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The health impact of free bus travel for young people in London: protocol for an observational study

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The health impact of free bus travel for young people in London: protocol for an observational study

Table of Contents

Abstract

Background The extension, in September 2005, of free bus and tram travel in London to people 12-16 years of age and, in September 2006, to people under 18 years is likely to have had a range of impacts with implications for public health. The 'On the Buses' project aims to evaluate these impacts using a mixed method quasi-experimental design. This paper describes the protocol for the analyses of quantitative data for the study.

Methods/Design Analyses will be based on routine travel survey and injury data for London, and will primarily entail comparison of pre-intervention to post-intervention change in the target age-group (12-17 years) against the corresponding change in people aged 25-59 years. The main outcome measures will include frequency and distance of all travel, and of active travel; frequency of independent travel, bus use; percentage of journeys <1 km travelled by mode; incidence of road injury, and of intentional injury. We will use conditional fixed-effects Poisson models.

Discussion This quantitative study is part of a larger evaluation which draws on qualitative data, economic evaluation and literature reviews to describe the effect of free bus travel for young people on public health. It will also contribute to methodological development in relation to causal attribution in the absence of controlled experimental evidence, and in the use of routine data sets for assessing the effect of interventions on public health.

Background

Transport for London (the body responsible for delivering the Mayor of London's transport strategy) introduced free bus travel for children aged 12-16 years of age in September 2005 and then extended it to all children under 18 years in full time education and unwaged training in September 2006. This large scale intervention was not primarily aimed at public health, but at the reduction of social exclusion by reducing 'transport poverty', which is a potentially important determinant of health and well-being. Whether there has been any observable impact on health or health behaviours is the focus of this project.

There is increasing interest in the role of transport systems in public health and a growing body of international evidence that demonstrates associations between 'active' commuting (e.g. walking and cycling) and lower risks for being overweight (see Gordon-Larsen *et al*[1] and Oja *et al*[2]). A systematic review estimated that active commuting was associated with an 11% reduction in cardio-vascular risk.[3] These gains are also seen for adolescents cycling or walking to school.[2] However, the picture is complex with Lee et al[4] and Faulkner et al[5] suggesting that while active travel increases total physical activity, there is no evidence of change in body composition. In addition to the direct health gain for the individual, increasing the proportion of active transport relative to private motorised transport has been linked with rather ambitious public health gains, such as reduced global warming and increased social cohesion and community safety.[6]

Evidence from the United States (US) suggests that increasing access to public transport can increase the amount of active transport undertaken enough to have a public health impact on obesity, particularly for men.[7 8] In addition to walking to transport, there may be a health gain from walking within transit systems. One example is from a study in Paris on the proportion of walking done within transport systems.[9] However, the role of public transport in encouraging active transport is poorly understood for the UK. In contexts such as London, with less private car use and better public transport provision, improving access to affordable public transport may have very different effects, and reduce the amounts of active transport undertaken, if it simply replaces walking. However, given the suggestive evidence from Scotland that concessionary fares can stimulate trip making,[10] the overall impact could be an increase in levels of active transport.

In addition to any health impacts that result from changes in levels of active transport, free bus travel may also change the pattern of young people's exposure to both road injury and intentional injury. Despite falling rates of road traffic injury in young people, stark inequalities remain in the risk of being injured on the road in the UK, with those in more deprived areas and those in some minority ethnic groups at highest risk.[11 12] A major contributor to this risk, and to inequalities in risk, is exposure. The risks of road injury remain higher in the UK for pedestrians and cyclists than car occupants[13] and the greater likelihood of those in lower income groups to be travelling on foot puts them at greater risk. Injury risk and inequalities in risk may change if bus transport displaces modes more exposed to road danger (i.e. walking and cycling) or modes less exposed (i.e. private car use). Increased access to bus transport may lead to an increase in exposure to assault (intentional injury), if increased bus use means that children travel more often, and further away from home.

We hypothesized that the introduction of free bus travel in London would have several important effects, both direct and indirect (Figure 1). To test these adequately requires a combination of quantitative and qualitative methods. The quantitative study is one component directed towards testing the active travel, road injuries and intentional injuries hypotheses. Its protocol is described in this paper.

Methods/Design

The overall aim of this study is to characterize changes in health behaviour and selected health outcomes in children and older adults following the introduction in September 2005 of the London free bus travel scheme for children aged 12-16 years and its subsequent extension to under those 18 in September 2006. There are three specific objectives:

1. To assess the impact of free bus travel for 12-17 year olds on their use of bus and other transport modes and on their non-car travel overall;
2. To assess the impact of free bus travel for 12-17 year olds on the use of bus and other transport modes by older age population groups;
3. To identify changes in the incidence of injuries in young people under 18 following access to free bus travel.

Research hypotheses

We hypothesize that the introduction of the free bus pass scheme is associated with:

(i) an increase in bus use and overall ‘independent’ travel (the latter represented from available data by all non-car travel*), but a reduction in active transport (walking and cycling) and car use, among the target age-group;

(ii) a reduction in bus use and trips <1 km made by people aged 65+, especially during the hours when children usually travel from, school;

(iii) a reduction in road traffic injuries in the target age group; and

(iv) an increase in intentional injury rates in the target age group.

We also hypothesize that:

(v) changes will be more pronounced in the inner-London boroughs (with denser bus networks) than in outer-London boroughs;

(vi) changes will be more pronounced in boroughs with a known higher take-up of free bus travel;

(vii) changes in distance/frequency of bus travel, independent (non-car) travel, and active travel, and in injury incidence, are greater in households with low income;

(viii) reductions in car use will be greater in households with high income;

(ix) changes in distance/frequency of bus travel and active travel, and in injury incidence, will be the same across all ethnic groups.

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* Independent travel refers to travel young people do without guardians. With no direct measure of this, we use a proxy measure of all travel except car travel and, for those under 17 years, motorbike travel.

Outcomes and measures

The outcomes we will use to assess the hypotheses are as follows:

1. frequency and distance of all transport, of active transport (i.e. walking and cycling) and of independent (non-car) transport (i.e. walking, cycling and public transport) in people aged 12-17 years;
2. frequency of bus use and distance travelled by bus in people aged 12-17 years;
3. frequency of bus travel and distance travelled by bus in other age groups;
4. incidence of intentional and non-intentional injuries in people aged 12-17 years.

We will use three main sources of data for our outcome measures:

Travel surveys

We will estimate travel patterns in the pre-intervention period using data from the 2001 London Area Transport Survey (LATS), and in the post-intervention period using data from the 2005–2008 London Travel Demand Surveys (LTDS). LATS includes 30,000 households and LTDS includes 5,000 households in 2005, with a further 8,000 households annually since 2006.

LATS and LTDS collect comparable data sets based on daily travel diaries, using comparable sampling designs. In every sampled household each person aged over 5 years living is asked to complete a one day travel diary to record the start, interchanges (e.g. change from bus to train), and end of every trip made on that day. Journey times are collected in LATS and LTDS and journey distance is estimated using the start-point, interchange and end-point of each trip. We will assign values to interchanges with missing data on time or distance travelled derived by multiple imputation. Interchanges with reported times and distances deemed implausible will be treated as missing and imputed.

LATS and LTDS include information on the age, ethnicity, household income and Lower Super Output Area (LSOA) of residence of each participant. We will code age using five categories (0-11, 12-17, 18-24, 25-59, 60-64, and 65+ years). We will exclude people aged 18-24 years from the analyses to protect against the possibility of any 'carry-over' effects of behaviours established in those who were teenagers in the early years of the scheme who then appear in the older age-groups for later years. We also exclude those aged 60-64 in analyses of impact on the older population because of the mix of retired and non-retired people. Ethnicity will be coded using four categories: White (white), Black (Black-Caribbean, Black-African, Black-Other), Asian (Indian, Pakistani, Bangladeshi) and other. Household income will be divided into three categories: less than £15,000, £15-49,999, and £50,000 or greater. LSOAs are small geographic areas corresponding to an average of 1,500 residents. There are 4,765 LSOAs in London, within 33 boroughs. Using data from the 2004 Index of Multiple deprivation (IMD, available at the LSOA level) we will assign each individual an area deprivation score based on their LSOA of residence. We will also assign each individual an Inner or Outer London code based on their LSOA of residence.

Road injuries

To investigate the impact of free bus travel on road traffic injuries we will use STATS19 data for the years 2000 to 2009. STATS19 is the official dataset of death and personal injuries from road traffic collisions that occur on the public highway in the UK. STATS19 data include information on the age and ethnicity of each casualty. Data will be grouped into similar age and ethnicity categories as described above for LATS and LTDS. The STATS19 data also include coordinates of latitude and longitude for location of road traffic collisions. Each collision will be linked geographically to a LSOA and through the LSOA code to both an IMD deprivation score and Inner-Outer London code.

Intentional/non-intentional injuries

We will obtain an extract of Hospital Episode Statistics (HES) data for England covering the period 2001 to 2009. We will identify all London residents using LSOA code of residence. We will identify hospital admissions due to external causes of injury, and specifically those external causes hypothesised to be directly influenced by transport access (e.g. transport injuries, assaults). We will conduct a sensitivity analysis using only severe injury admissions to assess whether differential admission rates by external cause over time may have introduced bias (e.g. due to differences in admissions policies).[14] HES data also include information on age, ethnicity, and through the LSOA code can be linked to a deprivation score and inner/outer London status.

Power and sample size

The LATS and LTDS samples include data on 3,000 young people before and after the intervention, giving over 80% power to detect a 10% relative reduction in average distances walked daily by young people (i.e. from 0.9 (SD 1.3) km to 0.8 (SD 1.3) km per day) at a 5% significance level. Similarly, the study will have over 90% power to detect a 10% increase in the average distance of bus travel (i.e. from 4.3 (SD 4.1) km to 4.7 (SD 4.1) km per day). For transport-related injury, the study would have 80% power to detect a 10% change, or 90% power to detect a 12% change significant at the 5% level. Statistical power is inevitably more limited for subgroup analyses, but there will be 90% power to detect a 15% change in average distance travelled by bus by young people within the most deprived quartile, for example.

Analyses

(i) Analyses will compare the changes in each outcome variable in the pre versus post intervention time periods in the target age group (12-17 years) to changes in the outcome variable pre and post intervention in 25-59 year olds (see Table 1 and Figure 2):

$$\text{Relative change} = \frac{\text{outcome(post-intervention)}_{age12\text{-}17} \,/\, \text{outcome(pre-intervention)}_{agesxgp\ 12\text{-}17}}{\text{outcome(post-intervention)}_{age25\text{-}59} \,/\, \text{outcome(pre-intervention)}_{age25\text{-}59}}$$

(ii) We will conduct similar analyses to compare pre-post intervention changes in outcomes by subgroups: area of London (inner versus outer; areas of high intervention take up versus low intervention take up); deprivation group (most deprived fifth of population versus least deprived 80%); household income (<£15k per year versus > £50k per year (for travel patterns only)) and ethnicity (White, Black, Asian, other) – see Table 3.

(iii) To explore whether older citizens are being displaced from buses and travel more broadly, we will compare the pre-post change in older citizens' travel during post-school commuting hours versus other times (see shell Table 2). (Prior to January 2009, older citizens were not able to use free buses before 9.30 am.)

(iv) For STATS19 road traffic injury data we will implement conditional fixed effects Poisson regression using Stata's xtpoisson command, based on annual counts of casualties and collisions. Robust standard errors will be obtained using jackknife procedures clustering on borough (n=33). The underlying trends in casualties and collisions will be fitted using linear terms. Analyses will be stratified by age-group, and comparisons will be made between the 12-17 years and older ages.

Discussion

There are real challenges in evaluating the health impacts of interventions such as free bus travel. First, a diverse range of long term and short term, positive and negative health outcomes are involved. Second, the causal pathways by which transport interventions might affect transport mode choice and therefore health are as yet poorly understood. There are likely to be complex interactions with, for instance, transport mode choices changing over time in response to the behaviour of other travellers. Third, we do not yet have sufficient evidence to quantify the risks and benefits of many of the known but distal effects of transport policy, such as the effect of reducing transport poverty.[15] Fourth, we know very little about the differential impact of transport mode choices on health across population groups, and thus the potential effect on health inequalities. For instance, using 'active' modes such as walking may have very different effects on mental health (and even physical health) for those for whom it is a choice than for those who have no alternatives:[16 17] we cannot assume that active transport is necessarily, for all groups, always a benefit for health.

Most challenging are the inherent methodological weaknesses of attributing causal effects in the absence of a controlled, randomised design. Despite these challenges there is an urgent need to develop the evidence base for public health in this area, and it has been noted that 'natural experiments' may offer the only possibilities for evaluation, despite their weaknesses.[18 19] Ogilvie *et al* [18] also suggest that single studies of transport interventions are unlikely to prove causal chains, and that we need to begin to build the evidence base to generate 'good enough' evidence for policy, and for potential future integrative reviews. This study is one such contribution.

In line with current recommendations for strengthening faith in causal attributions[20 21 22] we have pre-specified our hypotheses and the directions of change, and have developed a mixed method design which will draw on other evidence to explore the plausibility of those impacts. The quasi-experimental study described here is one component of this larger evaluation, which will include qualitative research, literature reviews and a cost-benefit analysis. We have illustrated here the potential causal pathways that link the intervention to health outcomes, and how we propose to assess the evidence for each part of these pathways. The qualitative component of this mixed-methods study will also help us understand these pathways, and in particular to better understand the everyday travel practices of those subject to the interventions. This is consistent with a growing awareness that evaluations need to show what works, for whom and in what circumstances. This mixed-methods approach may also help identify unanticipated positive and negative impacts of the intervention.

In conclusion, this paper describes the protocol for the quantitative component of an observational study of the impact on selected health outcomes of free bus travel for young people. Other components will draw on primary qualitative data and literature reviews to describe the effect of free bus travel on public health. Finally, a proposed cost-benefit analysis aims to assess whether the free bus travel scheme offers 'value for money' from a public health perspective.

In addition to contributing evidence on the role of transport systems in public health, this study will contribute methodological development in the area of strengthening causal attribution in the absence of controlled experimental evidence, and in the use of routine data sets for assessing the impacts of interventions on public health.

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Tables

Table 1. Summary of pre- (pre-2005) to post-intervention (2006 onwards) change in key outcome measures, 12-17 years and 25-59 years.

		Ages 12-17 years			25-59 years			Ratio of ratios
		Pre-	Post-	Ratio	Pre-	Post-	Ratio	
Active transport (i.e. walking and cycling)	Walking frequency							
	Walking distance							
	Cycling frequency							
	Cycling distance							
Bus use and the distance travelled by bus	Frequency							
	Distance							
Percentage of short distance trips <1km travelled by mode	Walking							
	Cycling							
	Bus							

	Car							
Independent transport (walking, cycling, and public transport)	Frequency							
	Distance							
Frequency of journeys to work or school	Number per week							
Incidence of road traffic injuries	Number per 1000 pyrs							
Incidence of intentional injuries	Number per 1000 pyrs							
Incidence of non-intentional injuries	Number per 1000 pyrs							

Table 2. Summary of pre- (pre-2005) to post-intervention (2006 onwards) change in key outcome measures, 65+ age-group

		Within travel from School hours (3-4 pm, Mon to Fri, in term time)*			Travel at other times			Ratio of ratios
		Pre-	Post-	Ratio	Pre-	Post-	Ratio	
Bus travel	Frequency							
	Distance							
	% of short distance trips by bus							
All travel	Frequency							
	Distance							
	% of all trips which are short distance							

* Varies by school / borough

Table 3. Pre- to post-intervention change in key outcome measures by principal subgroups, 12-17 years *vs* 25-59 years.

Outcome	Potential modifier		Pre-/post-intervention change	Evidence for difference between groups (test for interaction)
Distance by walking/cycling per week	Area of London	Inner London	X (95% CI x, y)	
		Outer London	X (95% CI x, y)	
	Deprivation group	Most deprived fifth of population	X (95% CI x, y)	
		Least deprived 80% of population	X (95% CI x, y)	
	Household income	<15k	X (95% CI x, y)	
		>=50k	X (95% CI x, y)	
	Ethnicity	White	X (95% CI x, y)	
		Black	X (95% CI x, y)	
		Asian	X (95% CI x, y)	
		Other	X (95% CI x, y)	

Road injuries	Area of London	Inner London	X (95% CI x, y)	
		Outer London	X (95% CI x, y)	
	Deprivation group	Most deprived fifth of population	X (95% CI x, y)	
		Least deprived 80% of population	X (95% CI x, y)	
	Ethnicity	White	X (95% CI x, y)	
		Black	X (95% CI x, y)	
		Asian	X (95% CI x, y)	
Intentional injuries	Area of London	Inner London	X (95% CI x, y)	
		Outer London	X (95% CI x, y)	
	Deprivation group	Most deprived fifth of population	X (95% CI x, y)	
		Least deprived 80% of population	X (95% CI x, y)	
	Ethnicity	White	X (95% CI x, y)	
		Black	X (95% CI x, y)	
		Asian	X (95% CI x, y)	
		Other	X (95% CI x, y)	

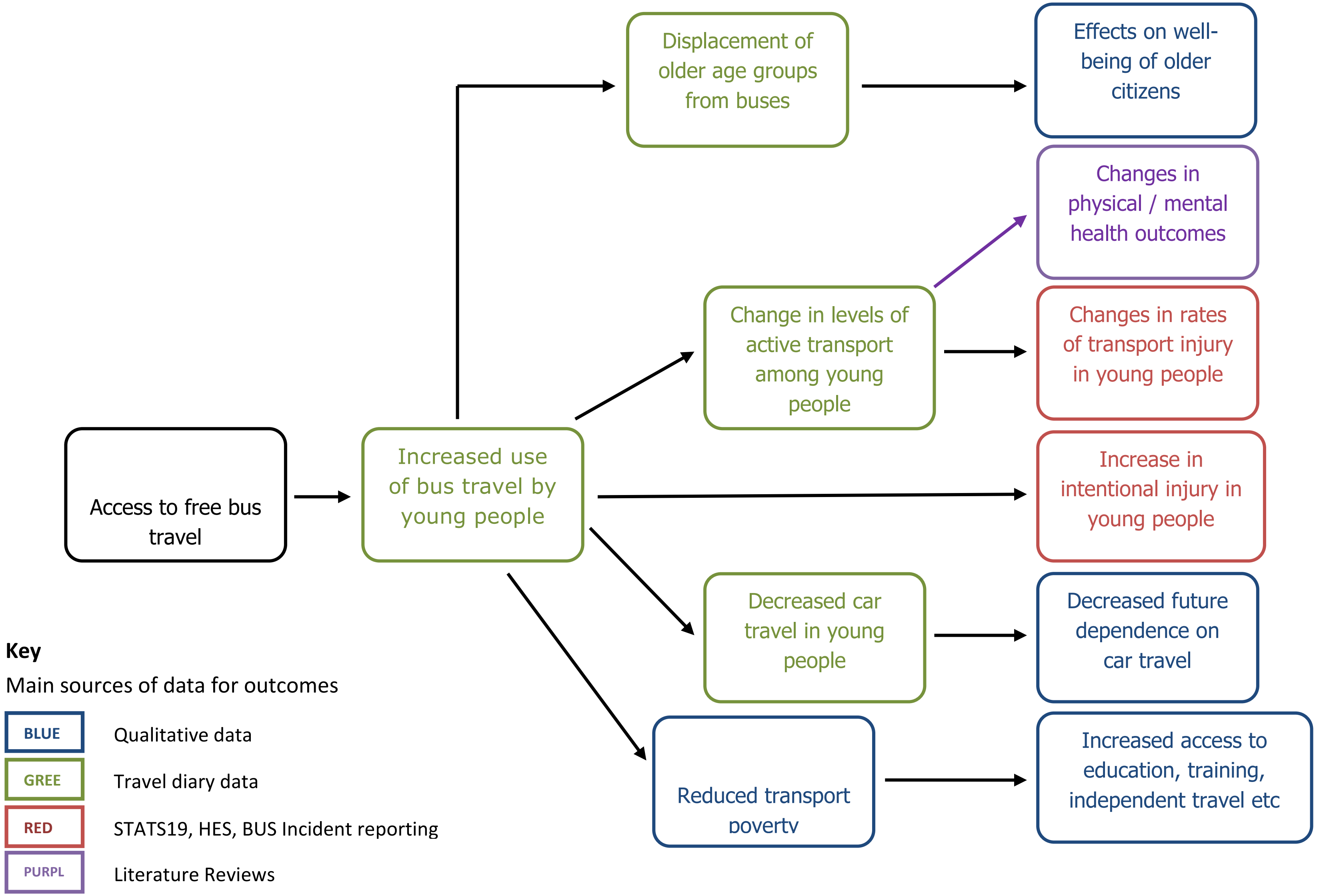
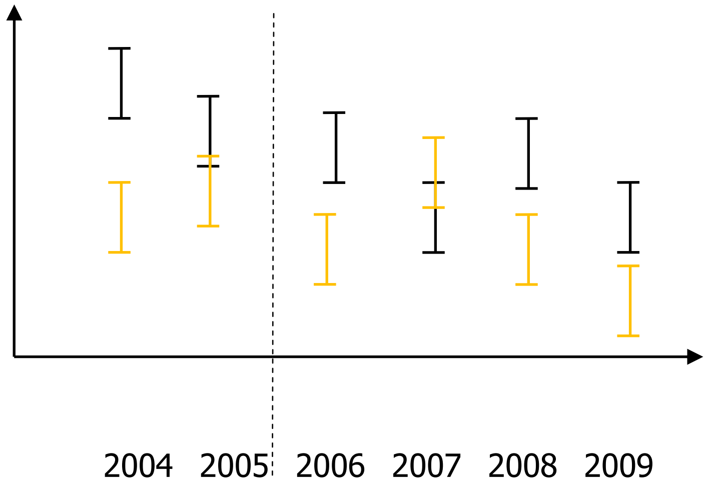


Figure 1. Hypothesized causal pathways and main sources of evidence for measurement of outcomes.

Outcome 1



Outcome 2 etc

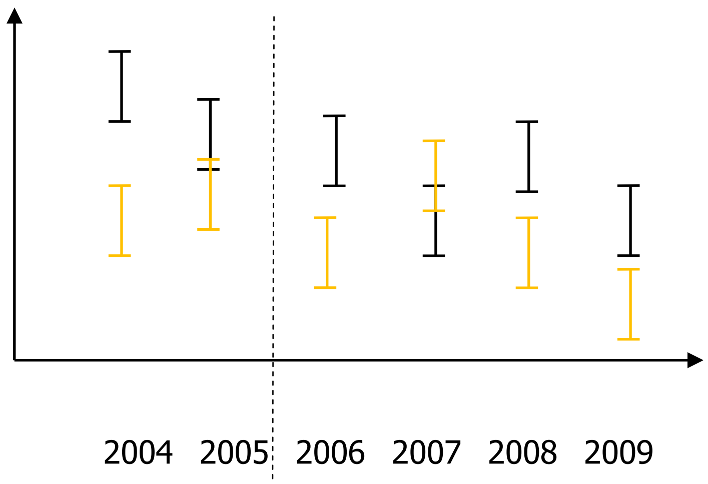


Figure 2. **Fictional data to illustrate graphical presentation of change in key behaviour outcomes by year for age-groups 12-17 years and 25-59 years.**

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