Reducing sitting at work: process evaluation of the SMArT Work (Stand More AT Work) cluster randomised controlled trial

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Abstract

Background Office based workers accumulate high amounts of sitting time. SMArT (Stand More AT) Work aimed to reduce occupational sitting time and a cluster randomised controlled trial demonstrated it was successful in achieving this aim. The purpose of this paper is to present the process evaluation of the SMArT Work intervention. Methods Questionnaire data were collected from intervention participants at 6 (n=58) and 12 months (n=55). Questionnaires sought feedback on the different components of the intervention and experiences of evaluation measures. Control participants (n=37) were asked about the impact of the study on their behaviour and any lifestyle changes made during the study. Participants from both arms were invited to focus groups to gain a deeper understanding of their experiences upon completion of 12 month follow up. Results Focus group and questionnaire data showed a positive attitude towards the height-adjustable workstation with a high proportion of participants using it every day (62%). Most participants (92%) felt the education seminar increased their awareness of the health consequences of too much sitting and motivated them to change to their behaviour. Receiving feedback on their sitting time and support from the research team also encouraged behaviour change. The DARMA cushion and action planning/goal setting diary were seen to be less helpful for behaviour change. Benefits experienced included fewer aches and pains, improved cognitive functioning, increased productivity, more energy, and positive feelings about general health. Conclusions Key elements of the programme identified as facilitating behaviour change were: the educational seminar, the height-adjustable workstation, behavioural feedback and regular contact with research staff.

Background

High levels of sedentary behaviour (sitting) have been shown to be detrimentally associated with a number of physical and mental health outcomes [1–3]. Moreover, with trends towards greater sitting in the workplace, office workers have been shown to engage in high levels of sitting [4]. The Stand More AT (SMArT) Work programme was an intervention tested within UK National Health Service (NHS) employees who worked predominantly at a seated desk [5 6 7]. A full study protocol is published [5], but, in brief, groups of desk-based staff within the same offices were randomised to either an intervention or control condition. The intervention participants received a multi-component intervention designed to reduce workplace sitting. Those in the control office clusters continued with their usual practice.

Results at 12 months showed favourable changes in the intervention group relative to controls for occupational sitting time, prolonged sitting, standing time, some musculoskeletal issues, various occupational measures (e.g., job performance, work engagement, occupational fatigue, sickness presenteeism), and quality of life [6].

To better understand how the SMArT Work intervention operated and was perceived by participants, we undertook several process evaluation assessments.

Method

Ethical approval was obtained from Loughborough University, and Research and Innovation approval was obtained from the University Hospitals of Leicester NHS Trust (EDGE ID 34571). All individual participants provided informed consent on entering into the study.

A sequential exploratory mixed methods approach was adopted with data collected from both intervention and control participants using questionnaires and focus groups. Table 1 shows the main methods and data collected. Intervention participants completed questionnaires at 6 months (6m; n = 58, 88% of intervention participants still in study; 74% female; body mass index = 25.8 ± 5.0 kg/m^2; age = 42.4 ± 11.3 years) and 12 months (12m; n = 55, 87% of intervention participants still in study; 71% female; body mass index = 26.0 ± 5.3 kg/m^2; age = 43.0 ± 10.8 years). A mix of open-ended, forced choice, and Likert scaling was used. Questionnaires sought feedback on the following elements of the intervention:

- educational seminar and leaflet: a 30-minute group educational seminar concerning the health consequences of sitting and the benefits of reducing or breaking up sitting and a leaflet to reinforce the key messages. Feedback was sought at 6 months only;
- feedback on their own sitting, standing and stepping generated from the activPAL monitor;
- height-adjustable workstation: participants were given the choice of two models. use of a sitting time diary: including action planning and goal setting;
- use of the Darma cushion: a cushion placed on office chair which connected to a smart phone via Bluetooth. Real time feedback on sitting is provided along with a vibration prompt to break up sitting regularly;
- Brief coaching sessions ('progress chats'): These took place every few months throughout the intervention. Feedback was sought at 12 months only.

Intervention participants and controls (n = 37, 80% of control participants still in study at 12 months) were also asked whether other lifestyle changes had been made during the study that might impact on the results, such as moving house or joining a gym, and about the impact of study measurement sessions and health feedback.

Twenty nine intervention participants (46% of intervention participants still in study at 12 months; 72% female; body mass index = 26.1 ± 5.6 kg/m^2; age = 41.1 ± 12.2 years), representing 16 intervention clusters (84%), also took part in focus groups after the 12 month follow up. These gathered responses concerning the facilitators to take part in the study, the impact of the intervention components on reducing sitting behaviour (as well as health and well-being), hindrances to desk use and adherence, and benefits and/or negative experiences of the interventions.

Five control group participants took part in brief focus groups (80% female; body mass index = 25.8 ± 3.7; age = 50.4 ± 14.3 years). Questions concerned any lifestyle changes made in the past 12 months, whether they felt part of the project, and whether the feedback they received from the measurements they undertook as part of the project affected their behaviour.

Data Analysis

The responses to questionnaire items were analysed with frequency counts or means and standard deviations using IBM SPSS V25. Open-ended responses were grouped into coherent themes using Template Analysis [11]. All statements were entered into Mindgenuis (V6) software and grouped by themes and sub-themes. Audio recordings from the focus groups were transcribed verbatim and subjected to Template analysis. The first stage of the template analysis was to define four a-priori themes relevant to the key functions of the process evaluation. Two members of the research team independentlyapplied these themes to the focus group data set to develop a template depicting the salient themes. Data that did not fit the initial template, but were relevant to the research aims, were coded and the themes were continuously modified as the data were interpreted, until a final template was created (see Table 2). There was agreement between the two researchers on the template themes identified and an additional theme around incidental culture of standing at work.

Results

Results are presented mainly according to intervention components with quantitative and qualitative data integrated throughout the results and themes shown in Table 2. Figure 1 shows the flow of participants through the randomised controlled trial.

Educational seminar and leaflet

Only seven participants (14%) did not attend the seminar face-to-face and were sent an audio recording instead. There was strong agreement that the seminar was delivered at an appropriate level (96% agreed or strongly agreed) and was an appropriate length (93% agreed/strongly agreed). Importantly, 92% felt that the seminar increased their awareness of the health consequences of too much sitting and 94% felt it motivated them to make a change to the amount of time they spend sitting.

Open-ended responses to assess receipt were requested concerning the key messages of the seminar. Of the 52 respondents, 40 provided comments, with three main themes emerging:

- standing and breaking up sitting is desirable to prolonged sitting
- excessive sitting is bad for your health
- exercise may not offset the detrimental effects of prolonged sitting.

In the focus groups, some participants discussed how knowledge learned from the seminar had a powerful impact on their understanding and attitude toward excessive sitting at work.

I'm quite aware of the effects of sitting all day but I think it's not until you sit there and actually listen to all the information that you think okay yes this can actually have a huge impact (Intervention participant, focus group 4)

For the educational leaflet provided, 89% said that they had read it. The level was seen as appropriate (88% rating agree/strongly agree). Most (88%) felt that the leaflet increased their awareness of the health consequences of too much sitting and 82% said it motivated them to make a change to the amount of time they spent sitting.

Height-adjustable Workstation

Participants were allowed a choice of one of two models (full electric desk or adjustable platform which sat on their existing desk), as well as a choice of size. They chose roughly evenly between the two models (60% chose a Varidesk platform and 40% the electric workstation). All those responding said that they used the workstation during the first 6 months.

At 6 months, all but two participants reported using the workstation at least a few times per week (35%) or everyday (62%). In the first month of installation, 65% used it every day, with similar rates between desk type. Participants did not find their workstation obtrusive to completing work tasks at 6m (98%) and 12m (100%). Data showed that participants were not self-conscious when using the workstations (87% at both 6m and 12m), nor did they think their colleagues minded when the workstation was being used (98% at 6m; 100% at 12m). These data were supported in the focus groups with participants highlighting that their non-participant colleagues did not impact on their use of the height-adjustable workstation.

the people who didn't have the desks, they didn't say anything or, like it wasn't awkward to stand up at any point in the office or anything like that, it was fine (Intervention participant, focus group 3)

Participants were asked how they scheduled the use of their workstations, such as specifying certain times or for particular tasks. At 6m, 42% reported scheduling often or very often, with a slight drop to 36% at 12m. The mixed responses were reinforced by the focus groups with some people stating that they had set times/periods when they used their desk, such as first thing in the morning or in the afternoon, but for some people it was used more randomly or when their body felt like it needed a change in posture.

Regarding perceptions of whether the workstations helped the participants reduce their sitting time, 94% reporting agreement at 6m and 12m. Agreement was high and broadly similar at 12m between the electronic workstation (100%) and for the Varidesk (92%). However, it was also evident that some people stood for prolonged periods at their desk despite regular posture change being recommended.

I had a period of time when I've come in every morning and lifted it up and I'd stand at it until I'd had enough. You know sometimes it was two hours and then I'd put it down and think I'm done for the day now (Intervention participant, focus group 1)

I stand for ages… but I like that, it feels really good for me (Intervention participant, focus group 3)

At 6m and 12m, participants were asked to write comments concerning what was positive about using their workstation. From 69 and 79 statements provided at 6m and 12m respectively, six main themes

emerged:

- musculo-skeletal and posture: better posture and fewer aches and pain, especially in neck, shoulders, and back
- mental benefits: better cognitive functioning and work productivity (e.g., 'feel more productive', 'allowed me to concentrate and focus'), enhanced mood ('feel my mood has improved'), and improved feelings of energy and alertness (e.g., 're-energises me',, 'felt more alert throughout the day')
- more movement: 'I am more likely to move about the office if standing'
- general health benefits: 'feel more positive about my health'
- social norms and benefits: 'more are willing to stand if I am standing'
- increased choice: 'gives me the option'.

Additional themes concerned 'comfort and utility' at 6m (e.g., 'more comfortable standing'; 'easy to use'), and 'ergonomics' at 12m (e.g., 'more natural eye line to the screen').

Musculo-skeletal outcomes were also reflected in the data from the focus groups:

Prior to this study, I did have problems with my shoulder and I've found standing does alleviate that because when you're with your mouse like that of at the keyboard, and now standing, it's different, your hands are lower, and I've not had a problem with my shoulder since the study (Intervention participant, focus group 6)

Many participants in the focus groups described how standing up during tasks led to increased productivity and confidence:

I feel I work better, I work faster when I am standing up, to be honest, when you are sitting down, you are sort of just there (Intervention participant, focus group 6)

Busy and stressful before, I just had hundred of emails hitting me, phone calls, doctors coming in, there was so much, but even then, I still stood up during then, I thought, actually, it made me feel like that different mindset… I felt more confident standing up… I felt I could deal with things. (Intervention participant, focus group 3)

As the study was a cluster design, where groups of people within the same office group were randomised to the same group, if one person was standing up (at their desk or elsewhere), this would often remind other colleagues to also stand up. Therefore, a knock-on effect of colleagues standing regularly was evident, as illustrated by this comment from the focus groups:

In the environment when there's lots of people standing up, you know, one person stands up, you know, then it's oh yes, I need to stand up, too (Intervention participant, focus group 6)

Barriers to desk use. Ten (19%) people specifically reported no negative issues related to the workstation at 6m, and nine (17%) at 12m. The main issue that emerged concerned the lack of space on the Varidesk platform. This was mentioned by 50% of those reporting negative issues at 6m and concerned papers and files falling off, and a lack of space for handling multiple papers. However, many reported that this led to strategies to enhance the tidiness of their desk, thus creating a positive outcome.

Other negative issues at both 6 and 12m were musculo-skeletal (e.g., 'initial low back pain'; 'initial leg pain'; 'swollen ankles and feet'), ergonomic (e.g., 'uncomfortable when typing a lot'; 'sometimes couldn't type when standing'; 'wires would get caught'), and additional work issues (e.g., 'remembering to use the workstation'; 'change to established work pattern'; 'feel awkward when standing').

Darma Cushion

The use of the Darma cushion and associated 'app' was moderate at 6m; 52% reported using it and few planned to use it in the future. Assessing over the past 6m, users of the Darma cushion reported varied responses, with 40% reporting infrequent use, while 37% reported daily use. Only 10 (22%) reported using the cushion in the 12m data, with 11% reporting infrequent use, 44% using it 'a few times per week', and another 44% reporting daily use. The use of the Darma cushion app was initially reasonable with 43% reporting daily use in the first month but this dropped to 17% by 6 months. Moreover, 62% reported infrequent use over the longer time period. The cushion vibration function was used by 66% of those that reported using the cushion, with most (85%) reporting it to be useful.

Ratings were provided on a number of characteristics of the Darma cushion at 6m and 12m. These are shown in Table 3. Data from the 28 participants using the cushion in the first 6 months suggested that it was easy to use (75% agreement), was not obtrusive (71%), it increased awareness (72%), and encouraged less sitting (68%). The small sample using the Darma cushion at 12m reported it as easy to use, largely unobtrusive, it increased awareness, although only 60% agreed it decreased sitting.

Many participants found other ways to set prompts including using the Varidesk computer/phone app and Google Chrome *Stand Up!* timer.

I'm using the computer prompt [Google Chrome *Stand Up!* Timer] *now because I didn't get on too well with the cushion (*Intervention participant, focus group 6)

It helped a lot [Varidesk phone app]*, you could set the time, if you needed that regime at the start, you could say I am going to stand up for half an hour and then down again (*Intervention participant, focus group 3)

At 6m and 12m, reasons given in the questionnaires for not using the cushion centred on lack of comfort, technological issues with the app and phone (e.g., syncing, storage and battery problems), length of charging lead and other reasons. The latter included a perception by some that it was not needed and

that they could implement their own behaviour change without it. Similar comments were also made in the focus groups:

It was very uncomfortable [and] it ran out of batteries so I never recharged it (Intervention participant, focus group 3);

The lead is really short, you had to plug it in, I think once it died…. (Intervention participant, focus group 3).

Some also reported that they used it initially but didn't need it once using the height-adjustable workstation became more of a habit:

I did at the very start but then after that I actually found, because I was generally pretty good with my standing desk that I didn't really see the requirement for the cushion (Intervention participant, focus group 7)

I think to start with, I had to use those timers and things to remind myself to stand up, but now it is just so natural…I just stand up until I feel like sitting down again or I stand up when I feel like I need to stand up" (Intervention participant, focus group 3)

Sitting Time Diary

Most reported that they either no longer used the diary to keep a record of their sitting (90%) nor used it for goal-setting (92%), or never used the diary within the first 6m (55%). Similar data were found for 12m.

Reasons for not using the diary, including for goal-setting, were given in open-ended comments and included perceived lack of time and time pressure of their job (e.g., 'work pressures—didn't think about it'), forgetting, not finding it useful (e.g., 'didn't see point'; 'doesn't work for me'), and motivation (e.g., 'effort of completing outweighs benefits'). Similar responses emerged from the focus groups:

I think realistically you are probably not going to carry a paper diary around with you…it became another thing to either forget, like keep up with. And you always have your phone on you, so it's easier just to write things on your phone (Intervention participant, focus group 3)

Some participants, however, stated that they did not use the diary because they felt they did not need it. Some stated that their height-adjustable workstation was enough to encourage them to sit less, while others had created their own routine and habit (e.g., 'stand when work allows me'; 'I usually stand in the morning').

Feedback on Sitting Time

A large majority of participants were in agreement, at both time points, that receiving feedback on their sitting time helped them think about their sitting, highlighted that they could be sitting too much, motivated them to change, helped plan and set goals, and was useful for reviewing progress (Table 4).

'Progress Chats' (i.e., coaching) with Research Team Staff

At 12m only, participants were asked to reflect on the coaching and support provided by research staff through the 'progress chats' that were provided. All but 1 of the participants who were left in the study at 12 months had all 4 coaching sessions (n = 62). There were 72, 65, 65, and 63 participants participating in the 1st, 2nd, 3rd and final coaching sessions, respectively. Participants reported that the chats helped them formulate plans (92%), helped them stay on track (93%), motivated them (96%), help them find solutions (86%), and provided 'enough' support (94%).

Lifestyle Changes

Lifestyle changes were reported to have been made by 39% in the first 6 months. Of those reporting the nature of such changes, 10 were positive (e.g., signing up for gym membership), and seven were negative (e.g., illness).

Other Facilitators and Barriers to Behaviour Change

Some participants commented on how the length of the intervention gave them time to adjust, learn self-motivation to change their behaviour toward sitting, to go through a trial and error period of incorporating standing (e.g., going back to sitting and starting again), and to become aware of the work benefits over time.

This has been quite a fundamental change, it's made me think very differently about workspaces, environment, the way I interact with other people, you know. … I've actually changed the way I work with my devices, and that means how I work with people, and the information and conversations I'm having, all that's changed, so to make that [change] all in one go would be hard, and it's needed a time period (Intervention participant, focus group 6)

Regarding barriers to behaviour change, it was reported by some that if they were having a stressful day or were engrossed in a certain tasks then they felt that they either needed to sit down or would simply forget to break up their sitting.

Sometimes if you get involved in a bit of work or whatever, a few hours can go by like two or three and then you are like oh I have just been sat here for three hours, I haven't even left my desk (Intervention

participant, focus group 3)

The culture of sitting in meetings was highlighted as a barrier. Participants did not feel comfortable or confident to stand in meetings, particularly those involving senior staff. It was felt that the chairperson of the meeting would need to highlight the acceptability of standing at the start of the meeting for them to feel more comfortable. Even then they may still feel somewhat self-conscious if they were the only one standing and did not want to attract attention to themselves.

Everyone has to be standing, otherwise the attention is on you, if you're the one person standing (Intervention participant, focus group 3)

If it is like an announcement and then an agreement, then everyone does it and everyone sits back down, it would be like not so awkward…you can't just be stood there, it would feel very uncomfortable (Intervention participant, focus group 3)

Control Participants

The coding of 41 open-ended questionnaire responses from 22 control participants led to six main themes concerning lifestyle changes during the project: lifestyle changes (positive), lifestyle changes (negative), less physical activity, more physical activity, diet changes, and other changes. Several said that they had moved house and this had caused a negative disruption to their lifestyle and health. Others reflected on positive lifestyle changes, including joining a weight management service. For physical activity, a significant number of comments reflected changes for both increasing and decreasing physical activity. A few stated positive efforts in changing their nutrition. Overall, a large number of life events were mentioned and these appeared to have both positive and negative effects on lifestyle and health.

The second question asked whether being part of the study, despite being in the control group, had affected their sitting behaviour at home or work. Coding of 30 responses from 16 control participants led to four main themes: sit less, move more, change diet, and awareness. The sit less theme reflected a number of changes control participants had made during the trial, including 'I consciously get up from my desk frequently', 'make effort to stand more at certain tasks', and 'more aware at home—do not sit for too long'. Others reported an emphasis on moving more, reflecting sub-themes of using self-monitoring (e.g., 'I count my steps daily'), incidental (e.g., 'increased my stair use'), and exercise (e.g., 'I try to walk at lunchtime'). Being part of the project seemed to create greater awareness in some control participants, mainly around sitting. This was reflected in a reduction for daily sitting time in control participants at 3 month follow up, although not at further follow-up [6].

Finally, participants in the control group were asked whether any changes were made to their lifestyle after receiving health test results from the assessments. From 37 responses, 22 (60%) said that the tests did not have any impact on their lifestyle.

It became apparent from the focus groups that the feedback they received from the health measures at baseline, 3, 6 and 12 month follow up was a key motivator to staying in the study.

It does make you more aware of, you know, the BMI and everything really...Its just to be aware of the whole, like, you've sort of had an MOT, haven't you...Every four months you have one, which I think is good (Control participant, control focus group 2)

Discussion

From this process evaluation, we can conclude by using the following categories recommended in Medical Research Council (MRC) guidance [9]:

- intervention context: the contextual factors that might affect the implementation and outcomes of the intervention
- implementation: the implementation of the trial itself
- mechanisms of impact: any mechanisms helping to explain the impact of the trial.

Context

Participants took part in the study for a variety of reasons, including novelty, health, and social influences (see Table 2). While most RCTs will tend to recruit 'interested' and 'motivated' participants, the reasons given for involvement in the current trial do not appear to suggest a significant bias in recruitment that may influence health-related outcomes or beyond what may be expected in a trial of this sort.

There was a mix of positive and negative changes made during the lives of intervention and control group participants during the course of the trial. There was no apparent systematic bias in this regard. However, taking part in the study did appear to influence controls, at least in the short term. It is clear that any assumptions that control group participants remain stable in their behaviours during the trial are unfounded. In the present study, 40% of controls who responded felt that feedback from their assessments led to either confirmation of their situation, a greater awareness of issues, or actual changes to behaviour. Given that changes in primary and some secondary outcomes in the trial were largely in the desired direction [6], any differences seen in the trial outcomes between intervention and control participants may be an underestimation.

Implementation

Five key implementation elements of the RCT assessed were the seminar and leaflet, the workstation, the Darma cushion, diary, and coaching 'chats'. The seminar and leaflet achieved good reach; most read the leaflet and attended the seminar.

The height-adjustable workstation was implemented somewhat as planned, with participants given a choice of two designs (full electric or platform design) to accommodate different office set ups and preferences. However, the ordering, delivery and installation of the workstations took longer than expected and this may have impacted on results at 3 months. However, nearly all participants used the workstations at least weekly, with about two-thirds using it daily. Fidelity of the Darma cushion and diary for self-monitoring and goal setting was moderate-to-low and very low respectively. Participants engaged with the coaching chats and feedback from the activPAL device.

The Darma cushion was chosen based on feedback from participants in our development work [7]. However, in the intervention study, responses to the cushion were mixed in terms of its usefulness. Some participants sought out their own methods for receiving prompts to break up their sitting. This highlights that 'one size does not fit all' and future interventions may wish to consider flexibility in the tools offered to participants. It is likely that diaries for action planning and goal setting were considered too difficult and an extra task not worth doing. If greater use of the Darma cushion is to be encouraged, issues concerning comfort and enhanced technology are priorities to address. It is unlikely that one self-monitoring or prompting tool will satisfy everyone, therefore there is a need to offer a greater choice of devices and tools for self-monitoring and prompting.

Comments from participants reflected low uptake of the diary and highlight that behaviour change techniques (BCTs) and other strategies provided by researchers may not always be seen in the same light by participants. However effective goal-setting may be as a BCT, it will not be effective if adherence is low. This will more likely be the case for BCTs and tasks that require greater cognitive effort and time.

Mechanisms of impact

The SMArt Work intervention was developed based on the Behaviour Change Wheel [7 8]. A key element of this approach is the 'COM-B' framework where behaviour (B) is considered to be a function of the capability (C) of the individual, the opportunity (O) they have, and their motivation (M). These can be seen as mechanisms of behaviour change and are considered in this discussion.

The educational seminar and leaflet were well received. They appeared to increase awareness of the health consequences of too much sitting and provided motivation to make changes to the amount of time spent sitting. This addresses the motivation element of the COM-B framework is more associated with 'reflective' forms of motivation, requiring participants to process information prior to decision making. In addition, the seminar and leaflet are likely to enhance perceptions of capability. One belief endorsed was 'exercise may not offset the detrimental effects of prolonged sitting'. The belief that exercise does not offset the deleterious health effects of too much sitting is a controversial point in the contemporary literature and is probably a reflection of the development of the research field. Early epidemiological studies and meta-analyses suggested that higher levels of sedentary behaviour were associated with negative health outcomes when controlling for levels of moderate-to-vigorous (MVPA) or

leisure-time physical activity [e.g., 2 12]. However, research has suggested that very high levels of MVPA are likely to attenuate the effects of sitting on mortality [13]. At the time of the development of the SMArT Work project, beliefs were more aligned with the comments emanating from the open-ended comments of participants. If we repeated the education, we would advise that the message reflect a more balanced view.

The height-adjustable workstation was also well received and was reported to have had numerous benefits.The two Varidesk models was viewed positively but some reported issues of a lack of space on the platform for papers. However, there was evidence that people adapted to this and it became a positive feature (i.e., they became tidier). The provision of such desks enhances participant's capability and opportunity to reduce their sitting time.

Some of the qualitative findings support our quantitative results [6] concerning positive changes for musculoskeletal problems. Other process evaluations have also found participants reporting improvement in musculoskeletal issues [15]. Our qualitative findings also support our quantitative results around job performance, work engagement and recovery from occupational fatigue [6]. Importantly, most of the participants discussed how regularly standing benefited their work performance including concentration, confidence, and creativity, and they also mentioned a positive impact on energy levels. These findings have also been reported in other qualitative studies evaluating small scale height-adjustable workstations [15–17]. Specifically, Leavy and Jancey [17] found their participants reported that they felt height-adjustable workstations helped to create energy within work spaces and increased work performance.

The process evaluation also highlighted how standing at desks not only improved interaction between colleagues related to work tasks, but it also had a wider positive influence on engaging other employees not involved in the study in terms of reducing their sitting. Our intervention therefore provides new insights into how the development of social norms of regular standing has a widening influence on the workforce. Future trials could evaluate the reach of the effect of these types of interventions and assess changes in behaviour among non-participants.

Facilitators to changing sitting behaviours at work were explored during focus groups. It appeared that the most important components of the intervention to change sitting behaviour were the educational seminar and the provision of the height-adjustable workstations. The seminar was considered a strong influence in using the workstation and shows the importance of providing some education alongside the provision of height-adjustable workstations.

Very few barriers were reported by the intervention participants in adhering to the intervention. The ones that were reported included a lack of space on the height adjustable desk platform that sits on top of an existing desk when raised to the standing position. However, participants often found ways to work around this during the intervention. The seminar session at the start of the intervention encouraged participants to identify other strategies in addition to using the desk to break up their sitting time. However, standing in meetings was considered difficult because of the wider predominant work culture of

sitting and feeling self-conscious in the presence of senior staff. This is consistent with work by Mansfield et al. [19] and suggests that wider social behaviour change strategies are needed to make standing in meetings acceptable and the norm.

A large majority of the intervention participants reported very positively on their interaction with research staff, and especially for the 'progress chats' (coaching) offered. These were reported as being helpful for motivation and planning, and appear to support the development of the processes in the COM-B framework, and in particular motivation and capability. Of note is that being part of the trial seemed to have positive consequences for just under half of the control group participants. These controls felt that they had made changes to their sitting behaviour, physical activity and nutrition.

In conclusion, the SMArT Work programme was successful in reducing sitting time for desk-based employees [6], and this process evaluation has provided valuable information on elements of the intervention and study that appear to have facilitated such behaviour change. These include the educational leaflet and seminar, the height-adjustable workstation, and behavioural feedback and interactions with research staff.

Strengths and Limitations of Process Evaluation

The main strengths of this process evaluation were the multiple methods used and two time points assessed through the questionnaires. A comprehensive set of indicators was assessed to judge context, implementation and impact of the intervention and RCT.

Limitations included the ability and willingness of participants to respond fully to open-ended questions in the questionnaires. However, even though less than half the intervention participants took part in the focus groups, 84% of the clusters were represented. Not everyone completed the process evaluation questionnaires.

List Of Abbreviations

SMArT Work: Stand More AT Work

NHS: National Health Service

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from Loughborough University, and Research and Innovation approval was obtained from the University Hospitals of Leicester NHS Trust (EDGE ID 34571). All *individual participants provided informed consent on entering into the study.*

Consent for publication

Not applicable

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

Prof Biddle reports membership of the International Advisory panel for Get Britain Standing and the Sedentary Behaviour Expert Working Group for the UK physical activity guidelines 2018–2019. Prof Yates reports membership of the Sedentary Behaviour Expert Working Group for the UK physical activity guidelines 2018–2019. Prof Davies reports personal fees from Novo Nordisk, personal fees from Sanofi-Aventis, personal fees from Lilly, personal fees from Merck Sharp & Dohme, personal fees from Boehringer Ingelheim, personal fees from AstraZeneca, personal fees from Janssen, personal fees from Servier, personal fees from Mitsubishi Tanabe Pharma Corporation, personal fees from Takeda Pharmaceuticals International Inc, grants from Novo Nordisk, grants from Sanofi-Aventis, grants from Lilly, grants from Boehringer Ingelheim, grants from Janssen, outside the submitted work. All other authors declare that they have no competing interests.

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Author contributions

CE, SJHB, MD, DD, DE, LG, TY, FM obtained funding for the research. All authors have contributed to the design of the study. SOC was involved in data collection and study co-ordination throughout. CE and FM supervised SOC. The first draft of this manuscript was produced by SJHB and SOC, the second draft was reviewed and edited by FM and CE and all authors have reviewed, edited and approved the final version.

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Tables

Table 1. Process evaluation methods and data collected for intervention and control participants.

Assessments	Intervention participants			Controls (n=37, 80%)
	6m questionnaire (n=58, 88%)	12m questionnaire (n=55, 87%)	Focus Groups (n=29, 46%)	
Facilitators to taking part			√	
Reducing sitting at work: attitudes, climate and behaviour change			√	
Perceptions of benefits of reducing sitting			√	
Wider/policy changes at work			√	
Other lifestyle changes	√	√		√
Height-adjustable workstation	√	√	√	
Education seminar	√			
Use of sitting diary	√	√		
Sitting behaviour feedback	√	√		
Use of Darma cushion	√	√		
Alternative support	√	√		
Educational leaflet	√			
Progress chats with research team		√		
Changes from being part of project				√
Changes made after test feedback				√

Table 2. Template Analysis: themes and sub-themes from focus groups.

Level 1-Main Theme	Level 2 sub-theme	Level 3 sub-theme
Facilitators to taking part in the study	Novelty Social influence Job type Current health problems	None
Attitude and behaviour change regarding reducing sitting at work	Factors that promote standing and habit formation	Seminar Feedback on physiological, anthropometric and activPAL feedback Prompts Social influence Length of intervention study
	Standing further reinforces other attitude and/or behaviour change	Other behaviour changes at work Sitting less at work Other external impacts
Creating an incidental socio-cultural environment of standing at work	None	None
Perceptions of the benefits of standing	Health benefits	Reduction in musculoskeletal problems
	Work-related benefits	Productivity Changes in work style Interaction with colleagues
Hindrance to desk use	Lack of motivation	Goal setting
	Aspect of the job	None
	Intervention components	Cushion
Wider/policy changes at work	Organisational-wide communication Mandatory training	None

Table 3. Means (SDs) for the Darma cushion reported at 6 and 12 months (ratings on 5-point scale: 1=low, 5=high).

	Comfort	Design/look	Battery life	Syncing data	Presentation of feedback	Navigation of feedback	Understanding feedback	Accuracy of assessing sitting
6m data	3.50 (1.26)	3.75 (0.97)	3.39 (1.13)	2.96 (1.48)	3.26 (1.26)	3.26 (1.29)	3.22 (1.19)	3.26 (1.35)
12m data	4.33 (1.00)	3.67 (1.00)	3.33 (1.12)	3.25 (1.28)	3.75 (0.89)	3.50 (0.76)	3.63 (0.92)	3.38 (1.19)

Table 4. Responses concerning receiving feedback from assessment of sitting time using the activPAL.

Statement: 'Feedback on my sitting time ...'	6 months		12 months	
	Agree (%)	Strongly agree (%)	Agree (%)	Strongly agree (%)
... made me think about how much I sit	40	46	55	45
... highlighted to me that I sit too much	45	37	53	29
... motivated me to make a change	42	44	47	41
... helped me set goals around my sitting time and plan to change my sitting behaviour	39	28	43	29
... was useful to review my progress	29	59	45	53

Figures
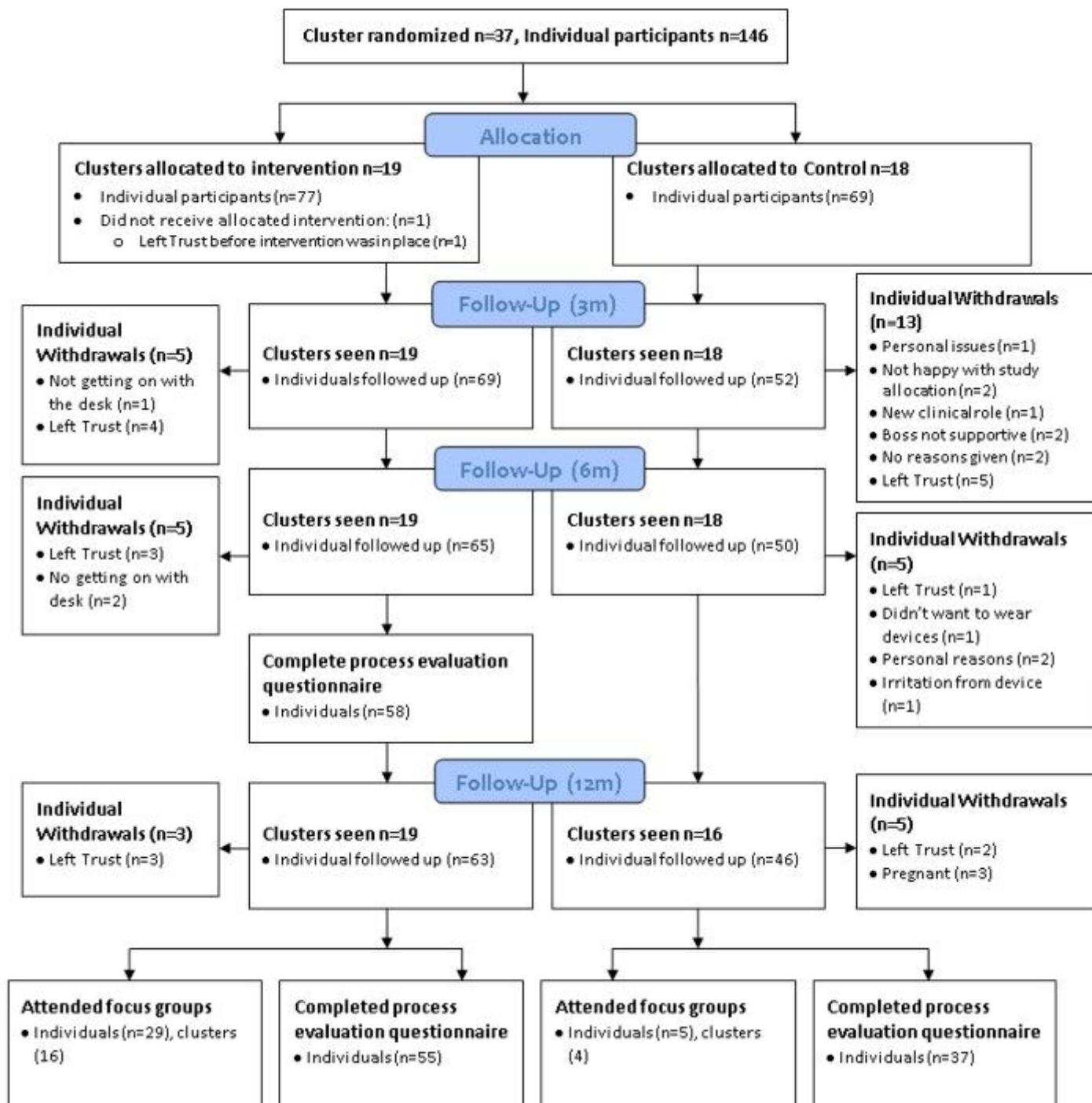
Figure 1

Flow of participants through the randomised controlled trial