An Account of Spatially Based Survey Methods and Recruitment Outcomes

Cancer Prevention Research Centre
School of Population Health
The University of Queensland
Level 3, Public Health Building
Herston Road
Herston Qld 4006
Email: c.swart@uq.edu.au
http://www.uq.edu.au/cprc

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Contents

Physical Activity in Localities and Community Environments (PLACE) Project

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Investigators: Neville Owen[1], Adrian Bauman[2], Graeme Hugo[3], Eva Leslie[1,4]

Project management: Eva Leslie[1,4]

Analysis of GIS data for the Australian Walkability index and sampling frame: Neil Coffee[3].

Data analysis and report preparation: Lorinne du Toit[1], Ester Cerin[1], Eva Leslie[1, 4]

[1]Cancer Prevention Research Centre, School of Population Health, The University of Queensland, Australia
[2]Centre for Physical Activity and Health, School of Public Health, The University of Sydney, Australia
[3]National Centre for Social Applications of Geographic Information Systems, Department of Geographical and Environmental Studies, The University of Adelaide, Australia
[4]School of Health & Social Development, Deakin University, Geelong, Australia

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Introduction

This account provides a description of the methods and outcomes of the Physical Activity in Localities and Community Environments (PLACE) project.

The aim is to make the PLACE project experience available to members of International Physical Activity and the Environment Network (IPEN) and to others who are planning similar studies.

The methods developed for the Australian setting have been based on the study design and measurement protocols from the Neighborhood Quality of Life Study (NQLS) (http://www.nqls.org/) in the USA. The PLACE project has collected spatially referenced area-level and individual-level data, to identify relationships between people's local community environments and their physical activity habits. PLACE was conducted in Adelaide, South Australia during 2003-2004.

A stratified multi-stage cluster sampling strategy was used to select communities defined by geographic information system methods as having high and low walkable environments and high and low socio-economic status. Households within these communities were selected using simple random sampling. Participants were recruited by mailed survey. There were some challenges in using this sampling strategy but it resulted in sufficient numbers of participants to represent the spatial areas in the study.

Aims of the PLACE Study

Responding to a challenging new research agenda, the PLACE study seeks to understand how environmental factors might operate to influence habitual physical activity [1-3]. In the context of the public health goal to increase regular moderate-intensity physical activity, walking is the behaviour that is most likely to be amenable to influence [4]. It is the most common adult non-occupational and non-household physical activity behaviour in Australia [5] and walking in and around local neighbourhoods is an important component of most adults' total physical activity [1, 2]. Attributes of local walking environments are associated with walking for different purposes: in particular, exercise and recreation, or transport.

Research in the fields of transportation, planning, geography and public health aim to understand how aspects of community design may influence physical activity [3, 6]. A recent review summarized a number of studies that have used a high and low walkable community comparison design, with frequency of walking as the outcome [6]. Consistently higher numbers of walking trips have been found to be related to living in high walkable compared to low walkable areas. Studies in the urban planning field are identifying complex issues in regard to how attributes of the built environment may act to influence behaviour [7-9]. There are significant conceptual and methodological challenges for such research [2, 10-12].

We describe below the methods used and report on how effective they were in meeting the requirements of the study's sampling frame for identifying clusters of communities with pre-defined 'walkability' attributes and recruiting participants from randomly selected households in the selected areas.

How was the PLACE study designed?

The PLACE study used a stratified multi-stage cluster sampling strategy. The methods have been developed for the Australian setting based on the study design and measurement protocols from the Neighborhood Quality of Life Study (NQLS) in the USA.

First, it involved selecting communities for:
- high and low walkable environments
- high and low socio-economic status

Secondly, households within these communities were selected using simple random sampling. It was conducted in Adelaide, South Australia during 2003-2004 with approval from the Behavioural and Social Sciences Ethics Committee of the University of Queensland.

Creating the Walkability index

A Walkability Index was calculated at the census collection district (CD) level, for four GIS-derived attributes [3, 7, 13] that have been found to be related to walking:
- dwelling density
- street connectivity
- land use mix
- net retail area

A number of spatial data sets were used. These were the 2001 South Australian Digital Cadastral Data Base (DCDB), 2001 South Australia Land Ownership and Tenure System (LOTS), land use and zoning data, road centreline data, and Adelaide Retail Database.

Using DCDB and LOTS, the South Australian Government Department for Transport and Urban Planning (Planning SA) calculates and allocates a dwelling count to all relevant parcels in South Australia. The CD level dwelling density measure was calculated using this dwelling count. The street connectivity measure was derived from SA Department of Transport road centreline data. Land use and zoning data from Planning SA was used to derive a measure of land use mix based on the distribution of land uses grouped into five broad classes (residential, commercial, industrial, recreation and other) for each CD. The retail opportunity or net retail area, a measure of the retail gross floor space as a ratio of the parcel area, was derived from the Planning SA Adelaide Retail Database. The GIS-derived attributes were summed to create a Walkability Index with a hypothetical range of 4 (lowest) to 40 (highest).

Matching for socio-economic status

Once communities representing the highest 25% and lowest 25% of the Walkability Index had been identified, socio-demographic analysis was undertaken on the basis of census level data. SES was included as a stratification variable because it is inversely related to physical activity in many studies [12], built environment may explain SES inequalities in physical activity, and SES differences have not been systematically examined in previous studies [1, 3].

The primary data source was the ABS 2001 Census of Population and Housing. Socio-economic measures included household income and labour force status. Median household weekly income was used as the primary SES indicator. Property valuations were used to adjust this categorisation since some districts can be income poor but asset rich, most notably those with high proportions of retirees. Some CDs were excluded on the basis of the property valuations to obtain better socio-economic selection. The selection process took account of average age in each CD. Ethnicity was not an element of socio-demographic selection, as with the changes in Australia’s immigration program in the last decade or so, ethnicity is not as strongly associated with SES as it was in the early post war years [14].

Selecting the communities

Thirty-two communities were selected from 2078 urban CDs in the Adelaide Statistical Division. The communities comprised contiguous clusters of CDs that were identified as high or low walkable, and then selected as high or low SES, based on census level data. A total of 156 CDs were represented in these communities. A CD is the smallest administrative unit used by the Australian Bureau of Statistics (ABS) to collect census data [15].

The selected communities were stratified into four study quadrants:

- high walkable/ high SES
- low walkable/ high SES
- high walkable/ low SES
- low walkable/ low SES

This aimed to facilitate comparison of physical activity level of residents possessing similar SES characteristics, but who live in high or low walkable areas (See Tables 1 and 2). The design also allows for examination of how built environment variables may operate differently for people in high and low SES contexts.

Sampling households and selecting participants

The study sample was drawn from residential addresses within the 32 selected communities. Simple random sampling, without replacement, was used to select households from each community using an address list constructed by the GIS methods described above. The study aimed to recruit approximately 2400 participants (75 per community), representing a spatial coverage from the 32 communities. Statistical power analysis indicated that, with such a sample size, low-moderate effects ($\Delta = 0.20 - 0.60$) could be detected with adequate power (0.80), even with an intra-class correlation of 0.10 in community clusters.

Participants were adults, aged between 20 and 65, who resided in private dwellings such as houses, flats or units. Residents of group-living establishments (hotels, nursing homes, hostels and military barracks) were excluded. In households with more than one potentially eligible participant, the person with the most recent birthday was asked to complete the questionnaires. Individuals unable to walk without assistance or to take part in surveys in English were excluded.

Table 1
Sampling frame showing number of CDs and Households per quadrant

Walk / SES	CD	Households
High/High 8 communities	43	7319
High/Low 8 communities	39	7288
Low/High 8 communities	35	7372
Low/Low 8 communities	39	7000
All 32 communities	156	28979

How were participants recruited and data collected?

Participant recruitment and data collection was by mail. Two questionnaires were mailed to eligible participants with a six-month interval between the first and second questionnaire. This was carried out during the period from July 2003 to June 2004. The survey design took into account, as far as feasible, strategies identified as having a positive effect on response rates [16-19]. These included pre-contact and follow-up procedures, questionnaire appearance and the addition of an incentive.

Recruitment of participants took place in three waves of mailing between July and December 2003. For the first two mailings, a letter introducing the study and inviting participation was posted to 250 randomly selected addresses in each community, totalling 8000 households. A coded reply form and prepaid envelope were enclosed. Respondents who declined or were ineligible to participate were logged, as were failed addresses (letters returned by Australia Post). Respondents willing to participate were sent an information sheet, the questionnaire, a token gratuity ($1 lottery ticket) and a reply paid envelope.

Thank-you letters with another gratuity were sent to participants on return of their completed questionnaire, and they were entered into a draw for one of five $300 grocery vouchers. Reminder letters, together with another copy of the survey, were sent to those who had not returned the questionnaire within three weeks. E-mail reminders were sent to those who had provided e-mail addresses.

As the completion rate after four months of data collection was 9.5%, an alternative approach within the budgetary and logistical constraints of the study was applied in the third mailing to try and boost responses. Firstly, the community sampling fraction, the number of households selected per community, varied according to the number of eligible returns already received. It was necessary to increment the household address list by 2,133 possible addresses in four communities in order to provide adequate numbers from which to select. Secondly, the survey package was mailed directly to all 8154 households selected. A trained team of students followed up non-respondents in six low-return communities.

A participant newsletter, including the draw results and reminder to provide address change details, was sent to all participants in February 2004. Contacts arising from this together with the return of undelivered newsletters resulted in 28 people dropping off the participant mailing list for the Survey 2 questionnaire. Data collection for Survey 2 followed the pattern of the original three waves of mailing starting in late February 2004. Enclosed with the second questionnaire were a covering letter, a $1 lottery ticket and reply paid envelope. Those returning completed forms received a Thank-you letter, further $1 lottery ticket and were entered into a second draw for one of five $300 grocery vouchers.

What are the measures of survey participation?

As part of the administration of the study, records were kept of contact and non-contact for each address in the sample. These records also included a unique identifier for each household address linking it to external geographic and Census data. We used the following definitions for calculating key measures of participation [17, 20]:

- Completion rate: the number of eligible persons in each community who completed a survey, as a proportion of the total sample
- Response rate: the number of eligible persons in each community who completed a survey, as a proportion of the effective sample (total sample less failed addresses)
- Non-contact rate: the number of households from which we received no return contact, as a proportion of the number that received the invitation to participate (effective sample)
- Exclusion rate: the number of persons who when contacted were deemed ineligible, as a proportion of the number of successful contacts
- Drop-out rate: The number of persons who initially agreed to participate but failed to return Survey 1 after prompting, as a proportion of the number who agreed to participate (applicable to first and second sampling only for Survey1)

Table 2
Overall recruitment outcome of the PLACE project by study quadrant

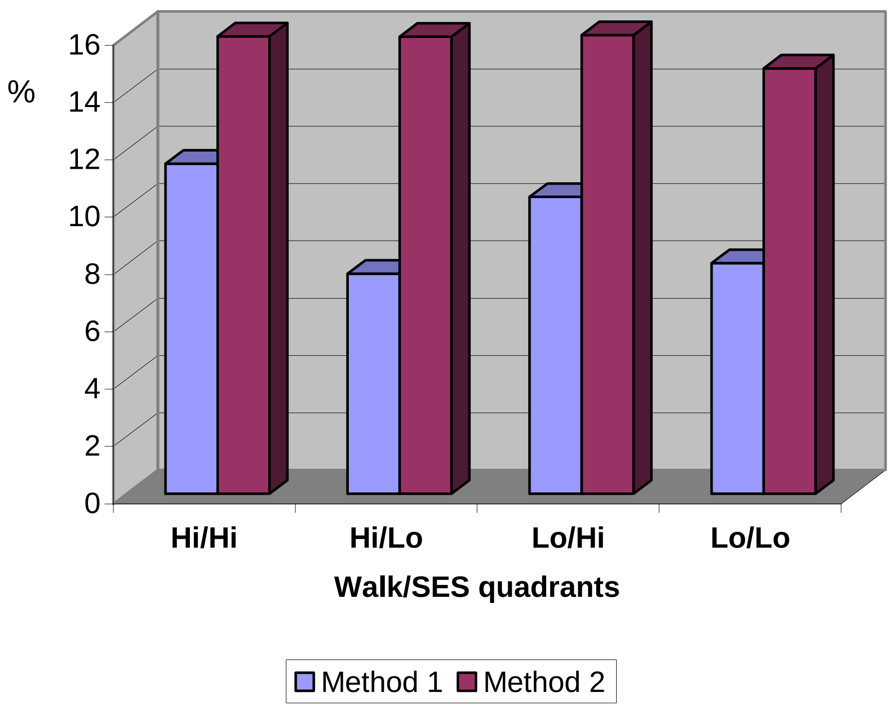
Participation element	High walk/high SES	High walk/low SES	Low walk/high SES	Low walk/low SES	Total
Total household addresses generated	8527	7041	7870	7279	30717
Household addresses mailed (initial sample)	5753	6111	5998	6298	24160
Failed addresses (RTS as % of sample)	558 (9.7%)	206 (3.4%)	136 (2.3%)	132 (2.1%)	1032 (4.3%)
Effective sample (Net mailing)	5195	5905	5862	6166	23128
No contact made (non-contact rate)	4305 (83%)	5081 (86%)	4871 (83%)	5298 (86%)	19555 (85%)
Replied: ineligible/ other -all waves	181	172	250	202	805
Replied: yes, dropped out at Survey 1	43	29	24	20	116
Completed Survey1 (Response rate)	666 (12.8%)	622 (10.5%)	717 (12.2%)	647 (10.5%)	2652 (11.5%)
Moved (% of Survey1 respondents)	45 (7%)	18 (3%)	18 (2.5%)	13 (2%)	94 (3.5%)
Dropped out at Survey 2 (% of Survey 1 respondents)	78 (11.7%)	123 (19.8%)	63 (8.8%)	97 (15%)	361 (13.6%)
Completed Survey2 (%of Survey 1 respondents)	544 (82%)	481 (77%)	634 (88%)	535 (83%)	2194 (83%)

Survey respondents were evenly distributed geographically across the sample communities. The median number of households sampled per CD was 154. The mode was 173 and the range was from a minimum of five to a maximum of 385. The median number of responses per sample CD was 17 and the mode was 12. The number of responses per CD varied from none to 48. This represents a median and mode of 82 responses per community ranging from 62 to 101.

A total of 2652 eligible participants from 154 CD returned the Survey 1 questionnaire. Although five individual communities were slightly short of the target, all four quadrants achieved their target of 600 participants. The return from those completing the survey, as a proportion of those known to have been contacted, was 74.2%.

The overall response rate (those eligible from the effective sample) was 11.5%, ranging from 10.5% in both of the low SES quadrants to 12.8% in the high walkable, high SES quadrant. There were higher levels of response (average of 15.7% compared to 9.4%) using the second method of recruitment (all χ^2 tests significant at $p < .001$). The increase in response rates using the second method was greater for low SES communities (increase of 7.5%) than high SES communities (increase of 5.1%). Response rates for the two main methods of recruitment are shown in Figure 1 below.

Figure 1
Comparison of response rates for Methods 1 and 2



Are there any differences between expected and actual characteristics of the sample by quadrant?

Compared to the 2001 Census data, the survey respondents were more likely to be older, female and in paid work (Table 3; all χ^2 tests significant at $p < .01$). Respondents from high walkable and high SES communities were also more likely to be more highly educated [all χ^2 tests significant at $p < .001$]. Finally, respondents from high SES communities were more likely to have higher income (all χ^2 tests significant at $p < .001$).

Table 3
Comparison of expected and actual quadrant characteristics

Profile items	Quadrant								All	
	High walk/ high SES		High walk/ low SES		Low walk/ high SES		Low walk/ low SES			
	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual	Expected	Actual
Walkability Index	30.6	30.9	25.8	25.9	15.1	15.1	19.1	19.1	n.a.	n.a.
Socio-economic indicators	%	%	%	%	%	%	%	%	%	%
*Age**:										
20-29	31.8	20.3	24.4	15.4	20.2	9.8	24	13.3	25.2	14.6
30-44	32.8	30.9	37.7	35.9	35.1	31	37.1	33.5	35.5	32.7
45-65	35.4	47.1	37.9	47.1	44.7	57.2	39	51	39.2	50.8
Gender*:										
F	46.3	61.9	49.0	64.5	51.9	62.1	50.3	66.2	49.3	63.6
M	53.7	37.5	51.0	34.9	48.1	37.1	49.7	32.6	50.7	35.6
Education#:										
Year 10 or below	19.4	6.2	42.2	30.7	29.9	20.8	45.2	36.8	33.6	23.3
Year 12 or equivalent	34.4	18.3	20.1	32.5	22	31	21.3	36.5	24.8	29.5
Tertiary	33.8	74.3	25.2	34.6	38.7	47	22.4	24.6	30.3	45.5
Not stated	10.8	1.2	9.3	2.3	5.6	1.3	7.5	2.2	8.3	1.7
Labour force status#:										
In paid workforce	55.0	70.8	42	55.5	61.3	67.4	44.8	48.4	51.1	60.8
Household income#:										
<$31,200 p.a.	35.2	21.5	51.3	47.9	29.1	22.2	48.9	52.6	41	35.4
$31,200-77,999 p.a.	33.8	42.9	32.2	37.9	39.0	45.5	35.4	35.9	35.1	40.7
>$77,999 p.a.	22.8	31.5	6.6	7.7	21.9	29.6	5.7	6.1	14.4	19.2

* N for expected = Census Population 20-65; # N for expected = Census Population Over 15

Checking the effectiveness of the stratification

The high walkable quadrants (high walkable/high SES and high walkable/ low SES) showed an adequate level of socio-demographic/SES difference. However, the level of walkability of the two quadrants was not perfectly matched. For instance there was significantly lower walkability in general, lower connectivity, and lower net retail area for the lower SES quadrant, at the CD level. The low walkable quadrants had appropriate socio-demographic profiles at the individual level, but significantly higher dwelling density and higher net retail area, for the lower SES quadrant, at the CD level.

In the high SES quadrants, there were substantial differences in almost all of the socio-demographic/SES measures between high and low walkable environments. In the low SES quadrants, there were no significant differences in socio-demographic/SES measures between high and low walkable environments but the difference in walkability between the two low-SES quadrants was less pronounced than that between the two high SES quadrants.

What are some of the limitations of the methods of the PLACE study?

The sampling strategies described are designed to recruit participants to represent a specific spatial coverage, rather than a general population sample. The sampling frame for PLACE consisted of the private residential addresses located within the 32 communities that were selected, using GIS-derived data, to represent high and low walkable environments, as well as high and low SES. The initial address list for random household sampling was constructed from the relevant land registry data set for the state of South Australia (2001 LOTS). This method resulted in sufficient numbers and distribution of participants from each of the geographically defined areas, and avoided some of the socio-economic biases that telephone or other directories can introduce. However, the process for selecting neighbourhood-level and individual-level units for each stratum was not straightforward.

Defining ‘communities’ for the purposes of the study

During the preliminary stage of community selection, the borders of the spatial units defining communities coincided with the boundaries of the outer CD in each community cluster. It has been argued that administrative divisions may not define the physical or perceived boundaries of neighbourhoods or the contextual factors under investigation [21, 22]. While census and other routinely collected area level data are linked to administrative units, during sampling for this study attention was paid to local knowledge about community boundaries. The research team (including an urban planner and a demographer with considerable local knowledge) carried out several field trips to directly examine the face validity of the Walkability Index and verify that the GIS-derived attributes were reflected in the physical surrounds for all quadrants [13].

The use of GIS and spatially referenced data has considerable versatility and enables aggregation of individual level data into a number of different and more contextually pertinent spatial units [23, 24]. For instance, spatial units describing the walking distance from a respondent's home or particular cluster of households could capture relevant objective environmental factors (such as footpaths, parks, open space, bus stops, shops) related to walking. However this presupposes access to datasets that include these factors which is not always the case.

The PLACE data show that there is an existing association between SES and walkability. This means that it is difficult to obtain non-overlapping units for each stratum. For example, low SES areas tend to be less walkable.

Recruiting sufficient numbers of participants

The two methods of data collection used were successful in meeting the study requirements for the number and distribution of participants. However, it took considerable effort and some change in procedures to achieve the target number of eligible participants to ensure robust data for analyses.

Response rate

The apparent low overall response rate for survey completion relative to households contacted (11.5%) merits attention, although it is difficult to do more than speculate as to underlying causes. The people we were least likely to recruit were men under the age of 30 years (4% of respondents). Those with lower levels of education and not in paid work were also under-represented when compared with the 2001 Census profiles.

Several factors contributed to the large size of the denominator (number of addresses). The effective sample is usually computed by deducting ineligible respondents and failed addresses from a total set of pre-identified respondents, referred to as the total sample size [17]. In this study, the sample population was households rather than people. Approximately 25% of the population, over 15 years of age, in the selected areas was ineligible solely on the grounds of the study age restrictions (20 – 65 years). However, due to the nature of data in the GIS constructed address lists, it was impossible to eliminate those private households in which no potentially eligible respondent lived prior to sampling. To reach the target number of respondents per community, re-sampling from additional households was undertaken, rather than following up unidentified non-respondents from the selected households. Thus, the total sample size (all pre-identified households) was inevitably large. It would be possible to narrow down the size of the "effective sample" by filtering for relevant data where data sets are available.

Potential sampling bias

Key concerns in evaluating sampling strategies and outcomes are non-coverage error (the intentional or unintentional exclusion of population elements in the sampling frame); and, non-response error, where population elements are present in the sampling frame but no data are obtained [17].

Non-coverage error

It seems unlikely in this instance that there was any significant relationship between the characteristics of people residing in the households accidentally omitted from the residential address list and the main dependent variables (physical activity and walking behaviour) under study. Nursing homes and aged care facilities were deliberately excluded since residents of these facilities were likely to be older than the 65-year age cut point for eligibility.

Addresses for new multi-unit developments might inadvertently have been omitted since it was difficult to check all addresses prior to selecting the initial sample for mailing. It was also difficult to derive some real addresses of rental apartments or housing units built recently on a single parcel of land fronted by more than one street. While the LOTS database indicates the number of household units on the parcel, in some instances the entrances to some units, and therefore the mailing addresses, are on a street different to the registered parcel address. This was the case for a number of public housing properties and may have led to an increase in the numbers of households who were not included in the sampling frame or for whom questionnaires were undelivered.

The initial contact mail that was returned as undeliverable amounted to 4.3% of the total mailing. Letters were not addressed to specific individuals but rather to “The Resident”, so mail returned unopened through the postal system largely reflected addresses that did not (any longer) exist, had no current equivalent (known to the post delivery person) or were vacant. Comparison of the household numbers from the 2001 Census data (28 979) and the PLACE household address list (29 685) did not indicate significant omissions.

Non-response error

The higher response rates when mailing the survey without any prior contact (Method 2), suggests that the extra step of inviting participation prior to mailing the survey may have increased participant burden and reduced the likelihood of agreeing to participate. The more consistent levels of response across the high and low SES communities using this method support this notion. The people we were least likely to recruit were men under the age of 30 years (4% of respondents). Those with lower levels of education and not in paid work were also under-represented when compared with the 2001 Census profiles.

Conclusions

As demonstrated in the PLACE study, a spatially and socially based methodology can be developed that takes into account several factors that may impact on walkability, as well as the socio-economic variation that may exist between different communities. The use of a spatially derived Walkability Index provides a tool for the selection of communities for household recruitment that maximizes the variability in the built environment. This increased variability in the walkability of areas from which participants are recruited is expected to result in an improved ability to detect differences in physical activity levels that may occur in objectively different physical environments.

However, the results of the PLACE recruitment show that socio-demographic/SES characteristics and community walkability are not independent. Subsequent analyses of the PLACE data will need to take into account the potential confounding of environmental attributes with SES.

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