appeared to be the most stable population with over half the respondents living in the suburb for 10 or more years. It also had the lowest average household income.

The built environment of the suburbs was significantly different with regard to land use. Table 2 shows that the traditional suburb had the highest mean number of destinations ($p<0.000$), shorter mean distances to bus stops ($p<0.000$), shops ($p<0.000$) and post boxes ($p<0.000$) and the most pedestrian paths. The conventional suburb had the highest mean score for social capital and the highest mean scores for feelings of safety and participation in activities within the suburb. The difference between suburbs was significant for all dependent variables ($p\leqslant 0.001$).

Multi-variate analyses

Correlates of social capital

As shown in Table 3, after adjustment for other demographic factors (Model 1), four demographic variables were significantly associated with social capital: presence of children under 18 yr at home ($p=0.002$), level of income ($p=0.031$), age group ($=0.012$) and dwelling type ($p=0.003$). Having children under 18 yr at home was associated with a mean social capital score 6.6% higher than for those without children. Compared with those aged 18–29 yr, the mean social capital score was higher for all other age groups. Social capital also increased with income, with those earning over $60,000 per year reporting a mean social capital score 7.2% higher than those earning less than $20,000 per year. Respondents living in apartments or flats had a 9.8% lower social capital score compared with those living in a detached house ($p=0.003$), while those living in a townhouse or villa complex had the highest mean social capital score.

Models 2–6 (see Table 3) each contained different environmental variables adjusted for demographic characteristics. Only having children at home and increasing age remained independent predictors of social capital irrespective of built environment factors and length of residency in the suburb. The positive influence of household income attenuated when area-based environmental variables were added to the model (Models 4 and 5). Similarly,

Table 2
Profile of respondent and suburb characteristics

Characteristics	Hybrid ($n = 107$)	Traditional ($n = 113$)	Conventional ($n = 106$)	p-value
Demographics	% Residents in suburb			
Female	67.3	52.2	61.7	0.068
Children under 18 years at home	50.5	11.5	59.1	0.000
Length of residency in suburb:				0.000
1–3 yr	20.6	36.6	15.7	
4–9 yr	26.2	31.0	40.0	
10–15 yr	32.7	12.4	26.1	
15–20 yr	18.7	10.6	15.7	
>20 yr	1.9	9.7	2.6	
Household income:				0.000
<$20,000	30.8	23.9	12.2	
$20,000–$40,000	32.7	31.9	27.0	
$40,000–$60,000	13.1	16.8	25.2	
>$60,000	12.1	23.0	31.3	
Refused or do not know	11.2	4.4	4.3	
Age group:				0.115
18–29	15.9	17.7	19.1	
30–39	20.6	17.7	27.0	
40–49	29.9	26.5	31.3	
50–59	18.7	12.4	11.3	
60 or above	15.0	25.7	11.3	
Dwelling type:				0.000
Detached house	86.9	40.7	92.2	
Duplex	2.8	2.7	5.2	
Townhouse, unit or villa in complex	9.3	21.2	1.7	
Apartment or flat	0.9	35.4	0.9	
Socioeconomic status (SEIFA index)[a]	928.1	939.1	1038.6	
Built environment	Mean score for suburb			
Mean number of destinations <1500 m	125.84	163.07	85.38	0.000
Mean number of destinations <800 m	42.70	57.29	31.23	0.000
Mean adequacy of facilities score[b]	53.84	55.85	55.88	0.067
Mean distance to nearest school[c]	656	820	823	0.003
Mean distance to nearest bus stop[c]	584	214	455	0.000
Mean distance to nearest shop[c]	1234	398	1110	0.000
Mean distance to nearest park or reserve[c]	263	441	490	0.000
Mean distance to nearest post box[c]	1238	423	817	0.000
	Categories[d]			
Street pattern	Hybrid	Traditional	Conventional	
Suburb upkeep	Low	High	High	
Dependent variables	Mean score for suburb			
Social capital[e]	55.30	55.25	60.36	0.000
Feelings of safety[f]	19.30	20.70	22.62	0.000
Participation in activities (no. activities)	1.73	1.33	2.46	0.000

[a]ASEIFA range 884–1102 for Western Australia, quintiles.
[b]Lowest possible agreement = 35, highest possible agreement = 80.
[c]Metres.
[d]Conventional = cul-de-sac street network, traditional = well-connected grid pattern, hybrid = a mix cul-de-sac and grid streets, low upkeep = low overall score for garden and street maintenance, high upkeep = high overall score for garden and street maintenance.
[e]Lowest possible score = 12, highest possible score = 89.
[f]Lowest possible score = 5, highest possible score = 30.

Table 3
Demographic and environmental correlates of social capital[a]

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	β	p	β	p	β	p	β	p	β	p	β	p
Intercept	53.806		59.627		51.683		62.787		61.076		64.693	
Gender (Male[b])		0.657		0.860		0.955		0.787		0.864		0.983
Female	−1.439		−0.170		−0.054		−0.147		−0.164		−0.021	
Children <18 yr at home (no[b])		0.002		0.012		0.007		0.003		0.004		0.010
Yes	3.541		2.854		3.054		3.445		3.297		2.942	
Length of residency (1–3 yr[b])		0.085		0.029		0.042		0.096		0.076		0.039
4–9 yr	1.821		1.567		1.403		1.454		1.360		1.332	
10–15 yr	0.820		0.431		0.262		0.863		0.757		0.397	
15–20 yr	2.002		1.682		1.610		1.706		1.684		1.212	
>20 yr	6.685		7.529		7.092		6.664		6.843		7.386	
Income (<$20,000[b])		0.031		0.026		0.025		0.195		0.175		0.035
$20,000–$40,000	0.511		0.591		0.819		0.145		0.173		−0.011	
$40,000–$60,000	1.003		1.092		0.988		0.150		0.152		0.300	
>$60,000	3.843		3.946		3.928		2.681		2.754		3.402	
Refused or do not know	−1.518		−1.229		−1.399		−1.237		−1.219		−1.739	
Age group (18–29 yr[b])		0.012		0.015		0.020		0.010		0.009		0.006
30–39 yr	2.529		2.220		2.261		2.197		2.275		2.648	
40–49 yr	3.324		3.394		3.434		3.320		3.380		3.742	
50–59 yr	5.823		5.467		5.253		5.753		5.828		6.970	
60 or above	5.144		4.884		4.754		4.884		4.863		5.051	
Dwelling type (detached house[b])		0.003		0.089		0.102		0.027		0.025		0.040
Duplex	−2.974		−2.334		−1.619		−3.114		−3.182		−2.948	
Townhouse/villa in complex	1.376		2.443		2.338		1.511		1.845		1.636	
Apartment or flat	−5.003		−2.180		−2.353		−3.891		−3.630		−3.431	
No. destinations <800 m			−0.146	0.000	−0.141	0.000	−0.151	0.001	−0.131	0.000	−0.200	0.000
Perceived adequacy of facilities					0.146	0.018						
Street pattern[c] (Conventional[b])								0.012				
Hybrid							−3.814					
Traditional							−1.218					
Upkeep[c] (low-level upkeep[b])										0.004		
High-level upkeep									3.080			
Distance to nearest school[d]											0.002	0.984
Distance to nearest bus stop[d]											0.709	0.002
Distance to nearest shop[d]											−0.393	0.028
Distance to nearest park[d]											0.150	0.413
Distance to nearest post box[d]											−0.240	0.081

[a]Dependent variable = social capital (12 = lowest possible score, 89 = highest possible score).
[b]Reference category (social capital adjusted mean or 'intercept').
[c]Measured at suburb level.
[d]100 m units.

the significance of dwelling type attenuated in Model 2 when the number of destinations within 800 m of respondents' homes (an individual-level variable) was added, and attenuated even further in Model 3 when 'perceived adequacy of facilities' was added.

Environmental variables measured at the suburb level were included in Models 4 and 5, and these were both significantly associated with social capital ($p<0.05$). Contrary to our hypothesis, respondents living in a suburb with the conventional street network had a higher mean social capital score

compared with those living in a suburb with a traditional street network, while the hybrid street network was associated with the lowest mean[2] social capital score (Model 4). Respondents who lived in a suburb with a higher level of upkeep had a 5.04% higher mean social capital score compared with those living in a suburb with a low level of upkeep (Model 5).

The number of destinations within 800 m of the respondent's home was negatively related to social capital, although the effect was small. For instance, with each additional 10 destinations within an 800 m buffer, the mean social capital score decreased by 2.5%. The association between social capital and destinations within 400 m was examined but was not significant (not shown). Model 3 shows that as the perceived adequacy of local facilities increased, social capital also increased slightly.

In Model 6, distances to specific destinations were examined. The distance to the nearest bus stop was negatively associated with social capital ($p = 0.002$) while the distance to the nearest shop was positively associated ($p = 0.028$). With each additional 100 m between homes and the closest bus stop, the mean social capital score increased by 1.04%, suggesting that proximity to bus stops negatively influenced social capital. Conversely, with each additional 100 m between homes and the closest shop, social capital decreased by 0.6%, indicating that proximity to a local shop had a positive effect on social capital.

Correlates of feelings of safety

Gender, household income and dwelling type were significant correlates of feelings of safety after adjustment for other demographic factors (Model 1) (see Table 4). Males reported a mean feelings of safety score 9.9% higher than females ($p < 0.000$). Feelings of safety were lowest among middle income earners and highest among high-income earners ($p = 0.003$); however, the difference between these groups was small. Those living in a detached house felt more safe than those living in a duplex, townhouse or apartment ($p = 0.023$).

Models 2–6 incorporated the environmental correlates either individually or in groups. The results for each model are depicted in Table 4. Gender and income remained significant predictors of feelings of safety in all models after adjustment for various aspects of the built environment. Overall, females reported feeling less safe, and feelings of safety generally increased with income. Although dwelling type was significantly associated with feelings of safety in Model 1, its significance attenuated when the number of destinations within 800 m was added (Model 2), and further still when adequacy of facilities was added (Model 3).

The suburb-level environmental variables were both significant predictors of feelings of safety (Models 4 and 5). Respondents living in well-kept suburbs reported a mean feelings of safety score almost 10% higher than those in poorly kept suburbs (Model 5). Respondents living in the traditional and hybrid suburbs reported feeling less safe than respondents living in the conventional suburb (Model 4). For the individual-level built environment variables (Model 6), post boxes were the only destination type significantly associated with feelings of safety. The relationship was positive, i.e., as the distance between the post box and the respondent's home increased, the mean feelings of safety score decreased.

Associations between social capital, feelings of safety and civic participation

Table 5 examines associations between social capital, feelings of safety and participation in activities within the suburb, controlling for demographic factors. The results show that social capital was positively associated with feelings of safety, and vice versa, indicating a two-way relationship. Similarly, there appeared to be a positive two-way relationship between social capital and participation in local activities. However, there was no relationship between feelings of safety and participation ($p > 0.05$) (not shown).

After adjusting for feelings of safety and civic participation, only age group and dwelling type significantly predicted social capital. Neither length of residency nor income was independently associated with social capital. Nor was having children under 18 yr at home when participation in activities within the suburb was included in the model.

Discussion

The main objective of this study was to examine the effects of objectively measured built

[2]Reference category (social capital adjusted mean or 'intercept').

Table 4
Demographic and environmental correlates of feelings of safety[a]

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	β	p	β	p	β	p	β	p	β	p	β	p
Intercept	21.783		23.535		17.420		23.369		24.659		25.467	
Gender (Male[b])		0.000		0.000		0.000		0.000		0.000		0.000
Female	−2.148		−2.067		−1.978		−2.075		−2.062		−1.948	
Children <18 yr at home (no[b])		0.734		0.965		0.806		0.695		0.540		0.601
Yes	0.183		−0.024		0.130		0.209		0.320		0.277	
Length of residency (1–3 yr[b])		0.390		0.294		0.279		0.560		0.578		0.525
4–9 yr	0.151		0.075		−0.051		−0.158		−0.086		−0.087	
10–15 yr	−0.828		−0.945		−1.075		−0.772		−0.692		−0.677	
15–20 yr	−0.911		−1.007		−1.062		−1.022		−1.005		−1.076	
>20 yr	−0.072		0.182		−0.152		−0.214		−0.349		0.102	
Income (<$20,000[b])		0.003		0.003		0.003		0.009		0.009		0.004
$20,000–$40,000	−1.261		−1.237		−1.062		−1.540		−1.561		−1.567	
$40,000–$60,000	−0.405		−0.378		−0.457		−1.106		−1.107		−0.905	
>$60,000	0.109		0.140		0.126		−0.730		−0.785		−0.534	
Refused or do not know	−3.182		−3.095		−3.225		−3.074		−3.087		−3.254	
Age group (18–29 yr[b])		0.384		0.381		0.297		0.219		0.254		0.258
30–39 yr	0.264		0.171		0.202		0.271		0.213		0.304	
40–49 yr	−0.289		−0.267		−0.236		−0.233		−0.278		−0.318	
50–59 yr	−0.055		−0.162		−0.326		0.175		0.008		0.012	
60 or above	−0.352		−1.430		−1.530		−1.463		−1.447		−1.437	
Dwelling type (House[b])		0.023		0.105		0.187		0.001		0.007		0.011
Duplex	−2.951		−2.758		−2.211		−3.468		−3.415		−3.169	
Townhouse/villa in complex	−1.252		−0.930		−1.011		−1.143		−1.394		−1.608	
Apartment or flat	−1.422		−0.572		−0.704		−1.499		−1.696		−1.575	
No. destinations <800 m			−0.044	0.010	−0.040	0.018	−0.017	0.423	−0.033	0.051		0.012
Perceived adequacy of facilities					0.112	0.000						
Street pattern[c] (Conventional[b])								0.000				
Hybrid							−1.855					
Traditional							0.918					
Upkeep[c] (Low-level upkeep[b])										0.000		
High-level upkeep									2.389			
Distance to nearest school[d]											0.072	0.175
Distance to nearest bus stop[d]											0.118	0.270
Distance to nearest shop[d]											−0.091	0.275
Distance to nearest park[d]											0.151	0.079
Distance to nearest post box[d]											−0.180	0.006

[a]Dependent variable = feelings of safety (5 = lowest possible score, 30 = highest possible score).
[b]Reference category (feelings of safety adjusted mean or 'intercept').
[c]Measured at suburb level.
[d]100 m units.

environment factors on social capital. The results shed some light on the potential for new suburbs to create social capital, and for the built environment of existing suburbs to be modified to improve social capital. Urban design approaches such as new urbanism frequently advocate a mix of land uses, including a range of destinations within walking distance. However, the results of this study suggest that 'more is not necessarily better' and that there may be an optimum number of destinations required to generate feelings of safety and social capital, with greater consideration needed to be given also to the type and quality of destinations rather than simply the quantity.

Table 5
Associations between dependent variables controlling for demographic characteristics

	Social capital[a]		Feelings of safety[b]		Participation[c]	
	β	p	β	p	β	p
Intercept	36.772		13.370		−2.645	
Gender (male[d])		0.174		0.000		0.429
Female	1.223		2.079		−0.180	
Children <18 yr at home (no[d])		0.382		0.482		0.000
Yes	0.934		−0.377		1.380	
Length of residency (1–3 yr[d])		0.169		0.287		0.542
4–9 yr	0.745		−0.136		0.504	
10–15 yr	0.744		−0.958		0.330	
15–20 yr	1.908		−1.225		0.267	
>20 yr	5.176		−1.121		0.443	
Income (<$20,000[d])		0.072		0.011		0.708
$20,000–$40,000	1.291		−1.341		−0.043	
$40,000–$60,000	1.668		−0.560		−0.337	
>$60,000	3.743		−0.491		−0.336	
Refused or do not know	0.671		−2.944		0.000	
Age group (18–29 yr[d])		0.001		0.087		0.722
30–39 yr	2.163		−0.132		−0.097	
40−49 yr	3.476		−0.808		−0.291	
50–59 yr	5.788		−0.964		−0.495	
60 or above	5.526		−2.157		−0.163	
Dwelling type (house[d])		0.008		0.055		0.579
Duplex	0.283		−2.482		−0.695	
Complex	2.301		−1.466		−0.227	
Apartment or flat	−3.584		−0.639		0.100	
Feelings of safety	0.622	0.00	–	–	0.001	0.969
Social capital	–	–	0.156	0.000	0.093	0.000
Participation in activities within suburb	1.457	0.000	0.004	0.969	–	–

[a]Social capital: 12 = lowest possible score, 89 = highest possible score.
[b]Feelings of safety: 5 = lowest possible score, 30 = highest possible score.
[c]Participation: number of activities.
[d]Reference category.

Social capital

In contrast to previous studies, we found no relationship between length of residency and social capital in the adjusted models (Riger et al., 1981; Halpern, 1995; Farrell et al., 2004; Ziersch et al., 2005). After adjusting for demographic and built environment factors, social capital was associated with increasing age and having children under the age of 18 at home. While this may appear contradictory, our findings are similar to those reported by Lund (2003). Social capital has been shown to increase with age in a number of other studies (Putnam, 1996; Cooper et al., 1999; McCulloch, 2003). One proffered explanation is that the relationship between age and social capital could reflect either a decrease in social capital in younger generations or changing perceptions of area over an individual's life course (Cooper et al., 1999). It is also plausible that the factors that influence participation, trust and relationship formation within suburbs vary across the age spectrum. For instance, one of the mechanisms through which children influence social capital appears to be through greater parental participation in activities within the suburb, which is also consistent with previous research (Riger et al., 1981; Lund, 2002).

While it has been suggested that different income groups have varying needs for social capital (Halpern, 1995), our results indicate that one's suburb of residence has more influence on social capital than individual household income. Further investigation is recommended, utilizing multi-level models to assess the relative influence of area versus individual-level socioeconomic factors on social capital.

Of the individual-level environmental variables examined, the number of destinations within 800 m and the perceived adequacy of facilities were independently associated with social capital. Contrary to expectations (Leyden, 2003), we found a negative relationship between the number of destinations and social capital, although the perceived adequacy of facilities and proximity to a shop were positively associated. Lund (2002) also found a negative relationship between destinations and social capital. While the magnitude of change in social capital for these variables was not large, even small differences in suburb-level social capital have been shown to be associated with mental health outcomes in other research affiliated with this study (Wood, 2006).

It is possible that an optimum number and mix of destinations is required to increase social capital, although the perceived adequacy of such destinations or facilities may also be implicated. Our findings suggest that some destination types promote, whilst others discourage, the formation of social capital, perhaps through interaction between residents and possibly due to exposure to traffic. This relationship is clearly complex. For instance, destinations may be concentrated on busy roads or in shopping complexes surrounded by large car parks. One study found that people who lived on busier roads were less likely to know their neighbours (Appleyard, 1978), while another concluded that traffic may be associated with anti-social behaviour among young people that results in social exclusion (Mullan, 2001). This relationship requires further investigation, including measuring both objective and perceptual aspects of traffic volumes. Further investigations will assist in developing a better understanding of the optimal number, distribution and mix of destinations that may promote social capital.

In our data, the number of destinations and adequacy of facilities appeared to be more important as a predictor of social capital than dwelling type. Nonetheless, the idea that an optimal dwelling type mix or dwelling density exists should not be ruled out and requires further investigation. Higher urban density in cities, for example, has been found to be associated with increased walking (Atkinson et al., 2005) and reduced social segregation (Burton, 2000). Dwelling densities are likely to bear a relationship with levels of mixed use planning and it is not yet entirely clear how much influence each of these factors has on social capital.

Our results suggest that higher suburb upkeep is associated with higher levels of social capital. However, a study of a larger number of suburbs would be required to confirm this finding. Also, causation remains unclear, i.e., does good upkeep create social capital, or do residents with good social capital take a greater interest in the presentation of their homes? Broken windows theory suggests that the built environment reflects social norms, portraying a message about the kind of behaviour tolerated within the suburb (Cohen et al., 2000). There may be a mutually reinforcing relationship between social capital and suburb upkeep, and further research might examine whether interventions designed to improve upkeep also improve social capital.

Feelings of safety

After adjustment for suburb, the initial association between feelings of safety and the number of destinations was no longer significant. This suggests that it may not be the number of destinations that influences feelings of safety, but rather the suburb itself. As the perceived adequacy of facilities increased, feelings of safety also increased, however, suggesting that the provision of facilities of an appropriate type and quality is beneficial to perceptions of safety.

Further investigation is required to ascertain whether it is the overall SES of the suburb, or some other factor, that affects feelings of safety. One qualitative study found that in low-income, high-unemployment areas, destinations were perceived as unsafe and large shopping centres were seen as impersonal and therefore detrimental to community cohesion (Baum and Palmer, 2002). This supports the notion that it is the quality of destinations in the suburb, rather than the quantity, that affects feelings of safety.

A high level of upkeep was associated with both a higher mean score for feelings of safety and social capital. There may therefore be a relationship between these three variables, with upkeep as the

mediating factor between social capital and feelings of safety. A study of small-town upkeep in the US found a significant relationship between upkeep and community involvement, although the direction of the relationship was unclear (Rice and Miller, 1999). Further research is required to understand this relationship; however, a useful hypothesis may be that upkeep improves feelings of safety, and will lead to an increase in social capital.

Overall, these findings, whilst exploratory and not without limitations (see below), suggest that there may be scope to improve social capital through the medium of suburban environments, particularly in newer suburbs that do not have their infrastructure fully established. However, further investigation is needed to elucidate which elements of urban form will have the most significant impacts on social outcomes. There may also be scope to improve perceptions of safety in suburbs. Our results suggest that improving both the quality of destinations and the upkeep of the suburb will go some way to creating a safer suburb. Given the two-way relationship between social capital and feelings of safety, these improvements may also improve social capital, perhaps through increased walking within the suburb. Further study of mediating relationships is required to better understand which improvements would affect both social capital and feelings of safety.

Limitations

The present study has a number of limitations that could be addressed in future studies. An assessment of causality was limited by the cross-sectional nature of this study, and by the small number of suburbs included. A larger number of suburbs would have enabled greater adjustment for suburb-level variables in multi-level analyses. The study was also limited to suburbs with similar SES. A more differentiated suburb selection would have enabled a better understanding of the role played by SES. The inclusion of an area level measure of SES would also have strengthened the analysis.

Walter's formula for computing sampling (Walter et al., 1998) was used to derive the sample size of 339. As the sample size was not large, this did contribute to larger confidence intervals when adjustment was made for multiple confounding factors (Pollack and von dem Knesebeck, 2004). Nonetheless, the sample size did yield sufficient power for the purposes of the research, with the study's final power computed to be 99.8% (Dupont and Plummer, 1997) based on the difference detected between suburbs on the social capital scale. The response rate of 34.3% and the associated potential for non-response bias is a limitation of the study, although it was within the range of those obtained in similar telephone surveys (Saguaro Seminar, 2000; Stone and Hughes, 2002; O'Brien et al., 2004). Validity is strengthened if the sample is representative of the population from which it is drawn (Lund, 2002) and the study sample did correspond to the Western Australian population on a number of key demographic and residency characteristics (Wood, 2006).

The limitations of aggregated individual data as a measure of social capital at the collective suburb level are much debated in the literature. This limitation was countered where possible within the constraints of the study design. For example, some items within the social capital scale had a community level attribution while others were deliberately couched in terms of individual perceptions or experiences. Moreover, as argued by others, social capital as invested in individuals is not mutually exclusive from a collective perspective (Macinko and Starfield, 2001; Pollack and von dem Knesebeck, 2004). While the multiple source of data is one of the strengths of the study, the associated limitation is that not all data were collected simultaneously. Most of the data used in this analysis were, however, collected to coincide with the survey period of 2002. While the upkeep measures were derived from an earlier study, there was no evidence (as assessed by the chief investigator through visitations to the suburbs) of major changes on relevant variables that would affect the accuracy of the upkeep measures.

More sophisticated multi-level modelling techniques for clustered data would have strengthened the study methodology and findings and furthered the understanding of the amount of neighbourhood variation attributable to individual versus contextual characteristics (Lindström et al., 2002; O'Campo, 2003; Oakes, 2004; Poortinga, 2006). Promising methods for more explicitly testing the mediating effect of suburb design and characteristics on the relationship between social capital and health include path analysis (Ziersch et al., 2005), sequential regression techniques (Bauman et al., 2002) or structural equation modelling (Masse et al., 2002).

Given that at least one study has found that sense of community mediates the relationship between suburb stability (marital status and residential

mobility) and residents' well-being (Farrell et al., 2004), suburb stability measures should be considered in future studies. Other additional variables that could have usefully been collected or included in the analysis include income homogeneity within suburbs, objectively measured traffic volumes and perceptions of traffic volumes.

Conclusion

The relationship between demographic factors, the built environment, social capital and perceived safety makes for a complex anatomy. It is a relationship that potentially influences health and thus warrants further theoretical consideration and empirical exploration. While demographic factors on their own also influence social capital, and indeed health, the demographic make-up of suburbs is generally not very amenable to intervention. However, the built environment appears also important and potentially modifiable, with shops nearby (but not too many), and suburb upkeep being positive aspects of the anatomy of a suburb conducive to social capital. Contrary to previous studies, the length of time lived in the suburb was found to be of lesser importance in this study after adjustment for other factors. It is plausible that the design and environmental characteristics of suburbs influence the social reality of new residents and warrants further investigation.

The design, composition and quality of the built environment have a role to play in creating safe and socially supportive suburbs. It is important, however, that these are not to be seen as a panacea for social problems. Environmental determinism alone cannot serve as an isolated explanation for either the presence or absence of social capital. Rather, congruent with an ecological view of health, consideration of the interactions between individuals and the socially constructed built and psychosocial environments is required.

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Appendix A. Subscales and item components of the social capital scale shown in Table A.1.

Table A.1

Scale	Component items	Measurement scale	Reliability
Reciprocity	*Activity undertaken* (*a*) *for and* (*b*) *by a neighbour or someone living in suburb in the last year*: Looked after house or garden or collected mail while away Minded, fed or walked their pet Lent them household or garden items or tools Listened to their problems Helped them with odd jobs Provided a lift or transport to shops or school Cared for, or minded, a child or other family member for them	Yes = 1, no = 0 (combined to form reciprocity scale, scored 0–14)	Cronbach's alpha 0.8376 Intraclass correlation 0.9231
Trust	*Generally, to what extent do you agree that you can trust*: Most people living in your section of your street or block Most people living in your suburb Most people generally	5 point Likert: 1 = strongly disagree, 5 = strongly agree (combined to form scale 1–15)	Cronbach's alpha 0.6011 Intraclass correlation 0.8033
Friendliness	*Characteristics of this suburb*: People who live here usually say hello to each other if out walking or in their gardens Neighbours are often seen chatting to each other A stranger moving into this suburb would be made to feel welcome	5 point Likert: 1 = strongly disagree, 5 = strongly agree (combined to form scale 1–15)	Cronbach's alpha 0.6404 Intraclass correlation 0.8621

Table A.1 (*continued*)

Scale	Component items	Measurement scale	Reliability
Civic engagement	*Involvement in following in suburb in the past year*: Attended a local council meeting Voted in local council election Written or spoken to council about a local issue Contacted your local state or federal member of parliament Signed a petition Attended a protest or local action meeting Written a letter to the editor of a newspaper about local issue Picked up other people's rubbish in a public place Reported or done something about graffiti or vandalism Made a donation (e.g., of food, money, blood or other)	1 = Yes, 0 = no (combined to form scale, scored 0–10)	Cronbach's alpha 0.597 Intraclass correlation 0.799
Community concern	*Perceptions of community interest and empowerment*: I am interested in local issues that affect this suburb If a local park or facility was to be closed down, people in this suburb would pull together to do something about it It is important for people to get involved in their local suburb	5 point: 1 = strongly disagree, 5 = strongly agree (summed to form scale, scored 1–15)	Cronbach's alpha 0.566 Intraclass correlation 0.704
Support	*Frequency of feelings regarding loneliness and support*: Felt lonely Found it hard to get to know people Wished that you had more help or support from other people	5 point: 1 = never, 5 = always (summed to form scale, scored 1–15)	Cronbach's alpha 0.6176 Intraclass correlation 0.8309
Networks	If you had a serious personal crisis or problem, how many people living within your suburb could you turn to for comfort and support?		n/a

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