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

Michael J. Duncan[1], Lou Atkinson[1], Sandra Abreu[2,4], Nuno Montenegro[3], Jorge[2] Mota, Paula Clara Santos[5,]

[1]Faculty of Health and Life Sciences, Coventry University, Coventry, UK.

[2]University of Porto, Faculty of Sports/Research Centre in Physical Activity, Health and Leisure–CIAFEL, Porto, Portugal.

[3] Department of Obstetrics & Gynecology, Medicine Faculty, S. João Hospital Center, University of Porto, Porto, Portugal

4 Faculty of Physical Education and Sport, Universidade Lusófona, Lisbon, Portugal

[5]Department of Physiotherapy, School of Health Technology of Porto, Polytechnic Institute of Porto, Porto, Portugal.

Michael J. Duncan: aa8396@coventry.ac.uk

Lou Atkinson: aa4977@coventry.ac.uk

Sandra Abreu: sandramrabreu@gmail.com

Nuno Montenegro: namontenegro@med.up.pt

Paula Clara Santos: paulaclara@estsp.ipp.pt

Jorge Mota: jmota@fade.up.pt

Please address correspondence and requests for reprints to Michael J. Duncan, *Faculty for Health and Life Sciences*, Coventry University, Priory Street, Coventry, United Kingdom, CV1 5FB or email: michael.duncan@coventry.ac.uk

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

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

Method: PA and SB were determined using accelerometry worn over 7 consecutive days during each trimester in 137 Portuguese females (mean age ± SD = 29.6 ± 5.7).
.

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

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

Keywords: Accelerometry; Guidelines; Maternal Health

1

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 2nd 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 3rd 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.

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

Methods

Participants

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

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

Procedures

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

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

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

Statistical Analysis

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

Results

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

	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

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

Discussion

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

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

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

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

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

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

Conflict of Interest: None

References

1. Tobias DK, Zhang C, van Dam RM, Bowers K, Hu FB. Physical activity before and during pregnancy and risk of gestational diabetes mellitus: a meta-analysis. Diabetes Care 2011; 34: 223–9.
2. Both MI, Overvest MA, Wildhagen MF, Golding J, Wildschut HI. The association of daily physical activity and birth outcome: a population-based cohort study. Eur J Epidemiol 2010; 25: 421–9.
3. Juhl M, Andersen PK, Olsen J, Madsen M, Jørgensen T, Nøhr EA, et al. Physical exercise during pregnancy and the risk of preterm birth: a study within the Danish National Birth Cohort. Am J Epidemiol 2008; 167: 859–66.
4. Juhl M, Olsen J, Andersen PK, Nøhr EA, Andersen AM. Physical exercise during pregnancy and fetal growth measures: a study within the Danish National Birth Cohort. Am J Obst Gynecol 2012; 202: e1-63.e8.
5. Phelan S, Hart C, Phipps M, Abrams B, Schaffner A, Adams A, et al. Maternal behaviors during pregnancy impact offspring obesity risk. Exper Diabet Res 2011;(Suppl p1):985139.
6. Jiang H, Qian X, Li M, Lynn H, Fan Y, Jiang H, et al. Can physical activity reduce excessive gestational weight gain? Findings from a Chinese urban pregnant women cohort study. Int J Behav Nutr Phys Act 2012; 9:12.
7. American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription (7th ed.) Lippincott, Williams and Wilkins, Philadelphia, USA, 2006.

8. ACOG. Exercise during pregnancy and the postpartum period. Clin Obstet Gynecol. 2003;46(2):469–99.
9. Royal College of Obstetricians and Gynaecologists. Exercise in pregnancy Statement No.4. London: Royal College of Obstetricians and Gynaecologists; 2006.
10. Sui Z, Dodd JM. Exercise in obese pregnant women: positive impacts and current perceptions. Int J Women's Hlth 2013; 5: 389-398.
11. Di Fabio DR, Blomme CK, Smith KM, Welk GJ, Campbell CG. Adherence to physical activity guidelines in mid-pregnancy does not reduce sedentary time: an observational study. Int J Behav Nutr Phys Act 2015; 12: 27.
12. Hayes L, Mcparlin C, Kinnunen TI, Poston L, Robson SC, Bell R, UPBEAT Consortium. Change in level of physical activity during pregnancy in obese women: findings from the UPBEAT pilot trial. BMC Pregnancy Childbirth 2015; 15: 52.
13. Evenson KR, Wen F, Metzger JS, Herring AH. Physical activity and sedentary behavior patterns using accelerometry from a national sample of United States. adults Int J Behav Nutr Phys Act 2015; 12: 20.
14. Mottola MF, Giroux I, Gratton R, Hammond JA, Hanley A, Harris S, et al. Nutrition and exercise prevent excess weight gain in overweight pregnant women Med Sci Sports Exerc 2010; 42:265–72.
15. Price BB, Amini SB, Kappeler K. Exercise in pregnancy: effect on fitness and obstetric outcomes-a randomized trial. Med Sci Sports Exerc 2012; 44: 2263–2269.

16. Santos PCR. Padrões de atividade física ao longo da gravidez sua influência na lombalgia e nos *outcomes* do recém-nascido. PhD thesis, Faculadae De Desporto, University of Porto 2012. Available from http://www.ciafel.fade.up.pt.
17. Artal R, O'Toole M. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. Br J Sports Med 2003; 37: 6–12.
18. Chasan-Taber L, Schmidt M, Roberts DE, Hosmer D, Markenson G, Freedson PS. Development and validation of a pregnancy physical activity questionnaire. Med Sci Sports Exerc 2004; 36(10): 1750–1760.
19. Ota E, Haruna M, Yanai H, Suzuki M, Anh DD, Matsuzaki M, Murashima S. Reliability and validity of the Vietnamese version of the pregnancy physical activity questionnaire (PPAQ). South Asian J Trop Med Pub Hlth 2008; 39: 562–570.
20. Maddison R, Jiang Y, Hoorn SV, Mhurchu CN, Lawes CM, Rodgers, Rush E. Estimating energy expenditure with the RT3 triaxial accelerometer. Res Q Exerc Sport 2009; 80: 249–256.
21. Ward DS, Evenson KR, Vaughn A, Rodgers AB, Troiano RP. Accelerometer use in physical activity: Best practices and research recommendations. Med Sci Sports Exerc 2005; 37; SS582–SS588.
22. Matthews CE, Hagströmer M, Pober DM, Bowles HR. Best practices for using physical activity monitors in population-based research. Med Sci Sports Exerc 2012; 44: SS68–SS76.

23. Santos PC, Abreu S, Moreiea C, Lopes D, Santos R, Alves O, Silva P, Montenegro N. Impact of compliance with different guidelines on physical activity during pregnancy and perceived barriers to leisure physical activity. J Sports Sci 2014; 32: 1398-1408.
24. Troiano RP, Berrigan D, Dodd K, MÂSSE LC, Tilert T. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc 2008; 40: 181–188.
25. Freedson PS, Melanson E, Sirard J, Calibration of the Computer Science and Applications, Inc. accelerometer. Med Sci Sports Exerc 1998; 30: 777–781.
26. Melzer K, Schutz Y, Boulvain M, Kayser B. Physical activity and pregnancy: cardiovascular adaptations, recommendations and pregnancy outcomes. Sports Med 2010; 40: 493-507.
27. Evenson KR, Moos MK, Carrier MK, Siega-Riz AM. Perceived Barriers to Physical Activity Among Pregnant Women. Mat Child Hlth J 2009; 13; 364-375.
28. Connelly M, Brown H, van der Pligt P, Teychenne M. Modifiable barriers to leisure-time physical activity during pregnancy: a qualitative study investigating first time mother's views and experiences. BMC Preg Childbirth 2015;15:100.