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Please note: All information is provided based on the pre-approved ethics, approved on 24<sup>th</sup> June 2020 (approval confirmation attached at the end of this document).

Study title: Substituting Sitting with standing and Walking in Free-living Conditions Improves Daily Glucose Concentrations in South Asian Adults Living with Overweight/Obesity

Brief Title: Substituting sitting with standing and walking in Free-living Conditions improves daily glucose profile in South Asians

#### Study aim:

The purpose of this study is to investigate the effects of substituting sitting under free-living conditions in South Asian adults with overweight and obesity on continuous glucose profiles.

#### Methods

##### Study overview

This was a randomised crossover design study with two activity regimens (SIT and SITless) undertaken in free-living conditions. The study was conducted according to the Declaration of Helsinki principles and approved by the University of Bedfordshire Institute for Sport and Physical Activity Research Ethics Committee (2020ISPAR006). Participants provided written informed consent to take part. The study was conducted and reported in line with the Consolidated Standards of Reporting Trials guidance. The trial was registered with [clinicaltrials.gov/\(NCT04645875\)](https://clinicaltrials.gov/ct2/show/study/NCT04645875). Experimental regimen order was randomised using an online computer-generated randomisation method (<https://www.randomizer.org/>). Following a preliminary testing visit and successful try-out-day, participants completed two experimental regimens, each lasting 4 days, with a 3 day washout period between to minimise potential carryover effects.

##### Participants

South Asian adults living in the UK aged 18 to 75 years living with overweight or obesity ( $\text{BMI} > 23 \text{ kg m}^{-2}$ ) were eligible to take part. The BMI thresholds were aligned with overweight/obesity-related comorbidities among South Asian populations and calculated as  $\text{body mass (kg)}/\text{height (m)}^2$ . 'South Asian' was defined as anyone identifying themselves as South Asian or British South Asian. Exclusion criteria were self-reported CVD, current diagnosis of COVID-19, diabetes, a known blood-borne disease, pregnancy, recent or current smoker and other health issues (e.g., neurological disorders) or physical limitations that might limit the ability to perform the required volume of LPA. Participants were recruited from the local community (Luton and Bedford, UK) using adverts through social media posts (e.g., Facebook and Twitter) and distribution of flyers.

##### Sample size calculations

A-priori sample size was calculated using G\*Power version 3.0.10. The primary outcome was postprandial glucose ( $\text{mmol L}^{-1}$ ) with the mean effect size taken from previous lab-based studies in participants with overweight and obesity ( $d = 0.9$ ; Dey et al. 2024; Dunstan et al. 2012; Henson et al. 2016). A total of 11 South Asian individuals living with overweight/obesity were required to achieve 80% power with an alpha value of 5%. Recruitment targeted 14 participants to allow for 20% dropout.

##### Detailed Description:

Anthropometric measurement tools, including a stadiometer, a measurement tape and a digital weighing scale, an activity monitor and a Flash Glucose Monitor and sensor, were posted to the participants' home or workplace or the research team dropped all these items at participants' doorstep to allow participants to

take their measures including height, weight, and waist circumference.

Participants performed a try-out day of the SITless regimen after preliminary testing and before the first experimental regimen. Participants were only eligible for inclusion if they were able to adhere to the experimental protocol (i.e., substitute a minimum of 5-h/day sitting with  $\geq 2$ -h of self-perceived light walking and  $\geq 3$ -h of standing), assessed via monitoring with an activPAL. Participants were provided with a second attempt if required.

After the try-out day, participants were set up with the FGM and activPAL, which were both worn throughout the experimental period. Setup was completed 24-h before the commencement of the first experimental regimen and subsequently worn for 11 days (i.e., 2\* 4-day regimens and 3 days washout). Regimen 1 (SIT or SITless) took place over 4 days (day 1-4: Monday to Thursday), followed by a 3-day washout period (day 5-7: Friday to Sunday), followed by regimen 2 (SIT or SITless) for 4 days (day 8-11: Monday to Thursday). Participants were informed of the order of their experimental regimens and provided verbal and written guidance on how to complete the protocols. The experimental regimens were as follows:

**SIT regimen:** Participants were instructed to restrict walking to  $\leq 1$  h/day and standing to  $\leq 1$  h/day during their waking day. Participants were allowed to perform their daily activities, including cooking and other household activities, within the 2-h of permitted walking and standing (instruction is attached below).

**SITless regimen:** Participants were instructed to substitute a minimum of 5-h/day sitting with  $\geq 3$ -h of standing and  $\geq 2$ -h of self-perceived LPA in addition to interrupting their sitting for 2-5-min every 30-min. A list of activities (including walking at a slow pace, walking on the spot, jumping up and down, and standing) was provided as examples of activities that participants could perform during this regimen. Participants received feedback on their non-sitting time and the number of light and moderate-intensity steps from the try-out day. They were guided towards achieving compliance in this regimen by identifying potential activities they could engage in to interrupt sitting, reviewing their number of sitting interruptions and aiming to accumulate approximately 12,000 steps per day (6,000 steps being equivalent to 1-h of moderate-intensity walking) (instruction is attached below).

Participants were asked to refrain from food and drink containing alcohol for 24-h before and to avoid performing structured exercise for 48-h before the experimental protocol commenced and throughout the entire experimental period (a total of 11-days). A kitchen scale was provided so participants could weigh and record all food and beverage consumption in a diary during the first 4-day regimen and replicate this dietary intake exactly during the second 4-day regimen. Participants were instructed to consume a standardised diet (at least 50% carbohydrate) in order to reduce dietary heterogeneity within the study population. Participants were advised that the meals were spaced evenly throughout the day with 3 to 4-h intervals, with snacks consumed between meals to ensure three distinct and consistent glucose responses across each day.

### SIT Regimen Instructions

Dear Participant,

During the Sit regimen, we want you to sit as much as possible. Please follow these instructions from dates [..... ] to [..... ]

1. Please limit standing to a maximum of **1 hour per day** and walking to a maximum of **1 hour per day** for each of the 4 days. Spend the rest of the day sitting down. **This is really important as we can then see how the Sitless regimen affects your health compared to days when you sit down a lot.** Where possible please use public transport or a car to travel to and from places to limit your activity levels.

**Please do not engage in any structured exercise (e.g., cycling, sports, gym workout, running session etc.) or consume any alcohol during the whole study.**

**Please make sure you continue your normal daily life during the 3 days between your “Sit Less” and “Sit” regimens.**

## **SITless Regimen Instructions**

Dear Participant,

During the Interrupting Sitting condition, you will be asked to follow the below instructions for each of the 4 days. This will take place on dates [...] to [...]

Each day please substitute a minimum of 5 hours per day of sitting with  $\geq 2$  hours of light-intensity physical activity and  $\geq 3$  hours of standing breaks. Try to spread this out over the whole day. In addition, you should try to rise from the seated position for 2-5 minutes every 30 minutes to engage in standing/light-intensity physical activities to interrupt your sitting.

If you have a long commute to work, need to sit through a long meeting, or cannot stand within a particular hour for a different reason, that is ok as long as you replace your sitting time with at least **5** hours of standing and light activity over the day.

**Please ensure you engage in a minimum of 3 hours of standing and 2 hours of light-intensity physical activity (e.g. from the activities below) on each of the 4 days.**

Here are some suggestions for activities you can do during your breaks:

- Walking at a slow pace
- Walking on the spot
- Jumping up and down
- Taking the stairs
- Standing (you could stand when you are unable to engage in the other activities e.g. during meetings)

**You will have been given a demonstration by the research team virtually. Tips to**

**remember to take your breaks**

1. Download a phone app to remind you e.g.
  - a. Stand Up! The Work Break Timer (Apple - recommended)
  - b. Break Reminder (Android)
  - c. Goodtime Productivity timer (Android - recommended)
2. Download a computer app that sends reminders to your screen e.g.
  - a. WorkRave (Windows – recommended)
  - b. PC Workbreak (Windows)
  - c. Time Out (Mac – recommended)
  - d. Awareness (Windows or Mac)
  - e. Break Timer (available on Chrome browser)
3. Set reminders on your phone, computer or outlook calendar
4. **You may want to tally up how many breaks you have taken each day too!**

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7. Set reminders on your phone, computer or outlook calendar
8. **You may want to tally up how many breaks you have taken each day too!**

**Please do not engage in any structured exercise (e.g., cycling, sports, gym workout, running session etc.) or consume any alcohol during the whole study.**

**Please make sure you continue your normal daily life during the 3 days between your “Sit Less” and “Sit” regimens.**

## Statistical analysis plan

Statistical analyses were performed using SPSS version 26.0 (SPSS Inc., Armonk, N.Y., USA). Data were tested for normality using Q-Q plots. Linear mixed models with a compound symmetry correlation structure were used to determine the main effect of experimental regimen (SIT vs. SITless) for the outcome variables, with experimental regimen included as a fixed factor and participants included as a random factor. The models analysing activPAL outcomes were adjusted for activPAL wear time. The models analysing FGM outcomes adjusted for BMI. Two-tailed statistical significance was set at  $p \leq 0.05$ . Cohen's d effect sizes were calculated, with 0.2, 0.5, and 0.8 indicating a small, medium or large effect, respectively (Cohen 1988). All data are presented as mean (95% confidence interval [CI]) unless stated otherwise.

## ISPAR Ethical Approval Confirmation



24/06/20

### ISPAR Ethical Approval Confirmation

Proposer: Kamalesh Dey

Proposal title: Effects of substituting sitting with standing and at least light-intensity activity in free-living conditions on cardiometabolic disease risk markers in overweight and obese South Asian adults.

Dear Proposer

Your research proposal has now received ethical approval from the Institute for Sport and Physical Activity Research (ISPAR) Ethics Panel and you are now able to proceed with the data collection for this study.

Approval number: 2020ISPAR006

Please note that if it becomes necessary to make any substantive change to the research design, the sampling approach or the data collection methods a further application will be required.

Please be advised that your research project may be subject to an ethical audit at any given time. If you require any further information please contact the ISPAR Ethics Chair, Dr Laura Charalambous.

Kind Regards

A handwritten signature in black ink, appearing to read "L. Charalambous".

Dr Laura Charalambous (ISPAR Ethics Chair)