Changing patterns of active travel in Sydney? An analysis of commuter trips 2001 to 2011

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Abstract: The paper examines changing commuter walking and cycling (active transport) trips in Sydney over 2001, 2006 and 2011 Census years. Although active transport has increased in absolute numbers and in overall mode share, increases are confined to certain geographic areas of Sydney. A detailed investigation of possible explanatory variables was undertaken using data from the 2011 census. Results identify that both commuter walking and cycling is positively correlated with employment accessibility. However, walking is more strongly associated with higher incomes and people aged in their twenties, while cycling is correlated with managerial and professional occupation, public service employment and distance to the CBD. The paper will discuss if further increases in active transport are likely, where they are to occur, and the drivers behind this. The paper will assist government decision makers in evaluating different land use and transport policy approaches used in Australian cities.

Introduction

Australian cities have relatively low rates of journey to work trips made by commuters walking and cycling. In Sydney for example, only 5% of journey to work trips are made by these modes. European countries such as Germany, Netherlands and Denmark have combined walking and cycling rates greater than 35% of mode share (Pucher & Buehler 2010). The low levels of walking and cycling in Australian cities has implications for health, livability, economic competitiveness and sustainability of cities.

A goal of many local and state governments in Australia is to better plan for, and to actively promote increase in walking and cycling. This is evident through transport policies which aim to increase participation rates in these modes, including *Cycle Strategy and Action Plan 2007 – 2017* (City of Sydney 2007), *Walking Strategy and Action Plan* (City of Sydney 2014), *Sydney's Cycling Future* (Transport for NSW 2013a) and *Sydney's Walking Future* (Transport for NSW 2013b) to name a limited few. Documents such these seek to address the low levels of cycling and walking through improvements to infrastructure, combined with soft policy intervention approaches comprising education programs, marketing, and information on routes and facilities.

A better understanding of walking and cycling travel behavior specific to Australian cities is required in order to better implement and evaluate urban policies relating to these modes. Decisions to increase active transport usage are often based on desires to improve the sustainability and energy efficiency of urban transport systems, as well as improving public health through increased physical exercise (Bassett et al., 2008; Bauman et al. 2008). Considering how changes in walking and cycling affect each other is an area where research specific to Australian cities can better inform policy. Policy objectives aimed at increasing rates of both modes need to be aware of what variables are associated with a mode shift to walking and cycling from private vehicles, compared with that from alternate modes. Better informed policy will have positive implications for economic productivity, health, livability and sustainability of cities.

Explaining changes in walking and cycling behaviour in Australia

Previous research investigating active travel behavior in Australian cities commonly includes analysis of journey to work Census Data. This is perhaps due to the accessibility of the data and the ability to undertake a comparison of different years. Zander et al. (2012) analyses 2001, 2006 and 2011 cycling mode share across local government areas (LGA) in Sydney The authors find that cycling has increased in inner LGAs and declined in outer areas, and suggest this is because cycling distances to work are achievable, and investments in cycling infrastructure occurred in inner areas. In a study using similar methods, but examining walking instead, Zander et al. (2013) shows that increases in walking has occurred in inner areas of Sydney, and argues this is due to built environment factors including higher density, greater mix of land uses, that are typically associated with smaller commuter distances in these areas. In Mees et al. (2006) examination of journey to work between 1976 to 2006 in capital Australian cities, the authors dismiss changes to cycling as minor and overstated, and argues that recent increase in walking are the result of increased inner city living and higher share of CBD jobs. The above studies provide a good analysis of changes in travel behavior but explanations for changes in travel behaviour are not tested due to the absence of analysis of explanatory variables such as infrastructure or built environment data.

Regression analysis of variables can provide some insight into possible explanations of active transport mode share. In an examination of built environment factors associated with mode share for journey to work in Sydney, Mckibbin (2011) finds that destination accessibility and population density appear to be most important. Owen et al. (2007) finds a positive association between weekly frequency of walking for transport and the objectively derived neighbourhood walkability index (assessed using dwelling density, street connectivity, land-use mix, and, net retail area) for Adelaide between 2003 and 2004, but finds no significant associations between environmental factors and walking for recreation. In a study of Adelaide and Ghent, Owen et al.(2010) uses logistic regression models to examine associations of bicycle use with walkability, the results of which indicate that higher neighbourhood walkability was associated with higher bicycle use, despite large differences between the cities for cycle ownership and use.

Comparisons between cities can also provide insights into active travel behaviour. Bonham and Suh (2008) examine intra-urban difference of cycling across Melbourne and Adelaide. The research found that the proportion of professionals and education is highly related to cycling rates in the statistical local areas (SLA) investigated, but that associations with low income households was unequal but fluctuating. As with other studies it was found that higher rates were found closer to CBD, but that there were some exceptions to this. Pucher, Garrard, et al. (2011) use a comparative analysis of a wide range of datasets between Melbourne and Sydney to identify reasons for the higher rates of cycling in Melbourne. Their results found that although there are higher public transport and walking in Sydney than Melbourne, there are double rates (and growing at three times the rate) of cycling in Melbourne's CBD which was argued primarily due to differences in topography, climate, and road network.

Merom et al. (2015) uses trend analysis of household travel survey and health survey data to show an overall trend of increased walking from 2002 to 2012, but lower levels in Western Sydney, South Western Sydney and Nepean and Blue Mountains. In a longitudinal natural experiment examining impact of urban planning on walking in Perth Giles-Corti et al., (2013) finds that following relocation to a new neighbourhood, walking for transport declined but recreational walking increased. But in neighbourhoods where access to transport destination increased, so did transport related walking. Argues the study provide evidence that walking behaviours respond to availability of local transport and recreational destinations.

Method

Study Aims

The purpose of this study is to find how rates of walking and cycling have changed spatially between 2001, 2006 and 2011 in Sydney; and what built environment, infrastructure and demographic variables can explain differences in mode share for walking and cycling in the 2011 dataset. This is intended to fill a gap in the literature where more detailed analyses of active transport behaviour and explanatory variables is required for Australian cities, particular Sydney.

Study Area

The Sydney metropolitan area was chosen as the study area. The examination of changes in active transport between 2001, 2006 and 2011 was analysed at a local government area (LGA) level, as this was the smallest geography with reliable data over these years due to changing geography used by the Australian Bureau of Statistics. The Statistical Area Level 2 (SA2) geographic unit was selected as the spatial level of analysis for the regression model of the 2011 data, as this provided a more detailed level of examination. Although analysis of smaller geographic areas was possible, due to the low numbers of walking in cycling in many areas, SA2 was considered to be the smallest spatial size where meaningful analysis and conclusions about these modes could be made. Some SA2 areas were excluded from the analysis due to anomalies, such as areas predominantly made up of National Parks where the population of the SA2 was zero or for the military bases where walking and cycling was rates were anomaly high. Inclusion of these areas would result in skewed results for some variables tested.

Data Sources

All transport mode share data was based on Australian Bureau of Statistics Census journey to work counts collected at the origin. The dependent variables used in the regression models were *Percentage Walk* (% of 2011 ABS census journey to work trips made by walk only at origin SA2); and *Percentage Cycle* (% of 2011 ABS census journey to work trips made by cycling at origin SA2).

Data was collected for built environment, demographic and infrastructure variables from a number of sources for the Sydney metropolitan region.

Measures for population density and the number of motor vehicles were based on Australian Bureau of Statistics 2011 Census data. The data was extracted using Australian Bureau of Statistics *Census TableBuilder.*

Measures for the amount of CBD employment and the numbers employed within the same SA2 (journey to work origin and destination SA2 area matching) were based on 2011 Census journey to work tables collated by the NSW Bureau of Transport Statistics.

Infrastructure variables including active transport network measures were based on geographic information system (GIS) datasets supplied by the NSW Roads and Maritime Service. This data was equivalent to that from *Cycle Finder* website (http://www.rms.nsw.gov.au/roads/using-roads/bicycles/cyclewayfinder/index.html) accessed in April 2014.

It should be noted that the active transport infrastructure measure *km_bikelane_per_km2* only included 'Bicycle Path, Shared Path and Separated Path' types of infrastructure; it did not include any routes or paths mixed with traffic such as on-street or road shoulder bicycle lanes. Local road length was also based on the NSW roads GIS dataset. To take into account the varying size of the SA2 areas, these two variables were measured using the amount of linear length (km) per area of the SA2 (km2).This was also considered to be a good proxy for street connectivity (Dill 2004).

The distance to CBD was calculated measuring the centroid of each SA2 to the centroid of the SA2 as best fit measuring the Sydney city centre (Sydney – Haymarket) using ArcGIS.

Table 1: Measures considered for use in the regression model

Measure	Variable	Description (Source)
Infrastructure		
Active Transport Infrastructure	km_bikelane_per_km2	Length (km) of active transport infrastructure (shared pedestrian / cycle paths, off street bike and separated bike lanes) per area (km2). *Source: RMS*
Car accessibility	No_motor_vehicles_Percentage	Percentage of dwellings with no motor vehicles. Source: (ABS 2011 Census)
	Average_Number_Cars	Average number of motor vehciles per dwelling. Source: (ABS 2011 Census)
Demographic		
Household Type	Households_with_children_Per	Percentage of households with children under 15 years (ABS 2011 Census)
Age	Aged10_19	Percentage of population aged between 10 to 19 (ABS 2011 Census)
	Aged20_29	Percentage of population aged between 20 to 29 (ABS 2011 Census)
	Aged_30_39	Percentage of population aged between 30 to 39 (ABS 2011 Census)
Occupation	Manager_Professionals	Percentage of workforce with occupation

		listed as a Manager or a professional (ABS 2011 Census)
	Machinary_Laboueres	Percentage of workforce with occupation listed as a machineray operator or labourer (ABS 2011 Census)
Education	Education_percentwithBachelor_or_higher	Percentage of residents with (ABS 2011 Census)
Income	High_Income_Over_78k Low_Income_under_32k	% of total employed with incomes over 78,000 (2011 ABS Census)
Industry of Employment	Local_Gov	% of workers employed in local government (2011 ABS Census)
	Public Sector	
Built Environment		
Land Use	PercentageCBDEmployment Distance_CBD	Geodisic measurement between centroids of SA2 and CBD SA2 (Haymarket – The Rocks)
Employment Accessibility	10000sJobs_5km	Number of 10,000 jobs within 5km of centroid of SA2
	10000Jobs_3km	Number of 10,000 jobs within 3km of centroid of SA2
	Percentage_Employed_within_SA2	Percentage of employed persons with origin and destination as same SA2 (BTS)
Density	Population_Density	Population per km2
Dwelling Mix	Single_Dwellings_Percentage	Number of single dwellings as a percentage of all dwellings (2011 ABS Census)
Street Connectivity	Local_Road_length_km_per_km2	Length (km) of local roads per area (km2). *Source: RMS*
Jobs Ratio	Jobs_ratio	The ratio of employees to resident population within a SA2 area

Analysis of 2001, 2006 and 2011 Census Data

Changes in walking and cycling
LGA level data for 2001, 2006 and 2011 was collected, collated in a single table, and mapped using ArcGIS to show spatial variations in walking and cycling change between 2001 and 2011. Walk and cycle trips were defined as ‘walk only’ and ‘cycle only’ trips. Journeys where walking and cycling formed part of a trip chain were not analysed, as the aim of this study was to investigate trips where walking and cycling are the dominate modes.

Multivariate Regression Model

Firstly a bivariate correlation of all variables listed in table 1 was run, and significant correlations were identified using a pearson coefficient. Only *jobs_ratio* was removed at this step as it showed no significant correlation with either dependent.

As the regression involved analysis of a proportional dependent variable, both *percentage_walk* and *percentage_cycle* were transformed using the arcsine function. Stepwise linear regression of all independent variables was run using SPSS. Variables were removed from the model if collinearity or no significance was found. The regression was re-run again with one of the variables removed until all variables were significant or collinearity was reduced.

For the commuter walk model, the variable *jobs 5km* was found to have collinearity with *jobs 3km*, and *no motor vehicles* with *average number of cars* and *single dwellings*. *Jobs 5km*, *average number of cars* and *single dwellings* were removed from the model. For cycling, *Professionals_Managers* was correlated with *education* and *labourers and machinery workers*, *% cbd employment* with *distance to CBD*, *no motor vehicles* with a number of other variables. *Education, labourers, % CBD* and *no motor vehicles* were excluded. *Jobs 3km* was also removed.

Figure 1: Percentage change in cycling mode share 2001 to 2011

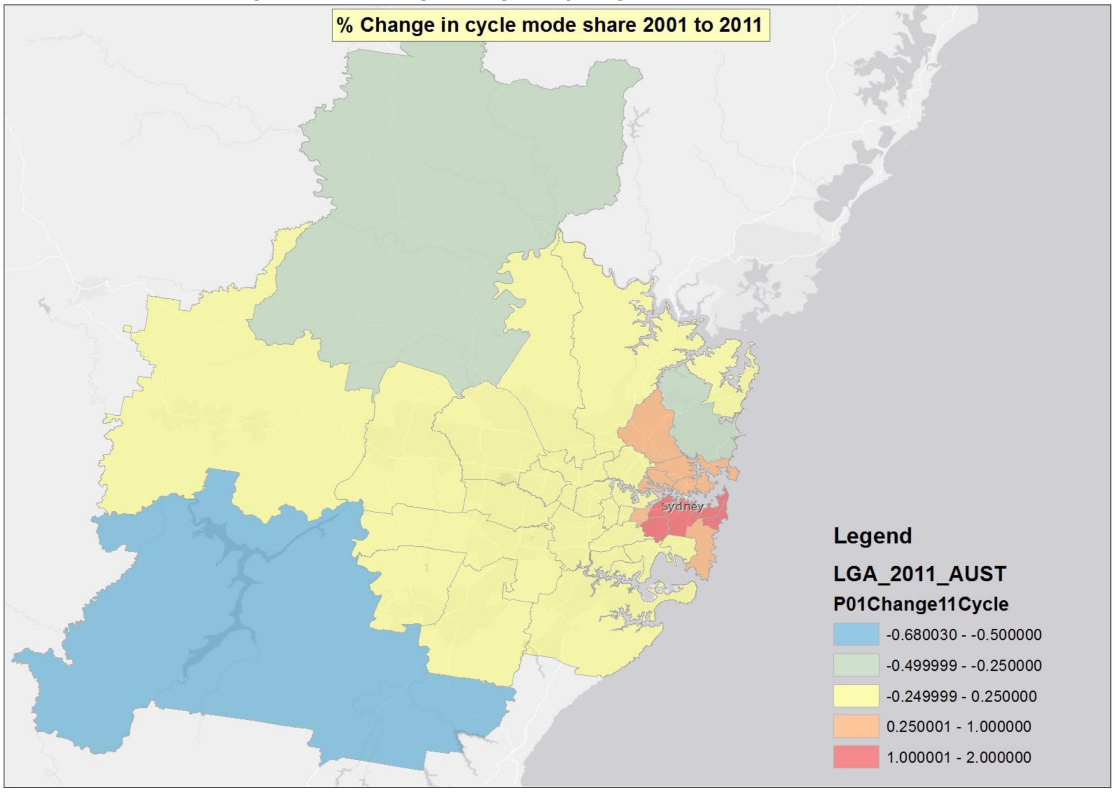
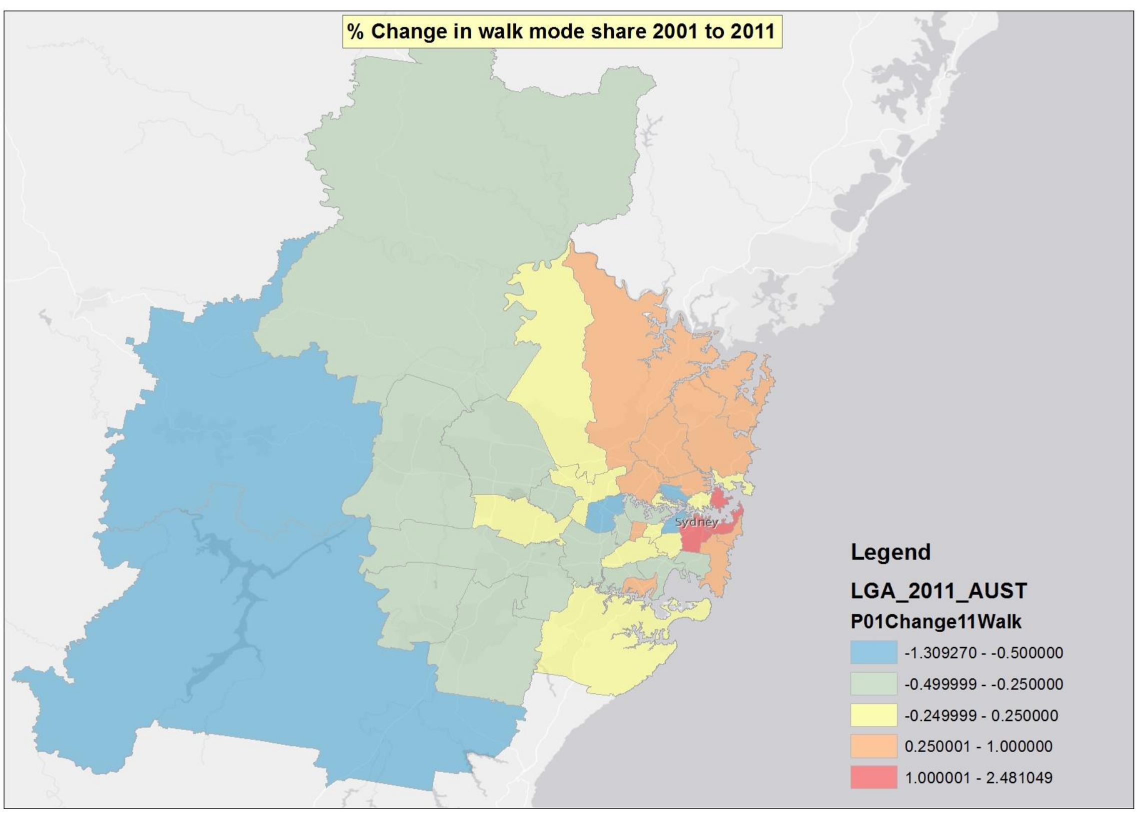


Figure 2: Percentage change in walking mode share 2001 to 2011

Table 2:Changes for walking and cycling rates by Sydney LGAs 2001 to 2011



LGA_Name	Percentage of walk JTW trips			Percen Change	Absolute Change	Percentage of cycle JTW trips			Percent Change	Absolute Change
	2001	2006	2011			2001	2006	2011		
Ashfield (A)	4.48%	5.37%	4.55%	0.07	111	0.73%	1.02%	1.57%	0.55	167
Auburn (C)	3.83%	3.93%	3.24%	-0.58	208	0.37%	0.51%	0.46%	-0.05	58
Bankstown (C)	2.53%	2.61%	2.14%	-0.40	-102	0.41%	0.41%	0.29%	-0.12	-55
Blacktown (C)	1.98%	1.93%	1.54%	-0.44	-32	0.34%	0.37%	0.29%	-0.08	20
Blue Mountains (C)	4.02%	3.60%	3.22%	-0.80	-152	0.55%	0.48%	0.45%	-0.03	-18
Botany Bay (C)	6.60%	6.48%	6.15%	-0.45	93	1.22%	1.40%	1.56%	0.15	86
Burwood (A)	4.96%	5.77%	5.34%	0.37	173	0.41%	0.67%	0.60%	-0.07	35
Camden (A)	1.71%	1.68%	1.45%	-0.26	50	0.31%	0.32%	0.22%	-0.10	-2
Campbelltown (C)	1.93%	1.86%	1.60%	-0.32	-98	0.33%	0.28%	0.19%	-0.09	-62
Canada Bay (A)	3.41%	3.27%	3.09%	-0.31	-428	0.29%	0.90%	1.11%	0.21	247
Canterbury (C)	2.73%	3.18%	2.74%	0.01	614	0.61%	0.38%	0.47%	0.09	69
Fairfield (C)	2.06%	2.09%	1.94%	-0.11	30	0.33%	0.39%	0.28%	-0.11	-12
Hawkesbury (C)	3.63%	3.64%	3.17%	-0.46	-28	0.85%	1.00%	0.66%	-0.34	-28
Holroyd (C)	2.84%	2.89%	2.46%	-0.38	15	0.36%	0.44%	0.37%	-0.07	25
Hornsby (A)	3.06%	3.53%	3.34%	0.28	398	0.31%	0.37%	0.44%	0.07	109
Hunters Hill (A)	3.10%	3.18%	3.28%	0.18	23	0.45%	0.28%	1.11%	0.82	34
Hurstville (C)	3.29%	3.37%	2.92%	-0.37	39	0.35%	0.36%	0.30%	-0.06	2
Kogarah (C)	3.32%	4.22%	4.04%	0.72	303	0.25%	0.31%	0.28%	-0.03	18
Ku-ring-gai (A)	2.50%	2.93%	2.81%	0.31	241	0.35%	0.36%	0.73%	0.37	172
Lane Cove (A)	6.39%	6.67%	5.68%	-0.71	-52	0.67%	0.88%	1.68%	0.80	149
Leichhardt (A)	7.69%	6.51%	6.38%	-1.31	-684	1.69%	1.81%	3.26%	1.45	320
Liverpool (C)	2.95%	2.79%	2.53%	-0.42	37	0.51%	0.46%	0.38%	-0.08	-30
Manly (A)	5.96%	6.81%	5.75%	-0.22	81	1.01%	1.30%	1.88%	0.58	170
Marrickville (A)	6.55%	6.95%	6.40%	-0.14	236	1.81%	2.49%	3.87%	1.39	825
Mosman (A)	4.95%	5.76%	5.95%	1.00	118	0.60%	0.78%	1.20%	0.42	68
North Sydney (A)	13.50%	14.21%	13.68%	0.18	513	0.74%	0.92%	1.48%	0.56	269
Parramatta (C)	4.71%	5.17%	4.55%	-0.16	524	0.44%	0.50%	0.46%	-0.05	69
Penrith (C)	2.15%	2.21%	1.85%	-0.30	-67	0.52%	0.43%	0.35%	-0.08	-88
Pittwater (A)	3.15%	3.63%	3.92%	0.77	216	0.66%	0.69%	0.68%	-0.01	13
Randwick (C)	6.28%	7.42%	7.15%	0.86	786	1.20%	1.50%	2.25%	0.74	626
Rockdale (C)	3.71%	3.94%	3.29%	-0.41	92	0.38%	0.46%	0.37%	-0.09	23
Ryde (C)	4.03%	4.21%	4.38%	0.35	323	0.47%	0.54%	0.70%	0.16	119
Strathfield (A)	3.77%	3.79%	3.31%	-0.46	103	0.23%	0.40%	0.36%	-0.04	29
Sutherland Shire (A)	2.26%	2.82%	2.48%	0.23	336	0.48%	0.50%	0.48%	-0.02	29
Sydney (C)	26.27%	28.17%	28.75%	2.48	11246	1.84%	2.02%	3.43%	1.41	1994
The Hills Shire (A)	1.73%	1.76%	1.58%	-0.15	113	0.21%	0.23%	0.29%	0.06	87
Warringah (A)	3.46%	6.81%	3.75%	0.29	373	0.78%	1.58%	1.12%	-0.45	254
Waverley (A)	6.17%	9.14%	6.50%	0.33	280	1.31%	0.77%	2.55%	1.79	402
Willoughby (C)	8.13%	4.97%	8.69%	0.55	490	0.55%	0.72%	1.26%	0.54	225
Wollondilly (A)	2.63%	10.12%	1.88%	-0.75	-24	0.24%	0.82%	0.14%	-0.68	-7
Woollahra (A)	9.31%	4.61%	10.41%	1.10	308	0.79%	0.49%	1.49%	1.00	160
GREATER SYDNEY	4.56%	5.10%	4.93%	0.36	16806	0.61%	0.69%	0.92%	0.23	6571

Results

Analysis of 2001, 2006 and 2011 Census Data

As shown in Table 2, overall there was an absolute increase in the numbers of commuters walking (+16,086) and cycling (+6,571) to work in Sydney between 2001 and 2011. Due to the overall increase in the numbers of commuters across these years, there was only a slight proportional increase for both modes. The mode share for walking increased from 4.56% in 2001, to 5.10% in 2006 and declined to 4.93% in 2011, while cycling increased from 0.61% of all commuter trips in 2001, to 0.69% in 2006 and 0.92% in 2011.

Figures 1 and 2 indicate that increases in active transport are distributed in certain LGAs of Sydney. Inner city LGAs such as Sydney City, Marrickville, Waverley, Woollarah and Leichardt had the highest increases in cycling. Sydney City had high increases in walking, with noticeable increases in eastern Woollahra and Randwick.

It is also evident that decreases in walking have occurred in areas with some of the greatest increases in cycling. This includes Leichardt and Marrickville, as well as Manly to a lesser extent. However, the City of Sydney was shown to have the largest increases in both mode share and absolute numbers of walkers and cyclists commuting to work.

Multivariate Regression

Walk

Commuter trips made by walking was found to be positively correlated with greater accessibility to jobs within 3km, a higher percentage of people living and employed within the same (SA2) area, higher percentage of dwellings with no motor vehicles, and higher numbers of people aged 20 to 29. Walking was negatively correlated with low incomes.

The number of jobs within 3km alone was highly explanatory, with an r^2 value of 0.840, which means 84% of the model can be explained by accessibility to jobs within 3km. For every increase in 10,000 jobs accessible with 3km, there was 0.62% (arcsine0.00617) increase in percentage of walkers. Including the other measures shown in tables 4 and 5 of the Appendix, the r^2 of the model increased to 0.914 which is considered to be a good fit.

Cycle

Commuter cycling was correlated positively with accessibility to jobs within 5km, areas with more people employed in the public sector, and with more manager and professionals, and greater percentage of dwellings with no motor vehicles. Cycling was negatively correlated with households with children and distance from the CBD (the further from the CBD the less likely cycling would be commuter mode). Local government workers and people aged between the ages of 10 and 19 were also shown to have a positive association, but were not found to be statistically significant. Interestingly there was a slightly negative correlation with bike lanes per $km^{2,}$ but this was also found not to be significant. The final model for cycle commuting using these variables had a r^2 value of 0.711, which is not as explanatory as the walking model. Full results are founding in table 6 and 7 of the Appendix.

Discussion

Between 2001 and 2011 it is evident that there is geographic divide in changes to walking and cycling travel behaviour. Although predominately concentrated in inner Sydney, there are notable differences for each mode. Increases in walking are far more widespread that just in inner Sydney, with growth stretching along the northern and eastern suburbs. Growth in cycling is more confined to the Sydney CBD, and inner west, lower north shore and some eastern suburbs. These areas already had high rates of active transport, so increases in these areas reinforce this geographic divide. Both walking and cycling recorded declines in all western and a number of southern LGA’s which is consistent with previous research.

Sydney is not alone in seeing increases in active transport concentrated in central areas. Cycling has found to be concentrated and increasing in central parts of cities and adjoining inner areas in Chicago, Minneapolis, Montreal, New York, Portland, San Francisco, Toronto, Vancouver, and Washington (Pucher, Buehler, et al. 2011) Minneapolis, St Paul (Krizek et al. 2009), Dublin (Caulfield 2014), and Melbourne (Pucher, Garrard, et al. 2011). Increases in inner city areas are also often counted by declines in outer suburbs.

It is possible that some of the increases in cycling commuting found in the inner west LGAs (Marrickville and Leichardt) may have come at the expense of walking. This is not totally unexpected considering that smaller trip distances likely to be found in these areas would be appealing to both walkers and cyclists. It is surprising that this hasn't been mentioned in any greater detail in studies of Australian cities. A few international examples have pointed to increases in cycling being at the expense of walking in other countries such as Germany (Buehler 2011), Ireland (Caulfield 2014) and in the Netherlands (Martens 2007).

It is evident that walking to work can be more easily explained than cycling from the measures used in this study, particular accessibility to the number of jobs within 3km. Other variables such as number of jobs within same statistical SA2 area reinforce the importance of trip distance for walking. Accessibility to jobs within 5km was a main explanatory factor for cycling as well, but not to the same extent as walking. This indicates that trips distances are highly important consideration for active transport, but that there may be greater potential to increase cycling. Research by Ellison and Greaves (2011) demonstrating that the majority of trips in Sydney under 5km could be made by bicycling support this statement.

Unlike walking, cycling was associated more with demographic and socio-economic measures such as industry of employment, including the percentage employed as public service or those working and managers and professions. This suggests that factors associated with the employment conditions could be behind the association. For example, flexible working conditions often associated with public service and professionals may be partly explanatory for the correlation. However, this study only showed correlation, and there is no evidence of causation between these employment types and high rates of walking and cycling. Future investigation into this link may assist in greater understanding.

Surprisingly, a number of variables which were expected to have explanatory power for walking and cycling commuter spatial variations in Sydney were not found to be significant. Population density was expected to be an explanatory, as other similar studies for Sydney had shown such as Mckibbin (2011).

There was some negative correlation with bike paths per km^2 and the amount of cycling, but was not found to be significant at the 95% confidence interval. This finding was surprising given the results of previous studies, but may be a result of the type of measure used which does not fully take into account active transport path connectivity. Although it would appear that demographic and socio-economic measures are more explanatory for cycling, it is possible likely that increases in cycle lanes and shared paths may influence mode choice at the destination, rather than the origin, as was examined through this study. Safety concerns of riding in heavy traffic, as found in central areas of cities, is often cited as a barrier to increased cycling (Chataway et al. 2014). Providing there are safer cycle conditions already be in place for the surrounding inner suburbs, improved cycle infrastructure in the CBD of Sydney may concerns of riding in heavy traffic in these areas. Changes in the commuter cycling patterns from 2001 to 2011 would certainly suggest increases are occurring in areas that are a distance commutable by cycling to the CBD. It is plausible that new cycle infrastructure has increased cycle commuting to the CBD, but further research is required to examine this.

There are some deficiencies with this study that need to be addressed in order for the results to be considered for policy decisions. This study did not account for residential self selection or personal attitudes. Personal attitudes (Handy et al. 2005; Kitamura et al. 1997) and residential self-selection (Cao et al. 2009) are shown to influence walking and cycling mode choice.

Although demographic variables were tested to gain an understanding of how these influenced travel behaviour, these were not independently controlled for to determine the effect built environment or infrastructure influences walking and cycling.

The use of census data is also problematic as walking and cycle are known to be affected by adverse weather. Localised and temporal variations in the weather may explain some variation between 2001, 2006 and 2011.

Some of the variables used could be improved. Proximity to the CBD would have been greatly improved by a network distance measurement instead of a geodesic measurement. The inclusion of topography as a measure may have explained some of the variations, particularly for cycling.

Conclusion

There are clear differences in where changes in active transport are occurring in Sydney. It is apparent that changes in active transport are increasing in the CBD, inner west, northern and eastern suburbs, while stagnating and declining across large parts of the larger western Sydney area. The regression model improves our understanding of walking and cycling in Sydney. The identification of employment accessibility as a major explanatory variable is consistent with the increases seen in the job rich inner suburbs. In terms of policy implications, increasing accessibility to jobs within walkable and cycle-able distances increases may not be the easiest way to effect travel behaviour in the short term. However, there needs to be greater discussion of reversing the declines in active transport seen in western Sydney to ensure all residents have a choice to use an active transport mode.

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Appendix 1

Table 4: Walking Model Summary[f]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.917[a]	.841	.840	.02699
2	.940[b]	.883	.882	.02315
3	.951[c]	.905	.904	.02094
4	.954[d]	.910	.908	.02047
5	.956[e]	.914	.912	.02001

a. Predictors: (Constant), Jobs_100_3km

b. Predictors: (Constant), Jobs_100_3km, Percentage_Employed_within_SA2

c. Predictors: (Constant), Jobs_100_3km, Percentage_Employed_within_SA2, No_motor_vehicles_Percentage

d. Predictors: (Constant), Jobs_100_3km, Percentage_Employed_within_SA2, No_motor_vehicles_Percentage, Low_Income_under_32k

e. Predictors: (Constant), Jobs_100_3km, Percentage_Employed_within_SA2, No_motor_vehicles_Percentage, Low_Income_under_32k, Aged20_29

f. Dependent Variable: arcsine_Walk_Pecentage

Table 5: Walking Model Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
5	(Constant)	-.025	.010		-2.587	.010	-.044	-.006		
	Jobs_10000_3km	.00617	.034	.640	18.081	.000	.550	.684	.306	3.267
	No_motor_vehicles_Percentage	.190	.036	.195	5.215	.000	.118	.261	.274	3.655
	Percentage_Employed_within_SA2	.234	.022	.220	10.860	.000	.192	.277	.934	1.070
	Low_Income_under_32k	-.062	.017	-.084	-3.599	.000	-.096	-.028	.707	1.415
	Aged20_29	.142	.042	.108	3.386	.001	.059	.225	.376	2.662

a. Dependent Variable: arcsine_Walk_Pecentage

Table 6: Cycling Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.842[a]	.709	.698	.00559

a. Predictors: (Constant), Aged10_19, Public_Sector, km_bikelane_per_km2, Manager_Professionals, Local_Gov_workers, Distance_CBD, Jobs_100_5km, Households_with_children_Per

b. Dependent Variable: arcsine_BikePecentage

Table 7: Cycling Model Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
		B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
1	(Constant)	-.001	.003		-.435	.664	-.008	.005		
	jobs_100_5km	.029	.005	.372	5.869	.000	.019	.039	.334	2.993
	Public_Sector	.053	.014	.180	3.701	.000	.025	.081	.568	1.761
	Manager_Professionals	.027	.006	.230	4.261	.000	.015	.040	.460	2.175
	Households_with_children_Per	-.033	.008	-.348	-4.361	.000	-.048	-.018	.211	4.731
	Distance_CBD	-.015	.004	-.236	-3.829	.000	-.022	-.007	.355	2.820
	Local_Gov_workers	.830	.300	.156	2.764	.006	.238	1.422	.419	2.385
	km_bikelane_per_km2	-1.681E-06	.000	-.033	-.894	.372	.000	.000	.967	1.034
	Aged10_19	.049	.028	.170	1.785	.076	-.005	.104	.149	6.727

a. Dependent Variable: arcsine_BikePecentage