Increasing active travel to work: sub-analyses of a quasi-experimental study of an intervention to encourage walking and cycling

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Abstract

Cycling and walking are transport modes that have potential public health and environmental benefits when they replace travel by private motor vehicles. The New Zealand Model Communities Programme, consisted of infrastructure construction and promotion of active travel. The overall impact of the programme on active travel has been analysed previously, showing a statistically significant 37% increase (95% confidence interval 8% - 73%) in the odds of all trips in the intervention cities being by active modes relative to the control cities. This study focuses on evaluating the effects of the programme on the trip to work, making use of two surveys over the study period, along with two population Censuses, which just recorded trip modes for the commute to work. Statistical models were fitted independently to the three data sources to estimate the odds of active travel mode choice. Despite the availability of a large amount of data from the three studies analysed here, the heterogeneity between the studies generated large confidence intervals. The point estimate was for a 1% decrease in the odds of active travel mode choice with a wide 95% confidence interval, ranging from a reduction in the odds of active mode choice of 55% to an increase of 119%. This estimated null effect on active travel mode choice for work trips contrasts with the overall statistically significant increase found for all trips, previously. Although there were a large amount of data analysed and the estimate presented in the current study was for no change, the large associated confidence interval provides a poor basis for speculating on reasons why the trip to work might have been unaffected.

Keywords: Work; active travel; active transport; active transportation; commuting

1. Introduction

In New Zealand, trips between home and the workplace constituted around 14% of all trip legs annually, based on New Zealand Travel Survey data 2007-2011 [1]. Around one third of all household driving time and distance is devoted to work-related travel, mainly commuting to and from work [2]. Changing from the driving mode to other active or public transport modes for trips with this purpose can therefore yield important benefits in terms of reduced carbon emissions and increased physical activity levels [3, 4]. Petrunoff et al [5] recently conducted a systematic review of interventions to promote active travel in the work setting, finding generally positive effects on active mode choice for the trip to work.

The ACTIVE study (Activating Communities to Improve Vitality & Equality) was a quasi-experimental two-group pre-post study design in which we estimated changes in travel behaviour from baseline in 2011 to mid-programme in 2012, and post-programme in 2013. The study design has been provided in detail elsewhere [6]. It aimed to determine whether the Model Communities Programme (MCP), a combined central and local government initiative to construct cycling and walking infrastructure married with promotion and facilitation of active travel, shifted travel from motorised (mainly driving or being a passenger in a motor vehicle) to active modes (walking and cycling), and more generally, increased levels of physical activity. Two different surveys were conducted over the period of the intervention (before, during and after): a New Zealand Travel Survey (NZTS) that had coverage of the intervention and control areas; and the ACTIVE survey, specifically conducted to evaluate the intervention [7]. Based on identical statistical models fitted to reported trip modes for each of these two surveys, we estimated odds ratios for active trips in the treatment areas relative to the control areas, in the year after the intervention relative to baseline. These two independent estimates were then combined using meta-analysis techniques to form a weighted average estimate of change derived from the two surveys. Relative to the control cities, the odds of trips being by active modes (walking or cycling) increased by 37% (95% confidence interval 8% - 73%) in the intervention cities between baseline and post-intervention. The net proportion of trips made by active modes increased by about 30% [7].

The aim of the analysis reported here was to use the same study design but focused on trips made to work. The two surveys were not sufficiently large to detect expected changes associated with the intervention within subgroups of people or subsets of travel purposes. However, the principal mode used for the trip to work on one single specified day of the year is reported on in recent New Zealand population Censuses. These data can be examined using the same quasi-experimental study design [6] without the limitation of small sample sizes. Their main limitation in this context is the time gap of five years between the Census (2006) measure used as a baseline and the actual intervention. This limits the usefulness of the data to infer changes as necessarily due to the intervention rather than to other unmeasured factors.

Despite this limitation, the Census data were used alongside the NZTS and the ACTIVE survey results to provide three independent estimates of the intervention effect on mode choice for trips to work, using the matched treatment and control areas identified for the quasi-experimental study [6]. This paper presents these results, synthesised into a single measure of the effectiveness of the intervention in changing the mode of trips to work.

2. Methods

The design of the study and the methods used have been described in detail elsewhere [6, 7]. A face-to-face survey (the ACTIVE survey) obtained information on walking and cycling. We drew also on the New Zealand Travel Survey (NZTS), a national ongoing survey of travel behaviour, which was conducted in the study areas, and two New Zealand Censuses, which were conducted nationally, but could be analysed for the study areas. Using the three sources of data, we estimate changes in travel behaviour. The intervention and control cities were matched in terms of socio-demographic variables and baseline levels of walking and cycling. For the NZTS and the ACTIVE surveys, changes are measured from baseline in 2011 to post-programme in 2013. For the Census data analysis, changes are measured from a baseline in 2006 to post-programme in 2013. For the purpose of the analysis described here, only trips to work were analysed in terms of the modes used (active – walking or cycling; or other – mainly car driver or passenger).

The estimation was conducted in two steps. First, models were fitted separately to the three studies (the ACTIVE survey, the NZ Travel Survey and the Censuses). The relevant estimates were then combined using meta-analysis [8].

The New Zealand Census of Population and Dwellings is generally conducted every five years. The 2011 Census was postponed, however, because of the February 2011 Christchurch earthquake, and was held instead in 2013. One particular item collected by the Census is relevant to the current study. Individuals aged 15 and over reported their main means of travel to work, which was specified as the mode used to travel the longest distance to the workplace on Census day (a specified Tuesday in early March). These data have limitations: as they relate only to the main means of travel on a particular day, they do not necessarily indicate a usual mode of travel to work; and although the 2013 Census provides an appropriately timed measure post-intervention, the previous Census, held in 2006, precedes the intervention by five years.

The SAS procedure GLIMMIX was used to fit models to the ACTIVE and NZTS survey data, fitting generalized linear mixed models with pseudo-likelihood estimation for weighted multilevel models [9]. Explanatory variables included respondent age group (in five ranges: 0-9; 10-19; 20-29; 30-59 and 60 plus), respondent sex, a treatment/control area identifier, a matching variable (to identify respondents from each treatment city to its matched control), year (either

2011 or 2013 – before or after the intervention), time of year surveyed (to account for seasonal impacts on mode choice) and an interaction between year and the treatment/control identifier. The estimated coefficient for this last term allowed estimation of the odds ratio for active trips in the treatment areas relative to the control areas, in the year after the intervention relative to baseline.

Individual-level data were not available from the Census. We used the SAS procedure LOGISTIC to estimate the odds of active travel mode choice as the main mode for trips to work. Explanatory variables included a treatment/control area identifier, a matching variable (to identify people from each treatment city to its matched control with values east and west), year (either 2006 or 2013 – before or after the intervention) and an interaction between year and the treatment/control identifier. The estimated coefficient for this last term estimated the odds ratio for active trips in the treatment areas relative to the control areas, in 2013 relative to 2006. The estimates from the three studies were then combined using meta-analysis, which created a weighted average of the log-scale estimates [8], which were then exponentiated to form an estimate of the odds ratio.

3. Results

As shown in Figure 1, constructed from on-line tables of Census data [10], walking or cycling as a main means of travel to work has fallen steeply from 1996 to 2006, followed generally by a smaller fall in active travel to work over the next intercensal period to 2013. The results for the four small cities represented in the graph are for Local Authority areas, which centre on the four cities in question but include outlying residents not targeted by the MCP. Overall, however, these data reflect generally decreasing levels of active travel in the last two decades [11, 12]. Considering the intervention cities (New Plymouth and Hastings) combined, from 2006 to 2013 there was a 2% increase in active modes reported as the main mode for the trip to work. Considering the control cities combined, from 2006 to 2013 there was a 9% decline in active modes reported as the main mode for the trip to work. Relative to the control cities, the intervention was therefore associated with a 13% increase in active modes reported as the main mode for the trip to work. The relative odds, whose log is shown in Table 1, show a 14% increase. As travel to work by active modes is relatively rare, these two estimates (the rate ratio and the odds ratio) have similar values.

When undertaking the meta-analysis, there was evidence from a statistically significant Cochran's Q statistic (P=0.012) that there was heterogeneity between the studies. This implied that a random effects model was more appropriate for synthesising the estimates from the studies than a fixed effects model. The results of the random effects model are reported below. The variances of the coefficients play an important role in determining these weights. For the Census, finite population correction factors reduce any variances of the estimated coefficients to near-zero as the Census has virtually complete coverage of the population. A variance of zero is not useful in meta-analysis as division by the variances becomes impossible. Arbitrarily, a variance of 0.0001 was used for the Census analysis to overcome these computational issues. Other small values were also tried, but with negligible resultant change in the overall estimate.

Table 1 presents the key estimated coefficients estimated by models fitted to the ACTIVE survey data, the New Zealand Travel Survey data and Census data for the cities studied, together with the combined meta-analysis estimate, shown in the final row. This shows the estimated odds ratio with a 95% confidence interval that combines the information from the three surveys. Relative to the control cities, the estimated odds of trips to work being by active modes (walking or cycling) were not statistically significantly different from 1. The point estimate was 0.99 with a 95% confidence interval of 0.45 to 2.19.

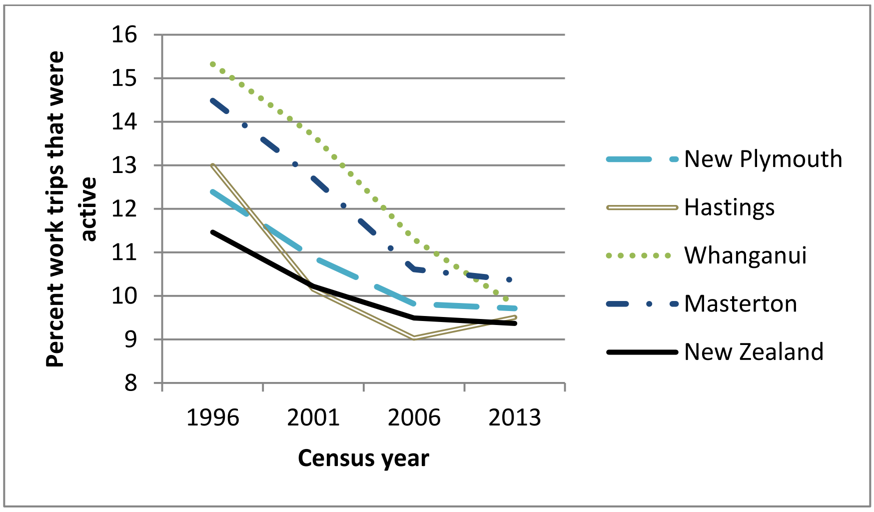

Figure 1: Percentage of main modes used to travel to work on Census day that were walking or cycling reported by people aged 15 and over, for four Censuses (compiled from available data [10]) The two intervention cities were New Plymouth and Hastings.

Table 1: For trips to work only: adjusted estimated coefficients (with standard errors in brackets) from models fitted to ACTIVE, Travel Survey and Census data pre-intervention and post-intervention with combined estimated odds ratio of active travel mode choice derived by meta-analysis (intervention post vs pre compared to control post vs pre) and confidence interval

Effect	**Estimate (with se or 95% CI)**
ACTIVE: Area*Year coefficient (intervention*post)	0.661 (0.34)
NZTS: Area*Year coefficient (intervention*post)	-2.022 (0.85)
Census: Area*Year coefficient (intervention*post)	0.132 (0.0001)
Meta-analysis estimate	-0.012 (0.41)
Estimated odds ratio (95% CI)	0.99 (0.45, 2.19)

4. Discussion

In the main analysis [7], comparing the intervention cities to the matched controls, we found substantial changes in walking and cycling. We thus conclude that the provision of infrastructure and associated programmes appeared to have successfully arrested the general decline in active mode use evident in recent years. The sub-analysis reported here does not conflict with the main finding, despite the point estimate indicating no effect. The very large confidence interval indicates that the combined surveys were inadequately powered to detect change in work trips associated with the intervention.

There was evidence from a statistically significant Cochran's Q statistic [13] that there was heterogeneity between the studies effects. There was no such evidence in the analysis of all trip purposes combined [7]. Such heterogeneity could arise in sub-analyses by travel purpose, but not in the overall analysis, because of the different ways that the travel information was elicited. In the ACTIVE survey, respondents reported on journeys to work, focusing on the main mode. The Censuses recorded the main mode used (to travel the greatest distance) in the journey to work on one particular day. In the NZTS, respondents reported all trip legs, which were analysed by the models fitted without consideration of their relative significance. So a journey to work mainly made by car that included a walk from the car park to the workplace was represented by both modes, weighted equally. The significantly heterogeneous effects implied that a random effects model was more appropriate for synthesising the travel to work estimates from the studies than a fixed effects model. Although all three studies can validly be used to infer change associated with the intervention, differences between the studies in terms of how travel was reported, and the timing of the baseline measure (in the case of the Census) are sources of such heterogeneity.

The Census data on the main mode used for travel to work on Census day showed a very small increase in active mode choice in the intervention cities, contrasting with a decline in the control cities. Based on these data, the intervention was therefore associated with a 13% increase in active modes reported as the main mode for the trip to work. Although sampling errors are not very relevant to Census data, meaning that there is negligible uncertainty associated with random variation due to sampling or lack of coverage of the population, these data are limited in the sense that only one day was reported on, and only the main mode (in terms of distance travelled) was considered. Nevertheless, as the treatment and control cities were matched according to geographic location, at least some of the effects of weather would have been controlled for in our analysis. A more important limitation is the timing of the measure used as the baseline from which the changes associated with the intervention were assessed. As mentioned above, New Zealand normally has Censuses every five years, but the Christchurch earthquake in 2011 created logistic difficulties that delayed the Census until 2013. The preceding Census, in 2006, was five years before the MCP intervention was put into effect. This is a long period during which other factors affecting mode choice to work could operate differentially between the intervention and control cities, including the Global Financial Crisis. Examination of Figure 1 shows nationally declining levels of active transport used as the main mode for trips to work over the four Censuses shown.

Despite the availability of a large amount of data from the three studies analysed here, the inference of change associated with the intervention was poorly-powered because of heterogeneity between the studies. The wide 95% confidence interval, ranging from a reduction in the odds of active mode choice of 55% to an increase of 119%, does not lend itself to firm conclusions of the effects of the intervention on travel modes used in the trip to work.

5. Conclusion

This study evaluated the effects of an intervention consisting of a combined central and local government initiative to construct cycling and walking infrastructure married with programmes and policies to promote and facilitate cycling and walking. Three independent measures of change in travel mode for the journey to work were synthesised using meta-analysis, showing no detectable change. The large associated confidence interval provides a poor basis for speculating on reasons why the trip to work might have been unaffected by the intervention. The null effect for work trips contrasts to the statistically significant overall increase in the odds of trips in the intervention areas being by active modes of 37% (95% confidence interval 8% - 73%) relative to the control cities found previously [7].

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