Detailed Project Description

1.Project title:

Does active design increase walking and cycling? Evaluation of a natural experiment examining whether moving into housing in East Village increases family levels of physical activity, particularly walking and cycling.

2. Background:

2.1. Existing research -

The low levels of physical activity in the UK population pose a serious threat to future health, both in adults and children. In the recent UK-based WHO Burden of Disease project report, low physical activity is the fourth leading cause of disability-adjusted life years lost, and accounting for approximately 6% of all years lost. In adults, low physical activity levels are associated CHD, stroke, type 2 diabetes and obesity.[1-6] In children, low physical activity levels are associated with increased levels of adiposity, insulin resistance, blood pressure and the metabolic syndrome.[7-15] Low physical activity levels are also strongly associated with poorer mental health.

This research is specifically directed to establishing ways in which changing the built environment can increase physical activity levels, particularly levels of walking and cycling, in the general population, both for adults and children. Indeed, even small shifts in population levels of physical activity, are likely to have impact on morbitity and mortality. This objective is highly relevant both to public health and to the National Health Service, which would face a reduced challenge if population-wide physical activity levels were higher, especially when 6% of the NHS budget is spent on ill-health related to low physical activity.[16] The need to increase levels of physical activity in both children and adults is now recognized in current health policy recommendations.[17;18] Increasing levels of physical activity from an early age, especially as levels of activity track into adulthood,[19;20] will be important in limiting lifelong exposure to overweight and obesity and their associated adverse health effects.[21;22] Walking in particular is a form of physical activity which is widely accessible to the population and of low cost. Efforts to increase walking tie closely with national Government policies on active travel, [16] and the UK Chief Medical Officer has recommended a focus on active travel because of the benefits on health and environmental outcomes.[17]

The focus on increasing levels of accessible and low-cost forms of physical activity will be particularly relevant to individuals and households of lower socio-economic status and has the potential to inform efforts to reduce health inequalities.[23;24] A particular emphasis in this research project will be examining the influence of changes in the built environment on physical activity in individuals and households from widely differing socio-economic circumstances. This will particularly allow us to investigate how the built environment can favourably influence physical activity (particularly walking and cycling) among low income groups, with least opportunity for recreational activities.[23] Evidence to date suggests that environmental factors that negatively influence walking and cycling, include limited access to facilities, such as parks and green space, sports facilities, pavements/sidewalks, bicycle/walking trails [25;26] and environmental characteristics that promote car use and discourage walking and cycling, such as poor road connectivity, land use diversity and 'walkability', lack of access to public transportation and safety associated with traffic and crime.[27-29] These factors are more likely to affect low income individuals, who live in more disadvantaged areas.

This research has the potential to generate important new knowledge about the influence of the built environment on physical activity levels both in adults and children, from the setting of a natural experiment, using a robust study design. This is particularly important because previous research on the effect of the built environment on physical activity has been largely based on a limited number of poorly controlled observational or ecological studies [30;31] and is often difficult to interpret.[32;33] Unfortunately, there is very limited high-quality experimental evidence examining the influence of change in the built environment on changes in physical activity levels (particularly longitudinal evidence).[34] A major challenge with evidence to date is studying self-selection. Study designs which examine people who relocate, allows various important aspects of self-selection to be removed.[35] Moreover, most of the existing evidence

relates to adult physical activity;[36] few studies have examined the influence of the built environment on physical activity levels in children and families, and the way in which this differs by socioeconomic groups.[23]

The study will provide important evidence about which elements of the built environment influence physical activity patterns, particularly walking and cycling patterns, in individuals and families from a wide range of socioeconomic backgrounds. Because the study is based on a natural experiment which will provide high quality homes specifically designed to encourage healthy, active living for people in the social, affordable and private rental sectors, the results will help to inform future urban residential housing developments, and should be widely generalizable within the UK.

2.2. Risks and benefits - This study is a natural experiment and the intervention (the introduction of a new built environment) is not under the investigators control. As such the study does not present any additional risk to participants. Given the innovative design of East Village we do not envisage that there will be any excess adverse safety / crime related events associated with moving into East Village compared to control areas. However, any such events will be monitored both in experimental and control areas. The possibility of accidents associated with use of improved recreational facilities, including cycle paths and networks etc. will be considered, with any adverse events being recorded. It is noteworthy, that a modest overall increase in physical activity levels (including walking/cycling) associated with moving into East Village, is likely to result in a small benefit in health outcomes / behaviours not harm.

2.3. Rationale for current study –

This research has the potential to generate important new knowledge about the influence of the built environment on physical activity levels both in adults and children, based on the setting of a natural experiment, using a robust study design. This is particularly important because previous research on the effect of the built environment on physical activity has been largely based on a limited number of poorly controlled observational or ecological studies [30;31] and is often difficult to interpret.[32;33] Moreover, most of the existing evidence relates to adult physical activity;[36] few studies have examined the influence of the built environment on physical activity levels in children and families, and the way in which this differs by socioeconomic groups.[23] The proposed study also fits with a recent call for studies, 'based on the most rigorous designs possible, to examine the impact that changes to the physical environment have on physical activity levels'.[16]

Examining Neighbourhoods and Activities in Built Living Environments in London study (ENABLE London) is funded by the NPRI to examine whether families moving into East Village show increased overall levels of physical activity, compared to families that do not. The current proposal seeks specifically to examine the effect of the East Village environment on walking and cycling and to unpack the 'black box' of what specific attributes of the built environment (including the provision of cycle paths and walkways) contribute to increases in these forms of activity and physical activity levels overall (measured objectively). The purpose is to identify specific design features rather than generic elements that contribute to increased walking and cycling, which can be replicated elsewhere. This would be of huge translational interest to urban designers and architects, responsible for the creation of new built environments.

3. Research objectives:

Study objectives will be to determine:-

(i) whether families living in East Village housing show a sustained change in their physical activity levels, particularly in walking and cycling, compared to their levels before moving into the Village, and by comparison with physical activity changes in families who do not move into the Village.

(ii) whether any increase in physical activity in children and adults living in East Village is directly attributable to use of their local built environment, which has led to increased levels of active transport, including walking and/or cycling, and uptake of public transport. We will also seek to establish whether any increase is attributed to use of open spaces, cycle paths, pedestrian walkways, recreational or green space, sporting venues, food access, retail usage.

(iii) whether changes in physical activity patterns, particularly in walking and cycling, in families living in East Village are influenced by socioeconomic position, housing type, use and perceptions of the local environment and their specific features.

4. Research design:

The ENABLE London study is a controlled longitudinal study, already being established with the support of the NPRI, which will evaluate the natural experiment represented by the opening of East Village accommodation. It will include both an intervention group (based on families selected to move into the Village, who will be studied before and after moving) and a control group (based on subjects applying for East Village accommodation but who remain in their original accommodation); they will be studied at the same time points as the intervention group. The ENABLE London study will recruit 1200 families applying to live in social and intermediate Village accommodation (owned by Triathlon Homes), and market rent accommodation (owned by Qatari Diar Delancey [QDD]) in the Village (2818 homes in all), approximately half of whom will move to East Village. Recruitment of those applying for social housing began in January 2013, allowing assessment in time for move in dates from October 2013. Recruitment of applicants for intermediate and private rental accommodation will occur later (late 2013) with interviews 8 weeks prior to move in dates. Participants will be studied at baseline (before Village accommodation is available) and at one year of follow up (when the intervention group is established in East Village). The recruitment process will follow that being currently used to recruit those seeking social housing, but with a shorter lag between interview and moving in. Those willing to consider participation will be asked to provide their contact details, which will be passed to the Research Team, who will then approach the applicants directly about participation. Close liaison will be maintained with East Thames, Triathlon Homes (Olaide Oboh, Sales and Marketing Manager) and QDD (Stuart Corbyn, Chairman of East Village Operations) throughout the recruitment process, to ensure recruitment targets are met.

5. Study population:

The target population will consist largely of current residents of East London (particularly based in Newham), mainly adults with younger families, seeking to move into East Village accommodation. This accommodation will range from one to four bedroom households, but most will be family sized accommodation (i.e., 2 bedrooms or more). At least one adult and one child from each family will be invited (we are able to extend this to a maximum of 4 family members); a small financial incentive will be offered to ensure return of accelerometers and GPS travel recorders. The study population will include people with a wide range of socioeconomic circumstances and will reflect the marked ethnic diversity of the East London population. Health and environmental assessments will be carried out each year for 2 years. Home visits will be made in year 1; subsequent assessments will be carried out at the Sir Ludwig Guttmann Health and Wellbeing Centre for Village occupants (we have outline permission to use this facility), home visits will continue for controls.

5.1. Inclusion/Exclusion Criteria – All applicants for social, affordable and market rent housing in East Village will be invited to take part in the study. While the study will be aimed at families, i.e., parents and children (aged 8 more than years), working aged adult only households will also be included. Households with disabled family members (adult or child) will be included in the study where appropriate, although able-bodied family members will constitute the primary focus of the study. All efforts will be made to include families not speaking English. We currently have French, Hindi, Punjabi, Urdu, Polish speakers involved in the study. For other speakers we will seek interpreters or rely on a family member / friend that can interpret. Families will be excluded if an interpreter cannot be found.

6. Socioeconomic position inequalities:

The focus on increasing levels of accessible and low-cost forms of physical activity will be particularly relevant to individuals and households of lower socio-economic status and has the potential to inform efforts to reduce health inequalities.[23] A particular emphasis in this research project will be examining the influence of changes in the built environment on physical activity in individuals and households from widely differing socio-economic circumstances. This will particularly allow us to investigate how the built

environment can favourably influence physical activity (particularly walking and cycling) among low income groups, with least opportunity for recreational activities.[23]

7. Planned interventions:

The planned intervention is the explicitly masterplanned mixed-use development of the East Village as a residential neighbourhood incorporating commercial, retail, educational and transportation resources, which contrasts with the more ad hoc nature of residential neighbourhoods in Newham as a whole. Half the cohort participants will directly benefit from the East Village development, and its features of active design, in the second year of the study once they move in. Those who remain in their place of origin (largely in Newham) or move elsewhere will act as controls. This effectively constitutes a 'natural experiment' and offers an important opportunity to examine the impact of a major and focused change in the urban built environment which has been specifically designed to encourage walking, cycling and healthy living among residents (both children and adults) who will be from widely differing socioeconomic backgrounds. Homes are specifically designed to encourage healthy, active living. Design components of the East Village and environs that will plausibly impact positively on walking and cycling related physical activity include: improving access to, and upgrading the quality of, green space, increased access to public transportation (rail, tube and bus links) and active travel options (walking and cycling paths, see http://www.youtube.com/watch?v=HD2evv6AJSE), design features of the local environment (such street furniture, provision and arrangement of pedestrianised space, public space aesthetics, secure bicycle parking) and the provision of new formal cycling and walking facilities in the Olympic Park such as the VeloPark, and cycle paths extend into the Lee Valley and connect to the London Cycle Network. A local school, the Chobham Academy, will be within walking distance and will provide schooling for all 3 to 19 year olds. Retail outlets will be located within easy walking distance for everyday use (creating plazas at ground level within dedicated areas of the Village). Restriction of resident car parking (where less than a sixth of homes will have a parking space) will be combined with improved public transport links to encourage residents to adopt active modes of transport. The study will therefore provide important evidence as to whether the built environment, including easy access to cycle paths and walkways, can alter health behaviours and outcomes, and if so whether any changes are observed equally across different housing types. Other developments on this scale have taken place, are underway or are being planned, but are less easily evaluated, given that the timescale of their development is much slower. The East Village thus offers an important opportunity for evaluation, with generalizable results that will inform evidence-based urban planning in the future. The intervention (East Village -E20), is already built. The Village is closed while the retrofit of kitchens is underway, the Village will be open to the public and for occupancy from November and December 2013, respectively. The rapid introduction of the intervention for public use and occupancy is one of the key advantages of the study.

8. Methods proposed:

Combining the novel GPS data with our established accelerometer data collection will allow us to describe both the level and location of physical activity within the physical environment (including identification of walking and cycling patterns in the intervention and control groups and the extent of change associated with moving to the East Village). In this method, both the accelerometer and GPS data are recorded at 10 second intervals, and are then combined (accGPS files) based upon matching the time stamp of the two sets of data. This allows the segmentation of accelerometer data into that recorded indoors and out of doors, and the objective measurement of time spent outside. Time spent outside is a significant and consistent predictor of children's physical activity, but until now has been measured poorly, generally by self-report or parent/teacher proxy. The use of GPS data allows a precise measure of time outdoors, and the combination with accelerometer data has allowed us to determine that outdoor physical activity is three-fold higher than indoors. Consequently, a built environment within the East Village that promotes greater independent mobility in children (by providing a safer environment) may be expected to increase time outdoors, and would also be expected to substantially increase young peoples physical activity levels. This will be explored in the new study. In addition, the methodology will allow particular journeys or time spent in different locations, to be identified and separated using GIS (so called 'spatial segmentation'). If there is higher physical activity in children in the Village, this methodology will enable us to investigate the

potential sources of this. For example, this method has recently been used to show the contribution of walking to school to daily MVPA in young people [37] by separating time and activity within the journey from other outdoor physical activity that may be taking place. These data confirm a major contribution of walking to school to childrens MVPA, with the journey contributing approximately one third of childrens total daily MVPA. This precision is not possible with accelerometer data alone, since the location and activity being undertaken (whether the children are travelling or not) cannot be determined. Similarly, the allocation of combined accGPS data points to specific land use types using Ordnance Survey Mastermap data has enabled the investigation of whether any broad environmental features (such as greenspace) are associated with higher physical activity in children. Such studies have confirmed that greenspace is associated with higher physical activity levels in children, but has also identified the importance of built "hard" surfaces for activity. This proposal will link personal GPS data with fine-grained environmental data operationalized within GIS to allow detailed examination of patterns and locations of movement among study participants both within the East Village facility and elsewhere. Specific features of neighbourhood environments will be identified before and after participants move to the East Village (as well as control areas), particularly features that might promote walking and cycling. GIS derived measures include land-use mix, street connectivity, residential density, walkability and connectivity indices. Environmental data will be obtained from print and online secondary sources, public and commercial directories (Public Register of Food Premises, Yellow Pages, telephone directories and corporate websites) and local authority data. Location of green space, built environment characteristics, road and path networks, and related environmental variables (such as distance to The London VeloPark) will be identified using Ordnance Survey (OS) MasterMap Topography Layer, Address Layer 2 and Integrated Transport Network (ITN) datasets. These data will be supplemented and updated with public planning data provided by the Olympic Delivery Authority and local authorities, as well as public transport infrastructure data from Transport for London (TfL) sources. Design features of the intervention (East Village) and control neighbourhoods will also be collected using the POST tool.[38] In addition these data will be used to inform qualitative spatial narratives from participants. These allow researchers to analyse qualitative data in the context of the location in which it was gathered (by combining GPS and GIS data),[39] providing adult and child perspectives for reasons and purpose of travel and how the built environment influences travel behaviour and physical activity.

9. Proposed outcome measures:

Existing outcome measures assessed at each visit will include objectively measured physical activity over 7-days using Actigraph GT3X+ accelerometers and anthropometric measurements (including height, weight, bio-electrical impedance). The present proposal will strengthen outcome assessment by making a simultaneous 7-day assessment of location using GPS Travel recorders (Qstarz BT-1000XT) and using Geographical Information Systems (GIS) to provide objective data on environmental features (including land-use mix, street connectivity, residential density, walkability and connectivity indices). Simultaneous use of Actigraph accelerometers and GPS Travel recorders will allow us to specifically identify the walking and cycling components of physical activity; this approach has recently been employed by two of the Investigators (Professor Cooper, Dr Page).[37;40] In addition, GPS data will identify the geographical location at which different levels of physical activity (from sedentary to vigorous, using established cut-offs in accelerometer data) are carried out. The present application will therefore strengthen the investigation by allowing GPS assessment in all study participants (both adults and children), and quantification of accessibility (in terms of proximity) to features of the built environment. GIS assessment will allow the influence of local environmental resources (e.g., cycle paths, walkways, green space, leisure facilities, food retail outlets) on patterns of walking and cycling to be studied in detail. GIS data sources exist for some baseline and control locations, but will need to be analysed and extended to encompass all areas, including East Village. Together, these further measures will allow accelerometry data to be interpreted in depth, to explain the nature, reason and location of recorded activities, particularly walking and cycling. Moreover, it will allow the contribution of local walking and cycling to differences in physical activity, between those living in East Village compared to control areas, to be quantified.

10. Assessment and follow-up:

Baseline and follow-up assessments after one year of study participants will be carried out at the participants' home (or at a convenient local location). The content of questionnaires and environmental assessment will be based on established methodologies (in many cases developed by the investigators), but will be refined using focus groups in a subgroup of families in different housing types. Questionnaires will be delivered in electronic form, and will include detailed information on walking and cycling in the local area. Spatial narratives (utilising the combined accelerometer/GPS/GIS data as prompts) from selected participants based on change in travel patterns will also be used to provide adult and child perspectives on reasons for, purpose of travel and choice of route. Information on self-defined ethnic origin (based on the Census, 2011) and a range of social markers will be collected (including employment status, income, duration and location of work), together with home address and postcode of residence, allowing distance to local amenities to be measured. Questions about general health / health status, well-being, anxiety, depression will be included (based on questions used in the Census, 2011, Integrated Household Survey, 2012, and EUROQUOL, 2009). Children and adults will be asked about attitudes to physical activities (including both sedentary, such as screen-time, and physically active forms) and factors which influence their physical activity behaviour. They will be asked about perceived personal, social and environmental influences on physical activity, their use of local recreational space (particularly walkways and cycle paths) and facilities (including costs incurred), especially at a family level. Parents/carers will be asked about rules/restrictions which they place on the activities of their child. We will ask parents about: the availability, accessibility (method of travel and journey times) and usage of local amenities (walkways, cycle paths, parks, swimming pools etc.); their perceptions of the safety of these amenities and the degree to which they permit their child independent or supervised use. We will also use the validated 'Neighbourhood Physical Activity Questionnaire' to gauge environmental correlates of walking within a neighbourhood,[41] the 'Neighbourhood Environment Walking Scale' (NEWS) to gauge perception of environment.[42;43] We will also ask questions to ascertain levels of social participation, support, cohesion and trust.[44] Uptake and use of walkways and cyclepaths by others may well impact on individual use.

11. Proposed sample size:

11.1 Sample size for NPRI work - The sample size is predicated by the ENABLE-London Study which will recruit 1200 families applying for social, affordable or market rent accommodation in East Village; approximately half of these families will be allocated to live in East Village and half will be in control homes located in the surrounding boroughs (i.e., 600 families in each group). Data from 2011 Census shows that Newham has one of the fastest growing populations, the largest average household size, and one of the highest proportion of the population with school-aged children. There are likely to be 3 family members on average per application (based Census 2011 data), and we propose to invite at least one adult and one child (>8 years of age) from each family to participate; thus a minimum of 2400 additional subjects will be examined at baseline (2013). Estimates of recruitment are based on a very conservative estimate of participation rate (43%) which has been markedly exceeded in pilot studies (70%). Statistical power calculations for the study have been based on the primary hypothesis of assessing whether moving into East Village increases physical activity, focusing on the number of steps taken, compared to the equivalent change in the control cohort based on analyzing children and adults separately. With a minimum of 1 adult from each of 420 families followed in the intervention group and 420 in the control group, we will have 90% power to detect a 0.27 SD change in continuous outcomes, based on two sided significance tests at P=0.01. We would have 80% power to detect a 0.19 SD change at $p < 0.05$. We will be similarly powered to detect a difference in children, if comparable recruitment rates are achieved. Assuming a common standard deviation for change in number of steps per day of 2200 (based on earlier studies), in adults we will have 90% power at P=0.01 to detect an increase of 587 steps/day and 80% power at P=0.05 to detect an increase of 425 steps per day. In children, we will have 90% power to detect a difference of 673 steps/day at P=0.01 and 80% power to detect a difference of 488 steps/day at p=0.05. This should be viewed in the context of an average 10,000 steps per day, and we would view an average 5% increase as a worthwhile average population level increase. If a difference is observed, the degree to which this can be attributed to walking and cycling in the local area will be quantified.

11.2 Proposed extension to NPRI work - Accelerometers and GPS receivers will record activity and location every 10 seconds for 7 days for each individual at both sweeps of data collection. Stitching the accelerometer and GPS records together matched on time will enable plotting of individuals routes in both space and time (see Figure 1).[40]

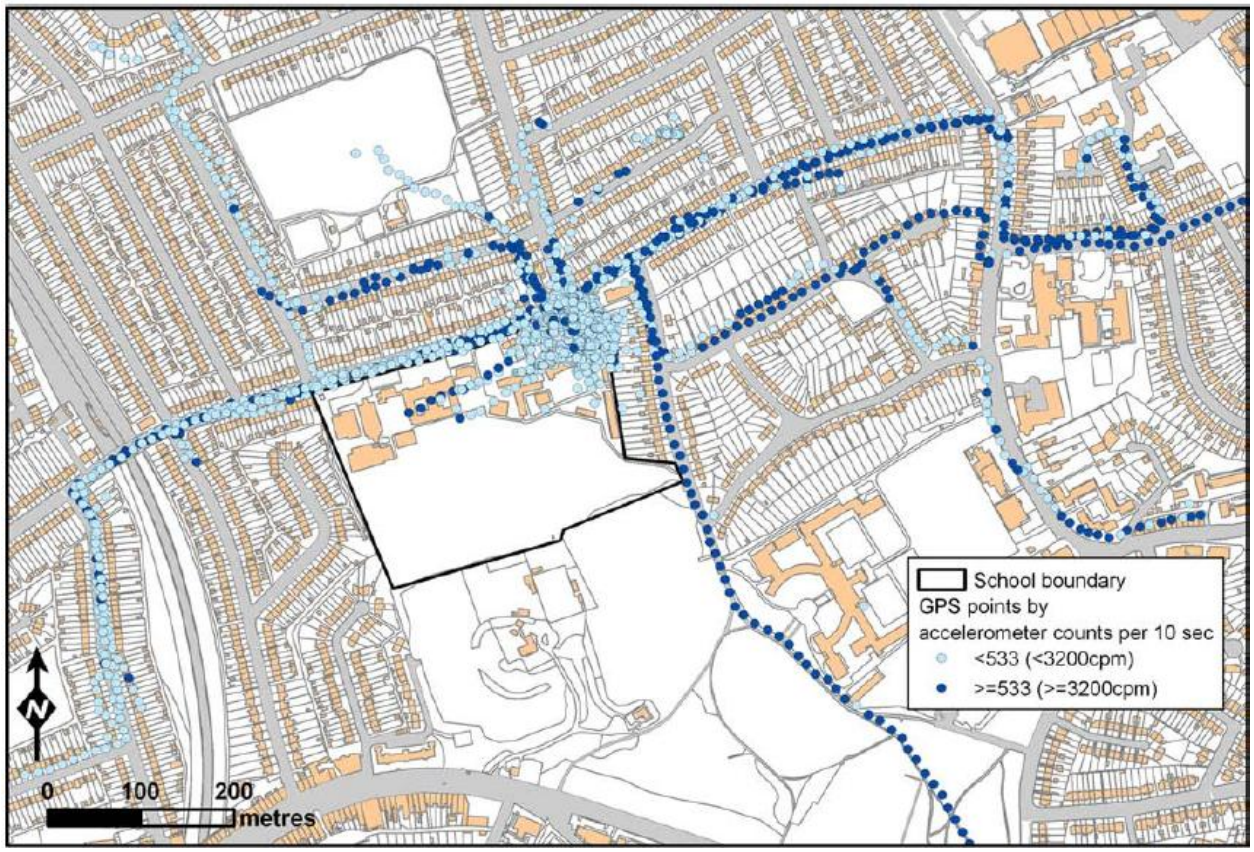

Figure 1. Map of combined accelerometer and GPS data points for pupils (n=31; 10 boys, 21 girls) who walked to the largest of the four schools in the study, 8:00AM to 9:00AM [40]

Activity volume and time in MVPA will thus be geocoded and time stamped, allowing us to attribute modes of transport (foot, bike, car etc) and level of activity. This will allow quantification of various measures of walking and cycling in relation to any geo-codeable object. For example we will be able to assess the amount of walking taking place within 1 mile of a person's residence both before and after moving into the East Village. Thus if an overall change in activity occurs this should allow us to ascertain whether changes in physical activity have taken place at particular locations, the duration of the activity and the type of activity. For example, we would be able to quantify the number of steps taken within a certain distance of their home and whether it is associated with particular locations. Analysis of change in such measures is feasible using the same approach as for overall physical activity, subject to acknowledging that such analyses are post hoc. Tracking mobility through the environment allows us to develop measures of travel routes and activity space precisely since residents engage in a multitude of activities both inside and outside their local environment.[45] Changes in the activity in the control group will also be important to examine in this way as their local environment may change over time (although potential for environmental changes will be more limited) and participants may move residence to other locations. Data from the control group will enhance the external validity and generalisability of the findings. GIS data will provide a much finer grained data on specific aspects of the built environment and environmental variables e.g. location and area of green space, road and path networks and distance to a variety of facilities using Ordnance Survey maps, public transport infrastructure.[46] Design features in intervention and control neighbourhoods will be collected using the POST tool.[38] Unpacking daily activities in relation to GPS data and linking this with GIS indices is a labour intensive task but a necessary step to understand and interpret the nature of any changes in walking and cycling patterns.

12. Statistical analysis:

12.1 Analyses funded by NPRI - Initial analyses will define baseline characteristics, including physical activity levels, frequency and duration of walking and cycling, in families allocated to live in East Village and control families; this will provide evidence of comparability between these two groups. The main analyses will examine the absolute change in within-family levels of physical activity from before to after moving into the Village, and will compare these changes in physical activity with those in the control areas. All analyses will allow for the hierarchical nature of the data, using multilevel models to take appropriate account of factors operating at an individual and family level in Village and control areas. Models will examine whether any differences between the intervention and control groups are modified by housing type and socioeconomic factors. We will also examine the influence of age group, gender, ethnic group, social class, proximity and accessibility to certain facilities. The extent to which changes in physical activity, particularly walking and cycling, in families living in the Village can be directly attributed to use of local facilities, and which facilities in particular, will be examined using data from questionnaires

12.2 Proposed extension of NPRI funded analysis - If changes in physical activity are observed we will be able to use the GPS data to describe walking and cycling patterns within the locality of participants place of residence both before and after they move into the East Village and at baseline and follow-up in the control group. In order to explore whether certain activities are linked to the location of features within the built environment such as parks, open spaces, cycle paths or retail outlets. Individual GPS traces will be linked with individual daily accelerometer data in order to unpack daily activities by time of day, duration, space location, speed or intensity of activity, type of activity (e.g. walking, cycling, running) or mode of transport. Mapping out the activity space in this way (see Figure 1) is important because residents are likely to engage in a multitude of activities both within and outside their local environment. Once we have unpacked the physical activity data in this way we will be able to attribute changes in walking and cycling to a specific location at a particular time. GIS mapping of the local area will add texture and allow us to interpret why changes in physical activity (specifically changes in patterns of walking and cycling) are happening. Some of the GIS indices will reflect more broadly the measures of the physical and built environment but we will be able to examine the finer details of the built environment of locations indentified by the GPS system where walking and cycling are occurring spatially. GIS measures will capture changes in exposure to the environment in intervention and control groups by measuring environmental variables at each wave of data collection. Construction of spatial maps will provide objective measures of accessibility to built environment features recorded as density or raw counts (measure of intensity of exposure to features of the built environment) but it will be important to create weighted counts adjusted for population or geographical area when trying to explain the distribution of features across areas as these may provide an explanation as to why some features appear in greater numbers in some areas and not others;[47] proximity metrics based on road network or buffers provide a refined individual-level metrics of density with buffers from household location. A buffer is a boundary that is placed around areas or points such as around a household or administrative unit. For example, the number of supermarkets within a buffer could be used to estimate a household's accessibility to supermarkets. Absolute metrics that express the density or proximity of particular environmental characteristics (e.g., spatial accessibility to green space and formal facilities (for walking and cycling); accessibility to shops, community facilities and other destinations, public transportation and traffic free walking routes (for walking) and cycle paths (for cycling) will be supplemented with relative metrics that aim to elucidate the importance, and appropriate balance, of a mix of these environmental resources as part of an integrated residential neighbourhood.

Time-dependent covariates that might affect absolute levels of physical activity such as weather and daylight should, by design, be balanced between the intervention and control area by examining families at similar times of year. Linkage of meteorological data (temperature, rainfall etc.) will allow more refined assessment of weather and season as effect modifiers. The analysis of GPS and GIS data in relation to changes in physical activity (especially walking and cycling) will substantively be interpretive. We will examine whether interpretation is influenced by individual level factors such as age, sex, access to motor vehicle, perception of safety and willingness of an individual to access the resource. With numerical GPS and GIS measures (continuous, categorical or binary metrics) we will use multi-level analysis to take

account of the repeated measures of physical activity within individuals and clustering of individuals within households; it is likely that we will analyse children and adults separately as the determinants of change in walking or cycling may vary. We will interpret univariate patterns initially and then expand models to interpret the interplay between GPS indices, GIS indices and individual level factors in multiple variable models.

13. Ethical arrangements:

The proposal already has full ethical approval from the City Road and Hampsted Ethical Review Board for the collection of data (including use of GPS monitors). As the GIS element of the work does not involve individuals an amendment to protocol will not be necessary.

14. Research Governance:

St George's, University of London is the nominated sponsor for the research. The PI will be responsible for study management, and will oversee liaison with co-investigators and GPS / GIS researchers at their respective institutions; the PI will be accountable for delivery of the proposed aims. The already appointed steering committee (chaired by Dr Hazel Inskipp) who are not directly involved in the day-to-day management of the study, will oversee the direction of the study. Regular bi-monthly meetings of London based co-investigators will ensure study goals are achieved. Sub-group meetings involving external investigators will be held to ensure study milestones for specific areas of inquiry. Emails and teleconferences will be used given the international and national geography of the investigators. However, opportunistic meetings will also be scheduled when investigators are commonly located. The Joint Research Office at St George's (working closely with colleagues at LSHTM, Bristol) will be responsible for financial management of the project.

15. Project timetable and milestones:

The study will take 36 months to complete. The research timetable is governed by recruitment of participants into the study (contingent on availability of East Village accommodation and East Thames, Triathlon housing associations). With a gradual build-up of housing recruitment, we have developed and established acceptability of study protocols and have recruited 390 households in the first 8 months of the ENABLE London study; so far 287 (74%) have been seen (of which half will move into East Village, while half will not). It has also allowed us, using our own resources, to pilot GPS wear in conjunction with accelerometry in a sub-set of over 100 study participants, and demonstrate compliance with wear and collection of good quality data in a sub-study of these participants. Should this proposal be funded, these households / areas will be re-visited where appropriate to ensure GPS and GIS measures are obtained. The first two years (January 2014 to 2016) will see recruitment of research assistants at Bristol and LSHTM to provide these data. Base-line recruitment will be complete in summer 2014, with follow up to summer 2015. The study is structured so that baseline and one-year follow-up fall within the same season. Continuation of the existing project manager (Miss Bina Ram) from February 2015 to July 2015 will allow continued co-ordination of the project and ensure all elements of the field work are complete. A Statistician / Epidemiolgist at St George's will begin analysing baseline data as of January 2015, with a one year overlap with the GIS (LSHTM) and GPS (Bristol) focused researchers. Completion of the project, including publication of main findings, is scheduled for January 2017.

Timeline	Jan 2014-Dec 2014				Jan 2015-Dec 2015				Jan 2016-Dec 2016			
GPS RA1 (University of Bristol)	▨	▨	▨	▨	▨	▨	▨	▨				
GIS RA2 (LSHTM)	▨	▨	▨	▨	▨	▨	▨	▨				
Continuation of study co-ordinator (SGUL)					▨	▨						
Statistician / Epidemiolgist RA3 (SGUL)					▨	▨	▨	▨	▨	▨	▨	▨
Tasks and Milestones												
Identification of primary and secondary measures of environment exposure for a range of variables (RA1, RA2)	▨	▨										
Data collection, data cleaning, and operationalization within an appropriate structure, e.g., creation of Spatial Database,	▨	▨										

Timeline	Jan 2014-Dec 2014				Jan 2015-Dec 2015				Jan 2016-Dec 2016			
Examine cross-sectional associations and writing-up of methods and survey papers based on year one data												
Data collection, cleaning and linkage to year 1 data												
Creation of year 2 metrics (with East Village focus), analysis of change, identification of key outcomes, research & writing of 2 primary papers												
Statistical analysis and continued write-up of ENABLE London data examining change in other health behaviours associated / attributed to increased walking / cycling (RA3)												
Project team meetings (face-to-face and/or virtual)												

References

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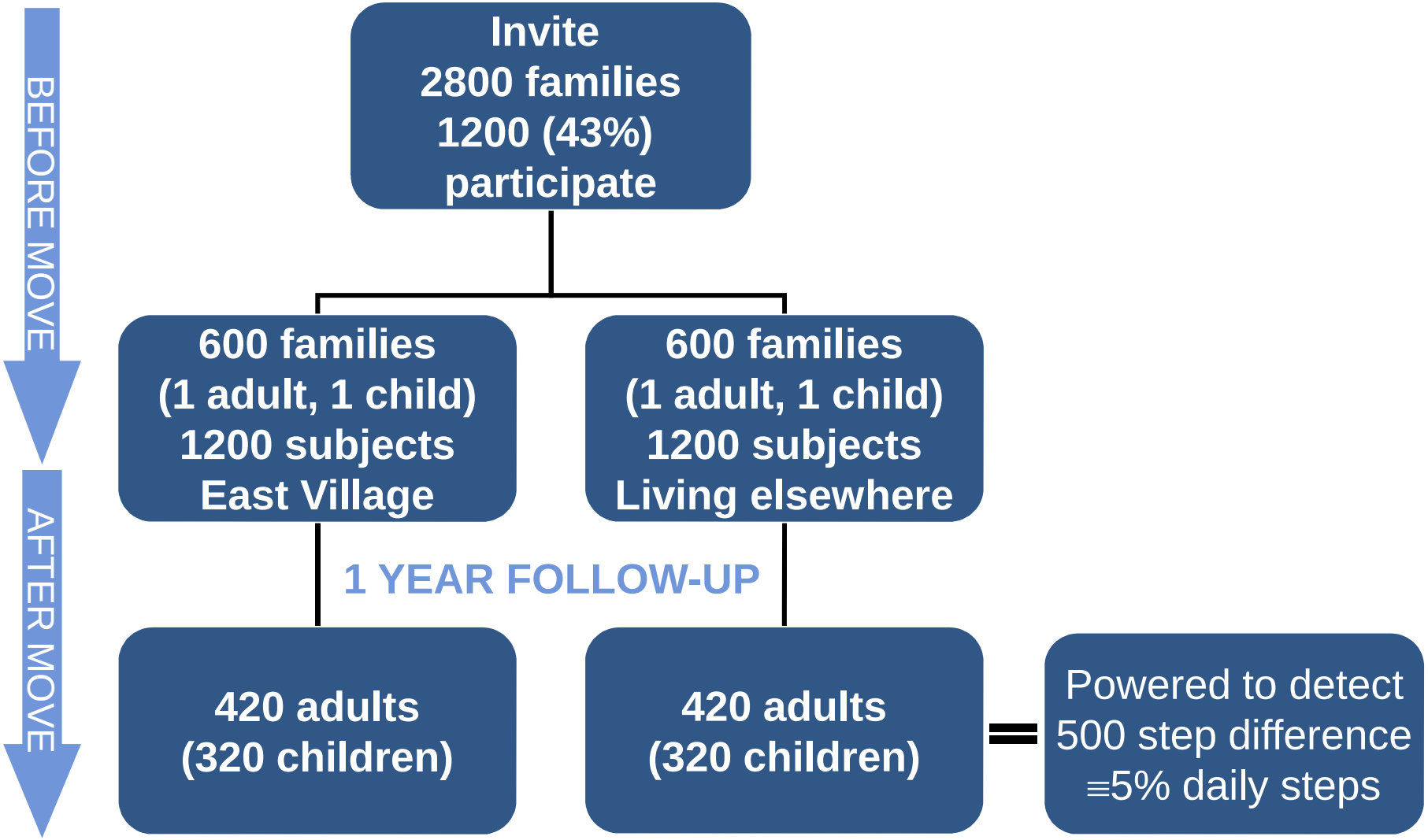
ENABLE LONDON study design



Control families matched to those moving into the Village

24th March 2013