

1 **Objectively assessed physical activity and sedentary behaviour during**  
2 **pregnancy in Portuguese women: Differences between trimesters and**  
3 **weekdays and weekends**

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1 **Background:** Engaging in physical activity (PA) and reducing sedentary behaviour  
2 (SB) are important for health during pregnancy, yet relatively few studies have  
3 examined these variables using objective measures and across trimesters during  
4 pregnancy.

5 **Objective:** To determine the amount of objectively assessed PA and SB engaged in  
6 whether there was any weekday to weekend day variation in PA and SB during the  
7 first and second trimester of pregnancy.

8 **Method:** PA and SB were determined using accelerometry worn over 7 consecutive  
9 days during each trimester in 137 Portuguese females (mean age  $\pm$  SD = 29.6  $\pm$  5.7).  
10 .

11 **Results:** In regard to the proportion of participants meeting the ACSM guidelines for  
12 PA, 37.5% of the participants in the first trimester and 29.6% of participants in the  
13 second trimester met the cut off of 30min or more of any type of moderate intensity  
14 activity on most (5) days of the week. Moderate intensity PA was significantly lower in  
15 trimester 2 compared to trimester 1 ( $P = 0.003$ ). Moderate intensity PA was also  
16 significantly lower during weekends compared to weekdays irrespective of trimester  
17 ( $P = 0.003$ ). SB, light and vigorous intensity PA were relatively stable from trimester 1  
18 to trimester 2 and between weekdays and weekends ( $P < 0.05$ ).

19 **Conclusion:** The present study suggests that the majority of women do not meet PA  
20 guidelines for health during pregnancy and that moderate intensity PA declines from  
21 trimester 1 to 2 and is lower at weekends.

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23 **Keywords:** Accelerometry; Guidelines; Maternal Health

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## Introduction

Engaging in physical activity (PA) during pregnancy has been identified as one potential approach to reduce risk of prenatal complications including gestational diabetes [1], pre-term birth [2, 3], large and small for gestational age infants [4, 5] and is also important in preventing excessive weight gain during pregnancy [6]. Current guidance recommends 30minutes of moderate intensity PA daily during pregnancy [7, 8, 9]. Despite this, studies examining PA during pregnancy are sparse and even fewer have examined sedentary behaviour during pregnancy. At present we do not know whether PA simply reduces as pregnancy progresses or whether sedentary behaviour also increases at the same time. A recent systematic review has suggested that a more detailed description of PA during pregnancy is needed to develop more effective interventions and to promote health during pregnancy and postpartum [10]. Two recent studies have however examined PA during pregnancy. Di Fabio et al [11] examined objectively assessed PA in 46 participants during the second and third trimesters. They reported that, during the 2<sup>nd</sup> trimester, 52% of time was spent in sedentary behaviour, 13% in light, 3% in moderate and 0% in vigorous PA. Sedentary behaviour increased (but not significantly,  $P = 0.07$ ) and moderate to vigorous PA decreased in the 3<sup>rd</sup> trimester. Hayes et al [12] also assessed PA using accelerometry in 183 British obese women in the first, second and third trimester. They reported that moderate and vigorous PA declined from 4.8% in the first trimester to 3% in the third trimester and that women who were more active in early pregnancy had a higher level of PA later in pregnancy. Hayes et al [12] also reported that sedentary time was 576, 55, and 571 minutes/day in the first, second and third trimesters respectively.

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2 Given the dearth of data relating to PA and SB during pregnancy further work is  
3 needed to examine PA during pregnancy. The studies that have assessed PA during  
4 pregnancy have also not examined whether there are weekday to weekend  
5 differences in PA. Given that there is considerable evidence of weekday to weekend  
6 variation in PA in adulthood [13], a limitation of the studies so far is the lack of  
7 examination of weekday to weekend variation in pregnancy. There appears to be  
8 considerable support for the promotion of PA during pregnancy [1, 10, 11, 12] and for  
9 the development of PA interventions during pregnancy [14, 15]. Understanding the  
10 adherence to PA guidelines, the amount of PA and SB undertaken and whether these  
11 differ from weekdays to weekends throughout pregnancy is important for more  
12 effective targeting of interventions to increase PA and reduce SB. The aim of this study  
13 was twofold, firstly to determine the amount of objectively assessed PA and SB  
14 engaged in during the first and second trimester of pregnancy and secondly, to assess  
15 whether there was any weekday to weekend day variation in PA and SB during  
16 pregnancy.

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## 18 **Methods**

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### 20 *Participants*

21 This prospective study examined a sample of pregnant women attending outpatient  
22 obstetrics clinics in São João Hospital in Porto, Portugal who were recruited and  
23 assessed, at the time of ultrasound screening [16]. This took place from July 2010 to

1 September 2012. Data were collected in two stages. The first stage was between the  
2 10th and 12th weeks of gestation (at the time of baseline assessment, first trimester  
3 (T1)) and the second was between the 20th and 22nd weeks (at the time of the second  
4 ultrasound, second trimester (T2)). Prior to assessment, all participants in this study  
5 were informed of the objectives of the study and gave written informed consent. The  
6 study was approved by the Ethics Committee of the Hospital de São João (Reference  
7 No. 09988) [16]. The inclusion criteria used in this study were spontaneous pregnancy  
8 and gestational age of 10–12 weeks, as confirmed by ultrasound. Women were  
9 considered ineligible if they had severe heart disease (including symptoms of angina,  
10 myocardial infarction or arrhythmia), persistent bleeding after 12 weeks of gestation,  
11 multiple pregnancy, poorly controlled thyroid disease, pregnancy-induced  
12 hypertension or preeclampsia, diabetes or gestational diabetes [17], an age of less  
13 than 18 or over 40 years, lack of competence in the Portuguese language or cognitive  
14 inability to answer a questionnaire [18, 19]. A total of 137 Portuguese females (mean  
15 age  $\pm$  SD = 29.6  $\pm$  5.7) participated in this study. From T1 to T2 there was a loss of  
16 five participants from the overall sample due to withdrawal from the study.

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## 18 *Procedures*

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20 *Anthropometric Measures.* Height was measured in bare feet to the nearest millimetre  
21 using a Holtain portable stadiometer (Crymych, Pembrokeshire, UK). Body mass was  
22 measured, with participants dressed in underwear and a t-shirt, using a portable digital  
23 beam scale (Tanita Inner Scan BC 532, Tokyo, Japan). From these measures, body  
24 mass index (BMI kg/m<sup>2</sup>) was then calculated as a measure of weight status.

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2 *Measurement of Physical Activity and Sedentary Behaviour.* PA and SB were  
3 assessed using accelerometry (GT3X ActiGraph, Pensacola, Florida, USA) in T1 and  
4 T2 which was worn over 7 consecutive days during each trimester. This lightweight,  
5 triaxial monitor has been shown to be technically reliable and valid as a measure of  
6 PA and SB [20]. The accelerometer was worn on the right hip, with the notch facing  
7 upwards. Participants were instructed to use the accelerometer during waking hours  
8 and remove it during water-based activities and whilst sleeping, in keeping with  
9 procedures established by the manufacturer [21]. Each participant also completed a  
10 diary to log relevant information in relation to device wear time. Accelerometers were  
11 setup with an epoch length set to 5 s to allow a more detailed estimate of PA intensity  
12 [22, 23]. The output data were analysed using ActiLife software (ActiLife v6.1.2,  
13 Actigraph, LLC) as per Santos et al [23]. Data files from individual participants were  
14 screened by detecting blocks of consecutive zeros; periods with 60 min of consecutive  
15 zeros were detected and flagged as times in which the monitor was not worn [23, 24].  
16 A day of activity monitoring was considered valid if it included at least 480 min of data  
17 each. Participants also had to have at least four valid days (including one weekend  
18 day) to be included in the analysis. Following data screening, raw activity “counts”  
19 were processed to determine the time spent on activities of different PA intensities  
20 with activity levels expressed in mean counts·min<sup>-1</sup>. The established accelerometer  
21 cutpoints proposed by Freedson, Melanson, and Sirard [25] were used to determine  
22 PA intensities and SB, similar to procedures used previously [23]. Data were  
23 processed into moderate and vigorous PA intensities with results for both intensities  
24 being accumulated. The pregnant women were classified, according to their  
25 adherence to PA recommendations from the American College of Sports Medicine

1 (ACSM) [7] The ACSM suggest 30 min or more of any type of moderate intensity  
2 activity on most (5) days of the week or vigorous if is carried out at least 20 min, three  
3 times per week for the general population and during pregnancy they recommend 30  
4 to 40 minutes or more of moderate physical activity on most, if not all days of the week.  
5 In the current study we therefore present data as time spent in the different intensities  
6 of PA (and SB) and also report the prevalence of participants who met the  
7 aforementioned ACSM recommendations during pregnancy.

8

### 9 *Statistical Analysis*

10 In order to examine any differences in SB, light, moderate and vigorous PA between  
11 weekdays and weekends and from T1 to T2 a series of 2 (weekday vs weekend) X 2  
12 (first trimester vs second trimester) way repeated measures ANOVAS were  
13 conducted. Where any significant differences were found, Bonferroni post-hoc  
14 pairwise comparisons were used to determine where these differences lay.  
15 Recognising that weight status might also influence the dependant variables, the data  
16 were reanalysed using a series of analysis of covariance using BMI and accelerometer  
17 wear time as covariates. This did not change the results from the ANOVA analysis and  
18 is therefore not presented. The Statistical Package for Social Sciences (SPSS inc,  
19 version 22) was used for all analysis and alpha level was set at  $P = .05$  a priori. The  
20 proportion of participants meeting/not meeting the ACSM guidelines was also  
21 determined for each trimester.

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### 23 **Results**



1 In regard to the proportion of participants meeting the ACSM guidelines for PA, 37.5%  
2 of participants in the first trimester and 29.6% of participants in the second trimester  
3 met the cut off of 30min or more of any type of moderate intensity activity on most (5)  
4 days of the week. Average accelerometer wear time (Mean  $\pm$  SD) was 1203.8  $\pm$  252.6  
5 mins and 1178.7  $\pm$  259.1mins for the first trimester and the second trimester  
6 respectively. Repeated measures ANOVA indicated no significant main effects for  
7 trimester ( $P = .131$ ) or weekday vs. weekend ( $P = .362$ ) or trimester X  
8 weekday/weekend interaction ( $P = .913$ ) for SB. This pattern was repeated for light PA  
9 for trimester ( $P = .635$ ), weekday vs. weekend ( $P = .703$ ) and trimester X  
10 weekday/weekend ( $P = .295$ ). For moderate PA there were however significant main  
11 effects for trimester and weekday vs. weekend (Both  $P = .003$ , see Table 1). Bonferroni  
12 post-hoc analysis indicated that moderate PA was significantly lower in T2 compared  
13 to T1 ( $P = .003$ ) and during weekends compared to weekdays ( $P = .003$ ). For vigorous  
14 PA there was no significant main effects for trimester ( $P = .860$ ) or weekday vs.  
15 weekend ( $P = .513$ ) or trimester X weekday/weekend interaction ( $P = .082$ ). Mean  $\pm$   
16 SE of minutes of sedentary, light, moderate and vigorous physical activity (mins) in the  
17 first and second trimester and between weekdays and weekends are shown in Table  
18 1.

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	Sedentary		Light		Moderate		Vigorous	
	M	SE	M	SE	M	SE	M	SE
First Trimester	1084.4	25.2	75.4	4.4	31.2*	1.9	11.7	3.5
Second Trimester	1028.5	30.5	73.5	3.8	25.9*	1.8	11.1	4.7
Weekdays	1044.1	17.3	73.9	3.3	30.8**	1.7	11.1	3.6
Weekends	1068.7	30.8	75.1	4.3	26.3**	2.1	11.6	3.8

2

3 Table 1. Mean  $\pm$  SE of minutes of sedentary, light, moderate and vigorous physical  
4 activity (mins) in the first and second trimester and between weekdays and weekends  
5 in a sample of pregnant Portuguese women (data collected 2010-2012). \* P = .003  
6 from first to second trimester. \*\* P = .003 between weekdays and weekends.

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## 9 Discussion

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11 This study is the first to present both objectively assessed PA and SB data during  
12 pregnancy in Portuguese women across two trimesters. It is also the first study to  
13 examine possible weekday to weekend variation in these variables during pregnancy.  
14 Such data are novel and important in better focusing efforts to enhance PA or reduce  
15 SB during pregnancy. The results of the present study suggest that, similar to findings  
16 for US and UK samples [11, 12], the majority of participants failed to achieve the ACSM

1 PA guidelines for PA during pregnancy in both the first and second trimesters, and  
2 that moderate intensity PA reduces from the first to the second trimester. This  
3 reduction in PA may be a result of hormonal, cardiorespiratory and musculoskeletal  
4 changes that occur during pregnancy, resulting in a lower tolerance to effort for  
5 pregnant women [26]. There is also a possibility that psychological barriers (e.g., views  
6 that PA may be harmful) and physical complaints (e.g., low back pain) increase during  
7 pregnancy resulting in reduced levels of PA. This suggestion is however speculative  
8 and additional research would be needed to determine any effects of psychological  
9 barriers and physical complaints on changes in PA and SB across pregnancy.  
10 Uniquely, the present findings suggest that moderate PA is lower during weekends  
11 compared to weekdays, irrespective of trimester. The data for vigorous PA appear  
12 relatively stable across trimesters and weekdays vs weekends.

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14 In regard to reasons why PA may change during pregnancy, work-related factors have  
15 previously been identified as particularly important barriers to PA during pregnancy,  
16 including lack of time and tiredness due to work [27] and perceptions that sufficient PA  
17 is accumulated during work activities [28]. Furthermore, recent work by Santos et al  
18 [23] has suggested the most common barrier to leisure time PA during pregnancy was  
19 lack of time, 'busyness' and dislike of exercise. Therefore, despite potentially having  
20 more time available for PA at weekends, lower PA levels on weekends may be  
21 attributable to women seeking to rest and recover on non-working days and/or  
22 perception of time constrains and non-liking of exercise.

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24 Despite, the use of objective monitoring of PA and SB in the present study it should  
25 be noted that accelerometers do have limitations including inability to capture

1 contextual information. Such information could be particularly useful if combined with  
2 accelerometry to better develop interventions and focus personalised messaging  
3 approaches to increase PA and reduce SB during pregnancy. This study is also based  
4 on a fairly small sample of participants, however recruitment of pregnant women into  
5 such studies is not as straightforward as recruitment of non-pregnant women. The  
6 present study also provides data for first and second trimesters. Additional studies  
7 should attempt to also include assessment of PA and SB for the third trimester as well  
8 as elucidating any associations between PA and SB with fetal development and birth  
9 outcomes.

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11 Irrespective of these, the presentation of both PA and SB data during weekdays and  
12 weekends does provide useful information for health professionals. This is because  
13 approaches to reducing SB may be different than those designed to increase PA.  
14 Pregnancy is a long life event and may be a powerful “teachable moment” for the  
15 promotion of healthy behaviours. Thus, health care providers should encourage as  
16 soon as possible healthy pregnant women to remain active and reduce SB during  
17 pregnancy. These PA and SB patterns can be used as intervention targets and as  
18 independent or dependent variables in future studies of correlates, determinants, or  
19 outcomes. The results of the present study suggest that the majority of women do not  
20 meet PA guidelines for health during the first and second trimesters of pregnancy that  
21 moderate intensity PA reduces from the first to the second trimester and is lower during  
22 weekends than weekdays irrespective of trimester. Sedentary behaviour and other  
23 intensities of physical activity were relatively stable during pregnancy from the first to  
24 the second trimester.

1 **Conflict of Interest:** None

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