Institution: University of Leicester

Unit of Assessment: 24

Title of case study: Sit Less, Stand and Move More: Prevention of Chronic Disease by Reducing Sedentary Behaviour

Period when the underpinning research was undertaken: 2012–2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
1) Charlotte Edwardson 2) Thomas Yates	1) Associate Professor in Physical Activity, Sedentary Behaviour and Health 2) Professor in Physical Activity, Sedentary Behaviour and Health	1) 2008–Present 2) 2011–Present

Period when the claimed impact occurred: 2015–2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

We all sit too much. Spending long periods of time sitting increases rates of diabetes, cardiovascular disease, mental health issues and all-cause mortality. Researchers at the University of Leicester tackled this growing health problem through the creation and implementation of the freely available Stand More AT Work (SMART Work) programme, enabling organisations and individuals worldwide to reduce sitting and move more at work. This programme and unique underpinning research have changed clinical guidelines, informed national initiatives and facilitated the development of self-monitoring tools such as the Fitbit movement reminder and sit-stand desks for IKEA.

2. Underpinning research

Leicester sedentary behaviour researchers (LSBRs), led by Edwardson and Yates, began with three main aims:

i. Understand the role of sedentary behaviour on morbidity and mortality.
ii. Examine the health effects of reducing and breaking sitting time with light physical activity.
iii. Develop and test the effectiveness and cost-effectiveness of free-living sitting reduction interventions on behaviour, health and work outcomes

The need for this research was clear and supported by GBP7,000,000 in funding from the NIHR, Department of Health and MRC **[G1–G3]**.

Ground-breaking systematic reviews and meta-analyses published by LSBRs in 2012 (~2000 citations) demonstrated that people with high levels of sedentary behaviour had an increased risk of metabolic syndrome, type 2 diabetes, cardiovascular disease and all-cause mortality **[R1, R2].** From this point, LSBRs have remained at the forefront internationally in furthering understanding of the relationship between sedentary behaviour, particularly when measured by wearable devices (i.e., accelerometers), and cardiometabolic health.

Epidemiological evidence published by LSBRs, showed that device-assessed sedentary time was positively associated with two-hour glucose, triglycerides, adiposity, MRI-assessed heart,

liver and visceral fat, inflammation, all-cause mortality and negatively with HDL cholesterol **[R3, R4, R5, G2, G3]**. Importantly, their research showed a substantially higher risk of death with ≥9.5 hours/day of device-assessed sedentary time; >60,000 downloads; Altmetric score 2586 (top 5% and listed in the 2019 Altmetric Top 100 list) **[R5]**. These outputs comprise part of the suite of epidemiological research conducted by LSBRs which has generated new hypotheses for experimental and intervention research globally.

LSBRs validated their epidemiological observations via a series of acute experimental studies. These confirmed that reducing sitting time across the day through short, frequent bouts of light activity (standing, walking and arm ergometry for five minutes every half hour) considerably improved markers of diabetes and identified key groups that would benefit more from such an intervention; females, South Asians, those with lower fitness levels or higher BMI **[R6, G2,G3]**.

Building on this evidence, LSBRs collaborated with researchers at Loughborough University to develop a sitting reduction intervention: SMART Work (Stand More AT Work). The programme aimed to reduce sitting time by 60 minutes per day and targeted one of the most sedentary populations: office workers. The randomised controlled trial was funded by the Department of Health Policy Research Programme **[G1]** and remains one of the largest of its kind internationally **[R7].** Results demonstrated that provision of education, height-adjustable workstations and additional behaviour change strategies led to large reductions (83 min/day) in sitting time after 12 months. These positive changes also gave demonstrable quality of life improvements, reductions in musculoskeletal issues and improvements in self-reported job performance, work engagement, occupational recovery and sickness presenteeism; >50,000 downloads; Altmetric score 589 (top 5%); news outlets 43 **[R7]**. The cost-benefit analysis showed a potential return on investment of GBP3 on every GBP1 spent as a result of increased productivity of 1.75 hours per week—a net saving of GBP1,770.32 per employee **[R8].** Due to the success of the intervention, it was scaled up for rollout nationally and internationally.

3. References to the research

R1. Edwardson CL, Gorely T, **Davies MJ, Gray L, Khunti K, Wilmot EG, Yates T**, Biddle S. Association of sedentary behaviour with metabolic syndrome: A meta-analysis. *PLoS One.* 2012;7(4):e34916.
R2. Wilmot EG, **Edwardson C**, **Davies MJ**, Gorely T, **Gray L**, **Khunti K**, **Yates T**, Biddle S. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. *Diabetologia*. 2012; 55(11): 2895-2905.
R3. Henson J, **Yates T**, Biddle SJH, **Edwardson C**, **Khunti K**, **Wilmot E**, **Gray L**, Gorely T, Nimmo M, **Davies M**. Associations of objectively measured sedentary behaviour and physical activity with markers of cardiometabolic health. *Diabetologia*. 2013; 56(5):1012-1020.
R4. Henson J, **Edwardson C**, Morgan B, Horsfield M, Bodicoat D, Biddle S, Gorely T, Nimmo M, **McCann G**, **Khunti K**, **Davies M**, and **Yates T**. Associations of sedentary time with regional fat distribution in a population at high risk of type 2 diabetes. *Medicine and Science in Sports and Exercise*. 2014; 47(8):1727-34.
R5. Ekelund U, Tarp J, Steene-Johannessen J, Hansen BH, Jefferis B, Whincup P, Diaz K, Hooker S, Chernofsky A, Larson MG, Murabito J, Spartano N, Dohrn IM, Hagströmer M, **Edwardson CL**, **Yates T**, Anderssen SA, Lee IM.. Dose-response associations between accelerometry measured physical activity and sedentary time with all-cause mortality: a harmonized meta-analysis. *BMJ.* 2019; 66:l4570.
R6. Henson J, **Edwardson CL**, **Davies MJ**, **Khunti K**, King J, Stensel D, **Zaccardi F**, **Yates T**. Predictors of the post-prandial response to breaking up prolonged sitting with standing or light intensity physical activity. *Medicine and Science in Sports and Exercise*. 2019; 52(6):1385-1393.
R7. Edwardson CL, **Yates T**, Biddle SJH, **Davies MJ**, Dunstan D, Esliger D, **Gray L**, Jackson B, O'Connell SE, Waheed G, Munir F. The effectiveness of the Stand More AT (SMArT) Work intervention: A cluster randomised control trial. *BMJ*. 2018;363:k3870.

R8. Edwardson CL, Davies MJ, Miller P, Biddle SJH, **Gray, LJ, Yates T**, et al. A Cost and Cost-Benefit Analysis of the Stand More AT Work (SMArT Work) Intervention. *International Journal of Environmental Research and Public Health*, 2020. 17(4): 1214.

Grants:
G1. Biddle SJH, **Yates, T**, **Edwardson C**, Esliger D, **Davies M**, **Gray L**, Munir F. *SMArT Work*: Stand More AT Work. Department of Health Policy Research Programme. 09/2014-09/2017. GBP598,885.
G2. Yates T, **Edwardson C**, **Davies M**, **Khunti K**, Biddle SJH, Esliger D, Gill J, Sattar N, Sinclair A. Sedentary behaviour in older adults: Investigating a new therapeutic paradigm. Medical Research Council. 11/2013-04/2017. GBP853,099.
G3. Davies M, Yates T. National Institute for Health Research Leicester-Loughborough Diet and Activity Biomedical Research Unit. 2012-2017. GBP4,500,000.

4. Details of the impact

LSBR's research has affected global change across a wide range of areas. Their work has defined guidelines, changed working practices, improved occupational health, and enabled individuals to make effective behaviour change.

Changing Guidelines

As a result of their established expertise and demonstrable success, LSBRs were invited to provide expert contributions to the first ever expert statement on sedentary behaviour levels in the workplace 'The Sedentary Office'. This statement (>130,000 downloads; Altmetric score 1201 (top 5%); news outlets 97), recommended that workers should aim to spend 50% of their working day upright and was aimed primarily at employers and staff working in office environments but has also been utilised by ergonomists, office furniture and equipment suppliers and occupational health promoters **[E1]**.

The expert statement provided impetus for widespread changes to clinical practice and working guidelines for which LSBR provided pivotal guidance and evidence. In 2019, the UK Chief Medical Officer published new 'UK Physical Activity Guidelines' for which Yates provided expertise as a member of the sedentary behaviour expert working group. LSBR research provides much of the evidence for the guidance and specifically underpins the recommendation to interrupt prolonged periods of sitting with light physical activity **[E2]**. Furthermore, Dempsey is a member of the guideline development group that updated the World Health Organisation's physical activity and sedentary behaviour guidelines for 2020 **[E3]**.

LSBR research has also gone on to underpin international guidelines and position statements covering sedentary behaviour. This includes: the Dutch Physical Activity Guidelines 2017; Physical Activity/Exercise and Diabetes Position Statement of the American Diabetes Association 2016; the 2018 USA Physical Activity Guidelines; the Canadian 24-Hour Movement Guidelines for Adults; the World Health Organisation's guidelines on physical activity and sedentary behaviour 2020; recommended interventions for increased physical activity among office workers by the Swedish Department for Public Health 2019; the National Heart Foundation of Australia's 'Blueprint for Active Australia' 2019**;** the American Cancer society guideline for diet and physical activity for cancer prevention; the European Association of Preventive Cardiology position statement on exercise training for patients with T2DM and cardiovascular disease; the joint statement of the British and Canadian Associations of Cardiovascular Prevention and Rehabilitation; the International Council for Cardiovascular Prevention and Rehabilitation; and

the British Association of Sport and Exercise Sciences on 'Acute glycaemic management before, during and after exercise for cardiac rehabilitation participants with diabetes mellitus' **[E4]**.

Improving Occupational Health

In 2019, the SMART Work programme was launched online (rebranded SMART Work and Life in late 2020). Building on the successful SMArT Work intervention **[R7, R8]** the programme is freely available for use by organisations, workplace champions or individual employees **[E5]**. It consists of online education, motivational posters, sitting less challenges, suggestions for environmental changes, free self-monitoring tools, action plans, case studies, top tips and a step-by-step guide for effective implementation. To date, employees from >225 national and international (Australia, New Zealand, USA, Canada, Europe) organisations have signed up. These organisations include: Caterpillar UK Ltd., 30 councils across England, NHS Trusts, Pharmaceutical companies (e.g., Sanofi), Universities, and Government agencies (e.g., HMRC). Furthermore, this programme has been endorsed by three height-adjustable desk provider companies, including Posturite, Sit-stand.com (through ActiveWorking.com), and COI Total Interiors and is being promoted on their websites, through their newsletters, blogs and webinars. The programme has also featured on the Affinity Health at Work's website and social media, WorkSpace Design and Build through an invited blog, in the Institution of Occupational Health and Safety (IOSH; a global organisation for health and safety individuals) news stories and a featured blog, and on BBC Radio Leicester. Edwardson was also an invited speaker at the Health and Safety Executive (one of the UK government agencies responsible for workplace health) **[E6]**.

Enabling Individuals to Make Effective Change

Fitbit is the world leader in wearable physical activity trackers with over 29,570,000 active users worldwide. A core function common across the entire Fitbit product portfolio is step counting and in 2016 they introduced a vibration reminder to the user should they be sedentary for too long to achieve at least 250 steps per hour. Fitbit introduced this feature as a direct result of LSBR research linking sedentary time to increased risk of chronic disease and reduced cardiometabolic health **[E7]**.

In 2016, LSBR research also enabled and underpinned the development and release of the Outstanding google chrome extension. Outstanding analyses computer input to determine levels of sitting and provide break reminders and cites LSBR research as both its inspiration and the evidence base **[E8].** This has had ~500 downloads.

As a result of the meta-analyses published in 2012 **[R1, R2]**, LSBR were invited, in 2013, by the Global Business Leader of the Workspace Range of IKEA, Sweden, to attend and present at a workshop on the impact of sitting on health and to explore with them ways to reduce sitting with workspace furnishings and ways of working. This workshop included LSBR, a potential furnishing supplier and IKEA leaders. The main output of the workshop was ideas for a range development and a case for manufacturing workspace furnishings to reduce sitting at scale **[E9]**. Subsequently, in late 2014, IKEA released its first range of motorised sit-stand desks (BEKANT range). These desks are proving popular with 21 desks now in the BEKANT range and eight in the IDASEN range, with sales of these desks increasing by 15% during 2019 **[E9]**.

'The Sedentary Office' fed into the development of a Desk Control App by LINAK (>50,000 downloads on the Google Play store), which pairs with electric sit-stand desks and provides reminders to change posture from sit to stand and vice versa and provides feedback on standing time **[E10]**.

LSBR research has also inspired the design of a chair launched by Movably in 2020 (with LSBR meta-analysis results highlighted on their homepage), which enables the user to switch between a seated and standing position and when standing, stand more comfortably. The associated app provides feedback on time spent sitting and standing and number of posture changes **[E11]**.

5. Sources to corroborate the impact

E1. The sedentary office: a growing case for change towards better health and productivity. Expert statement.

E2. List of expert working group and technical report for UK 2019 Physical activity guidelines

E3. List of guideline development group members and physical activity and sedentary behaviour guidelines for World Health Organisation 2020

E4. Evidence of underpinning guidelines and position statements: Health Council of the Netherlands Physical activity guidelines 2017; Physical Activity/Exercise and Diabetes: A Position Statement of the American Diabetes Association. 2016; USA Physical Activity Guidelines 2018; the Canadian 24-Hour Movement Guidelines for Adults 2020, Swedish Department for Public Health and Clinical Medicine 'Interventions for increased physical activity among office workers' 2019; National Heart Foundation of Australia 'Blueprint for Active Australia: Action Area 2: Workplaces' 2019; American Cancer Society guideline for diet and physical activity for cancer prevention; European Association of Preventive Cardiology position statement on exercise training for patients with T2DM and cardiovascular disease; joint statement of the British and Canadian Associations of Cardiovascular Prevention and Rehabilitation, the International Council for Cardiovascular Prevention and Rehabilitation and the British Association of Sport and Exercise Sciences.

E5. SMART Work Programme Website

E6. Endorsement of the SMART Work online programme by Posturite, Work Space Design & Build, Sit-stand.com (newsletters via email), Active Working (newsletters via email), COI, Affinity at Work, IOSH

E7. Fitbit Step Guidance and UoL Link active on fitbit website between April 2016 and March 2019 (when BRU website was deactivated and re-directed to BRC)

E8. 'Outstanding' Google Chrome Extension.

E9. Email correspondence with IKEA. BEKANT and IDASEN range and IKEA UK Annual summary.

E10. Initial 2017 report 'Making Office Workers Healthier: A Public Health Intervention making office workers use their height-adjustable office desks more' from LINAK which led to app development, Desk Control App description and download figures on Google play store.

E11. Height-adjustable chair to enable posture changes and more comfortable standing. https://www.movably.com/home