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1 Cognitive work on a walking desk does not lead to compensatory appetitive responses in  
2 healthy young adults

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**Running Title: Energy balance during cognitive task on active desk**

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## Abbreviations

BMI	Body mass index
EB	Energy balance
EE	Energy expenditure
EI	Energy intake
FFM	Fat-free mass
FM	Fat mass
HR	Heart rate
RER	Respiratory exchange ratio
REI	Relative energy intake
SD	Standard deviation
VO <sub>2</sub>	Oxygen consumption
VCO <sub>2</sub>	Carbon dioxide production
VE	Ventilation

11 **Highlights**

- 12 • Walking while working does not increase food intake at the subsequent meal
- 13 • Repetitive use of a walking desk could provide chronic health benefits
- 14 • A walking desk increases energy expenditure above sedentary levels contrary to a
- 15 standing desk

16

17 **Abstract**

18 **Context:** In addition to the low energy expenditure induced by sedentary behaviors such as  
19 sitting, it has been shown that intense cognitive work can lead to an increase in food intake.  
20 Walking Desk provide the opportunity for office workers to replace prolonged sitting at work  
21 with light intensity physical activity. **Objective:** To compare the effects of sitting *vs* standing  
22 *vs* walking during a cognitive task on energy intake, appetite sensations, food reward and  
23 overall energy balance. **Methods:** Fifteen normal weight (BMI:  $24.1 \pm 1.2 \text{ kg.m}^{-2}$ ) young men  
24 ( $23.4 \pm 2.1$  years) randomly performed three conditions: sitting desk (SitD), standing desk (StD)  
25 and walking desk (WD), while performing a 45-min cognitive task. Energy expenditure was  
26 measured by indirect calorimetry, regular appetite sensations were assessed using visual  
27 analogue scales, energy intake measured during an *ad libitum* meal and the relative energy  
28 intake calculated. Pre and post-test meal food reward was evaluated through the Leeds Food  
29 Preference Questionnaire. **Results:** Relative energy intake decreased by 150kcal in WD  
30 compared with SitD, however it did not reach statistical significance. There were no differences  
31 in appetite sensations nor food reward between the three conditions. Energy expenditure was  
32 significantly higher in WD ( $141.8 \pm 13 \text{ kcal}$ ) than in SitD ( $78.7 \pm 5 \text{ kcal}$ ) and StD ( $85.9 \pm 8 \text{ kcal}$ )  
33 ( $p \leq 0.05$ ). **Conclusion:** Walking desk use can decrease sedentary time while working without  
34 any appetitive compensation. The small reduction in energy balance with walking while  
35 working could induce significant health benefits if repeated over time. Future longer studies  
36 need to clarify whether active desks can contribute to the prevention or management of weight  
37 gain.

38 **Keywords:** appetite, sedentary behavior, walking desk, energy balance

## 39 **1. Introduction**

40 Sedentary behaviors have increased during the last decade and have worsened with the COVID-  
41 19 pandemic [1]. The increase in administrative occupational activities has largely contributed  
42 to this progression of time spent in a sitting position, which can represent as much as 77% of  
43 the whole workday [2]. Sedentary time, especially sitting time, has been recognized as an  
44 independent factor for mortality [3-6] and it is clear today that being physically active (i.e.  
45 reaching physical activity recommendations) does not protect against the harmful effects of a  
46 sedentary lifestyle, unless reaching at least three times the recommended levels of physical  
47 activity [3]. In addition to the negative effects of work-related sedentary activities in terms of  
48 reduced energy expenditure, performing intense cognitive tasks during sedentary occupational  
49 activities can also lead to an increase in energy intake (EI) [7, 8]. Thus, the low energy  
50 expenditure associated with sitting and tertiary work, and their relative propensity to increase  
51 EI, call for a new consideration of workspaces and workstations, to promote employee health.  
52 Interestingly, the implementation of physical exercise before lunchtime has shown to be  
53 efficient to decrease EI after a standardized cognitive task [9, 10]. However, the constraints  
54 associated with exercising at work (space and equipment available, changing rooms and  
55 showers available) may make it difficult to adopt this type of strategy on a daily basis [11].  
56 Active workstations such as sit-to-stand and treadmill desks provide the opportunity for office  
57 workers to replace prolonged sitting at work with light intensity physical activity [12, 13].  
58 Between the three main active desk strategies (standing desk, cycle desk and treadmill desk)  
59 that have been investigated over the last decade, treadmill desks are the more energy demanding  
60 while standing desks generate an energy load that remains slightly under the sedentary level of  
61 1.5 METs [14]. While the energetic impacts of such active desks during working (mental) tasks  
62 have been quite largely studied, their potential implications for appetite control remain poorly  
63 examined so far. In their work, Josaphat and colleagues [15] have shown that using a standing  
64 desk for 75min did not modify subsequent EI compared to the same work task performed in a

65 sitting position. Our group recently showed that the use of a cycle desk during a 30-min  
66 cognitive task increased absolute EI at the following meal without altering total energy balance  
67 (EB) compared to the same mental work performed in a sitting position [9]. In light of these  
68 two recent studies, while using active desks is recommended to break sedentary time, it remains  
69 unclear whether the induced increase in energy expenditure can significantly help reduce  
70 people's short term relative EI after mental work. Although walking desks are the more energy  
71 demanding strategy, no study has so far investigated their effects on subsequent appetite and  
72 EI.

73 The aim of this study was to investigate the effects of walking, standing or being in a sitting  
74 position during a cognitive task on appetite sensations, EI, energy expenditure and food reward  
75 in healthy adult men. We hypothesized that walking while performing a mental task would not  
76 affect absolute EI or appetite sensations while decreasing overall energy balance compared to  
77 standing or sitting positions.

## 78 **2. Methods**

### 79 **2.1 Population**

80 Fifteen healthy normal-weight young men were recruited to participate in this randomized  
81 crossover study. To be included in the study they had to be free of any illnesses or medications  
82 that could interfere with the study outcomes. The participants also had to be habitual breakfast  
83 consumers. To better describe the participants' eating behaviour traits, a French version of the  
84 TFEQ was administered to our subjects. This questionnaire assesses dietary restraint,  
85 disinhibition and susceptibility to hunger [16].

86 This study was conducted according to the guidelines laid down in the Declaration of Helsinki.

87 Written informed consent was obtained from all participants as requested by the local Research  
88 Ethics Committee (CPP Su Est VI).

### 89 **2.2 Experimental design**

90 After a full medical examination to assess eligibility, the included participants were asked to  
91 complete a food preference questionnaire (which was used to compose the buffet meals  
92 presented during the experimental sessions). Each participant came to the laboratory on three  
93 separate occasions. During the first visit, anthropometry and body composition parameters were  
94 assessed. Then, participants completed three experimental visits, in a standardized postprandial  
95 state, in a randomized order separated by at least 7 days to perform a cognitive task (text  
96 transcription) during 45 min under three different conditions. The first was a sitting condition  
97 where subjects were seated on a desk chair while working (SitD); the second corresponded to  
98 a standing condition on a standing desk (StD); and the third was a walking condition on a  
99 walking desk (WD). Cardiorespiratory parameters were assessed during each condition. Thirty  
100 minutes after each session, an *ad libitum* lunch meal was provided and EI measured. Before  
101 and after each condition, appetite sensations, food preference and reward were assessed at  
102 different times, as well as anxiety and mental workload. Physical activity level was assessed  
103 after the last condition during 7 consecutive days using accelerometers.

## 104 **2.3 Experimental conditions**

### 105 **2.3.1 Sessions**

106 Subjects were submitted to three experimental sessions in a randomized order. Participants  
107 arrived at the laboratory at 7:30 am, and were submitted to a standardized breakfast which  
108 represented 9.5 to 10 kcal per kg of body mass (55% CHO, 30% lipids and 15% protein) [17].

109 The participants were instructed to abstain from stimulants (coffee, tea) and from moderate-to-  
110 vigorous physical activity for 24 h prior to each session.

111 A standard seated workstation was used in the control condition. In the standing and walking  
112 (1.6 km.h) condition, the Desk (Activ'UP, Collonges sous Salève, France) was systematically  
113 adjusted before the task to the participant's height so that their arms were bent at a 90° angle.

114 During the three experimental sessions, subjects were in a stable environmental temperature



115 (22 ± 0.5°C). The cognitive task was a transcription of a text for 45 minutes. The participants  
116 were asked to transcribe as much of the text as possible, while making as few mistakes as  
117 possible. Participants could not rely on spellcheck. Energy expenditure and heart rate were  
118 monitored continuously during every cognitive task.

### 119 **2.3.2 Measurements**

#### 120 *2.3.2.1 Anthropometric and body composition*

121 Height and body mass were determined using a standard wall-mounted stadiometer and a digital  
122 scale (SECA, Les Mureaux, France), respectively. Body mass index (BMI) was calculated as  
123 body mass (kg) divided by height squared (m<sup>2</sup>). Body composition was assessed on the same  
124 occasion using impedance analysis (Tanita MC 780). This model has been validated in young  
125 adults of various physical activity levels [18].

#### 126 *2.3.2.2 Metabolic and cardiorespiratory parameters*

127 After calibration, oxygen consumption (VO<sub>2</sub>), carbon dioxide production (VCO<sub>2</sub>), ventilation  
128 (VE) and heart rate (HR) were continuously recorded throughout each of the 45-min sessions  
129 using indirect calorimetry (MetaMax 3b, Cortex Biophysik, Leipzig, Germany) and HR  
130 monitor (Polar, V800, Kempele, Finland). Respiratory exchange ratio (RER; VCO<sub>2</sub>/VO<sub>2</sub>) and  
131 total energy expenditure (EE in kcal) over the 45 min and, of each session, was calculated as  
132 follows: VO<sub>2</sub> (L.min<sup>-1</sup>) x energy equivalent of oxygen x duration (min)[19].

#### 133 *Ad libitum meals and energy intake*

134 Participants were provided with an *ad libitum* buffet meal for lunch (12:00pm). Food items  
135 were provided in excess of expected consumption and participants were instructed to eat until  
136 “comfortably satiated”. The food selection was covertly weighed by the investigators before  
137 and after the meal and participants were unaware of the quantity of calories served. Energy and  
138 macronutrient intakes were calculated using a dietary analysis software (Nutrilog software,

139 France). Relative energy intake (REI) for the *ad libitum* lunch meal was calculated as the EI  
140 minus the EE of each session.

#### 141 2.3.2.3 *Subjective appetite sensations*

142 Participants were asked to rate their hunger, fullness, desire to eat (DTE) and prospective food  
143 consumption (PFC) throughout the sessions (150 millimeter visual analogue scales, VAS) at  
144 baseline (fasted), immediately after breakfast, before and after the cognitive task, before and  
145 after lunch and 30 and 60 min after lunch [20].

#### 146 2.3.2.4 *Food preference and reward*

147 The Leeds Food Preference Questionnaire (LFPQ; described in detail by Dalton and Finlayson)  
148 [21] was administered before and after lunch to determine scores of implicit wanting and  
149 explicit liking for high-fat (>50% energy) or low-fat (<20% energy) foods matched for  
150 familiarity, sweetness, protein and acceptability [22]. Low-fat scores were subtracted from  
151 high-fat scores to obtain the fat appeal bias score and savoury scores were subtracted from sweet  
152 scores to obtain the taste appeal bias score; thus positive scores indicate greater liking or  
153 wanting towards high-fat compared to low-fat foods and towards sweet compared to savoury  
154 foods, respectively..

#### 155 2.3.2.5 *State-Trait Anxiety Inventory (STAI)*

156 The STAI consists of two distinct anxiety scales: trait scale (anxiety-trait) and state scale  
157 (anxiety-state) [23]. STAI questionnaire were fulfilled during the first visit for the evaluation  
158 of the anxiety-trait score, and before and after each experimental session for the anxiety-state.  
159 Both scales are composed of 20 questions and require that the subjects describe how they feel  
160 generally, on the anxiety-trait scale and how they feel at a specific moment, on the anxiety-state  
161 scale.

#### 162 2.3.2.6 *NASA Task Load Index (NASA-TLX)*

163 The NASA TXL questionnaire was fulfilled by the subjects immediately after the end of each  
164 experimental session. The NASA-TLX provides a subjective mental workload score based on  
165 the weighted average of six dimensions: mental demand, which signifies the amount of mental  
166 and/or perceptual activity required, such as thinking, calculating and deciding; physical  
167 demand, which indicates the amount of physical activity required, such as pushing, pulling,  
168 turning and controlling; temporal demand, defined as the amount of pressure felt due to the rate  
169 at which tasks or task elements occur; overall performance, which is how successful and  
170 satisfied one has been in performing a given task; effort, taken to indicate how hard one has had  
171 to work to accomplish a certain level of performance; and frustration, which denotes how  
172 discouraged versus content one has felt while completing the task [24].

#### 173 *2.3.2.7 Daily time spent physically active and sedentary*

174 Briefly, participants continuously wore for 7 days with at least one weekend day an ActiGraph  
175 wGT3X-BT accelerometer (ActiGraph, Inc., Pensacola, FL) to determine their PA, and an  
176 activPAL3 inclinometer (PAL Technologies Limited, Glasgow, UK) to characterise sedentary  
177 time. In order for data to be considered valid, every monitor's data needed to report at least 4  
178 days (including 1 weekend day) of wear with a monitor wear time of  $\geq 10$  hours/day (600  
179 min/day) [25, 26]. While the accelerometer was removed at night and the inclinometer was  
180 worn all day, only the time where every participant wore both the inclinometer and  
181 accelerometer were analysed. Subjects were asked to wear AG on the right hip on an elastic  
182 belt during waking hours. The AP device was positioned in a nitrile sleeve and attached to the  
183 anterior midline of the participant's right thigh using an adhesive patch. The monitor was worn  
184 continuously for 24 hours during the 7 days. Analytical approaches of ActiGraph [27, 28] and  
185 activPal [29] data have been detailed previously.

## 186 **2.4 Statistics**

187           The sample size estimation was calculated according to (i) differences reported in the  
188 literature [7] and (ii) effect-size bounds recommended by Cohen (Cohen, 1988) : small (ES:  
189 0.2), medium (ES: 0.5) and large (ES: 0.8, “grossly perceptible and therefore large”). Power  
190 calculation based on previous work [7] suggested that a sample size of 15 participants would  
191 allow detection of at least 40% difference in EI between cognitive task conditions, a probability  
192 of 0.05, and a beta level of 0.80. Statistical analyses were performed using Stata software,  
193 Version 15 (StataCorp, College Station, TX, US). Continuous data were expressed as mean and  
194 standard-deviation and the assumption of normality was assessed using the Shapiro-Wilk test.  
195 The comparisons between sessions (SitD, SD, WD) were performed using random-effects  
196 models for crossover designs, taking account of the following effects: session, sequence,  
197 *session x sequence* interaction and subject as random effect. The normality of residuals from  
198 these models was studied as aforementioned. In case of non-normal distribution, a logarithmic  
199 transformation was implemented. A Sidak’s type I error correction was applied to perform  
200 multiple comparisons. Random-effects models were also used to measure time effect during  
201 each exercise session, (1) time, session and *time x session* interaction as fixed effects, and (2)  
202 subject as random-effect in order to model between and within participant variability.  
203 Analogous statistical analysis plan was performed to study assumptions of random-effects  
204 models and multiple comparisons. Appetite sensations were also compared with area under the  
205 curve (AUC) values using the trapezoid method.

## 206 **3 Results**

### 207 *3.1 Study population*

208 Table 1 displays the descriptive characteristics of subjects enrolled in the present study.  
209 Subjects were young normal-weight men with no cognitive dietary restriction and low levels of  
210 disinhibition and susceptibility to hunger. Results for the STAI questionnaire showed low  
211 global anxiety-trait scores, underlying the absence of anxiety in their everyday life.  
212 Accelerometry data showed that our subjects were active, meaning that they reached the

213 recommendation for daily physical activity [30]. However, they still spent more than half of  
214 their waking hours engaged in sedentary behaviors.

### 215 *3.2 Metabolic and cardiorespiratory parameters*

216 As shown in Fig1A, heart rate was significantly higher in standing and walking sessions  
217 compared to sitting (SitD  $74\pm 9$  vs StD  $88.3\pm 10.2$  vs WD  $85.3\pm 10.9$  bpm;  $p=0.01$ ), without any  
218 difference between the StD and WD sessions ( $p>0.05$ ).

219 Energy expenditure during the whole session was significantly higher for WD compared to SitD  
220 and StD ( $141.8\pm 13.8$  kcal vs  $78.7\pm 9.8$  kcal vs  $85.9\pm 8.2$  kcal;  $p=0.01$ ) with no difference between  
221 those last two (Fig1B). Similarly, the Metabolic Equivalents (METs) was higher for WD  
222 compared to SitD and StD ( $2.4\pm 0.19$  vs  $1.3\pm 0.16$  vs  $1.4\pm 0.12$ ;  $p=0.01$ ) (Fig1C). There was no  
223 difference in substrate oxidation between the three sessions as reflected by the respiratory  
224 exchange ratio (SitD  $0.85\pm 0.02$  vs StD  $0.83\pm 0.02$  vs WD  $0.83\pm 0.05$ ;  $p>0.05$ ) (Fig.1D).

### 225 *3.3 Energy Intake*

226 As illustrated in figure 2A, there was no significant difference between the three conditions for  
227 absolute EI (SitD  $1031\pm 287$ , StD  $939\pm 257$ , WD  $939\pm 267$  kcal;  $p>0.05$ ) nor for relative energy  
228 intake (SitD  $952\pm 284$ , StD  $877\pm 246$ , WD  $798\pm 263$  kcal;  $p>0.05$ ). There was no significant  
229 difference in the absolute (kcal) or relative contribution (%) to total EI for carbohydrates (SitD  
230  $48\pm 7$  vs StD  $47\pm 8$  vs WD  $49\pm 8\%$ ;  $p>0.05$ ), lipids (SitD  $33\pm 7$  vs StD  $34\pm 7$  vs WD  $32\pm 7\%$ ;  
231  $p>0.05$ ) and proteins (Sit D  $18.1\pm 3$  vs StD  $18.3\pm 3.4$  vs WD  $18.6\pm 3.7\%$ ;  $p>0.05$ ) between the  
232 three conditions (figure 2B).

### 233 *3.4 Appetite sensations and food reward*

234 As showed in figure 3, no significant differences were observed between the three conditions  
235 for appetite sensations.

236 Regarding food reward, neither implicit wanting nor explicit liking was found significantly  
237 different between conditions as displayed in Table 2. There was a time effect with an increase  
238 in taste bias after the lunch for implicit wanting and explicit liking ( $p=0.001$ ) (Table 2).

### 239 *3.5 Anxiety and workload parameters*

240 Total score for the NASA Task Load Questionnaire was moderate to high (50 to 60) with no  
241 difference between the three conditions (Table 3). The physical demand dimension was the only  
242 sub-category showing significant differences with a higher score during StD compared to SitD  
243 ( $p=0.001$ ). EI during the three conditions were negatively associated with Physical ( $r=-0.318$ ,  
244  $p=0.03$ ) and Temporal ( $r=-0.371$ ,  $p=0.01$ ) demand dimension assessed after each session. There  
245 was a tendency for a positive association between EI and Frustration ( $r=0.29$ ,  $p=0.08$ ).

246 There was no time effect ( $p\geq 0.05$ ) and no difference in anxiety-state before (SitD:  $23.5\pm 4.6$  vs  
247 StD:  $23\pm 3.1$  vs WD:  $24.3\pm 4.1$ ;  $p\geq 0.05$ ) and after (SitD:  $23.4\pm 4.5$  vs StD:  $23.6\pm 3.7$  vs WD:  
248  $22.6\pm 3.1$ ;  $p\geq 0.05$ ) the task between the three conditions. A significant negative correlation was  
249 found between pre-task anxiety-state and EI ( $r=-0.374$ ,  $p=0.01$ ).

250

## 251 **4 Discussion**

252 The deleterious impact of tertiary work-related sedentary time requires the development of  
253 strategies to reduce the time spent seated. On top of the low energy expenditure associated with  
254 this sitting time, the stress caused by intensive mental work can induce fatigue and encourage  
255 excessive energy intake at the next meal. Several strategies to limit this energy compensation  
256 have been evaluated, such as the implementation of a short period of exercise before the meal  
257 [9, 10, 31], active breaks [32] or the use of active workstations during cognitive tasks [9, 15].  
258 In the present study we show for the first time that walking at 1.6km/h while performing mental  
259 work for 45 min did not affect subsequent absolute EI compared to the same cognitive task  
260 performed in a standing or a sitting position. When energy intake is adjusted to the energy

261 expenditure generated in the three conditions, the use of the treadmill favors the lowest energy  
262 balance (-150kcal) however this result remains non-significant. Nevertheless, including 45  
263 minutes of work on the treadmill daily could contribute to a significant deficit over a week or  
264 several months of work and promote weight management. This projection is consistent with the  
265 chronic effects demonstrated through the use of treadmill desks on body weight regulation in  
266 people with overweight or obesity [33]. Very few studies have investigated the acute effects of  
267 active desk use on energy intake. Recently, Josaphat et al [15] showed no difference in energy  
268 intake after a 75-min cognitive task performed in a sitting or standing position. Although the  
269 cognitive task used was longer in this previous study, our results are in line with it, as we did  
270 not find any effect of standing while working compared to sitting on energy intake.  
271 Furthermore, our research group has recently shown that the use of a cycle desk during a  
272 cognitive task did not reduce subsequent energy intake [9]. Indeed, we have shown that when  
273 compared to a seated position, the absolute energy intake was higher but when taking into  
274 account the energy expenditure generated from the cycling, the relative energy intake was not  
275 different. Thus, altogether, these results suggest that the acute use of active desks does not  
276 generate an anorectic effect; however, they do not induce a positive energy balance. In view of  
277 the low intensity induced by standing or walking on an active workstation, the absence of  
278 anorectic effect may seem to be in agreement with previous studies [9, 10, 34]. Indeed, as  
279 mentioned previously, it is now well accepted that intensive exercise (i.e. above 70%VO<sub>2</sub>max)  
280 is more likely to create an anorectic effect than low-to-moderate intensity exercise [34-36].  
281 Contrary to the results from Josaphat et al. [15], we did not find any difference in hunger or  
282 prospective food consumption between the different experimental conditions. Nevertheless,  
283 although not significant, the standing condition showed the lowest values. This is in line with  
284 the significant decrease found for these two appetite sensations in the standing condition in the  
285 work from Josaphat et al [15].

286 Importantly, our sample was composed of physically active young men who otherwise did not  
287 present an altered eating behaviour profile, which might partly explain the lack of difference in  
288 energy intake and appetite sensations between conditions. Cognitive or emotional stress has  
289 been shown to increase energy intake. However, it seems that this relationship is more prevalent  
290 in women than in men [37, 38]. We assessed the mental and physical stress and strain induced  
291 by the different conditions using different questionnaires (STAI and NASA TXL). Our results  
292 show that performing the same cognitive task while standing or walking does not induce any  
293 particular stress compared to sitting. We found that two dimensions of workload (physical  
294 demand and temporal demand) and the state-anxiety score before each session were negatively  
295 associated with energy intake. This indicates that when a higher workload or anxiety level were  
296 anticipated, a lower EI at the meal test was observed. This is in line with the study of Perusse-  
297 Lachance et al [39] underscoring sex difference in response to a cognitive stress. More  
298 specifically they found that a cognitive task increased EI in normal-weight women whereas it  
299 decreased EI in young normal-weight men. In addition to the intersex difference in the  
300 relationship between stress and energy intake, subjects with a moderate to high level of physical  
301 activity – which is the case in our sample – seem to better adjust their energy balance, which  
302 may also contribute to explain the observed lack of difference [40].

303 The energy expenditure generated by the use of the treadmill was significantly higher than that  
304 generated by the sitting and standing postures. Although few studies have compared the energy  
305 cost of these three postures/activities, our results confirm those of previous studies showing that  
306 only cycling desks or walking desks can increase energy expenditure above the sedentary  
307 threshold [41]. Although standing desks are presented as active workstation strategies, and  
308 have beneficial effects on certain parameters such as glycemic control, they remain a sedentary  
309 activity from an energetic point of view [42].



310 An interesting result of our study is that despite a lower energy demand than walking, the mental  
311 work performed in the standing position is perceived as a more strenuous physical demand  
312 when assessed by the NASA TXL questionnaire than walking. This last result underlines the  
313 good acceptability of new workspace management strategies such as the daily use of a walking  
314 desk.

315 Although this work provides new insights regarding the control of appetite in response to  
316 cognitive tasks performed in sedentary or active situations, some limitations must be mentioned.  
317 The relatively modest sample size composes the main limitation, but it remains in the range of  
318 previously published studies assessing energy expenditure and intake during posture allocations  
319 or low intensity exercises [7]. Moreover, this study only included young, normal-weighted men,  
320 which does not allow us to generalize our results to the general population. It will be essential  
321 to evaluate in future studies these appetitive and energy balance responses in women as well as  
322 in subjects with overweight and obesity.

323

324 To conclude, this study suggests the use of active desks such as the walking desk as an  
325 interesting strategy to reduce sedentary time without generating greater mental strain than  
326 during sitting work. In addition, despite the increase in energy expenditure with walking on a  
327 treadmill, subsequent energy intake is not modified compared to a seated condition. Thus, the  
328 use of walking desks among tertiary employees seems promising to reduce sedentary behavior  
329 and to prevent the associated health risks. However, further studies seem necessary to better  
330 identify the potential interactions between the use of such active desks and the nature of the  
331 mental tasks imposed to employees.

332

333 **Author contributions**

334 LM, DT, TG, MD, FC: Conceptualization; LM, TG, MD: Data curation, Investigation; BP, MD, KB,  
335 CB LM, DT: Formal analysis; LM, DT, KB,: Methodology, Project administration; LM, DT, KB, MD:  
336 Writing; LM, DT, KB : Review, Editing.

337

### 338 **Conflict of interest**

339 We have no conflict of interest disclose.

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#### 445 **Figure legends**

446 Figure 1: Heart Rate (A), Total energy expenditure (B), Metabolic Equivalent Task (METs) (C)  
447 and Respiratory Exchange Ratio (D) assessed during 45min of mental work done in a Sitting  
448 (SitD), Standing (StD) position or while walking on a walking Desk (WD). \* $p \leq 0.05$ , \*\*  
449  $p \leq 0.001$ .

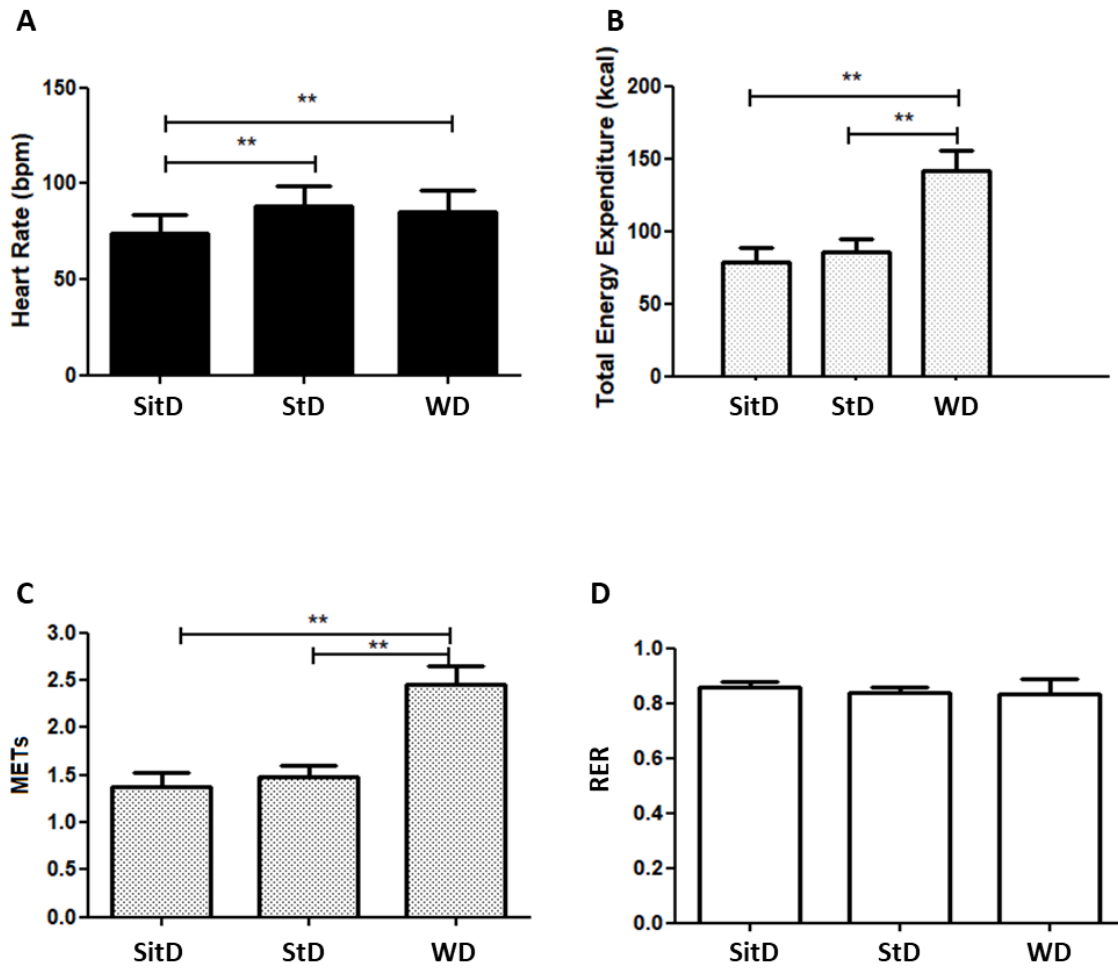
450 Figure 2: Absolute and Relative energy intake (A) and relative contribution of macronutrients  
451 (B) assessed after an *ad libitum* buffet meal proposed after 45min of mental work done in a  
452 Sitting (SitD), Standing (StD) position or while walking on a walking Desk (WD). CHO:  
453 carbohydrates; EI: energy intake \* $p \leq 0.05$ , \*\*  $p \leq 0.001$ .

454 Figure 3: Appetite feelings during each experimental condition (panels A, C, E and G) and Area  
455 Under the Curve (AUC) (Panels B,D,F and H): 45min of mental work done in a Sitting (SitD),  
456 Standing (StD) position or while walking on a walking Desk (WD). PFC: prospective food  
457 consumption; DTE: desire to eat.

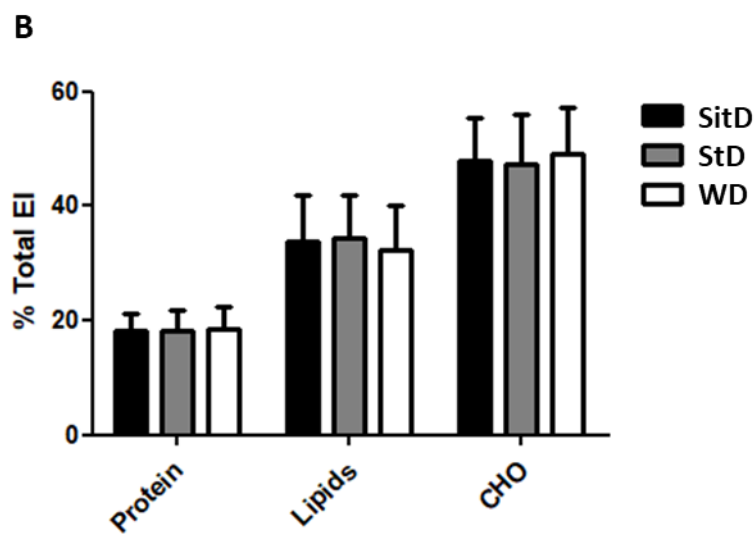
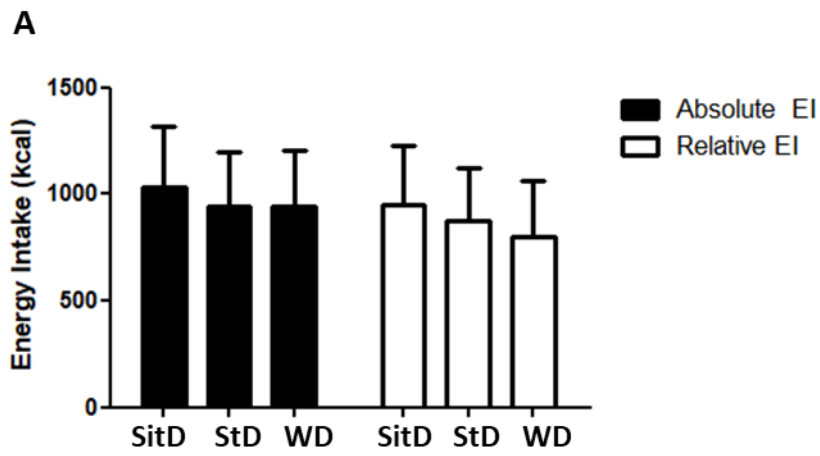
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459 **Fig.1**

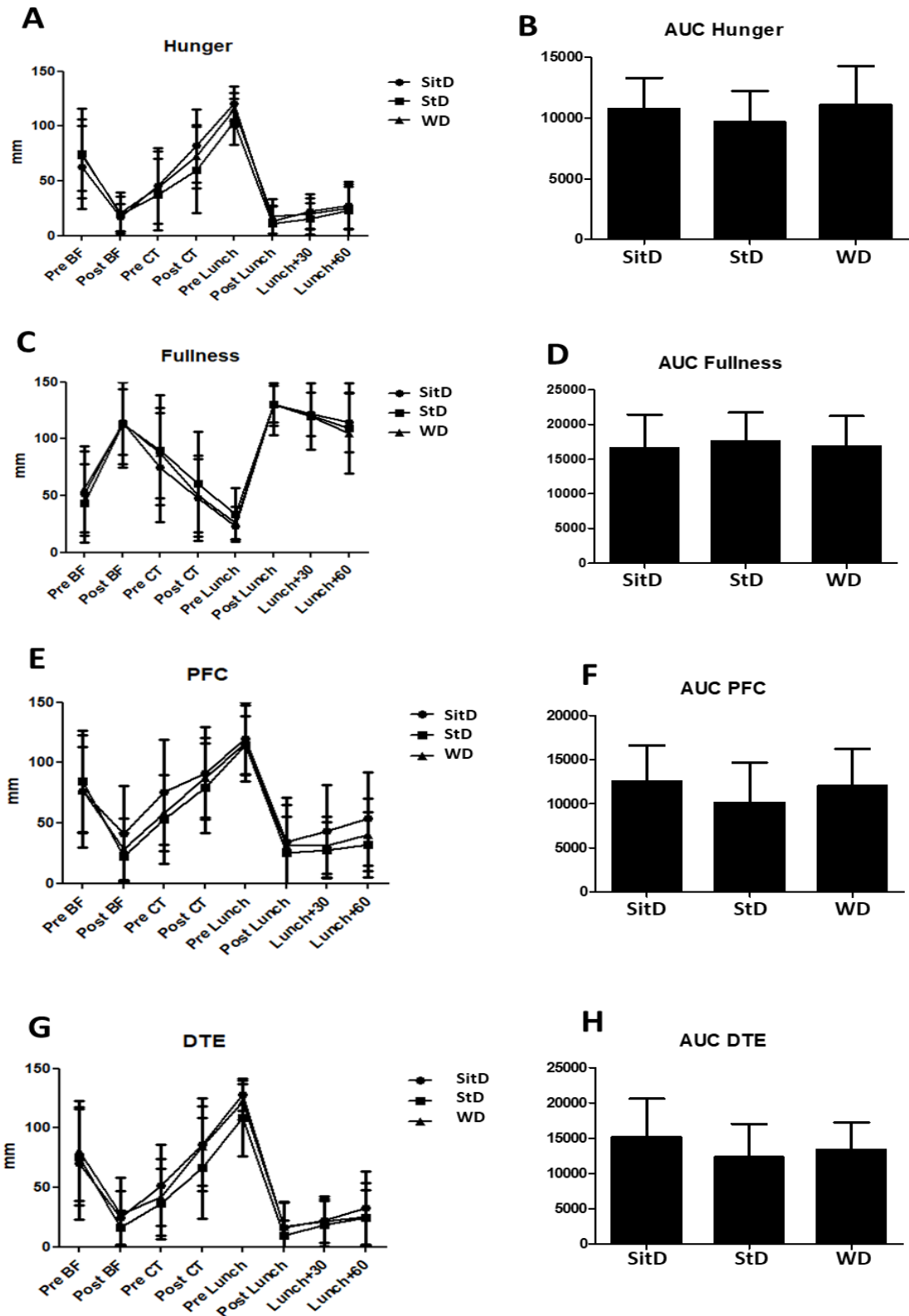
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465 Fig.3



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468 Table 1: Descriptive characteristics of research participants

<b>N=15</b>	
<b>Anthropometrics and body composition</b>	
Age (years)	23.4 ± 2.9
Body weight (kg)	76.8 ± 5.2
Height (cm)	178.4 ± 5.4
BMI (kg/m <sup>2</sup> )	24.2 ± 1.5
Fat mass (%)	17.3 ± 3.6
Fat-free mass (kg)	60.3 ± 4.2
<b>Eating Behaviour Profile</b>	
<i>Three factor eating questionnaire (TFEQ)</i>	
Cognitive dietary restraint	1.62 ± 0.5
Disinhibition	2.27 ± 0.6
Susceptibility to hunger	1.64 ± 0.5
<b>Anxiety Profile</b>	
<i>State Trait Anxiety Inventory (STAI)</i>	
Anxiety – Trait	33.3 ± 5.9
<b>Physical Activity Level</b>	
Sedentary behavior (min/day)	567.3 ± 75.3
Sedentary behavior (% of day)	68 ± 10.2
Light PA (min/day)	210.5 ± 75.1
Light PA (% of day)	24.8 ± 7.7
Moderate to Vigorous PA (min/day)	52.6 ± 24.1
Moderate to Vigorous PA (% of day)	6.4 ± 2.6
Vigorous PA (min/day)	8.2 ± 10.4
Vigorous PA (% of day)	0.9 ± 1.1

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473 Table 2: Implicit wanting and explicit liking for high vs low fat foods and sweet vs savory foods before and after lunch after 45min of mental work done in a  
 474 Sitting (SitD), Standing (StD) position or while walking on a walking Desk (WD).

			SitD	StD	WD	Time	Condition	Interaction time*condition
<b>Implicit Wanting</b>	Fat Bias	Before	15.07 ± 25.6	13 ± 34.1	11.4 ± 31.5	0.25	0.67	0.78
		After	9.2 ± 20.7	8.7 ± 15.2	6.1 ± 18.1			
	Taste Bias	Before	-32.5 ± 34.3	-20.6 ± 42	-24 ± 31.2	<b>0.001</b>	0.56	0.65
		After	55.4 ± 29.9	54.1 ± 27.2	45.9 ± 35.4			
<b>Explicit Liking</b>	Fat Bias	Before	3.3 ± 14.4	5 ± 18.2	5.2 ± 16	0.29	0.54	0.63
		After	5 ± 6.9	4.6 ± 8.9	3.2 ± 10.1			
	Taste Bias	Before	-8.8 ± 15.9	-7.5 ± 23.5	-5 ± 17.2	<b>0.001</b>	0.47	0.43
		After	22 ± 20.8	21.7 ± 15.2	25 ± 19.2			

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476 Table 3: Score at the NASA Task-Load during 45min of mental work done in a Sitting (SitD), Standing (StD) position or while walking on a walking desk  
 477 (WD)

		SitD	StD	WD	Condition
<b>NASA Task- Load index</b>	Total score	58 ± 11.5	60.4 ± 8.2	55.1 ± 10.9	0.37
	Mental demand	64.6 ± 18.5	64.3 ± 15.2	59.3 ± 20.7	0.67
	Physical demand	17.3 ± 12.4	44.6 ± 14.5*	34.3 ± 12.5	<b>0.001</b>
	Temporal demand	58 ± 16.34	50 ± 24.3	47.3 ± 12.8	0.40
	Overall performance	50.6 ± 20.4	49.6 ± 15.5	52 ± 17.8	0.93
	Effort	47.3 ± 21	59.6 ± 13.2	52.6 ± 17.8	0.19
	Frustration	48.3 ± 21.2	49 ± 17.2	44.6 ± 16.8	0.79

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\*Significantly different from SitD condition

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