

School for Public Health Research

1.	Project reference:	Final report date:	
	SPHR-UCL-PH1-WPD	17 th September 2015	
2.	Project title:		
	Active Buildings: modelling physical activity and movement in office buildings		
3.	Lead investigators on project:		
	Professors Jane Wardle and Alexi Marmot (UCL)		
	Other NIHR School collaborators (name, School for Primary Care/Social Care Research) on project:		
	N/A		
3.	Names and roles of others involved in project (e.g. include fixed term contract researchers and external collaborators / partners):		
	<p>UCL Dr Marcella Ucci and Dr Abigail Fisher – day to day project leads Dr Lee Smith, Dr Richard Spinney, Marina Konstantatou, Alexia Sawyer – Research Associates & Senior Research Associates Dr Mark Hamer, Dr Benjamin Gardner, Prof Gareth Ambler – additional collaborators from UCL</p> <p>Professor Jon Nicoll (Sheffield), Professor Mark Gabbay (Liverpool), and Professor Susan Cartwright (Sheffield) were members of the Advisory Board.</p>		
4.	Project start date:	Project end date:	Duration:
	6 th November 2012	31 st March 2015	2 years 5 months
5.	Project objectives originally outlined in proposal:		
	<p>An exploratory study aimed at understanding how and where physical activity and sitting accumulates within office environments, and to model the relationship between workplace layout and physical activity and sitting behaviour.</p> <p>These data will be used as a basis for estimating the potential for physical activity change through layout modification in future interventions or the design of new buildings.</p>		
6.	Briefly describe and explain the reason(s) for any changes to the project originally outlined in proposal:		
	<p>The aims of this project have remained the same. However, some essential changes to protocol and methods have been made.</p> <p>The following statement was made in the original proposal:</p> <p><i>“Phase 1. A comprehensive typology of office buildings will be developed to classify buildings according to factors likely to relate to physical activity (building floor area, total area occupied,</i></p>		



number of activity ‘hot spots’). UCL holds a database of every building in the country, and this will aid selection of a sample of buildings $\geq 2000 \text{ m}^2$ to provide sufficient variation for categorization of buildings into high, medium or low ‘hot spot’ density.”

We originally proposed to carry out an office typology aimed to aid in the selection of buildings, to ensure we would have a varied and representative sample. A preliminary scoping review of the office typology revealed that, whilst there are some data on office buildings by floor size or type, there is limited information on how this relates to distribution and density of activity hotspots (e.g. printers, coffee, WCs) and stairs. Preliminary analysis also revealed that the concept of ‘activity hotspots density’ would need to be refined based in part on the fieldwork findings. This is because spatial analysis highlighted that physical activity is likely to be affected not only by activity hotspots density (e.g. number of printers per floor or per desk), but also by clustering of various hotspot types. Overall, given the lack of comprehensive data on activity hotspot distribution and density in the UK office buildings stock, and considering that many different variations of hotspot clustering may occur in reality, an alternative approach has been taken for the sampling of the office buildings. This is based on the issues of co-location of activity hotspots by floor (stand-alone floors above 3rd floor, floors with shared activity hotspots, single storey building) as well as on the location of buildings in urban, suburban or office park locations. However, due to the complex nature of the recruiting process – where consent to study participation needs to be sought from several players in the organisation – the initial sampling strategy does not seek to actively exclude any particular organisation/building from the study. At mid-point during the fieldwork process, a review will be carried out of the buildings/organisations in the sample, with a view to identify building characteristics not represented in the sample up to that date. Whilst every effort will be made to actively recruit those remaining building types, it may not be possible to find suitable organisations willing to participate within our timescales in which case we will still aim to recruit as many organisations/buildings as our schedule will allow.

The following statement was made in the original proposal:

“Phase 2. On the basis of the office space typology, 21 buildings will be selected (7 high, 7 medium, 7 low hot spot density), and the physical activity of a sample of 50-100 workers from each building will be observed (using accelerometers and RFID tracking) over a 1-2 week period, to document how workers move within buildings.”

In addition to objective measurement (n= 50 to 100), to maximise participation and enrich the dataset all other workers in buildings to be studied will be asked to complete only surveys. Surveys contain questions on standard demographics, physical activity and sedentary behaviours as well as putative correlates of these behaviours.

We will endeavour to recruit 21 organisations into the study as originally proposed and will be able to carry out survey data for all of these. However, based on our experience of pilot data collection and recruitment to date, carrying out objective measurement in 21 organisations (as originally proposed) will not be possible.

As previously highlighted the numbers of companies we will be able to carry out objective measures in is lower than originally proposed. However, for the reasons described this will not affect our power to detect highly novel data and significantly advance the field.

7. Brief summary of methods, findings against objectives, and conclusions (2-4 pages max):

Methods:

Active Buildings was a unique collaboration between public health, built environment and computer science researchers. The study involved objective monitoring of indoor physical activity and tracking of movement in a subsample, complemented by a larger questionnaire arm. Predominantly London-based office buildings were selected based on a variety of

features, including office floor area and number of occupants. Questionnaires included items on standard demographics, well-being, physical activity behaviour and putative socioecological correlates of workplace physical activity. A sample of participants from each office building was recruited into the objective monitoring arm. Participants wore accelerometers (to monitor physical activity and sitting inside and outside the office) and a sub-sample of these wore a novel tracking device for five consecutive days. For a detailed account of the methods used see Smith et al. (2013) and Spinney et al. (2015).

Results (including findings in relation to the objectives):

A total 14 organisations took part in the Active Building study, 433 participants fully completed surveys and 131 provided valid objective measurement. Key findings to date include:

Among those who wore the ActivPal total sitting/standing time was similar on weekdays (10.6/4.1 hrs) and weekends (10.6/4.3 hrs). Total step count was also similar over weekdays (9682 ± 3872) and weekends (9518 ± 4615). The highest physical activity levels during weekdays were accrued at 0700 to 0900, 1200 to 1400, and 1700 to 1900; and during the weekend at 1000 to 1700. During the weekday the greatest amount of sitting was accrued at 0900 to 1200, 1400 to 1700, and 2000 to 2300, and on the weekend between 1800 and 2300. During the weekday the greatest amount of standing was accrued between 0700 and 1000 and 1700 and 2100, and on the weekend between 1000 and 1800. On the weekday the highest number of sit/stand transitions occurred between 0800 to 0900 and remained consistently high until 1800. On the weekend, the highest number occurred between 1000 to 1400 and 1900 to 2000. (Smith et al. 2015)

Preliminary data suggests that the number of trips per hour to various office building locations correlates with the number of steps performed per hour. Trips away from desks generally are associated with large and significant increases in the number of steps performed. There appears to be a strong relationship with kitchen usage and standing behaviour. (Spinney et al. 2015)

Younger participants perceived office destinations as being closer to their desk. Younger and female participants were more likely to perceive positive office social environments; there were no other differences by socio-demographics or job role. Perceived discouragement of breaks by management was related to occupational step count/hour ($B=-64.45$; 95%CI: -109.72 to -19.19). No other environmental perceptions were related to physical activity or sitting time. (Sawyer et al).

We developed novel spatial metrics to assess the indoor built environment (Ucci et al. in preparation) and a tool to allow other researchers to replicate these (www.activebuildings.co.uk). A key paper on how spatial metrics and the built environment relate is in preparation (Fisher et al. in preparation).

Conclusions:

We have generated the following conclusions from the analyses that we have carried out to date.

Office-based workers demonstrate high levels of sitting during both the working week and weekend. Interventions that target the working day and the evenings (weekday and weekend) to displace sitting with activity may offer most promise for reducing population levels of sedentary behaviour and increasing physical activity levels, in office-based workers residing in England.

Managerial discouragement of breaks could be related to meaningful decreases in occupational step count. Future research should aim to elucidate social correlates of occupational walking with a focus on the role of management.

	<p>Note: we are currently carrying out a number of other analyses to investigate associations between office layout and activity/sitting outcomes.</p>
<p>8.</p>	<p>Plain English Summary (400 words max) Please provide a summary of the project, including background, findings and conclusions:</p> <p>Health benefits of regular participation in physical activity and reductions in sitting time are well documented but population levels of physical activity are low and sitting time high. Office layout, and in particular the number and location of office building destinations (eg, print and meeting rooms), may influence both walking time and characteristics of sitting time. No research to date has focused on the role that the layout of the indoor office environment plays in facilitating or inhibiting step counts and characteristics of sitting time.</p> <p>To date the Active Buildings study has found that office-based workers demonstrate high levels of sitting during both the working week and weekend. Interventions that target the working day and the evenings (weekday and weekend) to displace sitting with activity may offer most promise for reducing population levels of sedentary behaviour and increasing physical activity levels, and thus benefiting health. This study has highlighted that perceived managerial discouragement of breaks is related to meaningful decreases in occupational step count and should be investigated further in intervention studies.</p> <p>We continue to analyse the data from the Active Buildings study to inform intervention on approaches to increase physical activity and reduce sitting in office-based workers.</p>
<p>9.</p>	<p>Keywords Please provide up to 8 keywords that relate to the research undertaken in this study:</p> <p>Sitting, Standing, Stepping, Office buildings, Office workers, Built Environment, Physical Activity, Spatial metrics.</p>
<p>10.</p>	<p>Dissemination – please detail planned or published articles in peer-reviewed journals (including web links):</p> <p>Published peer-reviewed manuscripts</p> <ul style="list-style-type: none"> • Sawyer A, Smith L, Ucci M, Jones R, Marmot A, Fisher A. Perceived office environments and occupational physical activity in office-based workers. <i>Occupational Medicine</i> (2017). DOI: 10.1093/occmed/kqx022 • Smith L, Ucci M, Marmot A, Spinney R, Laskowski M, Sawyer A, Konstantatou M, Hamer M, Ambler G, Wardle J, Fisher A. Active Buildings: modelling physical activity and movement in office buildings. <i>BMJ Open</i> 2013;3:e004103 • Smith L, Hamer M, Ucci M, Marmot A, Gardener B, Sawyer A, Wardle J, Fisher A. Weekday and weekend patterns of objectively measured sitting standing and stepping in a sample of office-based workers: the Active Building Study. <i>BMC Public Health</i> 2015; 15:9 • Spinney R, Smith L, Ucci M, Fisher A, Konstantatou M, Sawyer A, et al. (2015) Indoor Tracking to Understand Physical Activity and Sedentary Behaviour: Exploratory Study in UK Office Buildings. <i>PLoS ONE</i> 10: e0127688. • Smith L, Ucci M, Marmot A, Spinney R, Laskowski M, Sawyer A, Konstantatou M, Hamer M, Wardle J, Fisher A. A review of occupational physical activity and sedentary behaviour correlates. <i>Occupational Medicine</i> 2016 66:185-192. DOI: https://doi.org/10.1093/occmed/kqv164 • Smith, L., Ekelund, U., & Hamer, M. (2015). The Potential Yield of Non-Exercise Physical Activity Energy Expenditure in Public Health. <i>SPORTS MEDICINE</i>, 45 (4), 449-452. doi:10.1007/s40279-015-0310-2 • Marmot A and Ucci M, (Guest Editors), Special Issue on Indoor environments, physical activity and sedentary behaviour, <i>Building Research Information</i> 2015; 43:5. • Marmot, A, Ucci, M (2015) Sitting less, moving more: the indoor environment as a tool

for change, *Building Research Information* 2015; 43:5 561-565 Editorial

- Smith L, Ucci M, Marmot A, et al. (2013) Active buildings: modelling physical activity and movement in office buildings. An observational study protocol. *BMJ Open* 2013;3:e004103. doi:10.1136/bmjopen-2013-004103

Conference

- Poster presentation of “Perceptions of the office environment and occupational physical activity: Active Buildings” at SPHR Annual Scientific Meeting in March 2016
- Poster presentation of “Perceptions of the office environment and occupational physical activity: Active Buildings – challenges and questions” at SPHR Researchers’ Network Meeting in March 2016
- Presentation of “*Weekday and weekend patterns of objectively measured sitting standing and stepping in a sample of office-based workers: the Active Building*” Study at the International Society of Behavioural Nutrition and Physical Activity in Edinburgh in June 2015
- Presentation of the Active Buildings study at Cancer Research UK Innovation Workshop, September 2015.
- Presentation of the Active Buildings Study at the Glasgow Centre for Population Health Annual Public Engagement Conference, March 2015.
- Presentation of the Active Buildings Study at the Centre for Active Design, New York, November 2014
- Presentation of Active Buildings protocol at the European Public Health Conference in Brussels, October 2013
- Presentation of the Active Buildings study at the NIHR School for Public Health Annual Scientific Meeting 2013/2014
- Visiting Fellowship and team video conference, Nov 2013, with Curtin University, Perth Western Australia researchers on Active Workplace Design from Architecture, Centre for Health Promotion Research, School of Public Health and the Centre for Sport and Recreation Research. This may result in future joint research.
- Presentation of Active Buildings Methodology at the School for Public Health annual conference in October 2013

Workshops

- Event on active design to launch the ‘Building Research and Information’ Special Issue on indoor environments, physical activity and sedentary behaviour, 13 October 2015 at University College London.
- Workshop on agent based modelling, held at the Bartlett School of Graduate Studies, 20 Feb 2014.
- Workshop on agent-based modelling and indoor tracking, University of Cambridge, 6 Nov 2013.

Non-academic dissemination

Please see our website: www.activebuildings.co.uk

Presentation of the Active Buildings study at the Public Health Improvement Research Network Wales; Tackling workplace sedentary behaviour in Cardiff 2014.

We wrote a short opinion piece on active design for the Design Council’s Active by Design website: <http://www.designcouncil.org.uk/news-opinion/there-recipe-designing-low-fat-office-buildings>

Presentation of the Active Buildings study at British Institute of Facilities Management’s joint event of Special Interest Groups’ ‘Workplace’ and ‘Sustainability’, London, February 2015.

Presentation of the Active Buildings study at ‘Vision - The future of the built environment’, industry exhibition, Olympia Exhibition Centre, London, June 2015.

Presentation of the Active Buildings Study at the Health at Work Seminar Series; At Brunel University London in July 2015.

Launch seminar for special edition of *Building Research and Information* on Physical Activity, sedentary behaviour and the indoor built environment, UCL, 13 October 2015

We are also planning to present the results of the study at the *International Society of Behavioural Nutrition and Physical Activity (ISBNPA)* or similar next year, which includes a large audience of practitioners as well as academics.

We participated in a symposium at ISBNPA in South Africa in May 2016, presenting our novel data on spatial tracking and physical activity. This was very well received.

News and Social Media

We had an active Active Buildings Twitter account throughout the project @ActiveBuildings this account was used to promote our research and disseminate findings.

We created two YouTube videos to promote a Spatial Metrics Calculator that we developed as part of the Active Buildings Project see <http://www.activebuildings.co.uk/spatialmetriccalculator>. This tool allows for the easy calculation of key spatial metrics which could potentially be used in future studies and/or practice.

We update our study website www.activebuildings.co.uk on a regular basis with news and publications.

11. Public and participant involvement
Please provide comment on your experiences, any changes made and lessons drawn:

Numerous workshops were held throughout the Active Buildings project to help guide the research, its potential impact and dissemination. A variety of people were invited to these workshops including academics, policy makers, facility managers, and managing directors.

On the whole we found these workshops informative and useful. The workshops allowed us to tailor our research to maximise the data collected, present our findings to optimise impact, and allow for the dissemination of findings to reach the desired audience.

12. What impact has the research already achieved or what might it achieve? (i.e. policy, practice, academic):

The papers we have published from the Active Buildings study have received great attention. The paper titled *Weekday and Weekend Patterns of Objectively Measured Sitting Standing and Stepping in a Sample of Office-Based Workers: The Active Building Study* has been accessed 5106 times to date and has been awarded highly accessed status.

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Department of Health Disclaimer:

The views and opinions expressed therein are those of the authors and do not necessarily reflect those of the NIHR School for Public Health Research, NIHR, NHS or the Department of Health.