



Active travel intervention and physical activity behaviour: An evaluation



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ABSTRACT

A physically active lifestyle is an important contributor to individual health and well-being. The evidence linking higher physical activity levels with better levels of morbidity and mortality is well understood. Despite this, physical inactivity remains a major global risk factor for mortality and, consequently, encouraging individuals to pursue physically active lifestyles has been an integral part of public health policy in many countries. Physical activity promotion and interventions are now firmly on national health policy agendas, including policies that promote active travel such as walking and cycling. This study evaluates one such active travel initiative, the Smarter Choices, Smarter Places programme in Scotland, intended to encourage uptake of walking, cycling and the use of public transport as more active forms of travel. House to house surveys were conducted before and after the programme intervention, in May/June 2009 and 2012 (12,411 surveys in 2009 and 9542 in 2012), for the evaluation of the programme. This paper analyses the physical activity data collected, focussing on what can be inferred from the initiative with regards to adult uptake of physical activity participation and whether, for those who participated in physical activity, the initiative impacted on meeting recommended physical activity guidelines. The results suggest that the initiative impacted positively on the likelihood of physical activity participation and meeting the recommended physical activity guidelines. Individuals in the intervention areas were on average 6% more likely to meet the physical activity guidelines compared to individuals in the non intervention areas. However, the absolute prevalence of physical activity participation declined in both intervention and control areas over time.

Our evaluation of this active transport initiative indicates that similar programmes may aid in contributing to achieving physical activity targets and adds to the international evidence base on the benefits of active travel interventions.

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1. Introduction

Interventions to encourage reduced car use and substitute active travel alternatives are motivated by concerns to improve health, primarily through increased physical activity in the form of walking and cycling, and to improve the environment, both locally and globally (de Nazelle et al., 2011). There have been a number of evaluations which attempt to analyse the link between such interventions and levels of physical activity associated with walking and cycling. Greenberg et al. (2005) investigated the impact of a new transit train station on American commuters walking behaviours, with one-third of those surveyed reporting additional

physical activity mainly due to an overall increase in walking activity. In a related study Besser and Dannenberg (2005) investigated daily time spent walking to and from public transport in relation to recommended physical activity guidelines and found that about 30% of their sample population met the daily recommended physical activity guideline purely from transit related walking. Yang et al. (2012) analysed the association between active travel and physical activity in the Commuting and Health in Cambridge study and concluded that active travel was associated with increased physical activity in women but there was no association for men. In an international cross-sectional comparison study, Pucher et al. (2010) investigated the relationship between active travel and physical activity, obesity, and diabetes prevalence and found significant population health gains associated with active travel behaviour. The correlation between active travel and physical activity was significantly positive whilst significantly negative

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correlations were found between active travel and obesity, and active travel and diabetes. In a systematic review assessing the effects of interventions to promote walking, [Ogilvie et al. \(2007\)](#) found that the most successful interventions could increase walking among targeted participants by up to 30–60 min a week, on average. In a similar systematic review focused on interventions to promote cycling, [Yang et al. \(2010\)](#) found only two studies which assessed the effects of interventions on physical activity and it was thus unclear whether this type of intervention resulted in an increase in overall physical activity. A recent systematic review by [Wanner et al. \(2012\)](#) found some evidence that active transport is associated with greater self-reported total physical activity.

For overall physical activity health gains to be fully realised, it is not sufficient for there to be an increase in active travel; it must also be accompanied by an increase in physical activity by individuals who do not currently meet physical activity guidelines, as it is possible that an increase in active travel might be compensated for by a decrease in activity in other domains. Although most evaluations in the literature have tended to isolate the increases in walking or cycling activity associated with an intervention and have largely failed to measure whether this leads to a compensating reduction in other physical activities, [Sahlqvist et al. \(2013\)](#), in a longitudinal study, found that increases in active travel were associated with a commensurate increase in total physical activity and not a decrease in recreational physical activity.

It should be noted that there is some evidence of health gain associated with active travel independent of overall physical activity. [Hamer and Chida's \(2008\)](#) meta-analysis demonstrated an association between active travel and reduced cardiovascular risk, suggesting independent effects of commuting activity, with different types of activity potentially providing additive benefits.

Physical activity does not need to be strenuous to have significant effects on people's health, general wellbeing and productivity. Evidence shows that active people have longer lives, lower risk of developing diseases, greater wellbeing, fewer symptoms of depression, lower rates of smoking and substance misuse and the ability to function better at work and home ([World Health Organisation – WHO, 2010](#); [Wen and Wu, 2012](#)). Physical inactivity remains one of the major global risk factors for mortality ([WHO, 2007, 2009](#)) even though the evidence linking higher physical activity levels with better levels of morbidity and mortality is well-documented ([Andersen et al., 2000](#); [WHO, 2005](#)). The World Health Organisation (WHO) recommends adults to accumulate at least 30 min of moderate activity (the equivalent of brisk walking) on most days of the week for health gains to be realised and that physical activity promotion and interventions should be an integral part of national health policy emphasising, amongst others, policies that promote active travel such as walking and cycling ([WHO, 2004](#)).

The Scottish Government in line with other European countries has adopted the WHO recommendation on physical activity ([Physical Activity Task Force, 2003](#); [The Scottish Government, 2008, 2010](#)), supporting policies making physical environments more amenable to physical activity in everyday activities as part of the Scottish physical activity strategy with the objective “to develop and maintain long lasting, high-quality physical environments to support inactive people to become more active”. Ring-fenced funding in the Public Transport Fund supports initiatives encouraging individuals to walk and cycle ([Physical Activity Task Force, 2003](#), p. 23).

One such initiative is the Scottish Government Smarter Choices, Smarter Places programme (SCSP), a pilot initiative across Scotland between 2009 and 2012 to encourage uptake of walking, cycling and the use of public transport as a more active form of travel alternative to car use. Funds were directed at seven pilot areas

across Scotland which were selected for funding on the basis of their individual plans to encourage local individuals to adopt travel patterns aiming to save them money, help to make them healthier, reduce transport emissions and develop more cohesive communities. To achieve these goals, local authorities covering the participating towns delivered complex programmes to organise, enable, promote and provide sustainable transport solutions. A more detailed table describing the intervention package can be found in an [Annex online](#).

The latest results from the Scottish Health Survey show that between 2008 and 2011 there was no significant change in the proportion of adults meeting the recommendations ([The Scottish Government, 2011](#)). In 2008, 39% of Scottish adults aged 16 and over met the physical activity guidelines, 30% did not meet the guidelines but engaged in some physical activity (30 min or more on 1–4 days a week) and 31% had been inactive (fewer than 30 min of moderate activity a week); by 2011 those percentages were, respectively, 39%, 29% and 32%. Scotland therefore has some way to go to meet its long term target for 50% of the adult population to meet the recommended guidelines by 2022.

This paper analyses the physical activity data collected for the evaluation of the SCSP programme. In particular, we focus on what can be inferred with regards to (i) adult uptake of physical activity participation and (ii) conditional on participation, the effect on adults meeting the physical activity guidelines. From a policy perspective, the results are important since they will indicate whether this type of intervention was successful in achieving one of its intended aims. Evaluation of this initiative will therefore indicate whether similar programmes will aid in contributing to achieving physical activity targets and will contribute to the international evidence base on the benefits of active travel interventions.

2. Methods and data

2.1. The SCSP programme

As is often the case with public policy changes, the SCSP was not implemented as a controlled experiment ([Blundell and Costa Dias, 2000](#)). The challenge for the evaluation was to measure the impact on changes in individual behaviour without being able to observe what would have happened without the programme.

Implementation of SCSP was restricted to seven local areas with populations ranging between 8 and 39 thousand (Barrhead, Dumfries, Dundee, Glasgow East End, Kirkintilloch/Lenzie, Kirkwall and Larbert/Stenhousemuir). These areas had been selected through a competition for funding by the Scottish Government and, as such, cannot be considered a random or representative sample of areas. For the control, data zones in the intervention areas were matched with data zones in areas which had not applied for SCSP funding and three control locations (Arbroath, Bearsden and Dalkeith) were selected on the basis of the most matches. Key observable characteristics were chosen which (i) are known to impact on travel choices at the area level (population density and car ownership) and represented the baseline level of active travel in each area (proportion cycling to work) and (ii) could be reliably identified in local area statistics. Other characteristics were considered but were rejected on the basis that many of these factors are themselves correlated (e.g. GDP and unemployment) and have less direct links with travel behaviour. In addition, as the number of parameters rose, the number of required locations with the full range on each of the key characteristics also rose. Expanding the number of control areas would have presented methodological challenges in terms of the range of potential unobservable and confounding factors. Interim analysis of travel behaviour indicated that the 3 areas taken

together acted as a control for the 7 intervention areas taken together but were more problematic when attempting to produce synthetic controls for individual intervention areas. However, our analysis relies only on the combined data.

House to house surveys were conducted before and after the programme intervention, in May/June 2009 and 2012 (12,411 surveys in 2009 and 9542 in 2012). One adult per household (chosen from a random sample of households from a list of postcode areas) took part in the survey, selected using “next birthday”. The College of Physical Sciences (COPS) of the University of Aberdeen has an established ethic approvals procedure and in accordance with it the appropriate ethics approval form was completed. The COPS Committee signed off the application, as it was considered that there was nothing sensitive in the proposed research.

The sample represented between 8 and 10% of the total population aged 16+ in the areas. The response rates, based on the number of usable surveys (100% complete) were 14% for the SCSP areas in both years and 15% in 2009 and 14% in 2012 in the control areas.

In 2009, the surveys were administered using a questionnaire which was left at each household allowing for self-completion by respondents with additional assistance and support provided by surveyors on collection of completed forms. In 2012 a computer assisted survey approach (CAPI) was adopted, allowing surveyors greater control over the survey responses and delivering a better response rate than in 2009. However, as physical activity can be considered to be a socially desirable behaviour, it may have a tendency to be over-reported by respondents in surveys (Motl et al., 2005). Whilst physical activity is commonly measured using self-reported survey instruments, this change in methodology has the potential to exacerbate any social desirability bias due to the additional face to face contact between researcher and respondent in the after survey. However, we also note that a previous review of the effect of different types of physical activity survey measurements on social desirability concluded that the less structured the survey (i.e. the less detailed the questions on physical activity), the lower the social desirability effect (Adams et al., 2005). In the SCSP surveys, respondents were asked to simply record a number of days per week on which they undertook a certain level of exercise. It is also worth noting that the level of physical activity reported in the second survey was lower, which may suggest that any effect of the change in survey mode was small. In terms of the difference-in-difference analysis, the survey mode would only introduce bias into the results if the effect differed between the control and intervention samples and this seems unlikely.

The survey data provided the opportunity to construct a quasi natural experiment using ‘difference-in-differences’ (DID) methods. DID uses the before and after intervention differences in both intervention and control areas and the difference between these two differences, to assess the average effect of the intervention. This allows the time trend in both areas to be eliminated (Qin and Zhang, 2008). DID provides a robust test of whether the introduction of SCSP is associated with changes in physical activity levels and whether these are statistically significant.

The DID approach is useful in the context of this evaluation because the collection of the sample data could not control for all of the variables affecting physical activity decisions. We can account for some of the differences between the SCSP and control samples by controlling for demographic, socio-economic and health related factors. However, estimating the impact of the programme as the difference between these two differences (SCSP versus control areas) rests on the assumption that the areas are subject to the same changes over time apart from the programme introduction, that is, that “common time effects exist across groups” (Blundell and Costa Dias, 2000).

2.2. Data

In addition to providing details of their travel and social demographic data, respondents were asked to record how many days per week (outside of work) they typically undertook at least 30 min of moderate intensity exercise including walking and cycling. This definition was adopted because the amount of physical activity at work would be determined by job type rather than individual behaviour and is unlikely to be affected by the introduction of SCSP. Wording from the Scottish Health Survey questionnaire (2008–2011) was used to explain that this activity did not need to be undertaken all in one go. The specific question was:

“Thinking about what you do outside work, school or college, how many days per week would you say that you typically do at least 30 min moderate exercise? This does not have to be all in one go but can be across more than one session in a day. Examples of moderate exercise include fairly brisk walking, cycling, heavy housework or DIY, swimming, use of a gym, aerobics/keep fit/gymnastics, active sports such as football, rugby, tennis, badminton, and squash”.

Respondents had four possible answers: “Every day”; “5–6 days per week”; “1–4 days per week” and “No days”. From the responses an indicator variable was derived, “meeting recommendations”, taking a value of one if respondents reported physical activity of at least moderate intensity for at least 30 min on 5 or more days per week; zero otherwise. Based on the same survey question, a second variable was derived, “decision to do any exercise” which distinguishes those who are physically active (=1) from those who are inactive (=0). Similar single item questions have been used in other evaluation studies, for example, Van Stralen et al. (2009), based on the self-administered Dutch Short Questionnaire to Assess Health Enhancing Physical Activity (SQUASH): On how many days per week are you, in total, moderately physically active, by undertaking, for example, heavy walking, cycling, chores, gardening, sports, or other physical activities for at least 30 min? A recent paper has addressed the criterion validity of the single item question against accelerometry and concludes that it is valid for determining whether respondents are sufficiently active to benefit their health (Milton et al., 2013).

The surveys also included questions on household composition, access to car, respondent socio-demographic characteristics and health and disability.

2.3. Modelling the probability of meeting the physical activity recommendation

To assess the impact of the intervention on the likelihood of adults taking up physical activity and, conditional on participation, on adults meeting the Scottish physical activity guidelines, we estimate a probit regression model with sample selection (Van de Ven and Van Praag, 1981). Assume the existence of a latent binary variable y_1^* indicating whether an individual meets the physical activity guidelines which is expressed as a function of the determinants of meeting the physical activity guidelines and an error term accounting for unobserved factors that impact meeting the recommendation:

$$y_1^* = x_1 \beta_1' + u_1$$

In the data, however, we only observe the binary outcome, meeting the recommendation, if $y_1^* > 0$:

$$y_1 = \begin{cases} 1 & \text{if } y_1^* > 0 \\ 0 & \text{if } y_1^* \leq 0 \end{cases}$$

At the same time we also need to consider that y_1 is only observed if the individual participates in physical activity. Hence,

there exists a latent variable y_2^* indicating participation in physical activity which is a function of the determinants of physical activity participation such that

$$y_2^* = x_2\beta_2' + u_2$$

Again, we only observe the selection outcome if $y_2^* > 0$;

$$y_2 = \begin{cases} 1 & \text{if } y_2^* > 0 \\ 0 & \text{if } y_2^* \leq 0 \end{cases}$$

In this model the error terms in the two equations are jointly normally distributed with correlation coefficient ρ :

$$\begin{pmatrix} u_1 \\ u_2 \end{pmatrix} \sim N \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & \rho \\ \rho & 1 \end{pmatrix} \right]$$

Correlation of the error terms, $\rho \neq 0$, means that the probability of meeting the physical activity guidelines will depend on the probability of physical activity participation. If not accounted for, this will result in biased estimates of the outcome of interest, y_2 . In this case, y_1 and y_2 should be estimated jointly. If on the other hand the two error terms are uncorrelated, $\rho = 0$, the two equations can be estimated independently.

To test the independence assumption we compute a Wald test, distributed χ^2 with one degree of freedom, testing the null hypothesis that $\rho = 0$. Rejection of the null hypothesis implies that the two variables need to be estimated jointly.

For identification of the model parameters, we impose exclusion restrictions in the 'meeting the recommendation' equation. Measures of individuals' self-reported general health and disability status are included in the 'participation' equation but excluded from the 'meeting the recommendation' equation. Health reasons have been found to be a major barrier to physical activity participation and for individuals who do not suffer from ill health a motivator for physical activity participation to keep physically fit and healthy (The Scottish Executive Education Department, 2006). We expect physical activity participation to decline with worsening general health status and also to be lower for the disabled. Whilst there are reasons to believe that good general health may also impact on the amount and intensity with which physical activity is undertaken, the general health measures are excluded from the 'meeting recommendation' equation given that it focuses on a very specific definition of physical activity and that we judge health more important in determining participation.

To assess the impact of SCSP on the likelihood of participation and meeting the recommendation, an interaction term is included measuring the difference-in-difference effect of the intervention. This is a simple interaction term of the area and year and indicates the differential effect of the introduction of SCSP; it measures the change in the probability of participation and, conditional on participation, the probability of meeting the recommendation in the intervention areas relative to the areas not exposed to the intervention. Additionally the year and area indicator are also controlled for in the model. The 'area' variable shows the effect of living in an intervention area rather than a control area on the propensity to participate and meeting the physical activity recommendation. The 'year' variable shows the overall change in the response probabilities over time. To capture unobservable effects that are common within but not between areas (e.g. different economic/social tendencies), we use dummies to control for area fixed-effects in the analysis (Ahlfeldt and Kavetsos, 2014).

3. Results

Table 1 provides the descriptive statistics from the survey data for the control and intervention areas in the two years under consideration. For each year t -tests were estimated on the equality of means between control and intervention areas.

The proportion of individuals meeting the physical activity recommendations was significantly different ($p < 0.01$) between the control and intervention areas in both 2009 and 2012. Both areas experienced a decline. This was larger in the control (from 39.8% to 24.9%) relative to the intervention areas (34.2%–30.8%). A similar pattern emerges with respect to individuals who exercise regardless of physical activity frequency and intensity, although the difference in the proportion of individuals participating in physical activity between the control and intervention areas was only statistically significant ($p < 0.01$) in 2009.

In line with other studies that investigated the determinants of physical activity participation and time spent on physical activity (Farrell and Shields, 2002; Downward, 2007; Eberth and Smith, 2010; Brown and Roberts, 2011; Downward et al., 2001; Humphreys and Ruseski, 2011; Kokolakis et al., 2011) the model controls for the covariates in Table 2. A priori, we expect the likelihood of physical activity participation and meeting the recommendation conditional on participation to decline with increasing age. We also expect men to be more likely to participate relative to women and, conditional on participation, to be more likely to meet the recommendation. The presence of infants (children younger than two) is expected to impact negatively on the likelihood of participation and meeting the recommended guidelines due to the time commitments caring for infants whilst, a priori, the direction of the effect is unclear for older children.

The car indicator proxies accessibility constraints to physical activity, and as such is expected to increase the likelihood of physical activity participation (this might be most relevant in terms of sports participation). However, there is also evidence to support the hypothesis that individuals who do not own a car are more physically active as they have to participate in active travel (Lucas and Jones, 2009; Anable et al., 2010; Olabarria et al., 2012).

Education is thought to proxy an individual's knowledge regarding the health benefits of physical activity participation and awareness of the required amount of physical activity to maintain good health. We assume that individuals with increasingly higher education levels may be more likely to produce health (Grossman, 1972). However, education also serves as a proxy for the opportunity cost of time which is increasing with higher education levels given that wages of the higher educated should be higher relative to those of the lower educated. There are two dimensions to the wage effect: if physical activity is a normal good, an increase in wages will result in an increase in demand for physical activity consumption (income effect) but because the activity requires a time input by the individual, an increase in wages will reduce the time spent on physical activity (substitution effect). The net effect cannot be determined a priori. Similar considerations apply to the effect of employment status. Since individuals in employment have a higher opportunity cost of time, their likelihood of participating in sports may be lower. However, conditional on participation, it is unclear how employment status impacts on meeting the recommended guidelines. Previous studies found a clear income gradient in physical activity participation with individuals on low incomes being less likely to engage in physical activity. This suggests that income might be an important barrier to physical activity participation (Gidlow et al., 2006). We are unable to control for income as a determinant of physical activity participation since it was not possible to collect reliable income information from the respondents. Hence, this might introduce an omitted variables bias in

Table 1
Descriptive statistics: number and percentage of individuals in each area by year.

	2009				2012			
	Control		Intervention		Control		Intervention	
	Number	%	Number	%	Number	%	Number	%
Number of respondents	3011	24.3	9400	75.7	2316	24.3	7226	75.7
Meeting recommendations	1183	39.8	3206	34.2 ^a	576	24.9	2223	30.8 ^a
Decision to do any exercise	2358	79.3	6611	70.6 ^a	1623	70.1	5054	69.9
Young children in household (0–2 yrs)	107	3.6	341	3.6	77	3.3	312	4.3 ^b
Children 2–15 yrs in household	635	21.1	1867	19.9	381	16.5	1314	18.2 ^c
Access to car	2213	73.8	5622	59.9 ^a	1543	66.6	3414	47.2 ^a
Work status:								
Inactive ^a	374	12.7	1351	14.6 ^c	337	14.6	1330	18.5 ^a
Employed	1110	37.8	3565	38.6	800	34.7	2395	33.3
Unemployed	147	5.0	764	8.3 ^a	76	3.3	531	7.4 ^a
Retired	1309	44.5	3553	38.5 ^a	1090	47.3	2936	40.8 ^a
Male	1247	41.7	4004	43.0	993	42.8	30,206	41.7
Disability	688	23.0	2160	23.0	547	23.6	1909	26.6 ^a
Self reported health:								
Poor ^a	191	6.3	708	7.5 ^b	159	6.9	851	11.8 ^a
Fair	417	13.8	1193	12.7	300	13.0	1090	15.1 ^a
Good	735	24.4	2514	26.7 ^b	922	39.8	2175	30.1 ^a
Very good	1121	37.2	3155	33.6 ^a	773	33.4	2205	30.5 ^b
Excellent	531	17.6	1793	19.1 ^c	161	7.0	901	12.5 ^a
Age:								
16–24 years ^a	209	6.9	867	9.2 ^a	148	6.4	665	9.2 ^a
25–34 years	270	9.0	1129	12.0 ^a	201	8.7	971	13.4 ^a
35–44 years	433	14.4	1374	14.6	288	12.5	962	13.3
45–54 years	423	14.0	1432	15.2 ^c	322	13.9	1068	14.8
55–64 years	473	15.7	1433	15.2	402	17.4	954	13.2 ^a
65–74 years	813	27.0	2156	22.9 ^a	500	21.6	1433	19.8 ^c
75 or over	372	12.4	926	9.9 ^a	452	19.5	1168	16.2 ^a
No Qualifications ^a	769	26.3	3406	37.1 ^a	489	21.6	2172	30.4 ^a
School certificate	350	12.0	985	10.7 ^c	287	12.7	837	11.7
O grade equivalent	520	17.8	2068	22.5 ^a	559	24.7	2014	28.2 ^a
A level equivalent	434	14.9	982	10.7 ^a	318	14.1	985	13.8
Higher education	847	29.0	1740	19.0 ^a	606	26.8	1127	15.8 ^a
Ethnicity (white)	2913	97.8	9199	98.2	2277	98.4	7104	98.6

Note: *t*-Student tests with *a* = significant at 1%; *b* = significant at 5% and *c* = significant at 10%.

^a Base category in estimation.

the analysis resulting in a negative bias in the likelihood of participation. However, educational status is also highly correlated with an individual's income position and we therefore expect education to at least partially pick up the effect of income on the likelihood of participation in physical activity. Again, the main findings would only be affected if the trends in income over time differed between the intervention and control samples.

Table 2 presents the regression coefficients estimated from the independent probit models and the probit model with sample selection.

The Wald test rejects the independence assumption and confirms that the two variables should be estimated jointly. The negative correlation coefficient between the error terms for the two equations (ρ) indicates that those who participate in sports are not very likely to meet the recommended physical activity guidelines; most are participating at levels short of the 30 min of at least moderate intensity on five days per week.

Due to the rejection of the independence model, this section focuses on the sample selection model results. Positive coefficients are interpreted as increasing the likelihood of participating in physical activity and, conditional on participation, meeting the recommended physical activity guidelines whereas the reverse holds for negative coefficients.

The key variable of interest for the overall evaluation of the intervention is the 'SCSP' variable, an interaction term measuring the difference-in-difference effect of the intervention. The estimated coefficient reveals that the likelihood of physical activity participation is significantly higher in the intervention areas

relative to the control areas, and conditional on physical activity participation, significantly increases the likelihood of meeting the physical activity guidelines in the intervention areas relative to the control areas.

It is also useful to assess the biases generated in the results on the 'SCSP' variable across the independent and sample selection models. For the likelihood of meeting the recommended guidelines, comparison of the estimated coefficients reveals a positive bias on the 'SCSP' variable; an overestimation of the intervention effect when not controlling for selection.

We can also look at the separate effects of the area and year indicators. Individuals in the intervention areas were significantly less likely to participate in physical activity relative to the control areas but, conditional on participation, significantly more likely to meet the recommended physical activity level. The coefficient on the year dummy indicates that, over time, individuals in both the intervention and control areas were less likely to participate in physical activity. Conditional on participation, individuals were also less likely to meet the recommendation in 2012 relative to those who participated in 2009.

The other covariates controlled for in the model reveal that men are more likely to participate in physical activity and, conditional on participation, more likely to meet the recommended guidelines. Children in the household had no significant effect.

Individuals are significantly more likely to participate if they own a car and are in employment. The likelihood of participation is further significantly increased with increasing general health and educational attainment. As expected, individuals are significantly

Table 2
Regression results.

	(1)		(2)	
	Independence model		Sample selection model	
	Participation	Meeting guidelines	Participation	Meeting guidelines
SCSP (area*year)	0.42***	0.34***	0.39***	0.13**
Area ^a	-0.52***	0.01	-0.50***	0.29***
Year	-0.28***	-0.38***	-0.26***	-0.29***
Children	0.04	-0.02	0.05	-0.04
Young children	0.02	0.06	0.03	0.04
Car	0.10***	0.02	0.11***	-0.09**
Employed	0.10***	-0.07	0.11***	-0.12***
Unemployed	-0.04	-0.14***	-0.01	-0.18***
Retired	-0.06	-0.04	-0.05	-0.02
Gender	0.05	0.06***	0.05*	0.04*
Disability	-0.31***	-0.11***	-0.27***	
Fair health	0.66***	0.48***	0.63***	
Good health	1.17***	0.86***	1.13***	
Very good health	1.37***	1.12***	1.37***	
Excellent health	1.44***	1.33***	1.49***	
Age 25–34	-0.21***	-0.12***	-0.21***	-0.04
Age 35–44	-0.19***	-0.20***	-0.17***	-0.17***
Age 45–54	-0.27***	-0.28***	-0.26***	-0.21***
Age 55–64	-0.34***	-0.26***	-0.32***	-0.19***
Age 65–74	-0.50***	-0.43***	-0.47***	-0.29***
Age 75 over	-0.75***	-0.58***	-0.73***	-0.19***
Ethnicity (white)	0.04	-0.12*	0.04	-0.15*
School certificate	0.20***	0.16***	0.19***	-0.02
School equivalent	0.26***	0.17***	0.26***	-0.02
Post school	0.30***	0.14***	0.30***	-0.05
Higher education	0.46***	0.22***	0.47***	-0.02
Constant	-0.211	-1.18***	-0.14	0.30***
N	20,926	20,926	20,926	
ρ			-0.61***	
Wald test statistic			$\chi^2_{(1)} = 150.66$ ***	
Log pseudolikelihood			-19188.38	

*** significant at 1% ** significant at 5% * significant at 10%.

Location dummies were included in the estimation of the models.

^a Assumes the value of 1 for the intervention area.

less likely to participate with increasing age and if they suffer from a disability.

Conditional on participation, individuals are significantly less likely to meet the recommended level of physical activity if they own a car and are in employment or are unemployed, compared to the economically inactive. Note that 66% of the inactive are either at home (44%) or in education (22%) and only 34% are inactive due to illness. Education level has no significant effect. Relative to those aged 16 to 24, all other age groups, with the exception of the 25–34 year olds, are significantly less likely to meet the recommendation. Note however, that this is most pronounced for those aged 45 to 54 and those age 65 to 74.

3.1. Predicted probabilities

To get a better idea of the overall magnitude of the intervention effect, we used the regression output to estimate the predicted probability for 'SCSP' of meeting the guidelines for an individual with average sample characteristics. This was not significantly different between intervention and control areas in 2009 but in 2012 the difference was significant. Individuals with average sample characteristics in the intervention areas were 6% more likely to meet the recommended physical activity guidelines relative to those in the control areas.

Fig. 1 shows predicted probabilities of meeting the recommendations by education status for the control and intervention areas in 2009 and 2012. For individuals with no qualifications or the equivalent of an O-level qualification, there was no significant

difference in terms of the probability of meeting the recommended levels of physical activity in 2009. In 2012, the difference was significant, with the predicted probabilities of meeting the recommendations higher within the intervention areas; a 16% higher probability for individuals with no qualifications and 12% for individuals with O level equivalents. In 2009 individuals in the intervention areas with a school certificate were significantly less likely (9%) to meet the recommended levels of physical activity than those in the control areas. After the SCSP programme was introduced, the probability of meeting recommendation was higher in the intervention area but the difference was not statistically significant. Such changes were not observed in the higher education categories. Together the changes suggest that the SCSP programme had more impact on the likelihood of meeting the recommendations for individuals with lower or no educational qualifications relative to those with post school and higher education.

Similarly for age, estimated predicted probabilities (Fig. 2) in the intervention and control areas over time show that individuals in the younger (16–34) and older (65 and over) age groups in the intervention areas have seen their average probability of meeting the guidelines increase over time in comparison with the control areas whilst those in the 35–44 and 55–64 age ranges in the intervention areas are less likely or have no significantly different likelihood of meeting the recommended guidelines over time.

4. Discussion

Overall, the results show a positive association between the SCSP programmes and individuals' probability of meeting the physical activity recommendations. Even though the probability of participating in physical activity and meeting the targets reduced over time in both the intervention and control areas, the reduction was less in the intervention relative to the control areas. The evaluation demonstrates the strengths of the DID methodology in controlling for multiple confounding factors when dealing with samples that are neither random nor completely representative. The use of predicted probabilities from the probit to identify impacts on particular subgroups is another useful feature of the evaluation for policy makers.

There are, of course, some limitations to our study. The association between meeting the physical activity recommendation and the intervention cannot be interpreted as a causal relationship. In order to be confident in the results, it is important that the trends in the intervention and control areas would have been the same without the SCSP. The quasi natural experimental approach cannot entirely control for the multiple influences on physical activity behaviour, over a three year evaluation period, for towns spread across Scotland, facing potentially different economic and social change. There may be changes in the differences between the intervention and control areas which we are not able to observe and therefore could not control for in our models. If these changes coincide with SCSP funding we cannot differentiate between their impact and that of the SCSP intervention. For example, the building of sports/gym facilities or other physical activity-based initiatives outside of the SCSP programme or the relocation or closure of important trip generators such as employment sites or retail outlets.

In addition, local authorities were selected for SCSP funding on a number of criteria, one of which was a track record of delivering on similar projects. Therefore it is possible that local authorities receiving SCSP funding were on a different trajectory. If so, the effect could either be positive, in the sense that they were building on previous success, or negative, if the marginal gains to be made in active travel were small. A different issue with respect to isolating

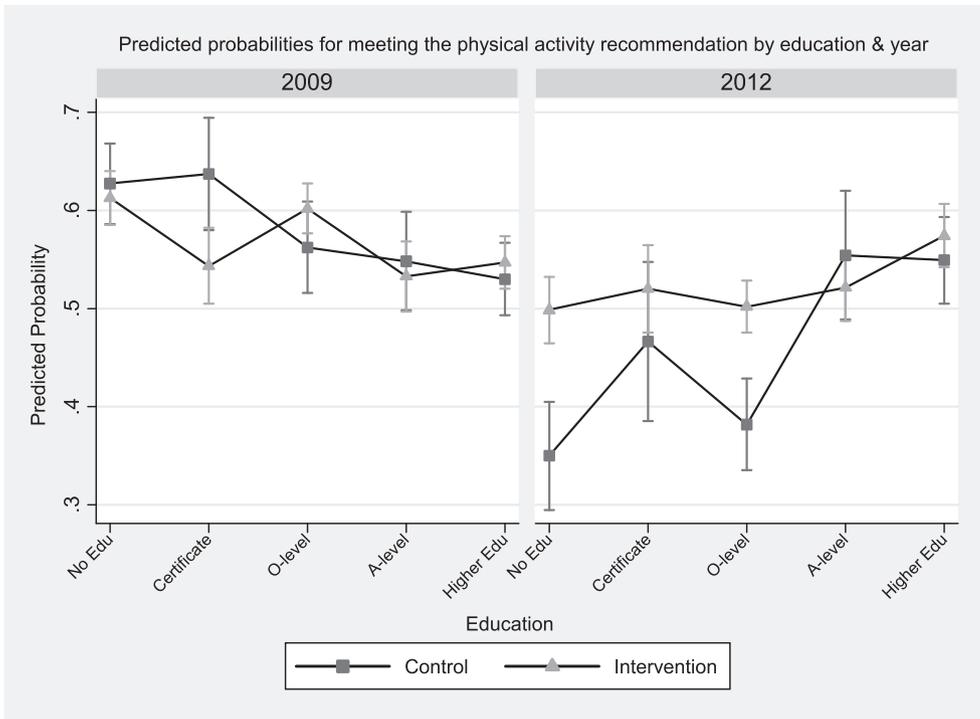


Fig. 1. Predicted probabilities for meeting the physical activity recommendation by education & year.

the effect of the programme is that areas which did not receive SCSP funding may have themselves introduced active travel initiatives during the study period. This could potentially reduce the differences between the intervention and selected control areas, or national controls, thereby leading to an underestimation of the impact of the active travel initiatives.

The controls were chosen from areas which had not applied for SCSP funding. Whereas local authorities that submitted unsuccessful bids for funding may have implemented initiatives developed through these proposals, even in the absence of dedicated support from Scottish Government, there is no information relating to the reasons why some local authorities did not bid for

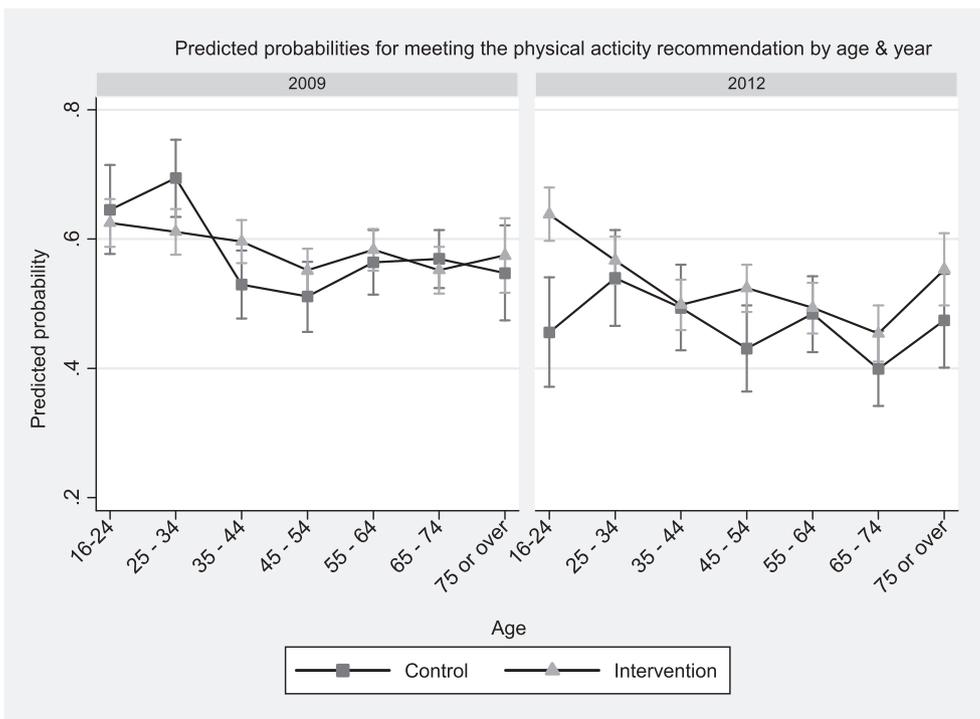


Fig. 2. Predicted probabilities for meeting the physical activity recommendation by age & year.

funding. Whilst we cannot assume that the control areas selected would not implement any active travel initiatives, this group were considered to be the more suitable choice. If, however, the control areas were uninterested in active travel, then the effect of the SCSP programme could be overestimated. Ideally, two control groups might have been constructed, those that were unsuccessful and those that did not apply, but this was beyond the scope of the evaluation.

If other active travel initiatives are being implemented outside of the SCSP areas, then the evaluation becomes more focussed on the impact of the additional funding and the additional initiatives associated with the SCSP. However, it is also possible that the SCSP programme substituted for investment which might have otherwise been provided through other programmes funded by Scottish Government to support investment by local authorities in active travel and streetscape improvements.

On a short three year evaluation there is insufficient time to investigate how the impact of the policy might decay or build up over time. There are a variety of reasons why it may take time for the impacts of travel-behaviour interventions to materialise including: learning by policy makers; the development of better methods which increase the effectiveness of soft measures over time; the tendency for investment in infrastructure (such as pedestrian improvements) to be completed later in an intervention programme; and the time taken to change social and behavioural norms (Cairns et al., 2004). It is, therefore, possible that the total programme benefit may be underestimated. On the other hand, it cannot be assumed that the benefits we observe during the lifetime of the intervention will be extended into future years if the behaviour changes are not maintained and reinforced. There is a general concern that behavioural effects often decay over time so that there may be virtually no continuation of the behaviour change after a few years (Cobiac et al., 2009). The empirical evidence on the magnitude of these build up and decay effects is limited and there is no reported standard trajectory of behaviour change and associated impacts that can be applied to an evaluation of active travel or physical activity interventions. Nevertheless, the potential for the impacts to be over or underestimated highlights the importance of understanding context when evaluating such initiatives. The benefits observed may depend upon whether other complementary initiatives are being introduced, over what timescale and the level of latent physical activity which can be inspired at each point in the programme.

Finally, we were limited in the amount of physical activity data that could be collected in the survey, which covered all aspects of active travel, and in the quality of the data collected on income. The frequency of physical activity in days, conditional on being physically active for at least 30 min of at least moderate intensity, was sufficient for evaluating whether the introduction of the intervention brought about a change in the propensity to meet physical activity guidelines. However, future intervention studies of this type would be more informative if they collect physical activity data in terms of duration, frequency and intensity, preferably on a longitudinal basis. This would allow an assessment of physical activity gains in the group of individuals who are physically active but do not meet the recommended guidelines. Longitudinal data would allow an assessment of whether those meeting the physical activity guideline *ex post* had been close to meeting it *ex ante* or had made larger changes in their physical activity behaviour. The income question included in the survey was not answered at all by the majority of the respondents, and answers which were collected were not always clear, resulting in usable data on only 10% of the sample. The inclusion of education and employment status provides some insight into the influence of economic factors, however. Collecting reliable income data with

a single question in a multi-component survey is challenging and consideration needs to be given to whether other variables provide an adequate proxy.

Despite the limitations, our results provide a valuable contribution to the rather small literature on the effects of active travel interventions on general physical activity, as opposed to travel related activity such as walking and cycling. We have found evidence that the intervention is associated with a statistically significant effect on physical activity participation in SCSP areas and on the probability of those who are active meeting recommended activity levels. This demonstrates that active travel interventions do have the potential to improve health through promoting higher levels of physical activity. Our study also demonstrates the usefulness of the difference-in-difference approach in overcoming some of the difficulties inherent in evaluating interventions in a quasi-experimental framework.

Additional policy messages can be identified from the covariates in the analysis. The likelihood of participation in physical activity was increased with car ownership, our proxy for accessibility. This suggests that meeting both the health and other aims of active travel initiatives might be improved in the future by specific consideration of accessibility to sports and leisure opportunities for non car owners. The coefficients in the probit analysis for education support the view that those with higher qualifications are more aware of the benefits of physical activity (increased participation) but, for those who are active, there is no effect on the likelihood of meeting the recommended level of activity, possibly due to the offsetting effect of time costs. The individual coefficients can only indicate direction of effect, but the results for the predicted probabilities indicate that the SCSP programme was more likely to improve physical activity for those with lower educational qualifications. This may give some indication that active travel interventions could contribute to narrowing health inequalities.

Further support for the effect of time constraints on the level of activity is suggested by the results for those in employment, who are more likely to participate in physical activity but less likely to meet the recommended level, when compared with those who are economically inactive. Strategies which incorporate physical activity into daily routines, including but not limited to active travel, may be more successful for those facing time constraints. Given the limitations discussed above this might be an underestimation of the evaluation of the SCSP impact on physical activity.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.socscimed.2014.05.003>.

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