Impact of compliance with different guidelines on physical activity during pregnancy and perceived barriers to leisure physical activity

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Abstract
The aims of the this prospective study were to analyze physical activity (PA) engagement during the first and second trimesters, considering the different guidelines published on PA, to document the individual characteristics associated with the accomplishment of these guidelines and to examine pregnant women's perceived barriers to leisure PA, using a socioecological framework. A sample of 133 pregnant women in two stages – at 10–12 weeks' gestation (T1) and 20– 22 weeks' gestation (T2) – were evaluated. PA was assessed by accelerometry during the T1 and T2 evaluation stages.
Socio-demographic characteristics, lifestyle factors and barriers to leisure PA were assessed via questionnaire. A large proportion of women (ranging from 32% to 96%) did not reach the levels of PA recommended by the guidelines. There were no significant differences between T1 and T2 with regard to compliance with PA recommendations. A decrease in PA levels from T1 to T2 was noted for all recommendations. No associations were found between participants' characteristics and adherence to the recommendations in T1 and T2. No significant differences were found in barriers to leisure PA between T1 and T2. The most commonly reported barriers to leisure PA were intrapersonal, not health related. Our results indicate that there were no differences between trimesters regarding compliance of PA recommendations, and perceived barriers were similar in both trimesters.

Keywords: physical activity, pregnancy, guidelines, barriers, socioecological model

Introduction

The leading health indicators from Healthy People 2010 recommend that physical activity (PA) be one of the greatest priorities in the enhancement of women's health (Maiese, 2002). PA plays a major role in preventing such chronic diseases as hypertension, type 2 diabetes and overweight/obesity, all of which are significant risk factors for cardiovascular disease (Caperchione, Kolt, Tennent, & Mummery, 2011; Clarke & Gross, 2004; Haakstad & Bø, 2011). During pregnancy, PA is also associated with reduced risk of preeclampsia, gestational diabetes and preterm birth, as well as improved pain tolerance, lower total weight gain and less fat mass gain and improved self-image (Gaston & Cramp, 2011).
For these reasons, many PA guidelines were provided. The American College of Obstetricians and Gynecologists (ACOG, 2002) encourages pregnant women without obstetric or medical problems to engage in regular PA. The Centers for Disease Control and Prevention (CDC) (Pate et al., 1995), American College of Sports Medicine (ACSM, 2006) and United States Department of Health & Human Services (USDHHS, 2008) support ACOG's advice, although their recommended parameters for PA are somewhat different (type, duration, intensity and frequency).
Pregnancy is a life-changing event that can initiate an adverse change in PA (Borodulin, Evenson, Wen, Herring, & Benson, 2008), and meeting PA guidelines during pregnancy can therefore be a challenge.
Some studies examining leisure PA during pregnancy have found a significant decrease in all summary measures of PA during pregnancy (Poudevigne & O'Connor, 2006). The largest decreases have been observed in sports and leisure PA (Clarke & Gross, 2004). Reduction of PA can have both acute implications for pregnant women (Hegaard, Pedersen, Nielsen, & Damm, 2007; Lokey, Tran, Wells, Myer, & Tran, 2004; Pivarnik et al., 2006) and long-term health implications (obesity, diabetes, hypertension and cardiovascular disease) for women who have been pregnant (Cramp & Brawley, 2009; Warburton, Nicol, & Bredin, 2006). Nonetheless, we found few studies where PA patterns during pregnancy were analyzed in comparison to different PA recommendations, and so limited conclusions can be drawn about women's adherence to PA guidelines during pregnancy (Borodulin et al., 2008; Pereira et al., 2007). To understand why a large percentage of pregnant women do not engage in PA, some authors have examined the

demographic correlates of leisure PA participation, including income (Ning et al., 2003), education (Clarke & Gross, 2004; Evenson, Savitz, Savitz, & Huston, 2004; Ning et al., 2003), ethnicity, marital status (Hinton & Olson, 2001) and parity (Hegaard et al., 2011; Mottola & Campbell, 2003; Zhang & Savitz, 1996). The association of each of these variables and engagement in PA is inconclusive, since some studies have found a positive association and others have found a negative association or no association at all (Gaston & Cramp, 2011). However, demographic correlates are only informative. Social cognitions may be more easily modified and, therefore, targeted for intervention. Perceived barriers to or constraints on PA are the most frequently cited correlates of physical inactivity during pregnancy (Gaston & Cramp, 2011), although they are still not well understood (Evenson, Moos, Carrier, & Siega-Riz, 2009) as studies of this topic have some limitations. Since pregnancy is characterised by many physical and behavioural changes, it is plausible that barriers encountered early in pregnancy might be different from those encountered in the second trimester. Thus, it may be pertinent to analyse barriers to PA during pregnancy by phase (e.g. by trimester), rather than as a whole. Besides, such barriers have sometimes been recalled retrospectively, which raises concerns about the validity of recall (Cramp & Bray, 2009). The socioecological framework is a comprehensive, multifaceted health promotion model that takes into account the relationships among multiple factors (McLeroy, Bibeau, Steckler, & Glanz, 1988; Sallis, Owen, & Fisher, 2008). Thus, this model may be useful when studying barriers to PA, since interventions designed to change behaviour should consider multiple dimensions simultaneously and comprehensively (Evenson et al., 2009). It is recognised that pregnancy may be a critical period for the onset of inactivity in women (Haakstad, Voldner, Henriksen, & BØ, 2009). The published activity guidelines of the ACOG, CDC, ACSM and USDHHS differ substantially, and it is important to understand how differences in these guidelines interfere with pregnant women's accomplishment of recommended PA levels (ACOG, 2002; ACSM, 2006; Pate et al., 1995; USDHHS, 2008). Besides, knowledge about barriers to PA may be useful when planning health promotion and preventive programs (Cramp & Bray, 2009; Haakstad et al., 2009). Thus, the purpose of this study was to analyse PA engagement during the first and second trimesters of pregnancy, with reference to the different PA guidelines published, to document the individual characteristics associated with adherence to these guidelines and to examine pregnant women's perceived barriers to leisure PA, using a socioecological framework.

Methods

Study design and sample

This was a prospective study focused on a consecutive sample of pregnant women attending outpatient obstetrics clinics in São João Hospital in Porto, Portugal. Women were recruited and assessed when they came in for ultrasound evaluation screenings from July 2010 to May 2012. All follow-up procedures for this study were completed by 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) and the second was between the 20th and 22nd weeks (at the time of the second ultrasound).

All participants in this study were informed of its objectives and provided written informed consent for their participation. The study was approved by the Ethics Committee of the Hospital de São João (Reference No. 09988); it was conducted in accordance with the World Medical Association´s Helsinki Declaration for Human Studies. 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 (Artal & O'Toole, 2003), an age of less than 18 or over 40 years, lack of competence in the Portuguese language or cognitive inability to answer a questionnaire (Chasan-Taber et al., 2004; Ota et al., 2008).

A total of 137 pregnant women were invited to participate in the study and 133 agreed to take part. Of those who agreed to participate, 102 and 97 completed all assessment in the first and second trimesters, respectively. The final sample, which included women who participated in both trimesters, consisted of 82 women. Pregnant women were subsequently excluded because of miscarriage (n = 1), no singleton pregnancy (n = 2) and age (n = 1) (Figure 1). Furthermore, the accelerometer data from 13 participants were excluded because they were lost or unusable, in some cases due to problems with their PA monitors; 17 women were excluded due to non-compliance with the requisites for analysis and 8 women dropped out.

There were no significant differences in the variables tested (age, educational level, marital status, professional status, monthly income, pre-pregnancy body mass index (BMI) and parity) between the final pair sample (n = 82) and the baseline sample (n = 133).

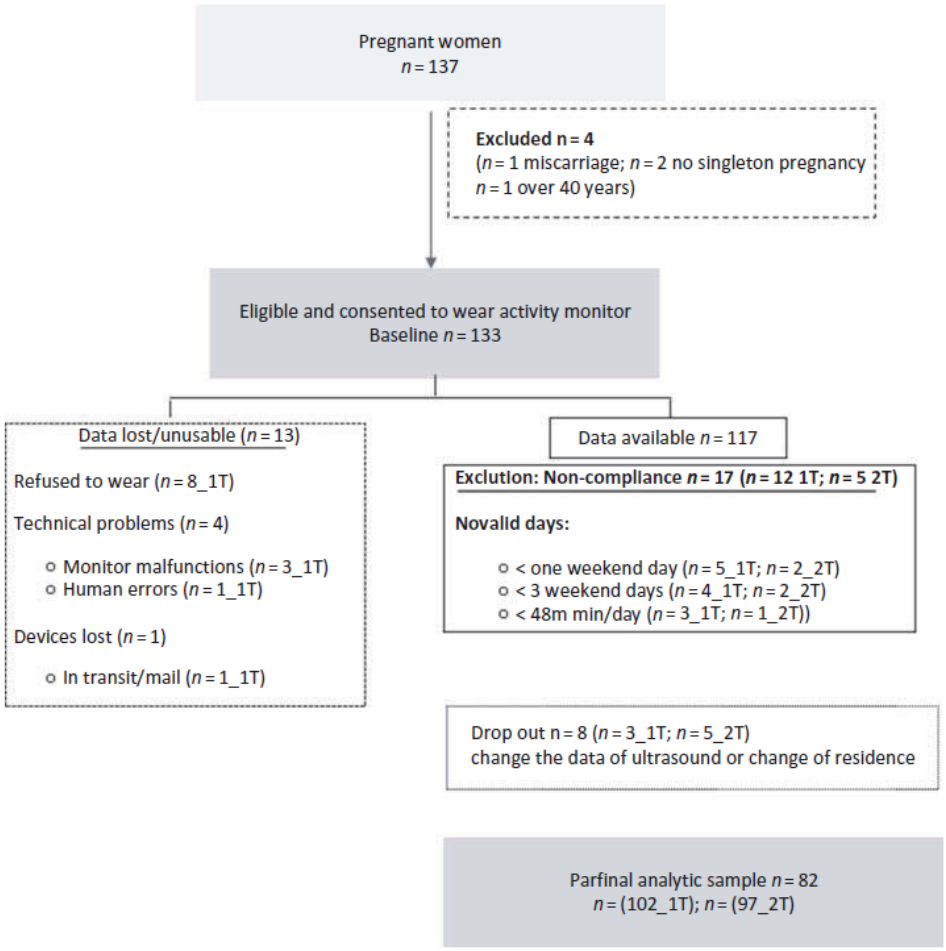

Figure 1. Flowchart of exclusions/losses and reporting physical activity monitoring results.

Assessment instruments/outcome measure
Data were collected at the time of ultrasound by researchers who administered structured and selfreported questionnaires. The questionnaires were designed to cover personal and socio-demographic data, lifestyle variables, health status during pregnancy and gynaecologic history.

Anthropometric measures. Height was measured to the nearest millimetre in bare or stocking feet, with participants standing upright against a Holtain portable stadiometer (Crymych, Pembrokeshire, UK). Weight was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and t-shirt) and with the use of a portable digital beam scale (Tanita Inner Scan BC 532, Tokyo, Japan) Pre-pregnancy BMI was estimated from selfreported weight and height, using the formula BMI = weight (kg)/height$_2$ (m$_2$). BMI was categorized according to the Institute of Medicine (IOM, 2009) guidelines: underweight, normal weight, overweight and obese.

Socio-demographic and obstetric variables. Professional status was assessed via a self-report questionnaire, and participants were divided into three categories: employed (full-and part-time), unemployed and student. Since there were only two participants in the student category, those were pooled with members of the employed category. Respondents were asked to estimate the total income (including pensions, allowances and investments) received by all household members in the last month and to indicate this using a single measure comprised of three narrowly ranged income categories. For the variable educational level, participants were divided into three categories, reflecting the organisation of the Portuguese educational system: mandatory or less (≤9 school years), secondary (10–12 school years) and college/university (>12 school years). Concerning number of gestations, women were considered primigest if this was their first gestation and multigest if they had at least one previous gestation.

PA *measurement*. The accelerometer GT3X Actigraph (ActiGraph, Pensacola, Florida, USA) was used to obtain detailed and objective information about daily PA over 7 consecutive days. This lightweight, triaxial monitor was the latest model available from the manufacturer at the time of data collection, and studies

have demonstrated that it is a technically reliable instrument, both within and across monitors (Maddison et al., 2009). The accelerometer was attached tightly to the hip, on the right side, with the notch facing upwards, and participants were instructed to use it during waking hours and remove it during water-based activities or while sleeping, in keeping with procedures established by the manufacturer (Ward, Evenson, Vaughn, Rodgers, & Troiano, 2005). A diary to log relevant information in wearing the device was provided. Accelerometers were setup with an epoch length set to 5 s to allow a more detailed estimate of PA intensity (Matthews, Hagströmer, Pober, & Bowles, 2012). The output data were analysed by the software provided by the company (ActiLife v6.1.2, Actigraph, LLC) that provided options for screening the data and computing outcomes. 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 (Troiano et al., 2008). Valid days included at least 480 min of data each, and participants had to have at least four valid days to be included (three working days and one nonworking day). Nonwear time was adjusted for by averaging activity counts over the total wear time only (i.e. 24 h – nonwear time; Evenson & Terry, 2009). After the screening was completed, the raw activity "counts" were processed to determine the time spent on activities of different PA intensities. Activity levels were expressed in mean counts·min^{-1}. The established accelerometer cutpoints proposed by Freedson, Melanson, and Sirard (1998) were used to determine PA intensities. To verify the participant's compliance of the PA guidelines, data were processed into moderate and vigorous PA intensities. The targeted results for both intensities were accumulated during the day and not in specific bouts of time.

The pregnant women were divided into four groups, according to their adherence to PA recommendations from the ACOG (2002), CDC (Pate et al., 1995), ACSM (2006) and USDHHS 2008).

The ACOG and the CDC/ACSM suggest 30 min or more of moderate-intensity activity on most (5) days of the week, but they differ on type of activity, as ACOG recommends only exercise and CDC/ ACSM recommends any type of PA. The ACSM's recommendation for vigorous exercise includes any type of activity that is vigorous and is carried out at least 20 min, three times per week. For pregnant women, USDHHS recommends ≥150 min (2 h and 30 min) of moderate-intensity aerobic activity per week. We created four recommended activity levels: (1) ACOG moderate ("American College of Sports Medicine Position Stand. The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness, and flexibility in healthy adults," 1998); (2) CDC moderate, (3) ACSM moderate to vigorous and (4) USDHHS moderate (Borodulin et al., 2008).

Women were considered to be engaged in leisure PA when they responded affirmatively to the question: "Currently, do you practice some form of leisure PA (like swimming, gymnastics, aerobics, cycling, walking)?"

Barriers according to the socioecological framework. All women who said that they engaged in no leisure PA in their first and second trimesters were asked about their reasons for not performing leisure PA. A table with types of barriers to leisure PA was constructed based on Evenson's study (Evenson et al., 2009); it included such possible answers as lack of time, work or social conflicts, being too busy, concern about the baby, not wanting to overdo it, medical necessity, dislike of exercise, lack of motivation, incontinence, lower back pain, pelvic pain, other medical conditions, having no one to exercise with, not having access to enough recreational facilities and not being able to afford such facilities. Participants had to indicate whether each option was considered as a barrier. Any barriers not listed in questionnaire could be listed by participants in a free-response section. The types of barriers were grouped by socioecological framework [i.e. intrapersonal (health and not health related), interpersonal, neighbourhood/ environmental and policy] (Sallis et al., 2008).

Procedures

The assessment instruments (questionnaires, anthropometric measures and accelerometer) were individually administered on ultrasound evaluation days. The women received a phone text message reminding them of how to use the accelerometer and the date of its return. The accelerometer was returned on the following week, in the hospital or by mail.

The assessment methods were common to the two evaluation moments and measured perceived barriers to leisure PA. The characterization questionnaire was applied exclusively in the first stage, and the accelerometry assessment was done in both stages (first and second trimesters).

Statistics

For statistical analysis, we used the software PASW Statistics 18 (SPSS® IBM Corporation, Route 100) for Windows 7®. A P-value of <0.05 was regarded as significant. Descriptive data are presented as means and standard deviations, unless otherwise stated. Associations between variables were analyzed via statistical

inference – specifically, using the Chisquare test or Fisher's exact test. Yates' continuity correction was used for analysis of 2 × 2 contingence tables. McNemar's test was used to compare paired proportions.

Results

At baseline, the mean age of participants was 30.4 ± 5.5 years. Almost half reported mandatory educational levels or less. Most were married or cohabitating and were employed. More than half were primigest, and 40% were overweight or obese before pregnancy (Table I).

Recommend PA levels

The proportion of women reaching ACOG's recommended level of PA during their first and second trimesters was less than 5%. About one-third of women reached the CDC's and ACSM's PA recommendations. The USDHHS recommendations had the highest percentage of accomplishment (68.3% and 57.3% in the first and second trimesters, respectively) (Table II).

Table I. Descriptive characteristic of sample at baseline.

	n	*n* (%)
Age (years)	133	
[18, 30]		67 (50.4)
[31, 40]		66 (49.6)
Educational level	132	
Mandatory or less		55 (41.7)
Secondary		41 (31.1)
College/university		36 (27.3)
Marital status	132	
Married/cohabitating		97 (73.5)
Single/divorced		35 (26.5)
Professional status	132	
Employed/student		100 (75.8)
Unemployed		32 (24.2)
Monthly income (€)	121	
<500		33 (27.3)
[500 – 1250]		60 (49.6)
≥1250		28 (23.1)
Pre-pregnancy weight status	133	
Underweight		2 (1.5)
Normal weight		78 (58.6)
Overweight/obese		53 (39.9)
Parity	133	
Primigest		77 (57.9)
Multigest		56 (42.1)

The percentages of women who met the PA recommendations of the ACOG, CDC, ACSM and USDHHS in both trimesters were 2.4%, 18.3%, 24.4% and 51.2%, respectively. The percentages of women who did not meet these recommendations in both trimesters were 93.9%, 58.5%, 52.4% and 26.6% (data not shown).

As concerns the paired sample, there were no significant differences between first and second trimesters in compliance with the PA recommendations of the CDC, ACSM and USDHHS ($P > 0.05$ for all). However,

a decrease in PA levels from the first to the second trimesters was noted for all recommendations, except the ACOG.

As regards the different PA recommendation groups, no associations were found between the participants' characteristics (socio-demographic, obstetric and behavioural) in the first and second trimesters ($P > 0.05$ for all, Table III).

Barriers to PA, according to the socioecological framework No statistically significant differences were found in the socioecological barriers to leisure PA between the first and second trimesters ($P > 0.05$ for all). The most commonly reported barrier to leisure PA in pregnancy was intrapersonal, not health related (Table IV). The non-health-related factors most frequently cited for not participating in PA were lack of time, busyness and dislike of exercise.

Table II. The definitions and proportion of pregnant woman who reached the recommended level of physical activity at 10–12 weeks (first trimester) and 20–22 weeks of gestation (second trimester) by the American College of Obstetricians and Gynecologists (ACOG), the Centers for Disease Control and Prevention (CDC) and the American College of Sports Medicine (ACSM) and United States Department of Health & Human Services (USDHHS).

	Definition			Reaching recommendation for total sample [*n* (%)]		Reaching recommendation for pairs sample [*n* (%)]		
	Type of activity	Frequency and duration	Intensity (Freedson et al. cut-points)*	First trimester *n* = 102	Second trimester *n* = 97	First trimester *n* = 82	Second trimester *n* = 82	*P*[1]
ACOG	Exercise	Accelerometry and diary ≥5 days + 30 min (moderate intensity)	Moderate (2491–5944 counts/min)	8 (7.8)	8 (8.2)	3 (3.7)	4 (4.9)	na
CDC	Any	≥5 days + 30 min (moderate intensity)	Moderate (2491–5944 counts/min)	34 (33.3)	24 (24.7)	28 (34.1)	21 (25.6)	0.167
ACSM	Any	≥5 days + 30 min (moderate intensity) or >3 days + 20 min (vigorous intensity)	Moderate (2491–5944 counts/min) or vigorous (>5944 counts/min)	39 (38.2)	29 (29.9)	33 (40.2)	26 (31.7)	0.164
USDHHS	Any	≥150 min (2 h and 30 min) of moderate-intensity aerobic activity per week	Moderate (2491–5944 counts/min)	69 (67.2)	58 (59.8)	56 (68.3)	47 (57.3)	0.064

Notes: na, not applicable; *(Freedson et al., 1998); [1] Analysis by McNemar's test.

Health-related factors that were frequently mentioned included lower back pain and pelvic pain.

Interpersonal barriers to leisure PA were infrequently mentioned by participants (less than 1%). Moreover, in the first and second trimesters, 13.3% and 10.2% of participants cited neighbourhood or environmental factors as barriers to leisure PA during pregnancy. Concerning policy barriers, less than 4% expressed concern about the costs associated with the practice of leisure PA.

Discussion

Recommended PA levels In this study, there were no significant differences between the first and second trimesters in compliance with the PA recommendations of the CDC, ACSM and USDHHS. However, a tendency for PA levels to decrease from the first to second trimesters was noticed for all recommendations. Thus, previous studies show that there is greater adherence to PA during the first trimester and a tendency for PA to decrease during pregnancy generally (Borodulin et al., 2008; Fell, Joseph, Armson, & Dodds, 2009; Gaston & Cramp, 2011; Poudevigne & O'Connor, 2006; Rousham, Clarke, & Gross, 2006). Lack of adherence to PA recommendations is mainly due to unawareness (Gouveia et al., 2007; Haakstad et al., 2009), beliefs (Duncombe, Wertheim, Skouteris, Paxton, & Kelly, 2009; Evenson & Bradley, 2010) and barriers (Cramp & Bray, 2009; Evenson & Wen, 2010; Hegaard et al., 2011). In this study, compliance with PA guidelines varied between 4% (ACOG) and 68% (USDHHS), depending on the type of recommendation, measurement of intensity and frequency of PA. All PA recommendations resulted in higher PA levels than the ACOG recommendation, because the ACOG recommendation only concerns exercise and thus is more restrictive. The low levels of adherence to ACOG PA recommendations may be due to the low frequency of leisure PA before becoming pregnant; in Portugal, more than 90% of women between 20 and 49 years do not exercise on a regular basis (Camões & Lopes, 2008).

However, Borodulin et al. (2008) have estimated that the prevalence of sufficiently active women varies between 3% (ACOG) and 38% (ACSM). The discrepancies between Borodulin's study and ours may be due to differences in sample characteristics (the women in Borodulin's study were older and had higher

educational levels and 71.6% were non-Hispanic whites). Furthermore, the evaluation moments were different in both studies (17–22 and 27–30 weeks in Borodulin's study; 10–12 and 20– 22 weeks in our study), as well as the methods of assessing PA levels. In the present study, PA was assessed by accelerometry, whereas in the Borodulin study, it was measured using a questionnaire. However, these two instruments have poor absolute agreement, especially in the third trimester (Harrison, Thompson, Teede, & Lombard, 2011).

Table III. Association between participant's characteristics and main barriers to physical activity, according to compliance with different physical activity recommendations.

	First trimester										Second trimester									
		CDC			ACSM			USDHHS				CDC			ACSM			USDHHS		
		Yes	No		Yes	No		Yes	No			Yes	No		Yes	No		Yes	No	
	n^1	*n* (%)	*n* (%)	P^1	*n* (%)	*n* (%)	P^1	*n* (%)	*n* (%)	P^1	*n*	*n* (%)	*n* (%)	P^1	*n* (%)	*n* (%)	P^1	*n* (%)	*n* (%)	P^1
Age (years)	102			0.159			0.289			0.635	97			0.947			0.874			0.930
[18, 30]		12 (26.1)	34 (73.9)		15 (32.6)	31 (67.4)		30 (65.2)	16 (34.8)			10 (23.3)	33 (76.7)		12 (27.9)	31 (72.1)		25 (58.1)	18 (41.9)	
[31, 40]		22 (39.3)	34 (60.7)		24 (42.9)	32 (57.1)		39 (69.6)	17 (30.4)			14 (25.9)	40 (74.1)		17 (31.5)	37 (68.5)		33 (61.1)	21 (38.9)	
Educational level	111										97									0.091
Mandatory or less		11 (28.9)	27 (71.1)	0.691	16 (42.1)	22 (57.9)	0.803	23 (60.5)	15 (39.5)	0.127		6 (17.1)	29 (82.9)	0.214	9 (25.7)	26 (74.3)	0.682	19 (54.3)	16 (45.7)	
Secondary		11 (34.4)	21 (65.6)		11 (34.4)	21 (65.6)		22 (81.2)	6 (18.8)			11 (35.5)	20 (64.5)		11 (35.5)	20 (64.5)		22 (71.0)	9 (29.0)	
College/university		12 (38.7)	19 (61.3)		12 (38.7)	19 (61.3)		19 (61.3)	12 (38.7)			7 (22.6)	24 (77.4)		9 (29.0)	22 (71.0)		20 (64.5)	11 (35.5)	
Marital status	111										97									0.430
Married/cohabitate		25 (32.1)	53 (67.9)	0.528	29 (37.2)	49 (62.8)	0.586	51 (65.4)	27 (34.6)	0.443		18 (23.4)	59 (76.6)	0.748	23 (29.9)	54 (70.1)	na	44 (57.1)	33 (42.9)	
Single/divorced		9 (39.1)	14 (60.9)		10 (43.5)	13 (56.5)		17 (73.9)	6 (26.1)			6 (30.0)	14 (70.0)		6 (30.0)	14 (70.0)		14 (70.0)	6 (30.0)	
Professional status	101										97									0.855
Employed/student		27 (34.6)	51 (65.4)	0.709	31 (39.7)	47 (60.3)	0.668	54 (69.2)	24 (30.8)	0.452		21 (26.2)	59 (73.8)	0.662	25 (31.2)	55 (68.8)	0.734	47 (58.8)	33 (41.2)	
Unemployed		7 (30.4)	16 (69.6)		8 (34.8)	15 (65.2)		14 (60.9)	9 (39.1)			3 (17.6)	14 (82.4)		4 (23.4)	13 (76.5)		11 (64.7)	6 (35.3)	
Monthly income (€)	92										91									
<500		7 (28.0)	18 (72.0)	0.142	10 (40.0)	15 (60.0)	0.070	17 (68.0)	8 (32.0)	0.970		7 (30.4)	16 (69.6)	0.286	9 (39.1)	14 (60.9)	0.368	14 (60.9)	9 (39.1)	0.969
[500–1250[		17 (39.5)	26 (60.5)		19 (44.2)	24 (55.8)		28 (65.1)	15 (34.9)			12 (27.3)	32 (72.7)		12 (27.3)	32 (72.7)		27 (61.4)	17 (38.6)	
≥1250		4 (16.7)	20 (83.3)		4 (16.7)	20 (83.3)		16 (67.7)	8 (33.3)			3 (12.5)	21 (87.5)		5 (20.8)	19 (79.2)		14 (58.3)	10 (41.7)	
Pre-pregnancy BMI	102									0.108	97									0.357
Non-overweight*		23 (39.7)	35 (60.3)		25 (43.1)	33 (56.9)	0.245	43 (74.1)	15 (25.9)			14 (25.9)	4.(74.1)	0.947	19 (35.2)	35 (64.8)	0.293	35 (64.8)	19 (35.2)	
Overweight/obese		11 (25.0)	33 (75.0)		14 (31.8)	30 (68.2)		26 (59.1)	18 (40.9)			10 (23.3)	33 (76.7)		10 (23.3)	33 (76.7)		23 (53.5)	20 (46.5)	
Parity	102	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)		97	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
Primiparous		16 (27.1)	43 (72.9)	0.119	17 (28.8)	42 (71.2)	0.022	42 (71.2)	17 (28.8)	0.371		15 (26.8)	41 (73.2)	0.759	16 (28.6)	40 (71.4)	0.913	34 (60.7)	22 (39.3)	0.995
Multiparous		18 (41.9)	25 (58.1)		22 (51.2)	21 (48.8)		27 (62.8)	16 (37.2)			9 (22.00)	32 (78.0)		13 (31.7)	28 (68.3)		24 (58.5)	17 (41.5)	
Smoke	101										97									
Yes		13 (76.5)	4 (23.5)	0.408	13 (76.5)	4(23.5)	0.185	6 (35.3)	11 (64.7)	0.784		11 (78.6)	3 (21.4)	na	11 (78.6)	3 (21.4)	0.544	4 (28.6)	10 (71.4)	0.392
No		54 (64.3)	30 (35.7)		49 (58.3)	35 (41.7)		27 (32.1)	57 (67.9)			62 (74.7)	21 (25.3)		57 (68.7)	26 (31.3)		35 (42.2)	48 (57.8)	
Exercise pre-pregnancy	101										97									
Yes		19 (70.4)	8 (29.6)	0.643	16 (59.3)	11 (40.7)	0.820	12 (44.4)	15 (55.6)	0.153		18 (75.0)	6 (25)	0.973	15 (62.5)	9 (37.5)	0.441	11 (45.8)	13 (54.2)	0.632
No		48 (64.9)	26 (35.1)		46 (62.2)	28 (37.8)		21 (28.4)	53 (51.6)			55 (75.3)	18 (24.3)		53 (73.6)	20 (27.4)		28 (38.4)	45 (61.6)	

Notes: na, not applicable; BMI, body mass index; CDC, Centers for Disease Control and Prevention; ACSM, American College of Sports Medicine; USDHHS, United States Department of Health & Human Services.

*Non-overweight pre-pregnancy BMI includes underweight and normal weight women.

[1]Analysis by χ^2 test or Fisher's test when appropriate.

Table IV. Survey participants' main barriers to physical activity, according to the socioecological framework at 10–12 weeks (first trimester) and 20–22 weeks of gestation (second trimester).

Barriers according to the socioecologic framework	Reasons for not engage in leisure PA	Total sample		Pairs sample		P^1
		First trimester n = 123* n (%)	Second trimester n = 105** n (%)	First trimester n = 98	Second trimester n = 98	
Intrapersonal						
Not health related						
	Lack of time, work or social conflicts, too busy	71 (57.7)	62 (59.0)	61 (62.2)	59 (60.2)	0.850
	Concerned for the baby, does not want to overdo it	16 (13.0)	10 (9.5)	13 (13.3)	10 (10.2)	0.581
	Medical indication	6 (4.9)	7 (6.7)	6 (6.1)	6 (6.1)	na
	Dislike exercise	24 (19.5)	21 (20.2)	18 (18.4)	21 (21.4)	0.629
	Lack of motivation	7 (5.7)	4 (3.8)	6 (6.1)	4 (4.1)	0.727
Health-related						
	Lack of urine	3 (2.4)	2 (1.9)	2 (2.0)	2 (2.0)	na
	Lower back pain	16 (13.0)	11 (10.5)	13 (13.3)	10 (10.2)	0.648
	Pelvic pain	9 (7.3)	12 (11.4)	7 (7.1)	11 (11.2)	0.554
	Other medical conditions	3 (2.4)	1 (1.0)	1 (1.0)	0 (0)	na
Interpersonal						
	No one to exercise with	1 (0.8)	1 (1.0)	1 (1.0)	1 (1.0)	na
Neighbourhood or environmental						
	Not enough recreational facilities	17 (13.8)	11 (10.6)	13 (13.3)	10 (10.2)	0.607
Policy						
	Too costly	3 (2.4)	4 (3.8)	3 (3.1)	4 (4.1)	na

Notes: na, not applicable. *1T_12 women did leisure PA; **2T_10 women did leisure PA; [1]Analysis by McNemar's test.

Moreover, the Borodulin study did not evaluate the USDHHS PA guidelines, to which a greater number of women adhere, since these recommendations are the least demanding.

This study provides new information on the compliance with different PA recommendations among pregnant women. Pregnant women are a risk group for inactivity or reduction of PA. There is substantial evidence to show that physical inactivity is a major contributor to death and disability from non-communicable diseases worldwide. Increasing levels of PA is one such priority (Beaglehole et al., 2011). In our sample, the application of CDC/ ACSM/USDHHS definition resulted in higher percentage of guidelines accomplishment than the ACOG moderate-intensity exercise definition. Based on our results and supported by literature, we must promote the guidelines on how to recommend any type of activity (CDC/ACSM and USDHHS) and not only exercise (ACOG). Within a socioecological framework, this study also explored barriers to being active during pregnancy, the socio-demographic characteristics of inactive pregnant women and compliance with different PA guidelines. The results showed no significant association between barriers and the variables studied (age, educational level, marital status, professional status, monthly income, pre-pregnancy BMI, parity, smoking and leisure PA pre-pregnancy).

The findings of previous literature on the sociodemographic characteristics and lifestyle factors associated with PA during pregnancy have been inconsistent. According to Camões and Lopes (2008), with Portuguese pregnant women, there is a relationship between socio-demographic and behavioural factors and adherence to PA. The authors of this study reported a greater predisposition to PA in women who had higher monthly incomes and higher educational levels and were single (not married or with a partner), in contrast to women who were smokers and who were more predisposed to inactivity. Likewise, Fell et al. (2009) and (Hegaard et al., 2011) found that younger women who were nulliparous and who did not perform leisure PA before pregnancy were at higher risk of being less active. On the other hand, the findings of some other studies have been in line with the results of the present study, reporting no significant associations between PA and age (Chasan-Taber et al., 2007; Mottola & Campbell, 2003; Watson & McDonald, 2007), education level (Chasan-Taber et al., 2007; Clarke & Gross, 2004), marital status (Fell et al., 2009; Mottola & Campbell, 2003; Mudd, Nechuta, Pivarnik, & Paneth, 2009), parity (Chasan-Taber et al., 2007; Petersen, Leet, & Brownson, 2005), professional status (Fell et al., 2009; Pereira et al., 2007) and pre-pregnancy BMI (Chasan-Taber et al., 2007; Ning et al., 2003; Watson & McDonald, 2007).

The present study showed no relationship between pre-pregnancy PA levels and PA during pregnancy. This finding is echoed by Hinton and Olson (2001). Nevertheless, some studies have shown that women who are

more active prior to pregnancy remain more active during pregnancy (Chasan-Taber et al., 2007; Clarke & Gross, 2004; Pereira et al., 2007).

Barriers to physical activity, according to the socioecological framework

In this study, according to the socioecological framework, no differences were found in barriers to leisure PA between the first and second trimesters. This is in accordance with Cramp et. al.(2009) finding that barrierswere consistent during pregnancy, except forwork. Women reported intrapersonal barriers, both nonhealth and health related, more often than they reported any other type of barrier to leisure PA during pregnancy. As regards non-health-specific reasons for lack of PA, participants referred most often to lack of time, being too busy and dislike of exercise.

A majority of the pregnant women in this study were employed and performing both professional activities and household tasks. Other studies have related that non-pregnant women only undertake PA outside of the home during daylight hours (Caperchione et al., 2011), which becomes hard with a day's work, and have also indicated that finding time to be active when not attending to family duties is a major barrier to PA engagement (Caperchione, Mummery, & Joyner, 2009), as family duties create time conflicts. Along the same lines, Evenson et al., (2009) found that 85% of a sample of 1535 pregnant women reported that intrapersonal factors were the main barriers to leisure PA. However, the evaluation moments in this study were different from the evaluation moments in our study (first evaluation at 20 weeks and second evaluation at 27–30 weeks).

In Rutkowska and Łepecka-Klusek (2002) study, lack of time was cited by 32% of pregnant women as a barrier to PA. Moreover, Cramp et al. (2009) reported that the proportion of women who reported work as a barrier to leisure PA was similar in the first and second trimesters.

Regarding the barrier "dislike of leisure PA", the results of the present study confirm the lesser commitment of Portuguese women to leisure PA pre-pregnancy.

Barriers related to health were third most mentioned. Only one-tenth of participants mentioned lower back pain. The findings were similar for pelvic pain, despite the high prevalence of lower back pain – 24% to 90% (Mogren & Pohjanen, 2005) – and pelvic pain – 4% to 76% – during pregnancy (Vermani, Mittal, & Weeks, 2010). These results were not expected and indicated that the women in this study may have considered their discomfort inherent in their condition. The results, however, are in line with those of other studies (Duncombe et al., 2009; Evenson et al., 2009; Haakstad et al., 2009; Rutkowska & Łepecka-Klusek, 2002). Interpersonal barriers to leisure PA, such as lack of support, were infrequently cited by our survey participants. This was in contradiction to our original expectations, since studies of non-pregnant women often cite social support as critical to leisure PA (Eyler et al., 2002). One explanation is that the survey participants were majority primigest (60%), and social support in the form of childcare is frequently needed for multigest mothers. However, studies analysing the barriers to leisure PA during pregnancy are scarce.

In our study, neighbourhood/environmental and policy barriers were infrequently cited as barriers to PA. Neighbourhood or environmental barriers to PA have been identified by pregnant women in other studies (Clarke & Gross, 2004; Evenson et al., 2009), but they are typically mentioned less frequently (Clarke & Gross, 2004).

The sample in this study was derived from a big city, and the participants might have had access to a higher number of facilities (i.e. gym) than most women in rural areas. However, big cities also have fewer leisure spaces (i.e. green space or parks) than non-urban areas. Furthermore, we should note that the study was carried out over 2 years and, for this reason, involved all seasons. In addition, Portugal has a temperate climate.

The different findings of various studies on PA during pregnancy are due mainly to the types of instruments used in these studies, as well as the characteristics of their samples. Although there was little consistency in the way that barriers were elicited (i.e. some studies used open-ended, while others used closed questionnaires), several different barriers to exercise emerged (e.g. feeling too tired, lack of time) (Gaston & Cramp, 2011).

The strengths of our study were: (1) to our knowledge, this is the first study to measure the effects of recommended PA level on pregnancy outcomes, evaluated with objective methods (accelerometer); (2) we quantified routine PA levels of pregnant women in free-living environments; (3) this is the first study to analyze objectively compliance with different PA guidelines in a sample of Portuguese pregnant women and (4) the majority of studies on pregnancy and PA barriers have involved specific groups with co-morbidities (i.e. obesity and diabetes).

There are few studies of healthy, and especially healthy pregnant, populations.

However, this study has some limitations, including the fact that Freedson's cut-points (Freedson et al., 1998), used for PA evaluation, were not specific to pregnant women, but were standardized for use with an average adult population.

Although an open question was included in the questionnaire, to solicit mention of barriers not defined within the questionnaire, our research was still limited to the investigator's list of barriers (Duncombe et al., 2009). More studies are needed to explore the existence of other barriers.

Conclusion

There were no differences between the first and second trimesters in compliance with different PA recommendations. Individual characteristics were not associated with PA guideline accomplishment. Perceived barriers to PA were similar in both trimesters. Intrapersonal barriers were the most-often perceived barriers to leisure PA. Implications for clinical practice Healthcare professionals should use PA guidelines in their clinical practice and encourage women to follow them.

The inclusion of PA in women's lifestyles, and especially in the daily routines of pregnant women, should be encouraged in free-living environments. Thus, it is important to develop strategies to increase or maintain overall PA levels during pregnancy and daily life.

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