Using GIS to integrate children's walking interview data and objectively measured physical activity data

Suzanne Mavoa[1], Melody Oliver[2], Nicola Tavae[1], Karen Witten[1]

[1]SHORE and Whariki Research Centre, School of Public Health, Massey University, PO Box 6137 Wellesley Street, Auckland 1141, New Zealand
Tel. 0064 9 3666136 Fax 0064 9 3665149

[2]National Institute for Public Health and Mental Health Research, Auckland University of Technology, Private Bag 92006, Auckland 1142, New Zealand.
Tel. 0064 9 9219999 Fax 00649 9219746

Email: s.mavoa@massey.ac.nz ; melody.oliver@aut.ac.nz ; n.tavae@massey.ac.nz ; k.witten@massey.ac.nz

Summary: Adequate physical activity is vital for children's health. There is increasing evidence that built environment characteristics can support or hinder physical activity levels. There is also evidence that perceptions of the built environment play a role. However, in terms of physical activity, the relative importance of the objective versus perceived built environment is not well understood. GIS has the potential to assist in untangling these relationships. This paper explores the use of GIS to integrate data derived from neighbourhood walking interviews about places important to children with objectively measured physical activity data.

KEYWORDS: qualitative GIS; children; physical activity; neighbourhood perceptions; walking interviews

1. Introduction

Physical activity is important for children's health and wellbeing. There is increasing evidence that objective characteristics of the built environment can support or hinder children's physical activity levels (Ding et al., 2011). There is also evidence of a relationship between children's perceptions of their neighbourhood environment and their physical activity levels (McCormack et al., 2010, Timperio et al., 2004). However, much of this research is limited by its reliance on self or parental reports of physical activity. Hume et al. (2005) addressed this limitation by objectively measuring physical activity in conjunction with qualitative data (mental maps and photos) on children's neighbourhood perceptions. This approach is promising and the integration of qualitative and quantitative data has the potential to generate new insights in physical activity research (Hume et al., 2005, McCormack et al., 2010).

GIS has played an important role in studying the relationship between the objective environment and physical activity. GIS can also be a useful tool in qualitative studies (Pavlovskaya, 2006, Kwan and Knigge, 2006, Dennis, 2006, Jung and Elwood, 2010). Yet despite this, few researchers have used GIS in to explore perceptions of the environment and physical activity. An exception is Wridt's (2010) study which used GIS to map children's perceptions and use of neighbourhoods for physical activity. Even though physical activity was not objectively measured, the results illustrated the usefulness of qualitative

spatial analysis. The study by Pooley et al. (2010) went a step further, using GIS to integrate qualitative and quantitative data about the environment and the journey to school, thereby producing new insights about children's travel. This paper builds on existing research by exploring the use of GIS to integrate quantitative data on the location of children's physical activity with qualitative data on neighbourhood perceptions.

2. Method

2.1 Data collection

Data for this analysis were drawn from a pilot investigation for the Kids in the City study - a study of children's independent mobility and physical activity in Auckland, New Zealand (Oliver et al., 2011). Figure 1 illustrates the data collection relevant to this paper. Mobility and physical activity for two boys and two girls aged 9 - 10 years were measured for four consecutive days using a Qstarz BT-Q1000 GPS (Qstarz International Inc., Taiwan) and an Actical accelerometer (BMedical Pty Ltd, Milton, Queensland, Australia), respectively.

The children also participated in neighbourhood walking interviews (Carpiano, 2009) to explore their perceptions of the neighbourhood environment as it relates to physical activity. The children took a researcher on a tour of their neighbourhood while carrying a digital camera and wearing a GPS unit and a digital recorder. The walking interviews lasted 30-60 minutes and during this time the researcher asked the children about "places of interest"; that is, places regularly visited, and places where physical activity occurs. The child took photos of these places during the interview.

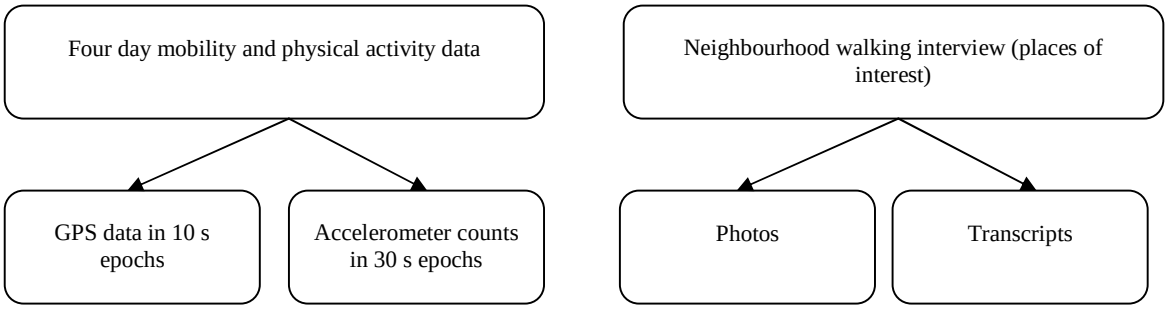

Figure 1. Data collection process

2.2 Data processing and analysis

The raw accelerometer count data for wear times only were manually extracted and accelerometer count thresholds employed to determine time spent sedentary and in light, moderate, and vigorous intensity physical activity (Puyau et al., 2004). GPS data for wear times only were extracted and data points with speeds greater than 8km/hour were removed in order to focus on travel and activities conducted on foot or bicycle. GPS records were matched to accelerometer data using timestamps and imported into ArcGIS 9.3 (ESRI, Redlands).

The GPS data recorded during the walking interviews were imported into GIS along with a land use dataset (Mavoa et al., 2011). Land use data intersecting the walking interview GPS data were extracted to represent neighbourhood "places of interest" (e.g. shops, parks, friends' houses). The four-day GPS and accelerometer data were combined with the places of interest to determine time spent and physical activity levels within these locations. Children's perceptions were examined by geocoding the interview transcript data.

3. Results

Figure 1 shows the percentage of time spent in sedentary, light, moderate and vigorous physical activity for each participant. Data points where the units were not worn and where the mode of travel was likely to be by vehicle were excluded.

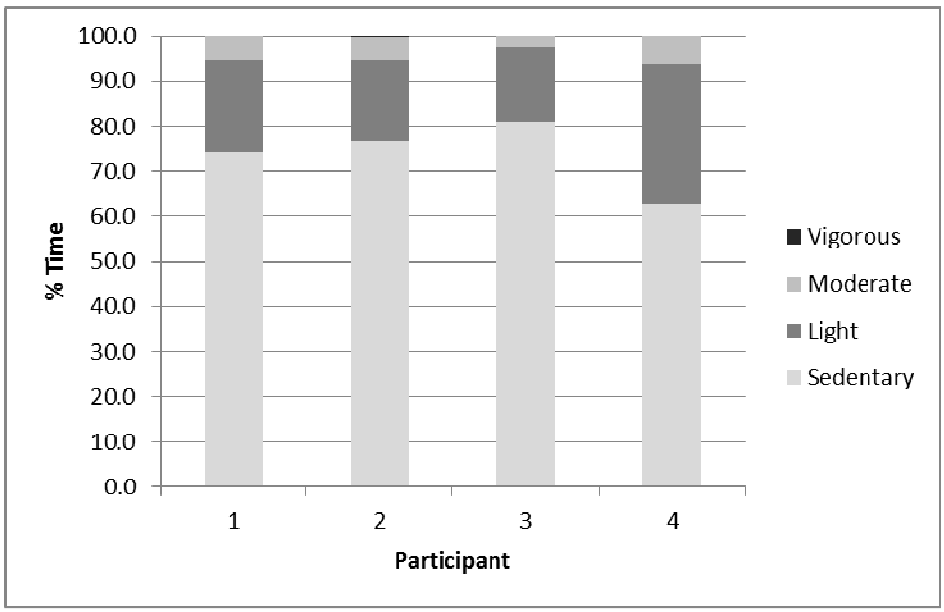

Figure 1. Percentage time spent in sedentary, light, moderate and vigorous activity.

Figure 2 shows the route and places of interest from the walking interview for participant 4 along with the maximum physical activity intensity at these locations. Quotes from the interview transcript have been added to the map.

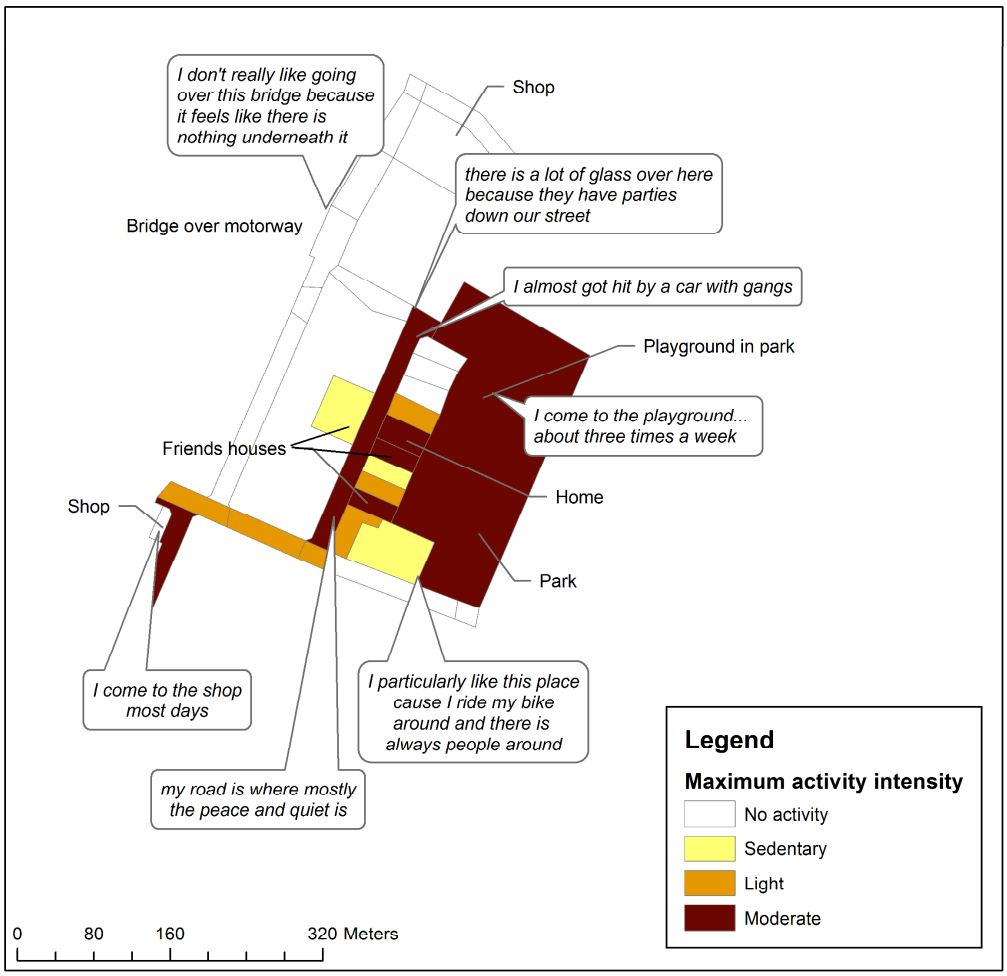

Figure 2. Maximum activity intensity in walking interview places of interest for participant 4.

During the four days of data collection, two of the participants spent no time or very little time in their neighbourhood places of interest (Figure 3). One participant spent 43% of their valid non-vehicle time in places of interest.

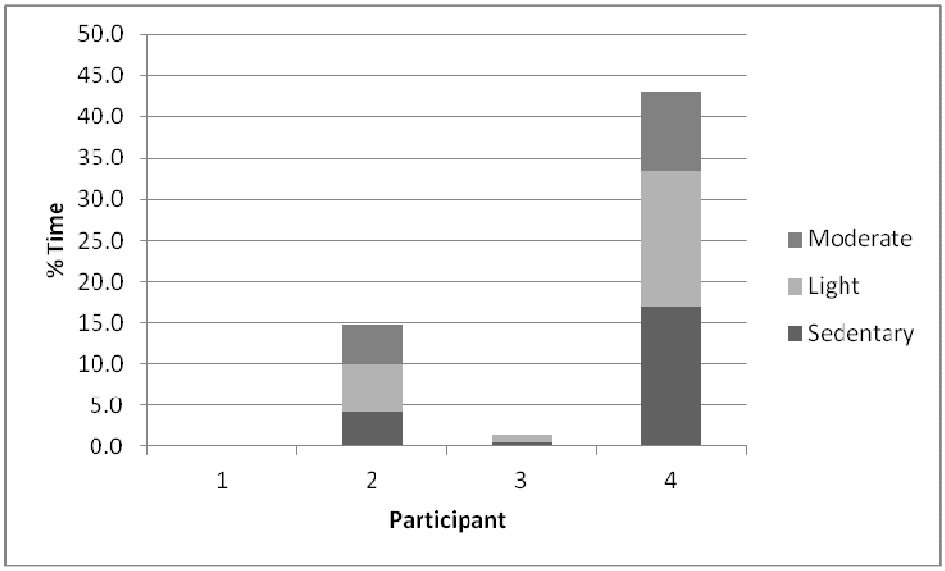

Figure 3. Percentage of valid non-vehicle time spent in places of interest.

The alignment between the four-day data and the walking interview data varied between participants. For example, participant 1 did not spend any time at the places of interest identified on their walking interview. Hence there was no physical activity at these locations. Yet during their interview they talked about visiting the places of interest "every single day" and being active there - "we have races, or just walk and stuff."

Moderate physical activity levels were recorded by participants 2 and 4 at the shops, friends' houses, parks, and in the street. Friends' houses and the street were the locations with the highest levels of recorded moderate physical activity.

4. Discussion and conclusion

This exploratory study illustrates the potential of GIS in linking quantitative and qualitative data. The small sample used in this analysis means we cannot draw conclusions about the relationship between the environment and children's physical activity. However it provides a useful point of departure for methodological developments for use with the larger Kids in the City study. In the first instance we plan to aggregate individual data to the neighbourhood level in order to identify specific neighbourhood locations associated with higher levels of physical activity, and with positive or negative perceptions for all children in the study.

This type of analysis can identify interesting phenomena. For example, one of the participants' self report and objectively measured data were in conflict. In this case a likely explanation is that data collection occurred during an atypical period. From talking with the participant we know they were sick during the quantitative data collection. This information was obtained informally and highlights a gap in the data collection methods used here. In hindsight an additional question at the end of quantitative data collection asking about any atypical events would have been useful. Conflicting quantitative and qualitative data could have implications on how the data is analysed and interpreted.

In summary, although quantitative data are important in assessing physical activity levels, qualitative data provide contextual information not captured by quantitative methods and the linking of the two datasets has the potential to generate new insights into the relationship between children's perceptions of their

environments and their physical activity levels. In the long term research like this can assist planners in designing cities that better support children's physical activity, and in the short term it may identify easily modifiable characteristics of the environment that are inhibiting children's opportunities to be physically active.

5. Acknowledgements

The 'Kids in the City' study is supported by a three-year research grant from the Health Research Council of New Zealand (grant number 10/497). Nicola Tavae is supported by a PhD scholarship from the SHORE & Whariki Research Centre, Massey University. We also thank the Kids in the City research team, Auckland Council for providing the GIS data, and the schools, parents and children that participated in the pilot and main Kids in the City studies.

6. References

Carpiano, R. M. 2009. Come take a walk with me: The "Go-Along" interview as a novel method for studying the implications of place for health and well-being. *Health & Place,* 15**,** 263-272.

Dennis, S. F. 2006. Prospects for qualitative GIS at the intersection of youth development and participatory urban planning. *Environment and Planning A,* 38**,** 2039 – 2054.

Ding, D., Sallis, J., Kerr, J., Lee, S. & Rosenberg, D. 2011. Neighborhood Environment and Physical Activity Among Youth: A Review. *American Journal of Preventive Medicine,* 41**,** 442-455.

Hume, C., Salmon, J. & Ball, K. 2005. Children's perceptions of their home and neighborhood environments, and their association with objectively measured physical activity: a qualitative and quantitative study. *Health Educ. Res.,* 20**,** 1-13.

Jung, J.K. & Elwood, S. 2010. Extending the Qualitative Capabilities of GIS: Computer-Aided Qualitative GIS. *Transactions in GIS,* 14**,** 63-87.

Kwan, M. P. & Knigge, L. 2006. Doing qualitative research using GIS: an oxymoronic endeavor? *Environment and Planning A,* 38**,** 1999-2002.

Mavoa, S., Oliver, M., Witten, K., Badland, H.M. 2011. Linking GPS and travel diary data using sequence alignment in a study of children's independent mobility. *International Journal of Health Geographics,* 10(64).

McCormack, G. R., Rock, M., Toohey, A. M. & Hignell, D. 2010. Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. *Health & Place,* 16**,** 712-726.

Oliver, M., Witten, K., Kearns, R. A., Mavoa, S., Badland, H. M., Carroll, P., Drumheller, C., Tavae, N., Asiasiga, L., Jelley, S., Kaiwai, H., Opit, S., Lin, E. Y., Sweetsur, P., Moewaka Barnes, H., Mason, N. & Ergler, C. 2011. Kids in the City Study: Research design and methodology. *BMC Public Health,* 11**,** 587.

Pavlovskaya, M. 2006. Theorizing with GIS: a tool for critical geographies? *Environment and Planning A,* 38**,** 2003-2020.

Pooley, C., Whyatt, D., Walker, M., Davies, G., Coulton, P. & Bamford, W. 2010. Understanding the school journey: integrating data on travel and environment. *Environment and Planning A,* 42**,** 948-965.

Puyau, M.R., Adolph, A.L., Vohra, F.A., Zakeri, I., Butte, N.F. 2004. Prediction of activity energy expenditure using accelerometers in children. *Medicine & Sceince in Sports & Exercise,* 36(9),1625-1631.

Timperio, A., Crawford, D., Telford, A. & Salmon, J. 2004. Perceptions about the local neighborhood and walking and cycling among children. *Preventive Medicine,* 38**,** 39-47.

Wridt, P. 2010. A qualitative GIS approach to mapping urban neighborhoods with children to promote physical activity and child-friendly community planning. *Environment and Planning B,* 37**,** 129-147.

7. Biography

Suzanne Mavoa *is a researcher and PhD student in the SHORE & Whariki Research Centre, School of Public Health, Massey University. Her research involves the use of geospatial methods in health-environment research, with a focus on GPS, built environment, neighbourhood, physical activity, children, independent mobility, and mixed methods.*

Dr Melody Oliver *is a Senior Research Fellow within the National Institute for Public Health and Mental Health Research at Auckland University of Technology, New Zealand. Her research involves investigating socio-ecological determinants and associates of health behaviours and health outcomes in children and their families.*

Nicola Tavae *is a PhD student in the SHORE & Whariki Research Centre, School of Public Health, Massey University and a recipient of a Doctoral scholarship. Her PhD focuses on the relationship between Pacific children and parents' neighbourhood perceptions and children's independent mobility and physical activity.*

Dr Karen Witten *is an Associate Professor at the SHORE & Whariki Research Centre, School of Public Health, Massey University. Her research interests centre on interactions between the physical characteristics of neighbourhoods and cities and the social relationships, health and sustainability related practices of the people living in them.*