



The Stand and Move at Work (SMW) Study

MANUAL OF PROCEDURES

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SMW Study Manual of Procedures

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1. Introduction

Stand & Move at Work is a two-arm group-randomized trial. Worksites (N = 24) of small to moderate size (20–50 employees enrolled; N=720 employees across the 24 sites) will be randomized to one of two interventions: (a) *MOVE+*, a multi-level behavioral intervention targeting increases in LPA at the worksite; or (b) *STAND+*, the multi-level *MOVE+* intervention along with the installation of sit-stand workstations to allow workers to stand at their desks while working. Both worksite interventions are expected to reduce sitting and increase LPA over 12 months and improve cardiometabolic risk and work performance outcomes. We hypothesize the effects to favor the *STAND+* study arm because the additional sit-stand workstation enhancement will provide a robust environmental stimulus to reduce sitting and provide a unique catalyst for LPA in the workplace. The *MOVE+* arm will receive sit-stand workstations at 12 months and both arms will be assessed for follow-up at 24 months.

Primary Aim:

To evaluate the relative efficacy of *MOVE* and *STAND+MOVE* interventions on LPA and sitting behaviors over 12 months, with process measures at 3 months and maintenance measures at 24 months. The *STAND+MOVE* intervention, relative to the *MOVE* intervention, will: (H1) increase LPA at work and (H2) reduce sitting time at work over 12 months. Additional process outcomes at 3 months and maintenance outcomes at 24 months will be collected.

Secondary Aims:

To evaluate the relative efficacy of *MOVE* and *STAND+MOVE* interventions on cardiometabolic risk (composite measure of fasting glucose, insulin, triglycerides, HDL-cholesterol, and blood pressure) over 12 months, with additional follow-up to 24 months. The *STAND+MOVE* intervention, relative to the *MOVE* intervention, will (H3) lower cardiometabolic risk over 12 months

2. Study Organization

The study was funded by the National Cancer Institute at the National Institutes of Health. The trial is managed collaboratively by the Principal Investigators (PI) at both study sites (i.e. Arizona State University and the University of Minnesota, Twin Cities).

2.1 Study Setting

Worksites will be enrolled in the greater Phoenix, AZ, USA and Minneapolis, MN, USA metropolitan regions. Twelve worksites will be randomized in each region. Selected worksites will be drawn from three distinct work sectors: higher education, industry/healthcare (e.g., law firms, health insurance providers), and government (e.g., state departments). Worksites will be equally selected in each sector across each region (n= 4/sector/region worksites).

Each site will be responsible for recruiting participating worksites and participating individuals within the worksties. A single digit site ID will be incorporated as the first digit of the three digit worksite ID that each enrolling worksite will be assigned.

2.2 Study Site Teams

The PI of each site will be responsible for his own staff and will secure IRB approval prior to the start of the study team. A research coordinator at each site will work with the PI to ensure the study stays on the scheduled timeline, and that data collection and study activities are implemented according to study protocols.

3. Training and Documentation

All staff will complete IRB-required training, including human subjects, in advance of the study. In addition, all data collection staff will be trained on the collection of anthropometric and blood pressure measures. Phlebotomists collecting biospecimens (i.e. venous blood samples) will have completed all necessary training for the collection and handling of biospecimens.

4. Worksite Enrollment Process

The worksite enrollment process refers to the tasks that each site undertakes to initiate Worksite accrual, beginning with identifying potential worksites, screening and consenting, and randomizing.

4.1. Identifying Potential Worksites

We will recruit worksites that meet our inclusion criteria and then recruit individual employees within each of the worksites (see Section 5). We aim to recruit 24 small to moderate sized worksites across our two geographical areas – Phoenix, AZ and Minneapolis/St. Paul, MN (12 worksites in Arizona and 12 in Minnesota; see inclusion criteria in Section 4.3). Partnerships with large companies from our preliminary studies will be leveraged to help identify participating worksites, although we will avoid recruiting individual worksites that have been involved in our past studies. We will also leverage others in our professional networks, including individuals involved in workplace wellness, to help identify potential worksites. In advance of the grant proposal, we garnered very strong and broad support from many employers and worksites of various sizes in both Arizona and Minnesota. We will be recruiting worksites from three different workplace sectors including academia, government, and healthcare to enable greater generalizability of study results.

4.2. Timeline

Participating worksites will be recruited as pairs within a single sector at each worksite utilizing a rolling recruitment method. We will also rotate the enrollment of sector pairs over the seasons of the full calendar year to help avoid seasonal effects, beginning with the first two pairs enrolled in January 2016 and the final two pairs enrolled in November 2016. Enrolling two pairs every other month will also alleviate logistical and labor burdens for recruitment, data collection, and intervention implementation.

4.3. Worksite-level Inclusion Criteria

Worksite level inclusion criteria include:

- (a) Size: small to moderate size worksite (20-60 employees)
- (b) Schedule: >80% of employees full-time

- (c) Occupation: seated office work, primarily computer- and telephone-based work, little movement or walking
- (d) Wellness environment: not currently undergoing a wellness program aimed at increasing activity at work
- (e) Workstations: willing to have sit-stand workstations installed at worksite
- (f) Willing to engage in worksite-level intervention activities
- (g) Willing to be randomized to either intervention condition

4.4. Screening

Worksites will be screened for eligibility by study questionnaires completed by worksite leadership and followed up with interviews by study personnel to verify eligibility. If a worksite meets the inclusion criteria, a general level of employee enthusiasm for the study will be assessed (see Section 4.4)

4.5. Employee Interest Survey

At worksites where inclusion criteria have been met, an anonymous survey will be sent to employees to gauge interest in participating in a study looking to decrease sitting time and increase light-intensity activity at work (i.e. level of enthusiasm and likely participation), and additional questions to assess both their physical workspace (whether the space could accommodate sit-stand desks) and individual level questions (to determine generally whether the person would meet the individual level inclusion criteria).

4.6. Memorandum of Understanding/Agreement to Participate

Presuming a worksite has enough employee interest to move forward, a memorandum of understanding will be developed and signed by the worksite manager and study principal investigators to facilitate adherence to the study timeline and intervention. As part of this process, both a study leader and study advocate(s) will be identified.

5. Participant Enrollment Process

This section details Participant enrollment, beginning with recruitment, screening and consenting, and randomizing.

5.1. Town Hall Presentations

All worksite employees will be invited to a Town Hall presentation(s) scheduled based on the suggestions of the worksite leader and/or advocates. Up to two town halls will be scheduled at any given worksite to allow for the greatest attendance. While in-person Town Halls are desired, electronic town halls will be made available as an option. For those unable to attend a Town Hall, a copy of the TownHall powerpoint presentation will also be provided. The purpose of the Town Hall meeting will be to allow the site PI to state the study goals, aims, methods, inclusion/exclusion criteria, and timeline. Following the town hall, interested (or all, depending upon the preference of the worksite leader) employees will be emailed a description of the study, including a consent form, along with a link to complete the eligibility screener questionnaire.

5.2. Participant-level Inclusion Criteria

Participant eligibility criteria will be as follows:

- (a) 18 years or older;
- (b) generally good health and able to safely reduce sitting and increase LPA;
- (c) working full-time on-site (i.e. 30+ hours and at least 4 days in the office per week);
- (d) not currently pregnant;
- (e) predominant worksite occupation being seated office work;
- (f) not currently using a sit-stand workstation at their primary desk location at work;
- (g) willing to have a sit-stand workstation installed at their desk; and
- (h) willing to be randomized to either study arm.

5.3. Participant Eligibility Survey

An online eligibility survey will be distributed to each worksite employee following the informational sessions. All eligible participants will be invited to schedule a 30-minute slot during an assessment morning held at the worksite.

5.4. Consent

Those who are eligible and choose to attend the baseline assessment visit will be sent a copy of the consent form will be sent in advance and reviewed in person prior to commencing the visit. If the participant agrees to take part, they will provide written consent. Note: Participants from Minnesota government worksites will also be asked to sign a Tennesen agreement.

6. Randomization

Randomization to either the *STAND+* or *MOVE+* intervention arms of the trial will be at the level of the worksite. Randomization will be stratified on the three sectors nested within each of the two regions (Phoenix, AZ and Minneapolis/St. Paul, MN). Within each region, eligible worksites will be enrolled in pairs matched on sector, and each matched pair will be randomized so that one is randomized to receive the *STAND+* intervention with the other receiving the *MOVE+* intervention. This scheme will ensure a balanced design by both region and sector.

Randomization will not occur until all four worksites in the recruitment wave (2 per region) have completed their baseline assessments. Therefore, a participant will be considered enrolled in the active intervention once they have consented, completed baseline assessments, and paired worksites have been randomized to study arm. Prior work by our research team has suggested that we should expect 40%–75% participation within the identified worksite, which based upon worksite size will approximate our target recruitment of N = 720 participants.

7. Study Interventions

7.1 Intervention Overview

The ‘Stand & Move at Work’ interventions will be delivered over 12 months and is based upon both the social ecological framework and social cognitive theory principles. The intervention development team is comprised of behavioral scientists, exercise scientists, ergonomists, and worksite wellness coordinators. The primary behavioral target of the *MOVE+* intervention is to

accumulate 30 min or more additional LPA each day. The primary behavioral target of the *STAND*+intervention is, in addition to the *MOVE*+ target, to increase time spent standing to 50% of desk-based time during the workday (e.g. standing for 3 h out of 6 total desk-hours per day).

Our approach will target intervention strategies at the individual, social, environmental, and organizational levels.

All intervention materials will be manualized into the Stand & Move at Work “Toolkit.” The toolkit will be distributed to each worksite prior to the intervention start date. It is expected that each worksite and/or sector may differ in the time, resources, space, and personnel available to dedicate to the implementation of the intervention. The Toolkit will therefore be comprised of both “required” strategies (i.e., strategies that are required to be implemented by worksite staff during the intervention period) and “optional” strategies (i.e., strategies that worksite staff are encouraged to implement as are appropriate given the worksite context). Additional strategies generated by the worksite staff will also be encouraged. This approach ensures uniformity of the delivered interventions across worksites and allows flexibility and autonomy among worksites. Actual implementation of intervention strategies will be closely monitored through quarterly worksite audits and worksite leader interviews.

To help facilitate these changes within the worksite, trained research staff met with worksite advocates quarterly to discuss implementation strategies for the upcoming quarter, as well as successes and barriers of implementation of the previous quarter. The worksite leader holds a higher level management position to which the department, division or unit employees report. This person will not be required to implement changes but will voice support, encourage participation and approve policy changes. Worksite advocate(s) plays an active role with program participants and will work to implement the selected changes. Considered a primary contact to link worksite employees and management. Advocate characteristics include: outgoing, ability to connect and engage with others, regular interaction with staff, good communicators.

7.2 Intervention Components

7.2.1. Policy-level components.

The intervention framework is highly dependent on the identification and engagement of worksite administrators and managers to enact policy-level workplace modifications, implement robust environmental changes (e.g., sit-stand workstations), and to model and promote behavior change. Therefore, a required item will be to identify a worksite leader and advocate(s). A leader is defined as a person holding a higher-level management position to which the department, division, or unit employees report. The primary role of this individual will be to provide higher-level support for intervention strategies to be implemented. Primary responsibilities will be to determine appropriate Toolkit items, encourage participation in worksite initiatives, and approve potential policy changes. An advocate is defined as a person who plays an active role with study participants and will work closely with the Stand & Move at Work study team to implement the selected changes. Advocates will be considered the primary

contact to link worksite employees, management, and the study team. Primary responsibilities will include

aiding the implementation of strategies agreed upon by higher-level management.

Organizational changes will be reinforced by the distribution of four quarterly support emails sent by the leader to employees in the workgroup. Templates will be provided to minimally include: (a) support for the program and employee participation; (b) a brief review of the previous quarter progress; (c) commendation of individuals who have shown high levels of engagement; and (d) an outline of new intervention initiatives for the upcoming quarter. Leaders will also formally agree to allow employees up to 5 min breaks every hour. Shared leader and advocate responsibilities will include quarterly meetings with an experienced behavioral science research team member who will be the designated worksite coordinator throughout the study to review past progress and plan for the coming quarter using the Toolkit as a guide. The aim of the research team member is to facilitate the intervention by ensuring all materials and concepts are explained fully explained, it is not to actively lead the intervention. As such, all team members will have extensive knowledge of the Stand and Move Toolkit to provide the leaders and advocates with support. Successes and challenges from the previous quarter will be discussed and each worksite will be encouraged to implement a new strategy to maintain or potentially increase employee interest in the program. Similarly, all worksite leaders and advocates will be invited to join a monthly *STAND+* and *MOVE+* conference call with the study principal investigators. These will serve several purposes: (a) to provide opportunities for other worksites to share and learn from other worksites within the same randomized study arm; (b) to document worksite participation, progress, and new strategies; and (c) to provide insight into the breadth and scale of the study to reinforce participation from a scientific and health-based perspective.

7.2.2. Environment-level components.

The primary environmental difference between the *STAND+* and *MOVE+* study arms will be the installation of a sit-stand workstation for the *STAND+* arm only. The workstations will be installed by our trained research staff, as well as worksite-specific ergonomic and wellness professionals. The Ergotron sit-stand workstation Workfit-TL model (Ergotron, Inc., St. Paul, MN) has been selected because it is able to be retro-fitted for use with almost all workspaces, requires little or no installation as it is simply placed on the existing desk surface, is affordable relative to many alternatives, has more desk surface area than many alternatives on the market, it can be easily raised and lowered to a broad range of positions, and can accommodate one or two large computer monitors. The Workfit-TL transitions from seated to standing positions by holding two levers and providing minimal force. Prior to installation a workspace inventory will be conducted for each participant to identify any potential barriers to use such as overhead shelving, insufficient computer cabling, or fixed keyboard trays. To eliminate these barriers, overhead shelving will be moved by worksite facilities management, cable extenders added (if needed), and additional wireless keyboards will be provided to those with keyboard trays so that participants are not required to move their existing keyboards with each sit-stand transition. The same Ergotron Workfit-TL will be installed at the 12-month time point for all *MOVE+* arm participants. All participants will receive ergonomic instructions for both sitting and standing postures via the e-newsletter and will undergo a coaching session at the time of installation.

Other required environmental changes will include a signage starter pack that is designed to (a) provide information about the behavior; (b) provide information on benefits of action (e.g., benefit of taking the stairs); (c) encourage goal setting (e.g., “make this a standing meeting”); (d) provide general encouragement (e.g., “we stand for health”); (e) provide instruction (e.g., walking routes around the office space); and (f) serve as visual cues. Signage will also demonstrate organizational support for the program and intent to change the cultural norm. Walking routes will be created for each worksite to reinforce the behavioral targets listed above. Typical routes will include alternative restrooms, centralized printing and trash can areas, and indoor and outdoor (if possible) perimeter routes. The distance per route and estimated number of steps will be provided on the signage. Advocates will be encouraged to place walking routes in communal and prominent areas throughout the worksite. All participants regardless of randomization will be provided with a footrest. The footrests will serve the following three purposes: (a) as a resting position for either foot while both seated and standing; (b) as a stretching aid (gastrocnemius and soleus); and (c) as a visual reminder regarding participation in the program. Leaders and advocates may also wish to implement additional optional environmental changes throughout the program via combined environmental, individual, and social strategies. For example, a prominent and interactive communal board to promote the Stand & Move at Work program (termed an “Ideaboard”) or implementing environmentally based worksite challenges (e.g., centralized printing only challenges). Ideaboard templates and example challenges will be provided in the Toolkit.

7.2.3. Individual- and social-level components.

An e-newsletter (The Insider) will provide a regular and direct medium for delivering individual- and social-level intervention content. The Insider will incorporate both individual (e.g., goal-setting) and social elements (e.g., quizzes and worksite social announcements). The Insider will be sent weekly during the first month of the intervention to facilitate transition and encourage early engagement. During months 2–12, the Insider will be sent bi-weekly, and a total of 26 newsletters will be sent. See Table 2 for a list of Insider topics. The content has been developed and designed by behavioral scientists and worksite wellness professionals to target 25 out of the 26 components of the behavioral taxonomy wheel. Motivational interviewing will be the only component not targeted, given the need for face-to-face interaction. The Insider will be coordinated with and reinforced by additional complementary organizational, environmental, and social components. Other individual level strategies will include a 1-on-1 coaching session to identify specific goals and behavior change strategies relating to the key intervention messages. Using a goal setting sheet, participants will be encouraged to record and display their goals within daily eyesight. Participants will also receive instructions regarding the deskbased ergonomic set up (both *MOVE+* and *STAND+*). The *STAND+* arm will receive specific instructions (guided by an experienced ergonomist) regarding their new sit-stand workstation set up. Key messages will include switching position regularly and gradually increasing standing or LPA time. Social strategies (i.e., formation of walking or stretching groups) may be endorsed by leaders via support emails, actively led by advocates, or promoted via additional signage and Ideaboard content. Due to the variation in worksite culture, job demands and environmental challenges, it is expected that new ideas and variations of the

suggested Toolkit items will emerge. This will be discussed and documented during the quarterly meetings and quarterly audits. The required multi-level tactics show reinforcement of behavior change across the social-ecological spectrum, utilizing all aspects of the behavior change taxonomy wheel. This integrated approach shows promise for shifting the cultural norm within a workplace from reinforcing highly sedentary, seated behavior patterns to one where standing and moving is expected, rewarded, and celebrated. This cultural shift is necessary to produce sustainable, long lasting changes that are likely to impact health and well-being on a large scale.

Both *STAND+* and *MOVE+* worksites received the same multi-component intervention toolkit targeting organizational, environmental, cultural, and social changes within the workplace. Examples organizational changes included: (a) installation of sit-stand workstations (b) quarterly support emails, (c) ergonomic support and (d) bi-weekly e-newsletters. Examples of Environmental changes included: walking routes, (b) signage, (c) waste and recycling bin reallocation, (d) use of centralized printing areas, (e) inviting stairways and an (g) ideaboard. Examples of cultural and social changes included (a) allowance of 5-min breaks every hour, (b) promotion of face-to-face interaction, rather than email, (c) standing meetings, (d) walking meetings, (e) stretch breaks), (f) contests), and (g) social groups.

7.3 Difference between Intervention Arms

The primary study arm differences will be implemented at the environmental level with the provision of a sit-stand desk at the start of the intervention for the *STAND+* group only. This primary difference will require small adaptations to other intervention strategies. First, participant goals will differ per arm to reflect the different arm intervention goals (i.e., increasing standing and LPA time for *STAND+* vs. increasing LPA only for *MOVE+*). All participants will be encouraged to adhere to a '30-min rule', however, the meaning of this target rule will differ per arm. For the *STAND+* group this will be communicated as achieving a 30:30-minute sit to stand ratio to ultimately replace half their sit time with a combination of standing and moving at work. For the *MOVE+* group this will be communicated as replacing 30 min of sit time with an equal accumulation of moving more throughout the work day. The 1-on-1 sessions held at the start of the program will facilitate specific goal setting at the individual level to help achieve the '30-minute rule' per arm. Consequently, the strategies communicated during the 1-on-1 session and throughout the study duration will differ slightly per arm (see Table 3).

Second, although the *STAND+* and *MOVE+* arms will be provided with an identical Stand & Move Toolkit and the same level of support to implement socio-ecological changes, it is likely that the application of the Toolkit will differ per arm to target the specific target intervention arm goals. Finally, in some instances, the e-newsletter topics will remain the same across arms but the content will be adjusted per arm to reduce contamination and ensure that information is specific to the intervention arm. For example, the ergonomically themed e-newsletter will include sit-stand desk information for the *STAND+* group, however, the *MOVE+* content will only include seated desk information. Stand & Move intervention support for *STAND+* will cease following the 12-month assessment period. However, *MOVE+* participants will receive a sit-stand desk and ergonomic advice at the 12-month time point, and after which no additional intervention

support will continue post-installation. Both arms will still have access to the Toolkit during this follow-up period (12–24 months).

8. Collecting Worksite Data

Worksite level data will be collected in conjunction with in-person (or by phone as a last resort) Quarterly meetings held with each worksite. These meetings will be held at Baseline, prior to the start of the intervention, 3-months, 6-months, 9-months, and a final meeting at 12-months.

Data collected at each of these time points will include:

- Planned intervention activities
- Completed intervention activities
- Successes or barriers of intervention activities
- *Quarterly Audit Survey* that asks about various organizational and individual level activities, events, resources, and facilities.

9. Collecting Participant Data

Participant level data will be collected in four time points, including baseline, 3-months, 12-months, and 24-months. Participants will be scheduled for fasting visits held in the morning at their respective worksites. As two worksites will be recruited to start the intervention at the same time, with collection dates being within one week of each other, participants can opt to attend a visit at the other worksite.

Data collected at the in-person fasting visit will include:

- Blood pressure
- Height (baseline only)
- Weight
- Pregnancy status (biologically females only)
- Fasting venous blood draw

An activPAL will be affixed to the right leg of each participant at the visit; this placement will be rescheduled if the participant will be out of the office for the majority of the upcoming week.

Daily surveys will be administered in conjunction with the activPAL wear. These logs will assess both daily sleep and work times and be sent via Qualtrics each morning for seven days.

Along with the in-person visit and activPAL wear, a main study survey will be sent out during each assessment period (baseline, 3-months, 12-months and 24-months). This survey will be used to collect demographic characteristics as well as information regarding sleep, diet, physical activity, and overall health.

10. Measures

All measurements will be taken at baseline and 12 months, with additional interim measurement at 3months and follow-up at 24 months. All questionnaires will be administered via Qualtrics (Salt Lake City, UT)

10.1 Blood Pressure

Blood pressure will be measured with the Omron BP742 automated machine and the Omron HEM-RML30 cuff (Omron Healthcare Inc., Lake Forest, IL) three times following 5 min of quiet sitting, with 30 s in between each measurement. The lowest two measures of diastolic and systolic blood pressures will be averaged for final blood pressure values.

10.2 Anthropometrics

Standing height will be measured in centimeters (cm) using a portable height board (SECA). Prior to the height measurement the participant should remove his/her shoes. If the subject has a hair accessory or hairstyle that interferes with the measurement, she/he will be asked to remove the accessory or change her/his hairstyle (e.g. take out ponytail band) if possible (some hair styles/accessories are difficult to remove or costly to replace, and these styles may be left in place).

- (a) Participant must stand erect with his/her back towards the stadiometer. The weight of the participant must be evenly distributed on both feet and the arms hang freely by the sides of the body, palms facing the thighs. The participant should place the heels together, with both heels touching the base of the vertical board. The feet should point slightly outward, at about 60° angle. Note: If the subject has knock-knees, the feet are separated so that the medial borders of the knees are in contact but not overlapping.
- (b) The subject's head should be positioned in the Frankfurt Horizontal plane. In this position an imaginary line can be drawn from the bottom of the eye socket (orbital margin) to the external opening of the ear (external auditory canal).
- (c) The heels, shoulder blades, buttocks, and back of the head should be against the vertical surface. Note: The heels, buttocks, scapulae, and posterior aspect of the cranium (head) of some subject cannot be place in one vertical plane while maintaining a reasonable natural stance. These subjects are positioned so that only the buttocks and the heels or the cranium are in contact with the vertical board.
- (d) The participant should be asked to inhale deeply and hold his/her breath, while maintaining the erect position and without altering the load on the heels. Reposition the head in the Frankfurt plane, if necessary. The moveable headboard should be brought onto the highest point of the head, with sufficient pressure to compress the hair.
- (e) If the participant is notably taller than the study staff member responsible for recording the reading, she/he should use a step stool to view the measurement.
- (f) The measurement is recorded to the nearest 0.1 cm. The measurement is called out by the measurer as follows: "height, 162.5" and repeated "162.5" as he/she writes down the number on the Anthropometry Form. The participant is asked to step away and then step back into the same position for a second measurement.
- (g) Repeat the process and record the second measurement in the 'Trial B' column of the height section of the Anthropometry Form.
- (h) If the first and second measurements differ by >1 cm repeat the measurements, a third measurement will be taken.

Any conditions or situations, which occur to make the measurement undependable on the bottom of the form. (e.g. subject couldn't or refused to comply with the removal of hair accessory, wouldn't remove shoes, etc.) will be noted.

Body weight will be measured in kilograms (kg) using a Tanita TBF-300A Total Body Composition Analyzer. The Tanita scale also allows for the calculation of percent body fat utilizing bioelectrical impedance. All participants will be queried about the presence of any medical device that would be impacted by the small electrical current. Only weight measures will be taken for those endorsing the presence of such devices.

- (a) The participant will be asked to remove shoes, any coat or cardigan, and empty his/her pockets.
- (b) The participant will stand in the center of scale, facing away from the balance, holding the head up. Body weight must be evenly distributed on both feet and the participant must have his/her hands hanging freely at his/her sides (i.e. make sure participant is not holding on to anything).
- (c) Weight is measured and recorded to the nearest 0.1 kg.
- (d) The body fat percentage will be displayed after a short pause, and should be recorded.
- (e) Have the participant step off the scale, and then repeat steps a-d, and record the second weight/body fat percentage.
- (f) If the first and second measurements differ by > 0.2 kg repeat the measurements, a third measurement will be taken.

Any conditions or situations, which occur to make the measurement undependable, should be noted on the bottom of the form.

10.3 ActivPAL

Our primary outcomes, time spent sitting and LPA at work, will be assessed with the activPAL3 micro accelerometer (PAL Technologies, Glasgow, United Kingdom) for seven consecutive days at each measurement time point. The activPAL will be waterproofed using medical grade adhesive covering and attached to the midline of the thigh using a breathable, hypoallergenic tape. This method allows for the monitor to be worn continuously for seven consecutive days without removing for bathing or other water-based activities (a valuable feature that reduces missing data). Additional adhesive dressing will be given to all participants for re-application as necessary. The primary outputs of the activPAL are time spent sitting, time spent upright, and time spent “stepping.” Participants concurrently will complete an online daily log where they will report their sleep/wake schedule and time arriving and departing their workplace. The daily logs will be used to filter time spent sitting and LPA during work hours. In addition, any uninterrupted sedentary bouts of more than 6 h that occur within reported wake times will be considered non-wear times and treated as missing data. Days with <10 h of monitor wear data or <4 hours of reported work time as monitor wear data will be excluded from analyses. Outcomes will be reported as a standardized 8 h workday to account for differences in total work time. Full details of activPAL initialization, wear, and download protocol are in Appendix 1.

10.4 Venipuncture

Participants will be instructed to fast for nine consecutive hours prior to each blood draw. Blood will be drawn from the antecubital vein into EDTA vacutainers, and plasma will be stored at -80°C until analysis in batch. Samples from the Phoenix site will be shipped to UMN on dry ice periodically for batch-processing. Biomarker analyses will be conducted by the Advanced

Research and Diagnostic Laboratory at the University of Minnesota, Minneapolis, MN, using a Roche COBAS 6000 chemistry analyzer (Roche Diagnostics, Indianapolis, IN). Plasma glucose will be measured by the hexokinase method (interassay CV = 1.3% at 97.2 mg/dL, 1.8% at 223.3 mg/dL). Plasma HDL-C will be measured by the modified direct enzymatic approach (interassay CV = 3.2% at 27.0 mg/dL, 1.9% at 51.7 mg/dL). Plasma triglycerides will be measured with the GPO-Trinder kit (Roche Diagnostics, Indianapolis, IN; interassay CV = 2.0% at 112.4 mg/dL, 2.3% at 195.8mg/dL). Plasma insulin will be measured with a sandwich immunoassay using electrochemiluminescence (Roche Diagnostics, Indianapolis, IN; interassay CV=3.1% at 121.2 pmol/L, 3.1% at 377.9 pmol/L).

11. Data Management

11.1 In-person Visit Data

In person visit data, including anthropometrics, blood pressure, and whether venous blood draws were successful will be collected on paper forms. These forms will be kept in secure, locked filing cabinets and entered into Qualtrics.

11.2. Survey Data

All survey data will be collected via Qualtrics. Qualtrics is a secure, web-based platform for designing, collecting, and securing survey data. All survey data will be stored on encrypted servers.

11.3 ActivPAL Data

ActivPAL data will be extracted and stored on secure study servers at each site. The University of Minnesota will upload this data to BOX for retrieval by ASU, who will be the primary site to compile, clean, and process this data.

11.4 Data Integrity

All clinical assessment data will be double entered. All blood data will be examined for computational value errors associated with out-of-range variables. All data will be examined for outliers and improbable values.

12. Data Analysis Plan

12.1 Data analysis.

Threats to internal validity (e.g. contamination, envy) preclude randomization of individuals within the same worksite; hence, a group randomized trial is being conducted [54]. Such a trial involves randomization of worksites with members within a worksite being assigned to the same experimental condition. Hierarchical linear (or generalized linear) models will be used to provide valid estimates of the intervention effect and its variance (for generating the test of statistical significance). Because the number of sites is limited by feasibility, the asymptotic balance of all measured and unmeasured confounders is not applicable, and hence it is important to randomize worksites within small blocks (or pairs) of matched worksites with similar characteristics likely to affect the outcome measure. Because our goal is to enroll 12 worksites in the Phoenix area and 12 in the Minneapolis area, we will stratify the randomization scheme

on geographical location so that we will not have any confounding by geographical location (AZ vs. MN). We will identify six pairs of sites in AZ and six pairs in MN, with the pair members having the same sector (academia, government, or healthcare/industry). Each pair will be randomized so that one worksite in each pair is assigned to the *MOVE+* intervention and the other in that pair assigned to the *STAND+* intervention. One of the site PIs and a Biostatistician at the University of Minnesota will be responsible for the randomization. Randomization will occur immediately following the baseline data collection for both sites. The PI will notify the biostatistician when there are two matched worksites ready for randomization. The two worksites will be ordered as “First” and “Second” depending on the calendar dates of the baseline data collection. The statistician, with no knowledge of the worksites, will use a coin flip to assign the two worksites to the *STAND+* or *MOVE+* interventions. Initial analyses will provide descriptions of the baseline frequencies and means (SD) of characteristics by worksite and by experimental condition. Statistical testing of differences in baseline characteristics is not necessary, but will provide assurance that the randomization has not produced a grossly unbalanced assignment. If the distributions of our outcome variables are not normally distributed, we will log-transform the outcome data. Our primary hypotheses will be tested by invoking a repeated-measures hierarchical linear model of the experimental contrast between the two conditions of the 12-month measure of LPA (min/ 8-h) and sitting (min/8-h), respectively. Because total time is standardized to 8 h, we will also express our outcomes in percent of time in LPA and sitting. A repeated measures hierarchical analysis will be conducted. The covariates expected to include are age, sex, body mass index, and the baseline values of the dependent variables (e.g., sitting time, LPA, and metabolic risk score). The resulting estimate and its standard error provide a t-statistic based on $2(g-1)$ degrees of freedom (df), where g represents the number of worksites per experimental condition [54]. A similar analysis will examine the secondary hypothesis for the metabolic risk score. Other outcomes, including sit-stand transitions, will use hierarchical generalized linear models with a log link. The analysis approach for process (3 month) and maintenance (24 month) outcomes will be similar. In terms of missing data, sensitivity to member-dropout is small; if on average only 85% are followed, the detectable effect sizes increase by a factor 1.05. Worksite dropout would be a major threat to validity, but that is highly unlikely to occur. Baseline characteristics of those not providing follow-up data will be examined to assess whether these are non-informative missingness. Under the assumption that dropout is not related to the measures that would have been collected, the analysis of the data excluding dropouts is unbiased.

12.2 Power Analysis

We aim to enroll 24 worksites ($N=12$ per condition) evenly distributed across Arizona and Minnesota with on average 30 employees per worksite (Total N members = 720 employees). In a baseline-adjusted analysis, let D represent the minimal detectable intervention effect, g the number of worksites per experimental condition, m the average number of members per worksite, S_2 the member variance, T_2 the work-site level variance, r_m and r_g the member and work-site correlations over time respectively, and $t(d, \alpha/2)$ and $t(d, p)$ the critical t-statistic values based on d df for $\alpha/2$ =Type I alpha level (2-sided) and p =power. Then the minimal detectable difference is $D_2 = (t(d, \alpha/2) + t(d, p))^2 (S_2(1 - r_{2m})/m + T_2(1 - r_{2g}))^2 / g$. Dividing by S_2 yields the square of the Effect Size (ES) and T_2/S_2 is the variance components ratio (VCR). In the unlikely

situation where the g are unequal, replacing $2/g$ by $(1/g_0 + 1/g_1)$ will lead to a minimal increase in D unless the g are grossly unequal. With $g=12$ (worksites per condition), $d=22$, and $N=720$, $m=30$; $a/2$ is set to 0.025 and power is set 80%. The detectable effect sizes for this trial range from 0.21 to 0.26 across the three outcomes, which are relatively small effects, and thus we are well powered in this study. On an absolute scale, as also shown in the table, we will be able to detect a difference between intervention arms as small as 12.2 min/8-hr work day of LPA and 14.6 min/8-hr work day of sitting time. Our preliminary studies clearly demonstrate our ability to achieve these effects: (a) For LPA; the crossover study (12) showed a 38.4min/8-hr workday increase (other two studies did not target LPA or did not use a monitor designed to detect LPA); (b) for sitting, both the crossover and natural experiment showed >30min/8-hr workday reductions; and (c) for cardiometabolic risk, all 3 studies showed moderate to large effect sizes. This study is powered well to detect effects that are considerably smaller than what we have observed in our preliminary studies

12. Adverse Event Reporting and Recording

Adverse events will be monitored during the study to ensure timely detection of events that may affect safety or continued participation. Protocol defined adverse events, as well as any unanticipated adverse events deemed possibly or probably related to study procedure, must be immediately reported to the study PI and/or Project Coordinator. In the event an adverse event occurs, the PI will submit an adverse event report to the IRB within 24hrs.

Appendix 1. ActivPAL processes

Appendix 1.1 ActivPAL Waterproofing and Taping

1. Wrap a finger cot around an initialized activPAL.

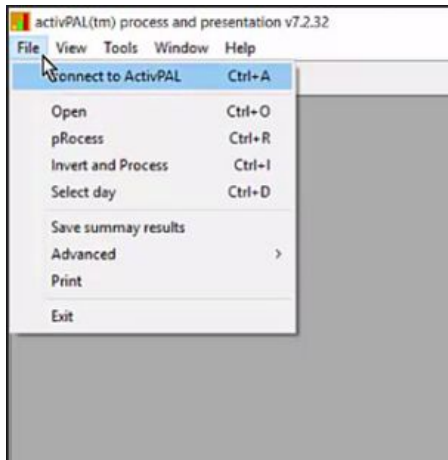


2. On the finger cot, label the activPAL with participant's ID number and an arrow going up (in the same direction as the human body on the activPAL). Ensuring orange side up, as pictured.
3. Wrap a 12cm by $\frac{1}{2}$ of the width of the wide opsite (clear) tape around the activPAL. Make sure the activPAL is thoroughly covered. This can be done efficiently by sticking one end of the opsite tape onto the edge of a table and rolling the activPAL up the length of the tape.
4. Cut out a 6 by 6 cm piece of hypafix (white) tape and a 6 by 6 cm piece of opsite tape.
5. Place the waterproofed activPAL in the center of the white side of the hypafix tape.
6. Place the opsite tape over the activPAL to secure it to the white side of the hypafix tape.
7. Use extra small opsite pieces of tape to ensure that the activPAL is secured to the hypafix tape. The activPAL should look like this:
8. Do not peel off the back of the hypafix tape until it is time to place it on the participant's leg.

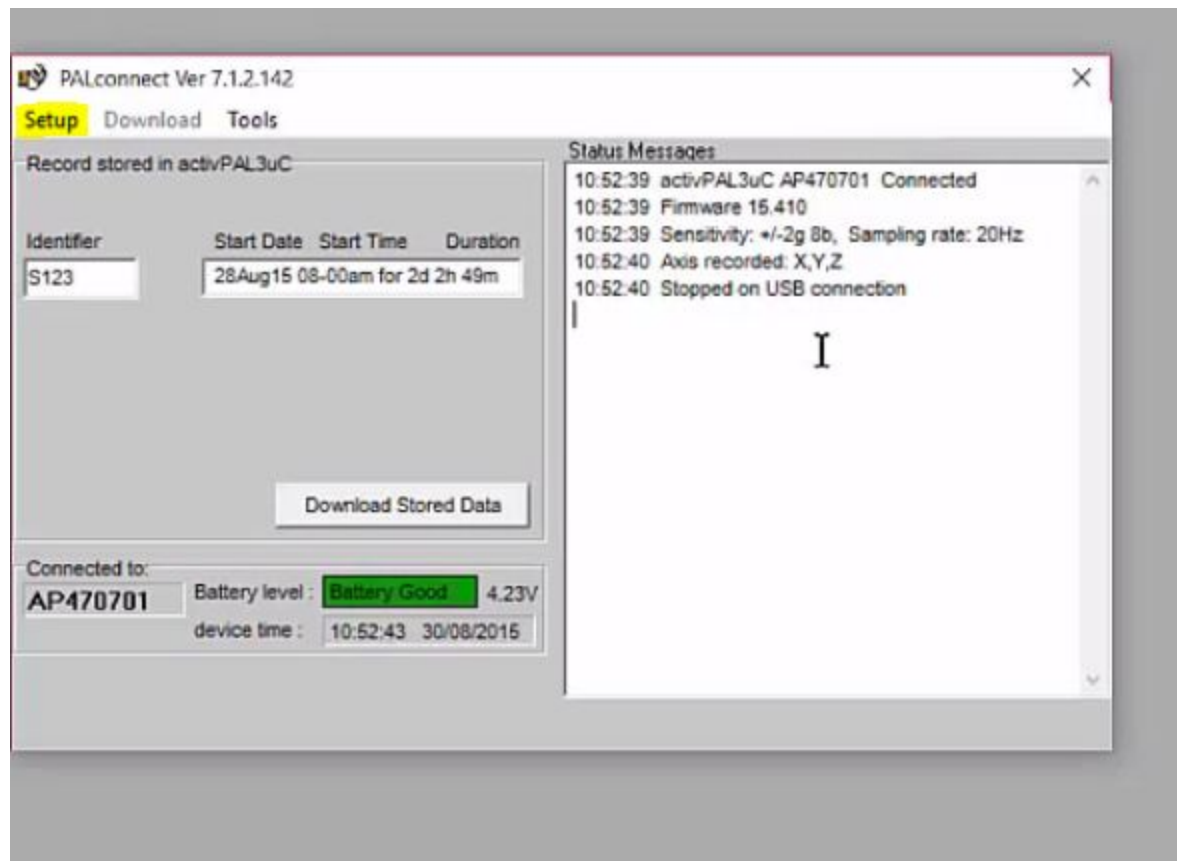
Appendix 1.2. Initialization



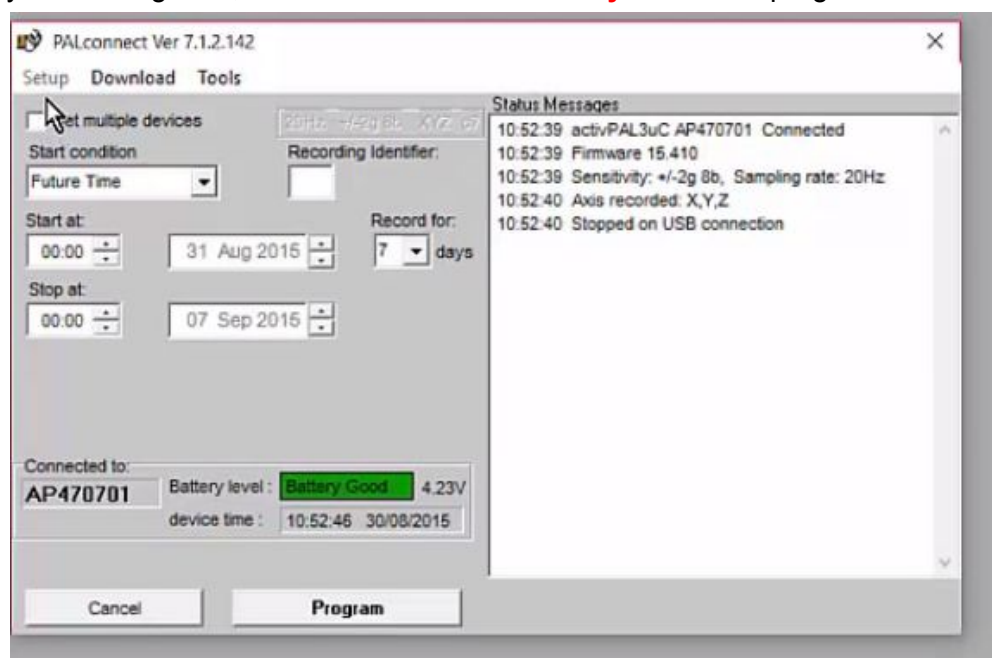
1. To initialize, place your designated activPAL into the 'PC INTERFACE' port; the other ports only serve as a charging area.
2. Plug in the activPAL dock to the computer/laptop using a micro USB cord.
3. Open the activPAL software and select File, then 'Connect to ActivPAL'



4. Verify Battery Level is at least **4.15 Volts**
5. Next select Setup – this is for initializing devices only.



6. Select '**Future Time**,' Enter in your participants de-identified 5 digit ID in the **recording identifier** section; choose your starting time (Stand and move is always **10:00 am**); Choose your starting date; then select record for **14 days**. Then hit program.



7. Click OK.

8. Remove the device.

Appendix 1.3. Handout instructions for reaffixing activPAL

To reaffix your activPAL:

If your activPAL is loose, or falls off, use the hypafix tape provided in your activPAL pack to reaffix the device to your right thigh.

We will also leave extra tape at your worksite in case you need more.

Remember that when affixing your activPAL, the arrow needs to be facing outwards and be pointing up.

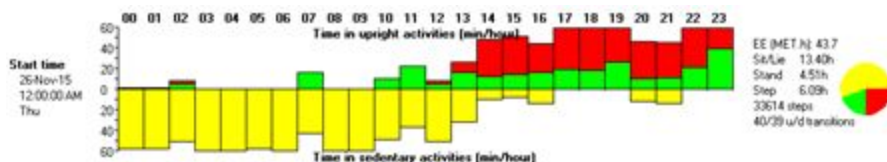
If you need additional tape please email us at move@asu.edu



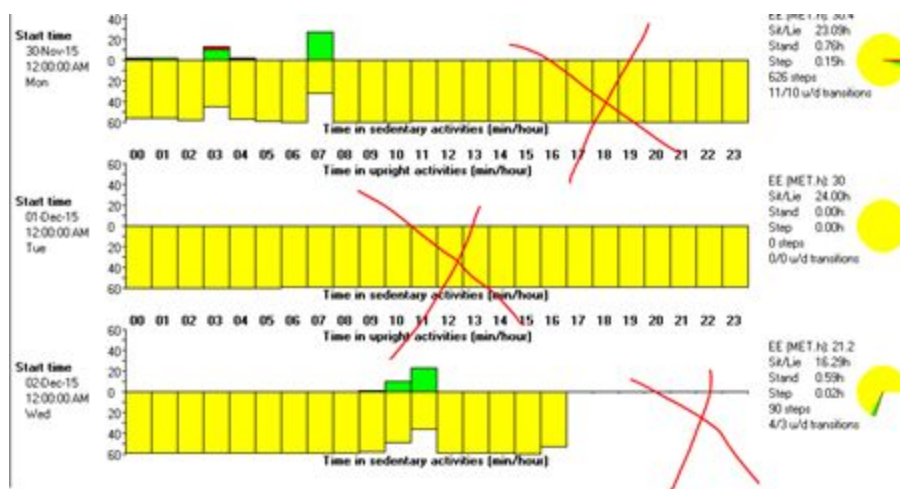
Appendix 1.4. Data download and processing.

1. Load activPAL software. Double click Icon on Desktop.
2. Insert ActivPAL into dedicated port on dock labeled 'PC INTERFACE'. Then, connect dock to desktop tower via USB cable.
3. Select 'File' --> 'Connect to ActivPAL'
4. Select 'Download' from top left of the 'PALconnect' window (unless download screen opens first)
5. Verify Identifier to participant # in Database.
6. Click 'Download Stored Data'
7. To save recording data, Click New Folder
8. Select the appropriate folder. E.g., for Stand&move@work: X:\Buman Lab\Stand and Move ASU_UMN\Data\ActivPAL\Visit #\ParticipantID#; (Visit= T1, T2, T3, T4, etc. based on timeline for each site); Participant ID= 5 digit number as indicated in Participant Database
9. Check the folder where you saved the data to double check that the file has been correctly downloaded. (6 files uploaded for each participant).
10. Once the data has been successfully downloaded, select view at the top of the activPAL software screen. Then select "view by week," and open the corresponding pal file. This is what we will be sharing with participants as feedback. In order for the activPAL data to be considered valid, there needs to be four valid days with 8hour/day of valid wear time per day.

Example of valid data



Example of invalid data



11. Log the non-wear times (6 hours of consecutive sitting or standing) here: Z:\Buman Lab\Stand and Move ASU_UMN\Data\ActivPAL\Errors.xlsx

12. To save the PAL file as a PDF, click the 'print' icon on the upper left corner of the activPAL screen. Click OK

13. A screen will prompt you to save the file à Save the file on (X:\Research\Buman Lab\Stand and Move ASU_UMN\Data\Participant Feedback\T#\ID#_T#).

14. The file should now be saved in the corresponding folder as a PDF.

- The PDF file can be sent to participants as feedback either by email or by printing.
- Refer to Sending activPal Feedback Protocol to email

Appendix 1.4. activPAL processing SAS code.

*****/

*ActivPAL Processing:

* Outputs the following variables:

- * 1. Long_sitbouts_dur - Total mins spent sitting > 30 mins bouts
- * 2. Long_sitbout_ct - Number of long sitting bouts
- * 3. Short_sitbout_dur - Total mins spent sitting < 30 mins bouts
- * 4. Short_sitbout_ct - Number of short sitting bouts
- * 5. Sit - Total minutes spent sitting
- * 6. Stand - Total minutes spent standing
- * 7. LPA - Total minutes spent on LPA (stepping activities)

with cadence <100 steps/mins) *

- * 8. MVPA - Total minutes spent on MVPA(stepping activities

with cadence <100 steps/mins) *

*****/

*****/

/*Set libref */

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/*****/

```
LIBNAME SMASU 'P:\Sample_SMASU\';  
Libname Track "X:\Buman Lab\Stand and Move  
ASU_UMN\Data\ActivPAL\ISO_TEST\SAS_FILES\DailyLogs";
```

```
LIBNAME ISO 'X:\Buman Lab\Stand and Move  
ASU_UMN\Data\ActivPAL\ISO_TEST\SAS_FILES\DATASETS';
```

*Create temnplate for daily summary;

```
DATA iso.Report_Final;  
  INPUT  
    ID  
    Mtime  
    Date  
    P1_Sitstand  
    P1_long_sitbout_ct  
    P1_long_sitbout_dur  
    P1_short_sitbout_ct  
    P1_short_sitbout_dur  
    P1_min  
    P1_Sit  
    P1_Stand  
    P1_LPA  
    P1_MVPA  
    P1_Step_min  
    P1_Step_ct  
    P1_step00_05  
    P1_step05_10  
    P1_step10_15  
    P1_step15_30  
    P1_step30_60  
    P1_step60_90  
    P1_step90_120  
    P1_step120_up  
    P1_nbouts_sed  
    P1_alphasit  
    P1_parm1_sit  
    P1_x50_sit  
    P1_min_t_sit  
    P1_max_t_sit  
    P1_totsed
```

P1_nbouts_sed_tot
P1_ginisit
P1_mean_period
P2_Sitstand
P2_long_sitbout_ct
P2_long_sitbout_dur
P2_short_sitbout_ct
P2_short_sitbout_dur
P2_min
P2_Sit
P2_Stand
P2_LPA
P2_MVPA
P2_Step_min
P2_Step_ct
P2_step00_05
P2_step05_10
P2_step10_15
P2_step15_30
P2_step30_60
P2_step60_90
P2_step90_120
P2_step120_up
P2_nbouts_sed
P2_alphasit
P2_parm1_sit
P2_x50_sit
P2_min_t_sit
P2_max_t_sit
P2_totsed
P2_nbouts_sed_tot
P2_ginisit
P2_mean_period
P3_min
P3_Sitstand
P3_long_sitbout_ct
P3_long_sitbout_dur
P3_short_sitbout_ct
P3_short_sitbout_dur
P3_Sit
P3_Stand
P3_LPA
P3_MVPA
P3_Step_min

P3_Step_ct
P3_step00_05
P3_step05_10
P3_step10_15
P3_step15_30
P3_step30_60
P3_step60_90
P3_step90_120
P3_step120_up
P3_nbouts_sed
P3_alphasit
P3_parm1_sit
P3_x50_sit
P3_min_t_sit
P3_max_t_sit
P3_totsed
P3_nbouts_sed_tot
P3_ginisit
P3_mean_period
P4_Sitstand
P4_long_sitbout_ct
P4_long_sitbout_dur
P4_short_sitbout_ct
P4_short_sitbout_dur
P4_min
P4_Sit
P4_Stand
P4_LPA
P4_MVPA
P4_Step_min
P4_Step_ct
P4_step00_05
P4_step05_10
P4_step10_15
P4_step15_30
P4_step30_60
P4_step60_90
P4_step90_120
P4_step120_up
P4_nbouts_sed
P4_alphasit
P4_parm1_sit
P4_x50_sit
P4_min_t_sit

P4_max_t_sit
P4_totsed
P4_nbouts_sed_tot
P4_ginisit
P4_mean_period
P5_Sitstand
P5_long_sitbout_ct
P5_long_sitbout_dur
P5_short_sitbout_ct
P5_short_sitbout_dur
P5_min
P5_Sit
P5_Stand
P5_LPA
P5_MVPA
P5_Step_min
P5_Step_ct
P5_step00_05
P5_step05_10
P5_step10_15
P5_step15_30
P5_step30_60
P5_step60_90
P5_step90_120
P5_step120_up
P5_nbouts_sed
P5_alphasit
P5_parm1_sit
P5_x50_sit
P5_min_t_sit
P5_max_t_sit
P5_totsed
P5_nbouts_sed_tot
P5_ginisit
P5_mean_period;

FORMAT Date date. waketime bedtime worktime offworktime datetime29.;
DATALINES;

RUN;

*Pull all filenames from directory;

filename DIRLIST pipe 'dir "X:\Buman Lab\Stand and Move
ASU_UMN\Data\ActivPAL\ISO_TEST\SAS_FILES>taggedfiles\T1*.csv" ';

```
data dirlist ;
infile dirlist lrecl=200 trunccover;
input line $200.;
length file_name $ 130;
if input(substr(line,1,10), ?? mmddyy10.) = . then delete;
file_name="X:\Buman Lab\Stand and Move
ASU_UMN\Data\ActivPAL\ISO_TEST\SAS_FILES>taggedfiles\T1\"|| substr(line,40);
Mtime="1";
ID=substr(file_name,101,5);
ID2=Id*1;
Site=substr(id,1,3)*1;
keep file_name ID Mtime site ID2;
run;
```

*Command to automatically create macro calls;

```
data test;
set dirlist end=end;
/*Where site>200;*/
/*where id2=10104;*/
count+1;

call symput ('filepath'||left(count),left(trim(file_name)));
call symputx ('ID'||left(count),ID);
call symputx ('Mtime'||left(count),Mtime);
if end then call symput('max',count);
run;
```

*Write log directly to the specified text file to prevent interruptions;

```
proc printto log="X:\Buman Lab\Stand and Move
ASU_UMN\Data\ActivPAL\ISO_TEST\AP_Processing_04.23.18.log";
run;
```

```
%let datetime_start = %sysfunc(TIME()) ;
%put START TIME: %sysfunc(datetime(),datetime14.);
options mprint symbolgen;
```

```
%MACRO APimport(filepath,ID,Mtime);
%do i=1 %to &&max;
```

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```
*import AP event file;
DATA import;
    INFILE "&&filepath&i"
           LRECL=32760
    ENCODING="WLATIN1"
    TERMSTR=crlf
    DLM=','
    MISSOVER
           firstobs=2
    DSD ;
    INPUT Datetimevar
           Count
           Intervalold_s
           ActivityCode
           APCumulativeStepCount
           APActivityScoreMEThr
           validday_est
           Sleepbout
           ID
           Mtime
           ;
    boutid = _N_;
    sasdatetimenumber = (Datetimevar - 21916)*86400;*convert exceldate to
sasdatetime;
    CumulativeStepCount_i = APCumulativeStepCount;
    steps_n = APCumulativeStepCount - lag(CumulativeStepCount_i);
    if boutid = 1 then
        steps_n = APCumulativeStepCount;

    if Datetimevar in (0,.) then
        delete;          *remove rows of 0s from end of some activpal event files;
    if intervalold_s in (0,.) then delete;
    drop CumulativeStepCount_i;*non cumulative steps;
    if intervalold_s>=21600 then delete=1;else delete=0;

RUN;

*recalculate intervals as time between each bout -> more precise than the rounded data;
proc Sort data =import;
    by id descending boutid;
run;

data events (drop= Datetimevar intervalold_s APcumulativestepcount);
```

```
set import;
boutidR = _N_;
sasdatetimenumber_endbout = lag(sasdatetimenumber);

if sasdatetimenumber_endbout = . & sasdatetimenumber ne . then
    sasdatetimenumber_endbout = sasdatetimenumber + Intervalold_s;
Interval_s = sasdatetimenumber_endbout -
    sasdatetimenumber;
basicdate = datepart(sasdatetimenumber);
noondate = datepart(sasdatetimenumber + 43200);

*dates at beginning of bout
for day and for noon to noon window;
format sasdatetimenumber sasdatetimenumber_endbout datetime26.6 basicdate
noondate ddmmyy10.;
run;

proc Sort data =events;
    by id boutid;
run;

*Expand each event into 1-seconds epochs;

DATA events2; SET events;
If interval_s>=1 then interval_p=floor(interval_s);
    else if interval_s<1 then interval_p=interval_s;

do _i_ = 0 to Interval_s-(Interval_s/interval_p) by (Interval_s/interval_p); *preserves elapsed
time of non-whole number intervals;
    datetime3=sasdatetimenumber+_i_;
    output;
end;
format datetime3 datetime26.6 date date9.;
Run;

*recalcualte interval between each epoch;

Proc sort data=events2;
by descending datetime3;
run;

data events2;set events2;
gap=lag(datetime3)-datetime3;
if gap>=1 then p=floor(gap);
```

```
        else if gap<1 then p=gap;
date=datepart(datetime3);
if gap=. then delete;
```

```
run;
```

```
Proc sort data=events2;
by datetime3;
run;
```

```
*pull log data;
```

```
DATA windows3(drop=gap date noondate mtime); SET track.masterlogs2;
    WHERE ID=&i*1;
    IF bedtime=. then delete;
```

```
        IF new_ootm=. then delete;
RUN;
```

```
*Merge logs with activpal data;
```

```
PROC SQL;
    CREATE TABLE APwake AS
    SELECT      t1.id,
                t1.Mtime,
                t1.Datetime3,
                t1.sasdatetimenumber,
                t1.sasdatetimenumber_endbout,
                t1.validday_est,
                t1.basicdate,
                t1.noondate,
                t1.activitycode,
                t1.Count,
                t1.gap,
                t1.Interval_s,
                t1.Steps_n,
                t1.boutid,
                t1.delete,
                t2.new_ootm,
                t2.bedtime,
                t2.MTS,
                t2.Sleeptime,
                t2.wake_freq,
                t2.total_time_awake,
```

```
t2.waketime,  
t2.ootm,  
t2.Workday,  
t2.MOT_to,  
t2.WorkTM,  
t2.OffWorkTM,  
t2.MOT_off,  
t2.Start,  
t2.End,  
t2.impute
```

```
FROM events2 AS t1  
NATURAL JOIN windows3 AS t2  
WHERE t1.datetime3 BETWEEN t2.new_ootm AND t2.Bedtime  
ORDER BY t1.ID, t1.datetime3;
```

```
QUIT;
```

```
RUN;
```

* export dataset to create intermediate files that can be re-analyzed for later use;

```
Data "X:\Buman Lab\Stand and Move  
ASU_UMN\Data\ActivPAL\ISO_TEST\SAS_FILES\DATASETS\MetaData\APWake_&&i.._T  
&&Mtime&i"; set ApWake;  
Run;
```

*Calculate cadence;

```
data step; set APwake;
```

```
Activity_code2 = Activitycode;
```

*calculating a 0/1 variable for whether the event is stepping (and relevant, to be included) or not;
ActStep =0;

```
if Activity_code2 =2 then ActStep = 1;
```

```
if ActStep = 1 then newstepbout = 1;
```

*calculating a 0/1 variable for whether the relevant stepping event is part of a new stepping bout or not;

```
if ActStep = 1 & ActStep = lag(ActStep) then newstepbout = 0;
```

```
newbout = 0;
```

```
if Activity_code2 in (.,0,1) then newbout = 1;
```

```
if Activity_code2 =2 & newstepbout=1 then newbout = 1;
```

```
If delete=1 then delete;* remove potential non-wear: bouts>6 hrs;
run;
```

```
data step2;
set step;
by id;
*numbering the stepping bouts [newboutid];
if first.id then newboutid = 0;
if newbout = 1 then newboutid + 1;
run;
```

```
proc means data = step2 noprint;
by id newboutid;
where ActStep = 1;
output out=step3 min(sasdatetimenumber)=bs_dt max(sasdatetimenumber_endbout)=be_dt
sum(steps_n)=steps_n;
;
run;
```

```
data step3 (keep= ID newboutid cadence stepboutdur);
set step3;
*date the stepping bout began for later aggregation;
```

```
basicdate = datepart (bs_dt);
*duration of the stepping bout;
stepboutdur = be_dt - bs_dt;
```

```
*cadence;
cadence = 2*steps_n/(stepboutdur/60);
```

```
run;
```

```
Proc SQL;
    Create table cadence as
        select a.*,
               b.Cadence,
               b.stepboutdur
    From step2 as a
    Left join step3 as b
    on a.ID=b.ID and a.newboutid=b.newboutid
    order by a.Datetime3;
Quit;
```


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*categorize epochs into either SED STAND LPA MVPA;

Data cadence2(drop=sasdatetimenumber);set cadence;
if start<=datetime3<=end then delete; *Delete errors/non-wear time;

date=datepart(datetime3);

IF Workday=2 or WorkDay=0 THEN Status=1; /*nonworkday*/
IF Workday=1 AND WorkTM <= datetime3 <= OffWorkTM THEN Status=2; /*atwork*/
IF Workday=1 AND not (WorkTM <= datetime3 <= OffWorkTM) THEN
Status=3; /*offwork*/

IF activitycode=2 AND cadence ge 100 THEN act_intensity=3; /*MVPA*/
ELSE IF activitycode=2 AND cadence lt 100 then act_intensity=2; /*LPA*/
ELSE IF activitycode=1 THEN act_intensity=1; /*Standing*/
ELSE IF activitycode=0 THEN act_intensity=0; /*Sitting*/

%MACRO PERIOD(tt); *Defines macro with variable (I chose to call it tt for time) that will be set
to 1-5;

%If &tt.=1 %then %do;

%Let P=1;

%end;

%If &tt.=2 %then %do;

%Let P=2;

%end;

%If &tt.=3 %then %do;

%Let P=3;

%end;

%If &tt.=4 %then %do;

%Let P=2 3;

%end;

%If &tt.=5 %then %do;

%Let P=1 2 3;

%end;

IF status in (&P.) then P&TT.=gap; else P&TT.=0;

IF status in (&P.) and act_intensity=0 then P&TT._Sit=gap;
else P&TT._Sit=0;

IF status in (&P.) and act_intensity ge 1 and lag(act_intensity)=0 then P&TT._Sitstand=1;
else P&TT._SitStand=0;

IF status in (&P.) and act_intensity=0 and interval_s>=1800 then
P&TT._long_sitbout_ct=1/floor(interval_s);
else P&TT._long_sitbout_ct=0;

IF status in (&P.) and act_intensity=0 and interval_s<1800 then
P&TT._short_sitbout_ct=1/floor(interval_s);

```
        else P&TT._short_sitbout_ct=0;
IF status in (&P.) and act_intensity=0 and interval_s>=1800 then P&TT._long_sitbout_dur=gap;
        else P&TT._long_sitbout_dur=0;
IF status in (&P.) and act_intensity=0 and interval_s<1800 then P&TT._short_sitbout_dur=gap;
        else P&TT._short_sitbout_dur=0;
IF status in (&P.) and act_intensity=1 then P&TT._Stand=gap;
        else P&TT._Stand=0;
IF status in (&P.) and act_intensity=2 then P&TT._LPA=gap;
        else P&TT._LPA=0;
IF status in (&P.) and act_intensity=3 then P&TT._MVPA=gap;
        else P&TT._MVPA=0;
IF status in (&P.) and activitycode=2 then P&tt._step_min=gap;
        else P&tt._step_min=0;
IF status in (&P.) and activitycode=2 then P&tt._step_ct=1;
        else P&tt._step_ct=0;
IF status in (&P.) and activitycode=2 then DO;
        if stepboutdur<5 then P&tt._step00_05=gap;
            else P&tt._step00_05=0;
        if 5<=stepboutdur<10 then P&tt._step05_10=gap;
            else P&tt._step05_10=0;
        if 10<=stepboutdur<15 then P&tt._step10_15=gap;
            else P&tt._step10_15=0;
        if 15<=stepboutdur<30 then P&tt._step15_30=gap;
            else P&tt._step15_30=0;
        if 30<=stepboutdur<60 then P&tt._step30_60=gap;
            else P&tt._step30_60=0;
        if 60<=stepboutdur<90 then P&tt._step60_90=gap;
            else P&tt._step60_90=0;
        if 90<=stepboutdur<120 then P&tt._step90_120=gap;
            else P&tt._step90_120=0;
        if stepboutdur>=120 then P&tt._step120_up=gap;
            else P&tt._step120_up=0;
        End;
```

%MEND; *Ends macro;

%PERIOD(1); *Runs for P1 variables;

%PERIOD(2); *Runs for P2 variables;

%PERIOD(3);

%PERIOD(4);

%PERIOD(5);

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Run;

data Lis;
set APwake;

```
IF Workday=2 or WorkDay=0 THEN Status=1; /*nonworkday*/
    IF Workday=1 AND WorkTM <= datetime3 <= OffWorkTM THEN Status=2; /*atwork*/
    IF Workday=1 AND not (WorkTM <= datetime3 <= OffWorkTM) THEN
Status=3; /*offwork*/
Run;
```

```
%Macro Pattern(tt);
%If &tt.=1 %then %do;
%Let P=1;
%end;
%If &tt.=2 %then %do;
%Let P=2;
%end;
%If &tt.=3 %then %do;
%Let P=3;
%end;
%If &tt.=4 %then %do;
%Let P=2 3;
%end;
%If &tt.=5 %then %do;
%Let P=1 2 3;
%end;
```

```
Data Upright; Set Lis;
where status in (&P.);
dur_bout = gap/60;
```

```
*set activity code to missing for any data that is not valid -
-sleep: exclude
-off time: exclude
-not valid day (for the type of day in question): exclude
-not part of the time you are interested in as appropriate - eg not work hours;
Activity_code2 = Activitycode;
if delete=1|validday_est=0 then do;
Activity_code2 = . ;
dur_bout = .;
```

```
end;
```

```
*split the actual valid time into bouts of upright/ not;
```

```
ActUpright =0;
```

```
if Activity_code2 in (1,2) then ActUpright = 1;
```

```
if ActUpright = 1 then newupbout = 1;
```

```
if ActUpright = 1 & ActUpright = lag(ActUpright) then newupbout = 0;
```

```
newbout = 0;
```

```
if Activity_code2 in (.,0) then newbout = 1;
```

```
if Activity_code2 in(1,2) & newupbout=1 then newbout = 1;
```

```
run;
```

```
data upright2;
```

```
set upright;
```

```
by ID;
```

```
if first.ID then newboutid = 0;
```

```
if newbout = 1 then newboutid + 1;
```

```
run;
```

```
proc means data = upright2 noprint;
```

```
by ID newboutid;
```

```
where ActUpright = 1;
```

```
output out=upright3
```

```
sum (dur_bout) = dur_actbout
```

```
;
```

```
run;
```

```
data upright3;
```

```
set upright3;
```

```
ln_dur_actbout = log(dur_actbout);
```

```
drop _type_ _freq_;
```

```
run;
```

```
proc means data = upright3 noprint;
```

```
by ID;
```

```
output out=upright4
```

```
mean(ln_dur_actbout) = mn_dur_actbout
```

```
stddev(ln_dur_actbout) = sd_dur_actbout
```

```
;
```

```
run;
```

```
*MEANPERIOD - mean of a lognormal distribution based on mle for a lognormal distribution;
```

```
data upright4 (keep =ID P&tt._mean_period);
set upright4;
P&tt._mean_period = exp(mn_dur_actbout + ((sd_dur_actbout**2)/2));
run;
```

```
*Recombine sedentary bouts;
Data sedbt;set lis;
    if delete=1|validday_est=0 then delete;
```

```
Run;
```

```
proc means data=sedbt nonobs noprint;
by id boutid;
output out= sedbt2
    sum(gap) = gap
    mean(status) = status
    mean(activitycode) = activitycode;
```

```
Run;
```

```
*** sedentary accumulation;
data sed (keep = ID boutid dur_sed);
Set sedbt2;
where status in (&P.);
if Activitycode = 0;
```

```
dur_sed = gap/60;
run;
```

```
proc sort data = sed;
by ID dur_sed;
run;
```

```
proc means data=sed noprint;
by ID;
output out=summary min(dur_sed)=P&tt._min_t_sit max(dur_sed)=P&tt._max_t_sit
sum(dur_sed)=P&tt._totsed ;
run;
```

```
data sed;
merge sed summary;
by ID;
```

*ln_tdivmint is used in calculating alpha - you can use the min setting in the AP software or the observed minimum. We use the observed minimum;

```
ln_tdivmint = log(dur_sed/P&tt._min_t_sit);
```

*ln_tdivmint = log(dur_sed/(10/60)); *alternative using the minimum setting in the AP software;

```
rename _freq_ = P&tt._nbouts_sed_tot;
```

```
drop _type_;
```

```
run;
```

```
proc means data=sed noprint;
```

```
by ID;
```

```
output out=alpha sum(ln_tdivmint)=ln_tdivmint_sum;
```

```
run;
```

```
data alpha;
```

```
set alpha;
```

```
P&tt._alphasit = 1 + ( _freq_ * (1/ln_tdivmint_sum));
```

```
drop _type_;
```

```
run;
```

```
proc means data=sed noprint;
```

```
by ID dur_sed;
```

```
output out=bybout sum(dur_sed)=dur_sed_tot min(P&tt._totsed)=P&tt._totsed
```

```
min(P&tt._nbouts_sed_tot)=P&tt._nbouts_sed_tot;
```

```
run;
```

```
proc sort data=bybout;
```

```
by ID dur_sed;
```

```
run;
```

*calculating gini and x50 -> non linear regression;

```
data accrual;
```

```
set bybout;
```

```
by ID;
```

```
percent = 100*( _freq_ / P&tt._nbouts_sed_tot);
```

```
prop_totsed = (dur_sed_tot / P&tt._totsed);
```

```
if first.ID then do;
```

```
cum_dur_sed = 0;
```

```
perpop=0;
```

```
end;
```

```
cum_dur_sed + dur_sed_tot;
```

```
perpop + percent;
cum_prop_sed = cum_dur_sed / P&tt._totsed;
proppop = perpop /100;
xlag = lag(proppop);
ylag = lag(cum_prop_sed);
if first.ID then do;
xlag =0;
ylag = 0;
end;
columna = (cum_prop_sed) * xlag;
columnb = (proppop) * ylag;
if first.PID then do;
suma = 0;
sumb = 0;
end;
suma + columna;
sumb + columnb;
P&tt._ginisit = suma - sumb;
if last.ID then do;
keepme=1;
end;
drop _type_;
rename _freq_ = P&tt._nbouts_sed dur_sed = bout_length;
*** cum_dursed is the cumulative sed time accrued at bouts that lenght or shorter
perpop is the cumulative proportion of bouts that lenght or shorter....
NOTE- not the cumulative % of total time accrued in bouts that length or shorter;
run;
*note that for x50 you only need
bout_length [bout duration in minutes] and
cum_prop_sed [cumulative proportion of sedentary in bouts <= each bout_length];

data gini (keep = ID P&tt._ginisit P&tt._nbouts_sed_tot);
set accrual;
if keepme =1;
run;

proc sort data = accrual;
by ID bout_length;
run;

*nonlinear regression fitting curve to find x50;
proc nlin data=accrual method=MARQUARDT noprint;
by ID ;
parameters parm1=-5 to 5 by 0.1 x50=0 to 60 by 1;
```

```
bounds x50 >= 0;
model cum_prop_sed= (bout_length**parm1) / ((bout_length**parm1) + (x50**parm1));
output out=x_estimates_sit predicted = pred_sit l95=l95_sit u95=u95_sit parms=parm1 x50;
run;
quit;
```

```
*x_estimates_sit: data at the level of each bout duration so as to plot accumulation curves if
desired;
data x_estimates_sit (keep = ID bout_length parm1_sit x50_sit pred_sit l95_sit u95_sit);
set x_estimates_sit;
rename parm1 = parm1_sit x50 = x50_sit;
run;
```

```
*x_person_sit: data at the level of each individual - the summary info to keep;
```

```
proc means data=x_estimates_sit noprint;
by ID;
output out=x_person_sit min(parm1_sit)=P&tt._parm1_sit min(x50_sit)=P&tt._x50_sit;
run;
```

```
data x_person_sit;
set x_person_sit;
drop _type_ _freq_;
run;
```

```
data P&tt._sitpattern;
merge alpha x_person_sit summary gini upright4;
by ID;
rename _FREQ_ = P&tt._nbouts_sed ;
drop _type_ ln_tdivmint_sum;
run;
```

```
%Mend Pattern;
```

```
%Pattern(1);
%Pattern(2);
%Pattern(3);
%Pattern(4);
%Pattern(5);
```

```
Data AP_var; Merge P1_sitpattern P2_sitpattern P3_sitpattern P4_sitpattern P5_sitpattern;
```


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by ID;

Run;

PROC SQL ;

CREATE TABLE sittostand AS

SELECT ID,

Mtime,

Date,

sum(P1_sitstand) as P1_Sitstand,

round(sum(P1_long_sitbout_ct),1) as P1_long_sitbout_ct,

sum(P1_long_sitbout_dur)/60 as P1_long_sitbout_dur,

round(sum(P1_short_sitbout_ct),1) as P1_short_sitbout_ct,

sum(P1_short_sitbout_dur)/60 as P1_short_sitbout_dur,

sum(P1)/60 as P1_min,

sum(P1_Sit)/60 as P1_Sit,

sum(P1_Stand)/60 as P1_Stand,

sum(P1_LPA)/60 as P1_LPA,

sum(P1_MVPA)/60 as P1_MVPA,

sum(P1_step_min)/60 as P1_step_min,

sum(P1_step_ct) as

P1_step_ct,

sum(P1_step00_05)/60 as

P1_step00_05,

sum(P1_step05_10)/60 as

P1_step05_10,

sum(P1_step10_15)/60 as

P1_step10_15,

sum(P1_step15_30)/60 as

P1_step15_30,

sum(P1_step30_60)/60 as

P1_step30_60,

sum(P1_step60_90)/60 as

P1_step60_90,

sum(P1_step90_120)/60 as

P1_step90_120,

sum(P1_step120_up)/60 as

P1_step120_up,

sum(P2_sitstand) as P2_Sitstand,

round(sum(P2_long_sitbout_ct),1) as P2_long_sitbout_ct,

sum(P2_long_sitbout_dur)/60 as P2_long_sitbout_dur,

round(sum(P2_short_sitbout_ct),1) as P2_short_sitbout_ct,

sum(P2_short_sitbout_dur)/60 as P2_short_sitbout_dur,

sum(P2)/60 as P2_min,

sum(P2_Sit)/60 as P2_Sit,

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	sum(P2_Stand)/60	as P2_Stand,
	sum(P2_LPA)/60	as P2_LPA,
	sum(P2_MVPA)/60	as P2_MVPA,
	sum(P2_step_min)/60	as P2_step_min,
	sum(P2_step_ct)	as
P2_step_ct,		
	sum(P2_step00_05)/60	as
P2_step00_05,		
	sum(P2_step05_10)/60	as
P2_step05_10,		
	sum(P2_step10_15)/60	as
P2_step10_15,		
	sum(P2_step15_30)/60	as
P2_step15_30,		
	sum(P2_step30_60)/60	as
P2_step30_60,		
	sum(P2_step60_90)/60	as
P2_step60_90,		
	sum(P2_step90_120)/60	as
P2_step90_120,		
	sum(P2_step120_up)/60	as
P2_step120_up,		
	sum(P3)/60	as P3_min,
	sum(P3_sitstand)	as P3_Sitstand,
	round(sum(P3_long_sitbout_ct),1)	as P3_long_sitbout_ct,
	sum(P3_long_sitbout_dur)/60	as P3_long_sitbout_dur,
	round(sum(P3_short_sitbout_ct),1)	as P3_short_sitbout_ct,
	sum(P3_short_sitbout_dur)/60	as P3_short_sitbout_dur,
	sum(P3_Sit)/60	as P3_Sit,
	sum(P3_Stand)/60	as P3_Stand,
	sum(P3_LPA)/60	as P3_LPA,
	sum(P3_MVPA)/60	as P3_MVPA,
	sum(P3_step_min)/60	as P3_step_min,
	sum(P3_step_ct)	as
P3_step_ct,		
	sum(P3_step00_05)/60	as
P3_step00_05,		
	sum(P3_step05_10)/60	as
P3_step05_10,		
	sum(P3_step10_15)/60	as
P3_step10_15,		
	sum(P3_step15_30)/60	as
P3_step15_30,		

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	sum(P3_step30_60)/60	as
P3_step30_60,		
	sum(P3_step60_90)/60	as
P3_step60_90,		
	sum(P3_step90_120)/60	as
P3_step90_120,		
	sum(P3_step120_up)/60	as
P3_step120_up,		
	sum(P4)/60	as P4_min,
	sum(P4_sitstand)	as P4_Sitstand,
	round(sum(P4_long_sitbout_ct),1)	as P4_long_sitbout_ct,
	sum(P4_long_sitbout_dur)/60	as P4_long_sitbout_dur,
	round(sum(P4_short_sitbout_ct),1)	as P4_short_sitbout_ct,
	sum(P4_short_sitbout_dur)/60	as P4_short_sitbout_dur,
	sum(P4_Sit)/60	as P4_Sit,
	sum(P4_Stand)/60	as P4_Stand,
	sum(P4_LPA)/60	as P4_LPA,
	sum(P4_MVPA)/60	as P4_MVPA,
	sum(P4_step_min)/60	as P4_step_min,
	sum(P4_step_ct)	as
P4_step_ct,		
	sum(P4_step00_05)/60	as
P4_step00_05,		
	sum(P4_step05_10)/60	as
P4_step05_10,		
	sum(P4_step10_15)/60	as
P4_step10_15,		
	sum(P4_step15_30)/60	as
P4_step15_30,		
	sum(P4_step30_60)/60	as
P4_step30_60,		
	sum(P4_step60_90)/60	as
P4_step60_90,		
	sum(P4_step90_120)/60	as
P4_step90_120,		
	sum(P4_step120_up)/60	as
P4_step120_up,		
	sum(P5)/60	as P5_min,
	sum(P5_sitstand)	as P5_Sitstand,
	round(sum(P5_long_sitbout_ct),1)	as P5_long_sitbout_ct,
	sum(P5_long_sitbout_dur)/60	as P5_long_sitbout_dur,
	round(sum(P5_short_sitbout_ct),1)	as P5_short_sitbout_ct,
	sum(P5_short_sitbout_dur)/60	as P5_short_sitbout_dur,
	sum(P5_Sit)/60	as P5_Sit,

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```

sum(P5_Stand)/60                                as P5_Stand,
sum(P5_LPA)/60                                  as P5_LPA,
sum(P5_MVPA)/60                                as P5_MVPA,
sum(P5_step_min)/60                            as P5_step_min,
sum(P5_step_ct)                                as
P5_step_ct,
sum(P5_step00_05)/60                            as
P5_step00_05,
sum(P5_step05_10)/60                            as
P5_step05_10,
sum(P5_step10_15)/60                            as
P5_step10_15,
sum(P5_step15_30)/60                            as
P5_step15_30,
sum(P5_step30_60)/60                            as
P5_step30_60,
sum(P5_step60_90)/60                            as
P5_step60_90,
sum(P5_step90_120)/60                          as
P5_step90_120,
sum(P5_step120_up)/60                          as
P5_step120_up

FROM cadence2
GROUP BY ID, Mtime, Date;
QUIT;

Data sittostand2; Merge sittostand Ap_var;
by ID;
Run;

PROC APPEND DATA=sittostand2 out=iso.REPORT_FINAL FORCE;
RUN;
%end;
/*proc Datasets lib=work nolist kill;*/
/*      quit;*/
/**/
/*      run;*/
%MEND APimport;
```

*nominate folder to find the events files, followed by \, such as;

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```
%let dir = X:\Buman Lab\Stand and Move
ASU_UMN\Data\ActivPAL\ISO_TEST\SAS_FILES>taggedfiles\T1;
%APimport;

proc printto;
run;

%put END TIME: %sysfunc(datetime(),datetime14.);
%put PROCESSING TIME:
%sysfunc(putn(%sysvalf(%sysfunc(TIME())-&datetime_start.),mmss.)) (mm:ss) ;

Proc SQL;
Create table Activpal as
select a.*,
       b.workday

From iso.Report_Final as a
Left join track.masterlogs2 as b
ON a.ID=b.ID and a.date=b.date
Order by a.ID, a.date;
Quit;

Data iso.AP_Final;
set Activpal;

if workday=0 and p1_min<600 then valid_p1=0;
if workday=0 and p1_min>=600 then valid_p1=1;
if workday=1 and p2_min<240 then valid_p2=0;
if workday=1 and p2_min>=240 then valid_p2=1;
if workday=1 and p3_min<240 then valid_p3=0;
if workday=1 and p3_min>=240 then valid_p3=1;

run;
```