Padrões de atividade física ao longo da gravidez sua influência na lombalgia e nos *outcomes* do recém-nascido

Dissertação apresentada com vista à obtenção do grau de Doutor no âmbito do Curso de Doutoramento em Atividade Física e Saúde, organizado pelo Centro de Atividade Física, Saúde e Lazer (CIAFEL) da Faculdade de Desporto da Universidade do Porto, nos termos do Decreto-lei 74/2006 de 24 de Março.

Orientador: Professor Doutor Jorge Augusto Pinto da Silva Mota.

Paula Clara Ribeiro Santos

Porto, Setembro de 2012

Referência:

Santos, PC (2012) Padrões de atividade física ao longo da gravidez sua influência na lombalgia e nos *outcomes* do recém-nascido.

Porto: P.C. Santos. Dissertação de Doutoramento em Atividade Física e Saúde apresentada à Faculdade de Desporto da Universidade do Porto.

PALAVRAS-CHAVE: ATIVIDADE FISICA, GRAVIDEZ, LOMBALGIA, BARREIRAS RECOMENDAÇÕES, *OUTCOMES* RECÉM-NASCIDO.

Financiamento

Este trabalho foi financiado em parte por uma bolsa de doutoramento da Fundação da Ciência e Tecnologia (FCT) SFRH/BD/45375/2008; PROTEC SFRH/BD/50002/2009; OE/SAU/UI0617/2011.

“Os ciclos da vida e das relações humanas...”

Parque Vigeland - Oslo
Gustav Vigeland

"Life is like riding a bicycle -
in order to keep your balance,
you must keep moving.” - Albert Einstein

"...dedico este trabalho aos quatro homens da minha vida… ao José e aos nossos queridos filhos, Francisco, Rodrigo e Dinis.

Agradecimentos

Ao Professor Doutor Jorge Mota pelo estímulo, apoio e pertinência das suas críticas e saberes ao longo de todo o processo de elaboração do trabalho.

Ao Professor Doutor Nuno Montenegro por acreditar neste trabalho, pela precisão científica dos seus comentários e colaboração.

Aos Professores Doutores Sandra Abreu, Carla Moreira, Rute Santos, Pedro Silva e Pedro Moreira pelo apoio e partilha de conhecimento ao longo deste percurso.

À Odete Alves, que desde o início acreditou neste projecto e me incentivou a

conclui-lo, por toda a ajuda, disponibilidade e partilha de conhecimentos.

À Diana Lopes e Diana Cruz pela colaboração.

À Paula Sales e à Luisa Vasconcelos pela amizade e disponibilidade de sempre.

Às “rainhas” pela compreensão, apoio e amizade.

Aos Profissionais do Hospital de Santa Luzia em Viana do Castelo e do Hospital de S. João no Porto.

Às enfermeiras dos Centros de Saúde do distrito de Viana do Castelo

pela colaboração dada na recolha de dados.

Às mulheres que constituíram a amostra.

Aos meus pais e irmãs, pelo apoio dado durante todas as fases da minha vida.

Aos colegas, amigos e familiares; pela sua confiança, ajuda e apoio incondicional.

A todas as pessoas que de alguma forma

colaboraram para que este projecto fosse uma realidade.

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Resumo

Introdução: A Atividade Física (AF) na gravidez tem sido referida como um factor protetor da saúde materno-infantil. Várias instituições emanaram recomendações para a prática de AF durante este período. Contudo alguns estudos referem que o nível de AF decresce ao longo da gravidez, existindo ainda alguma controvérsia relativamente ao efeito que este comportamento pode ter na saúde da mulher e do recém-nascido.
Objectivos:1) Analisar os padrões de AF durante a gravidez; 2) determinar a perceção das mulheres sobre o aconselhamento da AF pelos profissionais de saúde; 3) determinar a frequência de dor lombar não especifica durante a gravidez e a sua associação com o tipo e intensidade de AF bem como com a frequência de lombalgia antes de engravidar; 4) analisar o cumprimento das diferentes recomendações da AF nos dois primeiros trimestres de gravidez; 5) analisar as barreiras à prática de AF de lazer e 6) analisar a influência do cumprimento das recomendações segundo o *American College of Sports Medicine* (ACSM) e os *outcomes* do recém-nascido.
Metodologia: Foram realizados dois estudos longitudinais prospectivos, com duas amostras de grávidas saudáveis. Um dos estudos foi realizado nos centros de saúde da Unidade Local de Saúde do Alto Minho (ULSAM), sendo constituído por 118 participantes, que foram avaliados em todos os trimestres. Questionários auto-aplicáveis foram usados para a recolha de dados pessoais, obstétricos e clínicos. A AF foi avaliada com o *Pregnancy Physical Activity Questionnaire*. A lombalgia não específica foi avaliada por auto-referência. O outro estudo decorreu no Hospital de S. João, Porto e a amostra foi constituída por 133 participantes. As mulheres foram avaliadas em três momentos: às 10-12, 20-24 semanas de gestação e no pós-parto. Foram usados os mesmos questionários da ULSAM e além destes a AF durante a gravidez foi mensurada por acelerómetria. As barreiras foram identificadas por auto-referência. No pós-parto foram recolhidos dados relativos ao peso, comprimento, perímetro cefálico e *índice de apgar* dos recém-nascidos.
Resultados: Os valores (MET.h.wk-1) relativos à AF total, leve e moderada decresceram em todos os trimestres de gravidez ($p < 0.01$, para todos). A percentagem de profissionais de saúde que recomendou AF foi de 53.9% no primeiro, 70.4% no segundo e 56.8% no terceiro trimestre. A lombalgia não específica foi referida por 40.7%, 52.2% e 66.7% das grávidas no primeiro, segundo e terceiro trimestre, respectivamente. Não foram encontradas associações significativas entre lombalgia não específica e o tipo e intensidade da AF. No entanto, as mulheres que tiveram dor lombar antes de engravidar, comparativamente às que não tiveram, apresentaram um risco acrescido de terem dor lombar não especifica durante a gravidez (OR = 3.85, IC 95%: 1.344-11.025). Uma elevada proporção de mulheres não atingiu os níveis recomendados de AF propostos pelas diferentes organizações (4% para as recomendações do *American College of Obstetricians and Gynecologists* e 68% para as do *United States Department of Health and Human Services*). Não se verificaram diferenças significativas entre o primeiro e segundo trimestre em relação ao cumprimento das recomendações AF ($p > 0.05$ para todas). No entanto, foi observado uma diminuição nos níveis de AF do primeiro para o segundo trimestre. A barreira para a AF de lazer mais frequentemente mencionada foi a intrapessoal, não relacionada com a saúde, nomeadamente a falta de tempo e não gostar de praticar exercício. Não houve diferenças significativas entre as mulheres que cumpriram e não cumpriram as recomendações da AF segundo o (ACSM) nos *outcomes* (perímetro cefálico, peso, altura e *índice de apgar*) do recém-nascido ($p > 0.05$ para todos os resultados).
Conclusões: A intensidade total, leve e moderada de AF diminuiu ao longo da gravidez. Existe ainda uma percentagem elevada de profissionais de saúde que não recomendam AF moderada durante a gravidez. A lombalgia não especifica é uma condição frequente durante este período. O tipo e intensidade da AF não estão associados com a lombalgia gravídica. A dor lombar antes da gravidez é um fator de risco para a lombalgia. Um elevado número de mulheres não cumpre as recomendações da AF. As barreiras intrapessoais foram as mais frequentemente identificadas para a não adesão à prática de AF de lazer nomeadamente a falta de tempo. Assim as mulheres grávidas saudáveis devem ser estimuladas para o cumprimento das recomendações, uma vez que a AF parece não ter efeito negativo nos parâmetros fetais à nascença.

Palavras-chave: ATIVIDADE FÍSICA, GRAVIDEZ, LOMBAGIA, BARREIRAS, RECOMENDAÇÕES, *OUTCOMES* DO RECÉM-NASCIDO.

Abstract

Background: Physical activity (PA) in pregnancy has been reported as a protective factor of maternal child. Several institutions emanated recommendations for the practice of PA during this period, however, some studies indicate that PA levels decreases throughout pregnancy, and there is some controversy regarding the effect that this behaviour can have on women's health and neonatal outcomes.
Objectives: (1) to analyze the perception of PA; (2) to determine women's perception about health care providers' PA advisement during pregnancy; (3) to evaluate the proportion of non-specific pregnancy-related low back pain (NSPLBP) and its association with type and intensity level of PA during pregnancy and low back pain pre-pregnancy; (4) to analyze PA engagement during the 1st and 2nd trimesters, considering the different guidelines published on PA; (5) to examine pregnant women's perceived barriers to PA and (6) to determine the relationship between American College of Sports Medicine (ACSM) PA recommendations during pregnancy and neonatal outcomes at birth.
Methods: Two longitudinal prospective studies were conducted with different samples of healthy pregnant women. One was carried out with 118 participants; they were evaluated in all trimesters. Self-reported questionnaires were used to collect personal and obstetric data. PA was evaluated using the Pregnancy Physical Activity Questionnaire. NSPLBP was assessed via self-reported questionnaire.
Another study was conducted with a sample of 133 pregnant women in two stages: at 10-12 weeks' gestation and 20-24 weeks' gestation. PA was assessed by accelerometry. The pregnant women were divided into four groups, according to different PA guidelines. Barriers to PA were assessed via questionnaire. Postpartum medical records were examined for neonatal outcomes at birth: weight, length, head circumference and Apgar score.
Results: A decrease in values of self-reported PA (MET.h.wk-1) was found over the trimesters of pregnancy for respectively total, light and moderate intensity ($p<0.01$, for all). Pregnant women reported that PA was recommended by health professionals – 53.9% in 1st trimester, 70.4% in 2nd trimester and 56.8% in 3rd trimester.NSPLBP was reported by 40.7%, 52.2% and 66.7% of the subjects at first, second, and third trimesters, respectively. No significant associations were found between NSPLBP and type and intensity of PA. However women who had low back pain before pregnancy, compared to those who did not, had higher odds of expressing NSPLBP during pregnancy (OR= 3.85, 95% CI: 1.344-11.025).A large proportion of women (ranging from 4% - American College of Sports Medicine to 68% - United States Department of Health and Human Services) did not reach the levels of PA recommended by the guidelines. There were no significant differences between the 1st and 2nd trimesters with regard to compliance with PA recommendations ($p>0.05$ for all). However, a decrease in PA levels from the 1st to 2nd trimesters was noted for all recommendations. The most commonly reported barrier to leisure PA in pregnancy was intrapersonal, not health -related. Among the non-health-related factors reported, lack of time, busyness and dislike of exercise were cited most frequently.No significant differences in neonatal outcomes at birth were observed between the women who did and did not comply with ACSM PA recommendations ($p>0.05$ for all outcomes).
Conclusions: Self-reported PA decreased during pregnancy especially in total, light and moderate intensity. There are still some health care providers that do not recommend PA during pregnancy.NSPLBP was a common condition. The results of this study suggest that type and intensity of PA is not associated with the emergence of NSPLBP during pregnancy. Furthermore, low back pain before pregnancy is a risk factor for NSPLBP.A great number of women does not comply with PA recommendations and there were no differences between the 1st and 2nd trimesters. Perceived barriers were similar in both trimesters. Intrapersonal barriers were the most-often perceived barriers to leisure PA. Healthy pregnant women should be encouraged to follow the PA recommendations of the ACSM during pregnancy, given that no significant negative associations were found between PA and neonatal outcomes.

Key words: PHYSICAL ACTIVITY, PREGNANCY, LOW BACK PAIN, RECOMMENDATIONS, BARRIERS, NEWBORN-OUTCOMES.

Lista de Abreviaturas e Símbolos

ACOG - American College of Obstetricians and Gynecologists

ACSM - American College of Sports Medicine

AF - Atividade Física

bpm - batimentos por minuto

CDC - Centers for Disease Control and Prevention

DC - débito cardíaco

DP - Desvio Padrão

FC - Frequência Cardíaca

IMC – Índice de Massa Corporal

IOM - Institute of Medicine

Kg/m² - Quilograma por metro quadrado

m - metro

OMS - Organização Mundial de Saúde

p - Significância

PaCO2 - Pressão arterial de CO2

VC - Volume Corrente

VE - Ventilação por minuto

VO2 - volume de oxigénio

VR I - Volume de Reserva Inspiratória

VS - Volume sistólico

X^2 - Qui-Quadrado

VA - Ventilação Alveolar

ULSAM - Unidade Local de Saúde do Alto Minho

USDHHS- United States Department of Health and Human Services

HSJ - Hospital de São João

INTRODUÇÃO

Introdução Geral

A atitude perante a atividade física (AF) durante a gravidez mudou radicalmente nos últimos trinta anos (Charlesworth, 2011). Os nossos antepassados tratavam a mulher grávida como se estivesse doente, sendo aconselhada a descansar e a evitar exercícios (Duncombe *et al.*, 2009).

A evidência científica suporta cada vez mais a importância da AF para a saúde individual (Duncombe *et al.,* 2009) e comunitária (Beaglehole *et al.,* 2011). Da pesquisa efetuada, não foram encontrados estudos que mostrassem efeitos negativos da AF de moderada intensidade durante o período gravídico (Da Costa, 2003). Atualmente, existem recomendações para a prática da AF durante a gravidez, pelos benefícios demonstrados, tanto para a mulher como para o bebé (*Physical activity guidelines for Americans*, 2008).

O *American College of Obstetricians and Gynecologists* (ACOG) em 2002, emanou orientações para que as mulheres grávidas, sem complicações obstétricas, adotem as mesmas recomendações de exercício físico que as das mulheres não grávidas. Da mesma forma, o *Centers for Disease Control and Prevention* (CDC) e o *United States Department of Health and Human Services* (USDHHS), 2009 também recomendam a AF durante a gravidez.

No entanto mais de 35% das mulheres tornam-se sedentárias durante o período gravídico (Sternfeld et al., 1995). Existindo uma tendência para a diminuição dos níveis de intensidade da AF total na gravidez, especialmente do período pré- gestacional para o primeiro trimestre (Chasan-Taber et al., 2007a). A AF de lazer também diminui ou cessa para 28 a 63% das mulheres (Borodulin et al., 2008; Clarke et al., 2005), contudo 20% das mulheres referem aumentar este tipo de AF(Hinton & Olson, 2001). A tendência para a diminuição da AF pode manter-se mesmo depois do parto, uma vez que a maior parte das mulheres apresenta níveis de AF moderada inferiores aos recomendados no primeiro ano pós parto (Brown & Trost, 2003; Downs & Hausenblas, 2007). A

gravidez apresenta-se assim, como um período de risco para a mudança de hábitos de AF(Borodulin et al., 2009).

Contudo, os determinantes para a prática de AF na gravidez não estão bem explorados (Evenson et al., 2009).

A AF antes, durante e após a gravidez pode contribuir para a melhoria da condição física materna, levando a uma melhor adaptação cardiovascular, controlo no ganho ponderal e adiposidade (Ghodsi, 2012; Haakstad & Bo, 2011; Streuling *et al.,* 2011), prevenção da incontinência urinária (Bo & Haakstad, 2011), bem como da diabetes gestacional e tipo II (Mottola, 2008; Sandoval-Rodriguez *et al.*, 1997). Relativamente à lombalgia, os estudos são inconsistentes, uns referem que a AF previne a lombalgia (Garshasbi & Faghih Zadeh, 2005; Mogren, 2005), outros dizem estar associada a maior sintomatologia (Mogren & Pohjanen, 2005) e alguns não encontraram qualquer relação (Mens *et al.,* 2000; Vermani *et al.,* 2010).

Para além do efeito da AF na gravidez sobre a saúde materna, a sua influência nos *outcomes* fetais tem sido objecto de estudo. Alguns autores têm reportado de forma consistente que a vida intra-uterina é um factor de risco ou um fator protetor acrescido para algumas patologias na infância (Hopkins & Cutfield, 2011).

Das implicações que a AF tem nos *outcomes* fetais à nascença, salienta-se uma diminuição significativa de casos de sofrimento fetal e, por conseguinte, melhores resultados no índice de *Apgar*, bem como na prevenção do parto pré-termo (Brown *et al.*, 2007; Hartmann, 1999; Motahari Tabari, 2010). Apesar de alguns autores não encontrarem evidência que a AF melhorasse os *outcomes* fetais, também não verificaram qualquer efeito negativo (Barakat *et al.*, 2009a).

Batista (2003) e Conde *et al.* (2008) referem que a prática de AF tem influência para um peso mais adequado do bebé à nascença. Clapp *et al.* (2000) e Perkins *et al.* (2007) mencionam que a AF moderada leva a um aumento equilibrado do crescimento fetal, enquanto a AF vigorosa leva ao nascimento de bebés mais leves, mas dentro de valores referenciados para peso

adequado. O nascimento de bebés mais leves parece estar associada a uma diminuição da massa gorda, não se tratando, por isso, de um problema para a saúde do bebé, mas sim da prevenção da obesidade (Batista, 2003). Para sustentar esta relação serão necessários mais estudos.

Althuizen, em (2006), refere que a prevenção do excesso de peso durante a gravidez é um factor potencialmente importante para prevenir a obesidade da mulher em idade fértil, assim como a do bebé.

A maioria da literatura internacional avalia a AF com medidas subjetivas, sendo a mensuração realizada de forma indireta, através de questionários. O auto-relato de comportamentos de saúde implica o viés da desejabilidade social, podendo este ter maior expressão em amostras de grávidas em comparação com a população geral (Ford *et al.*, 1997). Também, a tipologia de estudo utilizada, maioritariamente, estudos retrospetivos e estudos transversais, pode levar a viés de memória e não permite avaliar o comportamento da AF ao longo da gravidez.

Além disso, as definições dos conceitos de AF e de exercício físico não estão bem claras em alguns dos artigos encontrados e poucos são os estudos que apresentam os resultados segundo as *guidelines,* dificultando a comparação entre estudos.

Face às características sociais e culturais específicas do nosso país, seria importante ter registos dos padrões de AF na população de mulheres grávidas.

Em Portugal, segundo o nosso conhecimento, só existem dois estudos sobre AF na gravidez e a variável de *outcome* principal não foi a AF (Gouveia *et al.,* 2007; Tendais *et al.*, 2011).

A pertinência deste estudo assenta na necessidade de informação sobre a AF nesta população específica da população portuguesa, bem como na falta de consenso da influência da AF na lombalgia e nos *outcomes* fetais à nascença. Sendo esta área de extrema importância em termos de saúde pública, é objetivo geral desta tese:

determinar os padrões de AF durante a gravidez e sua influência na lombalgia gravídica, bem como nos *outcomes* do recém-nascido.

Para alcançar este objetivo geral, foram delineados objetivos específicos dos quais resultaram quatro artigos originais:

1. Analisar os padrões de AF durante a gravidez numa amostra de mulheres Portuguesas

   Paper I. *Physical Activity Patterns during Pregnancy in a Sample of PortugueseWomen: longitudinal prospective study*

   Santos PC., Abreu S., Moreira C., Lopes D., Santos R., Alves O., Ferreira M., Vale S., Moreira P., Mota J.

2. Analisar o nível de AF durante a gravidez e a influência na lombalgia

   Paper II. *Association between Low Back Pain and Physical Activity during Pregnancy: A Longitudinal Prospective Study*

   Santos PC., Lopes D., Moreira C., Abreu S., Santos R., Ferreira M., Alves O., Vale S., Moreira P., Mota J.

3. Avaliar o cumprimento das diferentes recomendações de AF durante a gravidez, bem como a identificação das barreiras à AF

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

   Santos PC., Abreu S., Moreira C., Lopes D., Santos R., Alves O., Vale S., Silva, P., Montenegro N.; Mota J.

4. Avaliar a relação entre o cumprimento das recomendações da AF materna com os *outcomes* do recém-nascido

   Paper IV. *Physical activity during pregnancy and its effects on neonatal outcomes*

   Santos PC., Moreira C., Abreu S., Silva, P., Santos R., Cruz D., Vale S., Montenegro, M., Mota J.

De modo a dar resposta a estes objectivos, a presente dissertação está organizada em quatro capítulos.

O Capítulo 1 consta de uma revisão da literatura que serve de base à compreensão da AF na gravidez, aborda a AF e a saúde, as alterações fisiológicas na gravidez, estado da arte da AF na gravidez; determinantes associados à prática de AF, bem como o efeito da AF na mulher e nos *outcomes* do recém-nascido, as recomendações internacionais para a sua prática e instrumentos de medida da AF.

O Capítulo 2 apresenta os resultados do trabalho de campo organizado em artigos a submeter a publicações científicas com revisão de pares.

Uma discussão geral e reflexão crítica são apresentadas, no Capítulo 3.

No Capítulo 4 são apresentadas as principais conclusões da dissertação, recomendações e perspetivas para futuras pesquisas.

REVISÃO DA LITERATURA

Revisão da Literatura

Atividade Física e Saúde

A evidência aumenta no sentido de suportar a importância da actividade física (AF) para a saúde individual e comunitária World Health Organization [WHO] (2010). Estando a AF regular associada a uma melhoria dos parâmetros metabólicos fisiológicos e psicológicos, bem como a um reduzido risco de morbilidade e mortalidade (Melzer et al., 2010a). Recentemente, a AF foi considerada a pedra angular para o combate das doenças crónicas não-transmissíveis (United Nations, 2011).

Nesta tese, abordaremos a AF como qualquer movimento corporal produzido pelo músculo-esquelético e do qual resulta um aumento do dispêndio energético em relação ao que é consumido na situação de repouso, e que está fortemente correlacionado com a aptidão física[1] (Caspersen *et al.*, 1985). Este movimento traduz-se em funcionalidade, ou seja, à relação que a mulher grávida tem com meio envolvente.

A AF manifesta-se no movimento efetuado nas atividades da vida diária, na participação ocupacional, nas tarefas domésticas, no lazer, no caminhar… O critério de utilidade do movimento é a função, contribuindo esta para a saúde física, mental e social.

A diminuição dos níveis de AF está diretamente relacionada com o aumento do sedentarismo, o qual se está a tornar uma epidemia mundial. O comportamento sedentário está associado frequentemente a patologias como: doença cardiovascular, diabetes Mellitus tipo 2, obesidade, alguns tipos de cancro, alterações músculo-esqueléticas e a alguns aspetos da saúde mental (Melzer *et al.*, 2010a).

Pesquisas recentes indicam que o aumento da AF e a redução da obesidade são as maiores prioridades para o reforço da saúde da mulher ("Impact of

[1] A aptidão física é tipicamente definida como um conjunto de atributos ou características que as pessoas possuem (força, resistência aeróbia, flexibilidade e composição corporal) e que se relaciona com a capacidade de executar AF (Caspersen *et al.*, 1985).

physical activity during pregnancy and postpartum on chronic disease risk", 2006; Maiese, 2002) Healthy People 2010.

A AF tem importância na saúde, de tal modo que várias organizações e instituições reconhecidas (ACOG, CDC, ACSM, USDHHS) (ACSM, 2006; "First-ever federal guidelines for physical activity issued for Americans. Moderate aerobic exercise extends life and reduces the risk of a variety of conditions and diseases", 2009; "Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary", 2009) recomendam a AF para a população em geral, bem como para o grupo específico das grávidas.

As intervenções comunitárias devem concentrar a atenção sobre segmentos da população com maior nível de exposição ao risco (Glouberman, 2011). As grávidas poderão ser um grupo de risco pelo facto de, durante este período, terem tendência a adotar estilos de vida menos ativos. Os fatores protetores das doenças crónicas não transmissíveis devem estar incorporados ao longo do ciclo da vida, através de comportamentos saudáveis que devem ter início antes da gravidez, continuar ao longo da infância e na vida adulta (United Nations, 2011).

A identificação dos efeitos da AF antes, durante e após a gravidez apresenta implicações importantes na promoção de um estilo de vida fisicamente activo entre as mulheres. As gestantes que integram o exercício nas suas rotinas durante a gravidez apresentam maior tendência para continuar a sua prática no pós-parto (Mogren, 2008).

A adoção de hábitos saudáveis deve começar o mais atempadamente possível. A questão é por onde começar esta mudança cultural, cognitiva e comportamental, pela mãe ou pela criança?

A mulher tem um papel importante como modelo familiar e comunitário. Parte da nossa educação processa-se por imitação de comportamentos. Quando as mães são ativas, existe maior probabilidade dos filhos serem mais ativos e, consequentemente, de as gerações serem mais ativas (Tucker *et al.*, 2011).

Os ambientes familiares que incluem estilos parentais, com hábitos alimentares saudáveis e de AF, estabelecem as bases para a adoção de comportamentos saudáveis nas crianças (Fuemmeler *et al.*, 2011).

Alterações fisiológicas durante a gravidez

A gravidez[2] é um período em que ocorrem diversas alterações endócrinas, fisiológicas, metabólicas, sociais, bem como emocionais, que podem conduzir a adaptações e mudanças de comportamentos por parte da gestante (Borg-Stein *et al*., 2005; Conde, 2003; Gaston & Cramp, 2011) .

Todas estas alterações decorrem ao longo da gravidez, contudo a sua expressão é diferente e a manifestação dos sintomas torna-se característica em cada um dos trimestres de modo a manter a homeostasia materno-fetal (Wolfe & Mottola, 1993).

Caracterização dos trimestres gestacionais

O primeiro trimestre (1ª-13ª semana) corresponde à embriogénese. As principais alterações deste período englobam o aumento da tensão mamária e das secreções vaginais, polaquiúria, náuseas, mal-estar e anemia fisiológica, que se manifestam por fadiga e sono (Polden & Mantle, 2000).

O segundo trimestre (14ª-26ª semana) corresponde ao período do desenvolvimento fetal. É marcado pela regressão parcial dos sintomas anteriormente referidos, diminuição da pressão arterial, aumento das glândulas sudoríparas e sebáceas, podendo ocorrer hiperpigmentação na face – cloasma gravídico; estrias no abdómen, nádegas e pernas, e agravamento da obstipação. Durante este período, a mulher pode sentir os movimentos fetais,

[2] Gravidez: qualidade ou estado da mulher e das fêmeas dos mamíferos em geral, durante o tempo em que um novo ser se desenvolve no seu organismo.

percecionando as primígestas[3], em média, os movimentos por volta das 20-21 semanas e as multígestas[4] por volta das 19 semanas (Polden & Mantle, 2000).

O terceiro trimestre (27ª-40ª semana) corresponde ao período do desenvolvimento e crescimento fetal. Este período é marcado, essencialmente, pelo aumento do volume uterino e do peso materno. Este último tem o contributo da componente materna (aumento do volume mamário, uterino, e sanguíneo, reserva de gordura e fluido extracelular) e da componente fetal (feto, placenta e líquido amniótico). A ocupação da cavidade abdominal faz com que as vísceras se desloquem no sentido ascendente, empurrando o diafragma superiormente, acarretando dificuldades respiratórias (Troiano & Dorman, 1992). Pelo aumento da pressão do útero sobre a bexiga pode existir polaquiúria (Santos *et al.*, 2006). A formação de edema nos membros inferiores e o agravamento das varicosidades são devidas a dificuldades do retorno venoso, pela retenção hidroelétrica e diminuição da resistência periférica (Polden & Mantle, 2000). A síndrome de hipotensão supina ocorre por compressão da veia cava inferior na posição de decúbito dorsal (Lumbers, 2002; Polden & Mantle, 2000).

Alterações do sistema endócrino

Especialmente, no primeiro trimestre de gravidez, ocorrem grandes e rápidas alterações do sistema endócrino (hipersecreção de progesterona, estrogénio, relaxina, renina, vasopressina e lactogéneo placentário humano) que explicam as mudanças sentidas durante a gravidez (Lumbers, 2002).

As alterações hormonais e metabólicas ocorrem, essencialmente, para manterem um adequado suplemento de todos os nutrientes ao feto (King, 2000).

Apenas vamos fazer referência à progesterona, estrogénio e relaxina por serem as alterações endócrinas que mais influenciam as mudanças

[3] Primígestas - mulher que tem a primeira gravidez.

4 Multígesta - mulher que está grávida pelo menos pela segunda vez.

cardiovasculares, respiratórias e músculo-esqueléticas que podem interferir com a prática de AF.

A **progesterona** desempenha um papel fundamental na manutenção da gravidez, pois é responsável pelo relaxamento da musculatura lisa, favorecendo o aparecimento de veias varicosas nas pernas, reto e vulva, contribuindo para a diminuição da atividade peristáltica e da motilidade gástrica. Previne a expulsão prematura do feto, contribui para o aumento da sensibilidade dos centros respiratórios e da temperatura corporal (0,5 a 1ºC), bem como do volume mamário (Stables & Rankin, 2010).

O **estrogénio** tem como principal função promover a proliferação de determinadas células, por exemplo, das células musculares lisas do útero, o alargamento pélvico, o crescimento das mamas e dos seus elementos glandulares, além de deposição de tecido adiposo em áreas específicas femininas, tais como coxas e quadris, ou seja, o estrogênio é responsável por desenvolver as características sexuais femininas. Durante as primeiras 15-20 semanas de gravidez, o corpo lúteo é responsável pela secreção do estrogénio e da progesterona. A secreção destas hormonas aumenta duas a três vezes. Porém após a décima sexta semana, a placenta passa a produzir estas hormonas, aumentando de forma drástica a sua produção e fazendo com que a secreção de estrogénio seja, aproximadamente, 30 vezes superior ao normal. O estrogénio será o principal responsável pelo aumento da retenção hidroelétrica durante a gravidez (Stables & Rankin, 2010).

A **relaxina,** a partir da segunda semana de gestação, começa a produzir-se e atinge os valores mais elevados no final do primeiro trimestre. Como provoca alterações no colagénio, este fica mais elástico e extensível nos ligamentos e tecido conectivo, o que prepara o corpo para o trabalho de parto (Stables & Rankin, 2010). Consequentemente pode levar a uma maior instabilidade articular e ligamentar, que associado a um aumento de peso corporal, pode conduzir ao esmagamento da arcada plantar e contribuir para o aparecimento ou exacerbação de sintomatologia músculo-esquelética (Artal, 2003).

Alterações do sistema cardiovascular

As mudanças hemodinâmicas mais importantes na gravidez são o aumento do volume sanguíneo, aumento do débito cardíaco e diminuição da resistência vascular periférica (Stables & Rankin, 2010). Estas alterações têm início entre a segunda e a terceira semana de gravidez e continuam até ao terceiro trimestre. Ocorrem, essencialmente, para assegurar a distribuição de oxigénio e nutrientes ao feto (King, 2000).

Entre a 10ª e a 12ª semanas de gestação, existe um notável aumento do volume sanguíneo aproximadamente de 1500 ml, devido ao aumento do plasma (1000 ml) e dos eritrócitos (500 ml). Como o aumento do volume plasmático é superior ao dos eritrócitos, ocorre uma diluição, que habitualmente se traduz na anemia gravídica fisiológica (± 12 g/l), que explica a fadiga desde as primeiras semanas de gravidez (Melzer *et al.*, 2010a).

Em média, a frequência cardíaca de repouso aumenta progressivamente ao longo da gravidez, cerca de 8 bpm à 8ª semana e 16 bpm no final da gravidez (Stables & Rankin, 2010).

O débito cardíaco aumenta como resultado do aumento da frequência cardíaca, do volume sistólico, bem como do volume sanguíneo. O débito cardíaco de repouso às oito semanas de gestação aumenta 1 l/min o que representa mais de 50% da totalidade das alterações gravídicas (Melzer *et al.,* 2010a).

A pressão arterial não é aumentada em condições normais na gravidez ou diminui discretamente, devido à redução da resistência vascular periférica. Na verdade, a pressão sistólica continua bastante estável, enquanto a pressão diastólica baixa até 15 mm/Hg, na primeira metade da gravidez tendo tendência a aumentar aproximadamente na 36ª semana (Melzer *et al.,* 2010a).

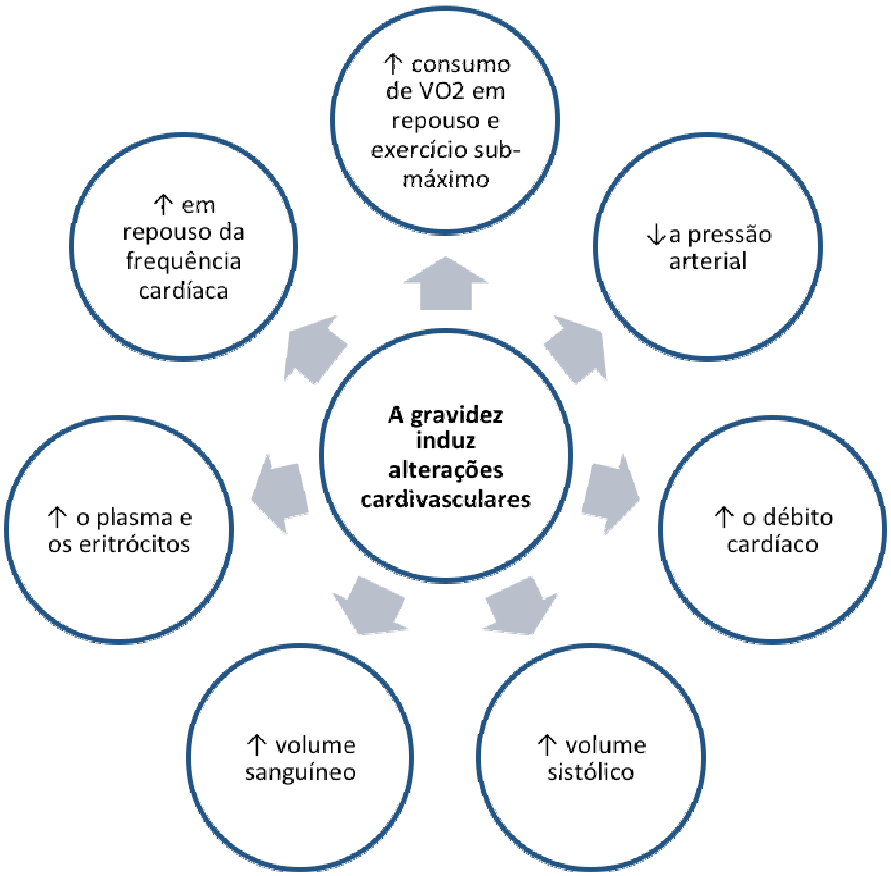

Figura 1 -Alterações cardiovasculares induzidas pela gravidez (↑- aumenta; ↓diminui)

Alterações do sistema respiratório

O estímulo da progesterona e as alterações biomecânicas causadas pelo aumento do útero são os grandes responsáveis pelas alterações na função pulmonar. Devido ao aumento do metabolismo basal, verifica-se um aumento do consumo de oxigénio (Brayshaw, 2003). Para compensar, existe um aumento da frequência respiratória, o que explica por que é que algumas mulheres têm dispneia em atividade, mesmo no início da gravidez (Brayshaw, 2003; Widmaier E. P., 2007).

No final da gravidez, as alterações respiratórias podem estar mais comprometidas devido a uma diminuição na excursão diafragmática em cerca de 4 cm ou mais. Esta alteração contribui para o aumento do diâmetro ântero-posterior e transversal das costelas inferiores em aproximadamente 10 cm

(Brayshaw, 2003). Esta alteração leva a uma diminuição da perfusão alveolar nas bases, que poderá também estar relacionada com a dispneia ao esforço (Melzer *et al.,* 2010a).

Alterações do sistema músculo-esquelético

São várias as alterações músculo-esqueléticas e biomecânicas que ocorrem no corpo da gestante ao longo da gravidez.

O ganho ponderal contribui para o deslocamento anterior do centro de gravidade, que aumenta o braço de alavanca das forças aplicadas anteriormente à coluna lombar. Os músculos abdominais alongam para acomodar o útero em expansão, podendo ocorrer diástase dos retos abdominais e encurtamento dos pilares diafragmáticos (Borg-Stein *et al.,* 2005). A musculatura do pavimento pélvico sofre aumento de pressão que pode conduzir a fraqueza muscular (Bo & Haakstad, 2011).

As alterações acima descritas podem contribuir para a instabilidade lombo pélvica que pode provocar *stress* sobre a região lombar (Artal & O'Toole, 2003; Garshasbi & Faghih Zadeh, 2005; Mogren, 2008; Mogren & Pohjanen, 2005).

Dentro da sintomatologia músculo-esqueléticas, a lombalgia é uma das mais frequentes. Os estudos referem valores de prevalência entre os 24% e os 90% (Mogren & Pohjanen, 2005; Mohseni-Bandpei, 2009). Em mulheres grávidas, a dor lombar é quatro vezes mais comum que em mulheres não-grávidas (Kashanian et al., 2009). Este sintoma tem causas multifatoriais e é classificado como lombalgia específica em 10% dos casos (ex.: fratura, tumor e estenose do canal medular) e como lombalgia não específica (NSLBP) em 90%. Dentro da NSLBP, 30% são de origem psicológica e 60% de origem biomecânica, podendo-se relacionar com deficiência do movimento ou alteração do controlo do movimento (O'Sullivan, 2005). A lombalgia pode surgir durante o primeiro trimestre de gravidez, mas para a maioria das mulheres tem início por volta das 18 semanas de gestação, atingindo um pico de intensidade entre as 24 e as 36

semanas (Garshasbi & Faghih Zadeh, 2005; Mogren & Pohjanen, 2005; Sabino & Grauer, 2008).

Um número significativo de mulheres experiencia dor lombar pela primeira vez durante o primeiro trimestre, quando as alterações biomecânicas ainda não desempenham um papel significativo na etiologia da dor. Este facto sugere que, em certos casos, a dor pode estar relacionada com alterações hormonais e não apenas com fatores biomecânicos (Bastiaanssen *et al.,* 2005).

Alguns estudos revelaram uma relação entre os níveis circulantes da hormona relaxina e a lombalgia gestacional (MacLennan *et al.,* 1986; Vermani *et al.,* 2010), enquanto outros não encontraram qualquer associação(Albert *et al.,* 1997; Sabino & Grauer, 2008).

Atividade física na gravidez

Por questões de saúde e em contraste com o treino para o desporto específico, o atual interesse na participação em AF surge em grande parte pela necessidade de melhorar os parâmetros relacionados com as componentes da aptidão física, principalmente, cardiorrespiratória (Melzer *et al.,* 2010a).

As alterações no consumo submáximo de VO^2 durante a gravidez dependem do tipo de exercício realizado. Durante o repouso materno ou exercício de carga submáximo, o consumo de VO^2 é significativamente maior em comparação com o estado de não gravidez. A magnitude da mudança é aproximadamente proporcional ao ganho de peso materno (Melzer *et al.*, 2010a). Durante a gravidez, pretende-se manter ou melhorar a capacidade aeróbia de modo a preservar o nível de aptidão física, levando a que as alterações físicas e fisiológicas inerentes à gravidez não sejam promotoras de inatividade, quer a curto quer a longo prazo, uma vez que a adoção de hábitos sedentários é um fator de risco para as doenças crónicas não transmissíveis, afectando deste modo a saúde da mulher (Melzer *et al*., 2010a).

A redução ou cessação da AF leva à reversão parcial ou completa das adaptações fisiológicas adquiridas com exercício. Estas alterações são mensuráveis, após uma ou duas semanas de descondicionamento. A perda total pode ocorrer dentro de vários meses (McArdle W, 2000).

Na tabela 1, podemos ver resumidamente as adaptações cardiovasculares, respiratórias e músculo-esqueléticas que ocorrem na gravidez e as suas implicações para o exercício.

Tabela1 - adaptações e alterações que ocorrem na gravidez e suas implicações para a AF

Adaptações/ Alterações	Consequências	Implicações/ Precauções
Cardiovasculares		
Hemodinâmicas	↑ Frequência Cardíaca	
(↑ volume de sangue + de 50%	↑ Volume Sistólico	
plasma 1l e eritrócitos 0,5l)	↑ Débito Cardíaco	Evitar Posições Mantidas em Pé
	Anemia Gravídica/ Fadiga	Evitar Manobra de Valsalva
↓ Resistência Periférica	↓ da Tensão Arterial /Tonturas	
	Edema Membros Inferiores	
Respiratórias		
(alterações no transporte de O_2)	Baixa Resistência ao Esforço; ↓ da	
↑ Volume Corrente	Aptidão Física	Evitar Exercícios Vigorosos
↑ Frequência Respiratória	↓ Oxigénio Disponível; Hiperventilação	Fazer Exercício Aeróbio
↓ Excursão Diafragmática	Alcalose Respiratória; PH no Limite	Trabalhar Grandes Grupos Musculares
	Superior à Normalidade	
	↓Mobilidade torácica; Dispneia para	
	Pequenos Esforços	
Músculo-esqueléticas		
↑ de Peso	Alteração do Centro de Gravidade e do	Evitar Extremo das Amplitudes
↑ Relaxina	Equilíbrio	Evitar Decúbito Dorsal
↑ Volume Uterino	Alterações das Curvaturas do Ráquis	(por compressão da veia cava inferior)
	↑ Metabolismo Basal	
	Laxidez/Instabilidade Ligamentar e	Importante manter Boa Postura / Bom
	Articular	Posicionamento
	↓ Mobilidade Corporal	Assegurar uma boa estabilidade dos
	Desconforto e/ou Dor Lombopélvica	músculos do *core*

Legenda: ↓ - diminui; ↑- aumenta; l litro; O2- oxigénio

Alguns estudos têm sido realizados no sentido de se perceber quais os padrões da AF durante a gravidez, bem como quais as implicações que a AF tem na saúde da grávida e do recém-nascido (ACOG, 2002; Borg-Stein *et al.*, 2005; Paisley *et al.*, 2003).

Estado da arte da atividade física ao longo da gravidez

Os padrões de AF na gravidez têm sofrido alterações, nas últimas décadas. Estas alterações devem-se a um aumento do conhecimento da resposta fisiológica ao exercício na gravidez, quer a nível materno quer fetal (Charlesworth, 2011).

Para verificarmos o comportamento das mulheres grávidas, relativamente à AF, fizemos uma sinopse dos artigos consultados. O objectivo desta análise foi perceber o comportamento das grávidas em contexto das Atividades da vida diária.

A tabela 2, refere-se a estudos prospetivos da AF na gravidez.

Podemos verificar que apenas três estudos utilizam a medida objetiva acelerómetro para avaliar a AF (Langhoff-Roos *et al.*, 1987; Rousham *et al.*, 2006; Stein *et al.*, 2003), os restantes utilizam questionários desenvolvidos maioritariamente pelo investigador, entrevistas ou registos diários.

A definição de conceito de AF e exercício são diferentes de estudo para estudo, bem como as variáveis de *outcome* que podem ser traduzidas em diferentes unidades de medida ou modo de expressão (METs, *counts*, cumpre *vs* não cumpre recomendações, faz *vs* não faz AF). Apenas o estudo de Borodulin se refere ao cumprimento de *guidelines,* nomeadamente as da ACOG em que apenas 3% das mulheres cumpre as recomendações e as do CDC/ACSM em que se verifica uma diminuição no cumprimento destas recomendações do segundo para o terceiro trimestre quer na intensidade absoluta quer na percecionada (Borodulin *et al*., 2008).

O tipo de AF (total, doméstica, ocupacional, de lazer e desporto) avaliado, bem como a intensidade (baixa, moderada, vigorosa) também variam entre os estudos, sendo o tipo de AF mais avaliado a de lazer, doméstica e ocupacional. Nenhum dos estudos analisados inclui todos os tipos de AF.

Além disto, os estudos apresentam tamanhos amostrais muito diferentes variando entre 10 (Clapp *et al.*, 1987) e 9.889 participantes (Liu *et al.,* 2011).

Os momentos de avaliação variam entre 2 (Borodulin et al., 2008; Chasan-Taber et al., 2007b; Hinton & Olson, 2001; Stein et al., 2003) e 5 (Clarke *et al.,* 2005; Rousham *et al*., 2006; Van Raaij *et al.*, 1990), contemplando alguns o período pré-gestacional (Chasan-Taber et al., 2007b; Clarke et al., 2005; Hinton & Olson, 2001) e outros apenas períodos ao longo da gestação (Borodulin *et al*., 2008; Watson & McDonald, 2007). Ainda, relativamente a estes períodos, uns referem-se a momentos específicos - semanas de gestação (Clarke *et al.,* 2005; Rousham *et al.,* 2006) e outros a períodos gestacionais - trimestres (Duncombe *et al.*, 2006; Watson & McDonald, 2007).

A falta de uniformidade na metodologia torna difícil a comparação entre estudos.

Porém, a maioria dos estudos analisados referem uma tendência para a diminuição dos níveis de AF totais ao longo da gravidez, especialmente do momento pré-gestacional para o primeiro trimestre (Chasan-Taber et al., 2007b), outros referem que este declínio se mantém ao longo da gravidez (Rousham *et al.*, 2006) ou que permanece inalterado do segundo para o terceiro trimestre (Borodulin *et al*., 2008; Poudevigne & O'Connor, 2005).

A actividade laboral diminui 5% (Rao *et al.*, 2003) e 7% das mulheres reporta diminuir tarefas que implicam levantamento de pesos (Hatch *et al.*, 1997).

A AF de lazer diminui ou cessa entre 28 e 63% (Clarke *et al.*, 2005), contudo algumas mulheres (20%) referem aumentar este tipo de atividade (Hinton & Olson, 2001).

Relativamente à duração e intensidade da AF, a maioria dos estudos refere existir uma diminuição (Clapp et al., 1987).

Em Portugal, só encontramos dois estudos que mensuraram a AF na gravidez. No entanto, esta variável não era o *outcome* principal e ambos usaram medidas subjetivas, tendo o estudo de Tendais *et al.* (2011) usado o questionário genérico - *International Physical Activity Questionnaires* (IPAQ) e Gouveia *et al.* (2007) um questionário realizado pelo investigador.

Tabela 2 - Estudos prospetivos das alterações da AF durante a gravidez.

Estudo	Tamanho amostral	Medida da Atividade Física (instrumento)	Momentos de avaliação	Resultados
Liu, J., *et al.*, 2011	9.889	Questionário (pergunta feita pelo investigador- pelo menos uma vez por semana faz qualquer atividade regular, como caminhada rápida, jardinagem, trabalho doméstico*, jogging*, ciclismo, etc., o tempo suficiente para a fazer transpirar?)	2 momentos 18 e 32s	= Às 18 e 32s a prevalência da prática de AF que era suficiente para provocar a transpiração para ≥3 h/semana foi semelhante (48,8%). ↓ Depois de engravidar, cerca de duas em três destas mulheres relataram reduzir os níveis de AF às 18 semanas de gestação. A AF mais referida foi: caminhada rápida, seguido de natação e exercícios pré-natais. Usando modelos ajustados para as variáveis estudadas, verificou-se que as mulheres mais jovens, de classes sociais mais baixas, desempregadas, casadas e multíparas (em comparação com as que não têm estas características) foram mais propensas a relatar prática de AF extenuante e foram as que referiram menos reduzir a AF.
Tendais., *et al.*, 2011	56	IPAQ	3 momentos Pré-gestacional (retrospetivo) 10-15s e 19-24s	= mantiveram-se os valores na AF de lazer, AP e de transporte, apenas se verificaram diferenças significativas na ↓AF vigorosa de lazer do pré para o 1º e 2º momento. Não se verificaram diferenças entre o 1º e o 2º momentos
Borodulin, K.M. *et al*. 2008	1482	Entrevistas via telefone para avaliar tipo, frequência, duração e intensidade da AF durante a semana anterior	2 momentos Entre as 17-22s e 27-30s	= Mantém-se estável o nº de mulheres que reporta AP, sendo 32% 2T e 30% 3T, mas reportam níveis de intensidade muito baixos. As atividades dentro de casa e as recreativas representam uma grande parte da atividade total 25%. = do 2T para o 3T a proporção de mulheres que cumpriu as recomendações da ACOG 3,0% vs. 3,1% (P = 0,90) de intensidade absoluta e 12,9% vs. 10,8% (P = 0,05) de intensidade percecionada. ↓ do 2T para o 3T a proporção de mulheres que cumpre as recomendações do CDC/ACSM moderada/vigorosa a proporção foi de 15,2% vs. 11,4% (P <0,001) para a intensidade absoluta e 38% vs. 33,7% (P = 0,005) de intensidade percecionada.
Chasen – Taber, 2007	1231	Kaiser Physical Activity Survey 1)AD e assistência à família 2)Profissional 3)Hábitos de vida ativos 4)Desporto ou exercício	2 momentos pré-gestacional (ano anterior - retrospetivamente) Início da gravidez -15 s Meio da gravidez - 28 s	↓a AF Total de pré-gestacional para o início da gravidez. ↑Ligeiramente do início para o meio da gravidez. ↓AP do pré-gestacional para o meio da gravidez. ↓AF desporto do pré para o início e = do início para meio da gravidez.
Duncombe, *et al*. 2007	158	Registo diário de 7 dias (número total de minutos de exercício)	3 momentos Pré-gestacional (retrospetivamente), 1T:16-23s, 2T:24-31s, 3T:32-38s	↓ o nº de minutos de exercício de pré-gestacional para gravidez ocorrendo a > ↓ do pré-gestacional para o 1T seguida de 1T para 2T e a ↓é < de T2 para 3T

Tabela 2 - *continuação*

Estudo	Tamanho amostral	Medida da Atividade Física (instrumento)	Momentos de avaliação	Resultados
Pereira *et al,.* 2007	1442	Escala modificada de AF de Idosos	2 momentos 1 ano antes da gravidez (avaliação retrospetiva) 2 º trimestre (26-28s) 6 meses pós-parto	↑ a frequência de estilo de vida insuficientemente ativo de 12,6% pré-gestacional para 21,6% durante a gravidez (foi considerado Insuficientemente ativo quem tinha atividade < 150 min/semana).
Watson *et al.,* 2007	197	Auto-referência Registo de 24h de AF em 3 dias (Média diária total dos níveis de atividade em METs calculada a partir de esta informação)	3 momentos Início do 4 º mês de gravidez Início do 7º mês de gravidez 2 meses pós parto	↓ a mediana de METs do 4º para o 7º mês.
Gouveia *et al.,* 2007	475	Questionário elaborado pelo investigador	3 momentos Pós parto 3 e 6 meses pós-parto	↓Exercício de 23,8% antes da gravidez para 16,6% durante a gravidez. (exercício físico foi perguntado retrospetivamente e não foi a principal variável de *outcome*).
Rousham *et al*., 2006	57	Acelerómetro "Actiwatch AW2" Questionário de Auto perceção da AF *Modified Baecke Questionnaire* Avalia AF em "free-living".	5 momentos (12, 16, 25, 34 e 38 s)	Declínio no nível de AF ao longo da gravidez ↓a média dos níveis de AF do 2T para o 3T , quer por auto-referência média 24 h níveis de AF (1,51 vs. 1,29 METs.h/dia , P<0,01) quer por acelerómetro (200,05 vs. 147,42 counts/min, P<0,01)
Poudevigne *et al*., 2005	24	Diário da AL/AP	3 momentos Em cada mês para 7 dias consecutivos exceto no 1T	= não houve diferenças significativas no total da semana no DE do 2T para o 3T
Clarke *et al.*, 2005	57	Entrevista semi-estruturada Questionário modificado de Baecke usado para avaliar hábitos desportivos e AL (últimos 7 dias) (avaliou tipo de desporto, intensidade e frequência)	5 momentos pré-gestacional, 16, 25, 34 e 38s	Entre as 16 e as 38s, 63% das grávidas cessaram ou reduziram a AF desportiva ou de lazer
DaCosta *et al.*, 2003	180	Avalia AL (questionário desenvolvido pelo investigador)	3 momentos 8-14s; 18-19s; 31-32s	↓ a AL em 28% do 1T para o 3T Relativamente ao tipo de atividade ↓ do 1T para o 3T as atividades aeróbias ↑ do 1T para o 3T as caminhadas (18%) e natação (20%)
Stein *et al*., 2003	56	Frequência cardíaca, acelerómetros; e diário desenvolvido pelo investigador da AL/AP	2 momentos 20 e 32s	↓ 11% do DE baseado no acelerómetro para mulheres ativas ↑ o DE em 6% (diário) e ↓ 4% (frequência cardíaca) para mulheres sedentárias
Rao *et al*., 2003	797	Avalia AL, AP (questionário desenvolvido pelo investigador)	2 momentos 18 e 28 s	↓3% na AD ↓5% na AP(atividades agrícolas)

Tabela 2 - . *continuação*

Estudo	Tamanho amostral	Medida da Atividade Física (instrumento)	Momentos de avaliação	Resultados
Agarwal *et al.*, 2001	2331	Avalia AD (questionário desenvolvido pelo investigador)	3 momentos 16, 28 e 36 s	↓ o DE em kcal/dia do 1T para o 3T ↓ o tempo dispendido em atividades de alta intensidade AD (23%)
Hinton *et al.* 2001	622	Avalia AL (inespecífico)	2 momentos Pré-gestacional Durante a gravidez	= AL para 40%;↑ AL para 20%; ↓AL para 40% das grávidas em relação à AL pré-gestacional
Rabkin *et al.*,1990	1507	Avalia AL, AP, AD (questionário desenvolvido pelo investigador)	3 momentos 3 momentos (17, 28 e 36s)	↑ de absentismo laboral em 38% do 1T para o 3T ↓ o DE no trabalho: <700 kcal (83%) 1º T, 700-999 kcal (96%) 2ºT e > 999 kcal (97%) 3ºT ↓ a caminhada no trabalho (97%) 44% das grávidas reportam ↓ AD em <1,5 h 30% das grávidas reportam ↑ AD em 3-4,4h
Dufour *et al.,* 1999	157	14h de AL _ Observação e frequência cardíaca para estimar o DE	3 momentos 15s; 25s; 35 s	↓ a AF avaliada por DE em 18% do 1 para o 3T ↓ em 50% o tempo de caminhada moderada
Hatch *et al.*, 1997	575	Avalia AP (questionário desenvolvido pelo investigador)	3 momentos 13s; 28s; 36s	↓ em 7 % o nº de grávidas que reporta fazer tarefas com levantamento de pesos na AP (20 para 13%) do 1 para o 3T
Sternfeld *et al.*, 1995	388	Avalia AL (inespecífico)	3 momentos 16s; 26s; 36s	↓ % de AL de 42 para 14% do 1T para o 3T ↑ % das mulheres sedentárias de 28% para 63% = níveis de andar a pé inalterados ao longo da gravidez
Hatch *et al*. 1993	462	Avalia AL, AP (questionário desenvolvido pelo investigador)	3 momentos 13s; 28s; 36s	↓ 5,4% do 1T para o 3T a % reportada pelas grávidas de gastos de >1000 Kcal/s ↑ 5,6% do 1T para o 3T a % reportada pelas grávidas de gastos de < 1000 kcal/s Mudança no tipo de actividade, passando a fazer atividades de menor intensidade (caminhada, natação)
Grisso *et al.*, 1992	67	Diário de AD; AL; AP (inespecífico)	3 momentos 22-25s; 26-29s; 30-33s	↓ de trabalho pesado em (7%) em AD (7%), e em AL (10%) = nenhuma mudança em caminhar e subir escadas das 22-25s para 30-33s
Clapp & Capeless, 1991	40	Monitor de frequência cardíaca para a intensidade e duração Índice de duração-intensidade	2 momentos Pré-gestacional 1ª metade e 2ª metade da gravidez	↓ o índice de duração-intensidade em 28% da 1ª metade da gravidez vs pré-gestacional ↓ o índice de duração-intensidade em 44% da 2ª metade da gravidez vs pré-gestacional
Clapp. 1990	131	Índice de duração-intensidade (Frequência cardíaca)	Todas as 6-8s durante a gravidez	↓ a duração em 23% da 1ª metade da gravidez vs. pré-gestacional ↓ a intensidade (50-76%) da 2ª metade da gravidez vs. pré-gestacional

Tabela 2. - *continuação*

Estudo	Tamanho amostral	Medida da Atividade Física (instrumento)	Momentos de avaliação	Resultados
Clapp *et al*. 1990	132	Índice de duração-intensidade (Frequência cardíaca)	2 momentos Pré-gestacional 1ª metade e 2ª metade da gravidez	↓ o índice de duração-intensidade em 31% da 1ª metade da gravidez vs. pré-gestacional ↓ o índice de duração-intensidade em 35% da 2ª metade da gravidez vs. pré-gestacional
Van Raaij *et al.*, 1990	18	Diário AL (7 categorias)	5 momentos 10, 16, 22, 28, 34s	↑ todas as atividades da 34 vs 10s devido a ↑ andar devagar
Langhoff-Roos, 1987	54	Acelerómetro (*counts*) - (modelo inespecífico, 3d)	2 momentos 17 e 33s	↓ 7% no nº de *counts* das 17 para as 33s
Clapp *et al*., 1987	10	Monitor de frequência cardíaca para a intensidade e duração	2 momentos 2 meses pré-gestacional 20, 32 s	↓ a intensidade em 23% até às 20s sem mais alterações até às 32s ↓ a duração em 26% até às 32s

CARDIA - Coronary Artery Risk Development in Young Adult study; **s** – semana; ↓ - diminui; **<** - menor; **>** - maior; DE - dispêndio energético; AF- atividade física; AD - actividade doméstica; AL - atividades de lazer; AP - atividade profissional; T – trimestre; International Physical Activity Questionnaire (IPAQ); Equivalentes Metabólicas (METS)

Determinantes associados à prática da atividade física

Os determinantes associados à prática de AF, segundo um modelo socio ecológico são de múltiplos níveis nomeadamente: individuais, interpessoais, ambientais e políticos/organizacionais (Sallis, 2008), sendo que os:

- Individuais são relativos às características psicológicas e/ou biológicas.
- Interpessoais estão relacionados com o suporte social (família, amigos, trabalho), bem como com as normas culturais.
- Ambientais podem ser divididos em:
    - Ambiente social: comportamento dos pares - comportamento modelado e segurança.
    - Ambiente circundante: desenho urbanístico; rede de transportes públicos; parques e zonas de lazer; zonas pedonais e ciclovias.
    - Ambiente natural: vegetação; topografia; clima; trilhos de caminhadas e parques nacionais.
- Políticos/organizacionais referem-se a sistemas de transporte; urbanismo e arquitetura; parques e recriação; setor da saúde e educação; organizações desportivas e planos e políticas de AF.

Cada um destes determinantes pode funcionar como barreira ou facilitador à prática da AF, a interação entre eles poderá maximizar ou diminuir a sua influência à prática da AF (Bartholomew, 2011).

Influência da atividade física ao longo da gravidez na mulher e no recém-nascido

A investigação tem demonstrado que a prática de AF moderada e regular apresenta efeitos positivos na saúde materna e fetal (Halvorsen, 2012; Hegaard, 2008; Melzer *et al.*, 2010b).

A AF durante a gravidez tem uma relação positiva com a prevenção de complicações e desconfortos durante a gravidez e melhora os *outcomes* relacionados com os parâmetros fetais (Melzer *et al.*, 2010b)

Influência da atividade física na grávida

A evidência relacionada com a influência da AF na grávida tem demonstrado benefícios na melhoria da sua aptidão física, nomeadamente na capacidade cardiorrespiratória (Mottola *et al.*, 2010; Phelan, 2010; Shaikh *et al*., 2010), na diminuição do edema nos membros inferiores, na diminuição da incidência de diabetes e hipertensão gestacional, na diminuição nas alterações de humor e no controlo dos ganhos ponderais na gestante (Cioffi *et al.*, 2010; Evenson & Pompeii, 2010; Gaston & Cramp, 2011; Haakstad & Bo, 2011; Melzer *et al.*, 2010b).

Relativamente aos sintomas/lesões músculo-esqueléticos na mulher grávida a evidência é inconclusiva, uns referem que a AF é benéfica (Garshasbi & Faghih Zadeh, 2005; Mogren, 2005), outros dizem estar associada a maior sintomatologia (Mogren & Pohjanen, 2005) e alguns não encontraram qualquer relação (Mens *et al.,* 2000; Vermani *et al.,* 2010).

Paralelamente aos efeitos físicos importa também salientar os efeitos emocionais positivos que a AF regular e moderada tem para a gestante (Barakat *et al.*, 2011; Cioffi *et al.,* 2010; Evenson & Bradley, 2010; Melzer *et al.*, 2010b).

Influência da atividade física no recém-nascido

A AF de intensidade elevada, especialmente a partir do segundo trimestre da gravidez, levanta muitas questões uma vez que pode influenciar os parâmetros fetais à nascença (Barakat *et al.*, 2011; Barakat *et al*., 2009b). Estas questões estão relacionadas com a possibilidade de hipoxia fetal, acidose, hipertermia, alterações cerebrais e alterações do crescimento fetal (McMurray *et al.,* 1993).

Os estudos mais recentes para avaliar o efeito do fluxo sanguíneo uteroplacentário, a regulação da temperatura materna e a utilização de substrato alimentar foram feitos em ratos e ovelhas. Nos humanos, tem sido estudada a frequência cardíaca e medidas relacionadas com os *outcomes* à nascença (Juhl et al., 2010; Sports, 2009).

Os benefícios da AF para o feto incluem a diminuição da massa gorda, uma melhor tolerância ao *stress* e uma maturação neurocomportamental melhorada (Hegaard *et al.,* 2010; Melzer *et al.,* 2010b; Wolfe *et al.*, 2003; Wolfe & Weissgerber, 2003).

Estes benefícios devem-se a um aumento da extração de oxigénio, melhor redistribuição intrauterina e hemoconcentração, sendo um fator protetor das malformações do tubo neural no primeiro trimestre (Schlussel *et al.*, 2008).

Alguns autores referem que as grávidas praticantes de exercício físico têm bebés com maior peso à nascença (Downs & Hausenblas, 2007). Contudo, outros autores dizem que a AF não influencia o peso (Both *et al.*, 2010; Gouveia *et al*., 2007) e em contrapartida alguns referem que diminui o excesso de peso à nascença (Takito *et al.*, 2009).

A AF, segundo Batista em 2003, reduz as complicações do parto, diminuindo assim a incidência de sofrimento fetal, obtendo-se melhores índices de *Apgar* (Batista, 2003).

Atualmente, há evidência que elevados níveis de humor estão associados a melhores estados de saúde do feto (Da Costa, 2003; Poudevigne & O'Connor, 2006).

Os riscos que anteriormente eram referidos como associados ao exercício incluíam a possibilidade do feto em desenvolvimento poder ser forçado a competir com os músculos esqueléticos da mãe por sangue oxigenado (conduzindo a hipoxia fetal) e nutrientes essenciais (conduzindo a restrições no crescimento fetal). Suspeitava-se, igualmente, que o aumento da temperatura corporal do *core* materno, decorrente da prática de exercício, pudesse conduzir a hipertermia fetal e potenciais efeitos teratogénicos. As preocupações englobavam também o possível aumento do risco de aborto espontâneo e trabalho de parto precoce (Melzer *et al.,* 2010a; Melzer *et al.*, 2010b; Wolfe & Weissgerber, 2003).

Recomendações para a atividade física durante a gravidez

No passado, a AF na gravidez baseava-se na cultura tradicional e costumes de cada país e não na evidência científica.

Em 1950, era aconselhado às mulheres grávidas a continuação das tarefas domésticas e percorrerem 1,6 km a pé por dia, de preferência em vários percursos curtos, no entanto, o desporto e o exercício[5] eram desencorajados (Pivarnik *et al.*, 2006).

Em 1985, o ACOG formulava uma das primeiras recomendações para a AF de lazer durante a gravidez (ACOG, 1985). Estas recomendações eram bastante conservadoras. Em geral, o limite máximo recomendado para as grávidas correspondia ao limite mínimo sugerido pelo ACSM para adultos. O exercício não devia induzir a um aumento da frequência cardíaca acima de 140 bpm e o exercício vigoroso não devia durar mais do que 15 minutos (Pivarnik *et al.,* 2006). Referiam, ainda, contraindicações absolutas e relativas, estando as mulheres obesas e as mulheres com estilos de vida de extremo sedentarismo incluídas. Contudo, as mulheres com boa aptidão física poderiam tolerar um programa mais exigente desde que fosse recomendado pelo seu prestador de cuidados de saúde (ACOG, 1985).

Em 1994, o ACOG faz uma revisão às recomendações, tornando-as menos restritivas (ACOG, 1994). Estas recomendações focavam os benefícios da AF de lazer, indicando que o exercício físico deveria ser realizado três vezes por semana e retiraram a condição de que o exercício não devia induzir a um aumento da frequência cardíaca acima de140 bpm (ACOG, 1994).

A revisão mais recente das recomendações do ACOG ocorreu em 2002. Este documento é o reflexo da evidência científica produzida até à data. Os benefícios da AF de lazer são enfatizados e propõe que, na ausência de complicações médicas ou obstétricas, as mulheres grávidas devem adotar as

[5]Exercício físico é um tipo de actividade física planeada, estruturada e que implica repetição do movimento como objectivo de aumentar ou manter um ou mais componentes da aptidão física (Caspersen et al., 1985).

mesmas recomendações para a prática de AF que as mulheres não grávidas. A prática de exercícios de intensidade moderada é aconselhada durante 30 minutos, devendo esta ocorrer na maioria, se não todos os dias da semana (ACOG, 2002).

Se estas orientações enfatizam uma ampla gama de atividades recreativas que são seguras durante a gravidez (caminhar, nadar, andar de bicicleta…), porém são desaconselhadas atividades com um alto potencial de queda ou trauma, como desportos de contacto, atividades que impliquem a posição de decúbito dorsal prolongada e mergulho, devido a preocupações com a saúde do feto, uma vez que podem levar a uma deficiência do retorno venoso do fluxo sanguíneo (ACOG, 2002).

A promoção da AF na gravidez, segundo o ACSM e o CDC, deve ser direcionada tanto para as mulheres que eram ativas no período pré-gestacional como para as que sempre foram sedentárias (ACSM, 2006).

O CDC e o ACSM recomendam que todas as mulheres saudáveis, que não sejam sedentárias, devem fazer pelo menos 150 minutos de atividade aeróbica de moderada intensidade por semana durante a gravidez e no período pós-parto (ACSM, 2006). A atividade deve ser acumulada ao longo da semana, ou seja, 30 minutos por dia pelo menos 5 vezes por semana (ACSM, 2006).

O ACSM refere, ainda, que pode ser AF vigorosa se for feita, pelo menos 20 minutos, três vezes por semana. Para as gestantes que apresentavam um estilo de vida sedentário antes de engravidar são recomendados 15 minutos de exercício contínuo, três vezes por semana, com uma progressão gradual para sessões de 30 minutos, quatro vezes por semana (ACSM, 2006).

As mulheres que eram vigorosamente ativas antes de engravidar são encorajadas a manter a atividade durante a gravidez e pós parto se tiverem uma gravidez saudável. Para isso, devem trabalhar com os prestadores de cuidados de saúde no sentido de desenvolverem programas que privilegiem a baixa resistência, muitas repetições e em que seja solicitado o trabalho de grandes grupos musculares. Os programas devem ser ajustados ao longo do tempo (ACSM, 2006).

Em 2008, surgem as recomendações de AF do *United States Department of Health and Human Services* (USDHHS) que são mais permissivas, uma vez que admitem que uma grávida saudável, que não fosse muito ativa antes de engravidar ou que não fizesse atividade vigorosa, faça pelo menos 150 minutos (2 horas e 30 minutos) por semana de AF aeróbica de intensidade moderada, devendo esta ser distribuída preferencialmente ao longo da semana, mas podendo ser cumulativa("Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary", 2009) .

Tabela 3 - Comparação das recomendações da AF na gravidez

	ACOG	**CDC**	**ACSM**	**USDHHS**
Tipo	Exercício	AF	AF	AF aeróbica
Duração	≥30 min	≥30 min	≥30 min ou ≥20 min	≥150 minutos
Intensidade	Moderada*	Moderada*	Moderada* ou Vigorosa †	Moderada*
Frequência	Na maioria dos dias da semana	≥5 vezes por semana	≥5 vezes por semana ou ≥3 vezes por semana	AF acumulada semanalmente, mas de preferência ao longo da semana

Legenda: **ACOG**_American College of Obstetricians and Gynecologists; **CDC**_ Centers for Disease Control and Prevention; **ACSM**_ American College of Sports Medicine; **USDHHS**_ United States Department of Health and Human Services; ***Moderada**_ 3-6 METs (geral de adultos) e 4.8-7.1 METs para o grupo etário dos 20 – 39 anos; †**Vigorosa** ≥ 7.1 METs†; Equivalentes Metabólicas (METS); AF – Atividade Física

Da análise da Tabela 3, verifica-se que estas recomendações diferem quanto ao tipo de atividade, uma vez que a ACOG recomenda exercício físico e o CDC, ACSM e USDHHS referem-se à AF. Têm ainda discrepâncias em relação à distribuição do tempo de realização das atividades, bem como em relação à sua periodicidade. Contudo, todas são consensuais e enfatizam a importância da AF regular de moderada intensidade durante uma gravidez saudável.

Para melhor compreendermos os níveis de AF, vamos fazer referência ao seu modo de classificação. Estes podem ser classificados de acordo com os gastos energéticos expressos em equivalentes metabólicos METs (Ainsworth *et al.*, 2000).

Considerando que 1MET representa o metabolismo basal sem esforço, a AF sedentária seria representada por um consumo de energia inferior a 1,5 MET; a AF leve por 1,5 a 3 METs; a AF moderada por 3 a 6 METs para adultos no geral e 4,8 a 7,1 METs para a faixa etária dos 20 aos 39 anos e a AF vigorosa exigia um consumo de energia superior a 6 METs, o que corresponde a uma caminhada rápida a aproximadamente 5-7km/h (Ainsworth *et al.*, 2000).

Instrumentos de medida da atividade física

A AF é uma construção complexa, que engloba diferentes dimensões, tais como: gasto energético; intensidade (sedentária, leve, moderada, vigorosa); tipos de atividade, que se relacionam com o contexto em que é realizada (ocupacional, de lazer/exercício, transporte, domésticas) e tipos de atividade, que se relacionam com a forma e objetivos da sua realização (aeróbica, fortalecimento muscular e equilíbrio) (Troiano, 2009).

Dada a complexidade da construção e a variedade de aplicação de instrumentos em função dos estudos (de vigilância, epidemiológicos, clínica e de intervenção), parece não existir um instrumento que dê resposta a todas estas necessidades (Troiano, 2009).

A evidência mostra que o ideal será o uso de abordagens que combinem medidas objetivas (como acelerómetros, localização geográfica, sensores e monitorização da frequência cardíaca) e medidas subjetivas (como, por exemplo, registos diários ou questionários) (Troiano, 2009).

A escolha de instrumento de avaliação depende dos objetivos do estudo, da dimensão da AF que o investigador pretende medir, da tipologia de estudo, do tamanho amostral (grupos ou indivíduos), das características da população alvo e dos recursos disponíveis (Troiano, 2009).

Os instrumentos de medida baseados em auto-referência apelam à memória, o que implica que a perceção da atividade pode não refletir com precisão o comportamento efetuado (Troiano, 2009).

Para avaliar a AF existem muitos questionários (Helmerhorst *et al*., 2012), desde genéricos (IPAQ) a específicos. Para esta população específica (que seja do nosso conhecimento) só existem dois questionário: o *Pregnancy Physical Activity Questionarie* (PPAQ) (Chasan-Taber *et al*., 2004) e o *Leisure Time Physical Activity* (LTACC) (Aittasalo *et al*., 2010).

Apesar de cada vez mais estudos usarem medidas objetivas para avaliar a AF em grandes grupos populacionais, os questionários são considerados complementares à investigação (Helmerhorst *et al*., 2012), provavelmente por causa do seu baixo custo e comodidade, mas têm limitações e, por isso, devem ser selecionados e utilizados criteriosamente (Helmerhorst *et al*., 2012).

A maioria dos questionários de AF é concebida para serem capazes de medir dimensões múltiplas da AF, que informam o tipo e o local de domínio. No contexto da actividade, fornecem estimativas de tempo gasto em atividades de diferentes níveis de intensidade e podem ser capazes de classificar os indivíduos de acordo com os níveis de intensidade da atividade referida (Helmerhorst *et al*., 2012).

O acelerómetro é um instrumento válido e fiável, muito utilizado para medir a AF em contexto comunitário, tendo sido já usado na população específica das grávidas (Harrison *et al*., 2011).

MATERIAL E MÉTODOS

Metodologia

Esta tese apresenta os resultados relativos a dois trabalhos de campo, referente a dois estudos longitudinais prospetivos:

O primeiro, refere-se a uma amostra comunitária de 118 mulheres grávidas que faziam a sua vigilância da gravidez, nos Centros de Saúde que fazem parte da Unidade Local de Saúde do Alto Minho. As mulheres constituíram uma coorte que foi avaliada nos três trimestres de gravidez. O período de colheita de dados decorreu de setembro de 2009 a novembro de 2011.

O segundo, diz respeito a uma amostra consecutiva de grávidas vigiadas no Centro de Saúde da área de residência e que fazem as ecografias de rotina no Hospital de S. João no Porto. Estas mulheres foram convidadas a participar no estudo às 10-12 semanas de gestação, aquando da realização da primeira ecografia e constituíram uma coorte que foi reavaliada às 20-22s. O estudo teve início em setembro de 2011 e está ainda a decorrer.

A realização de dois trabalhos de campo prende-se com o facto de apesar de a temática abordada nos dois estudos ser a mesma, AF na gravidez, eles se tornarem complementares, ou seja no primeiro usamos medidas subjetivas da AF, avaliando a perceção da atividade e no segundo, avaliamos a AF objetivamente com acelerómetros.

Além disso, os diferentes momentos de avaliação ao longo da gravidez no primeiro estudo foram feitos durante um período de tempo que se referia a um trimestre de gravidez enquanto no segundo foi feita em semanas específicas do trimestre da gravidez.

A metodologia utilizada para a elaboração desta tese está descrita de forma resumida no quadro 4. Nele constam as características principais metodológicas referentes a cada artigo: tipologia de estudo, o tamanho amostral, critérios de inclusão e exclusão, instrumentos de avaliação, variáveis em estudo, variáveis de *outcome* e análise estatística.

Apresentamos os aspetos em comum e as principais diferenças, estando a metodologia descrita detalhadamente em cada um dos artigos na secção dos métodos. Os artigos 1 e 2 referem-se a dados do primeiro estudo, os artigos 3 e 4 referem-se a dados do segundo estudo.

	Artigo 1	Artigo 2	Artigo 3	Artigo 4
Tipo de Estudo	Longitudinal prospetivo setembro 2009 a novembro 2011	Longitudinal prospetivo setembro 2009 a novembro 2011	Longitudinal prospetivo julho 2010 a maio 2012	Longitudinal prospetivo julho 2010 a maio 2012
Amostra	Consecutiva Comunitária n=118	Consecutiva Comunitária n=118	Consecutiva Comunitária n=137 Amostra final:barreiras n= 98 Amostra final:recomendações n= 82	Consecutiva Comunitária n=137 Amostra final n=70
Critérios de inclusão	Gravidez confirmada Semanas de gestação 1T: <15 s de gestação 2T: 15 a 28s 3T:> 28s	Gravidez confirmada Semanas de gestação 1T: <15 s de gestação 2T: 15 a 28s 3T:> 28s	Gravidez espontânea 10-12s de gestação - confirmada ecograficamente	Gravidez espontânea 10-12s de gestação - confirmada ecograficamente
Critérios de exclusão	Hipertensão diabetes, doença cardíaca; Gestação gemelar, Idade <18 ou> 40 anos Falta de competência no idioma Português	Hipertensão diabetes, doença cardíaca; Gestação gemelar, Idade <18 ou> 40 anos Falta de competência no idioma Português	Doença cardíaca grave, sangramento persistente após 12 semanas de gestação, gravidez múltipla, problemas de tiróide, hipertensão induzida pela gravidez ou pré-eclampsia, diabetes ou diabetes gestacional Idade <18 anos ou> 40 anos; prematuridade e falta de competência no idioma Português	Doença cardíaca grave, sangramento persistente após 12 semanas de gestação, gravidez múltipla, problemas de tiróide, hipertensão induzida pela gravidez ou pré-eclampsia, diabetes ou diabetes gestacional Idade <18 anos ou> 40 anos; prematuridade e falta de competência no idioma Português
Momentos de avaliação	Referente a um período (ao longo de cada trimestre) 1T: <15 2T:entre as 15 e as 28s 3T:> 28s	Referente a um período (ao longo de cada trimestre) 1T: <15 s 2T:entre as 15 e as 28s 3T:>28s	Referente a semanas específicas 1T: (10-12s) 2T: (20-22s)	Referente a semanas específicas 1T: (10-12s) 2T: (20-22s) pós parto: 1as 48 horas
Instrumentos	Questionário (dados pessoais e obstétricos) PPAQ	Questionário (dados pessoais e obstétricos) PPAQ	Questionário (dados pessoais e obstétricos) Questionário de identificação de barreiras à prática de AF baseado no modelo ecológico Acelerómetro Actigraph GT3X	Questionário (dados pessoais e obstétricos) Acelerómetro Actigraph GT3X Escala de ansiedade de *Zung* QFA Balança neonatal
Procedimento	Avaliação na data da consulta pelo enfermeiro (treino prévio da equipa de enfermagem)	Avaliação na data da consulta pelo enfermeiro (treino prévio da equipa de enfermagem)	Avaliação na data da ecografia sempre pelo mesmo investigador Acelerómetro: -usar 7 dias consecutivos, -validos: 480 min/dia -3 dias de trabalho e 1 dia de descanso(fim semana	Avaliação na data da ecografia sempre pelo mesmo investigador e no pós parto Acelerómetro: -usar 7 dias consecutivos, -validos: 480 min/dia 3 dias de trabalho e 1 dia de descanso
Variaveis de *outcome*	Níveis de AF; tempo despendido por tipo de AF; aconselhamento dos profissionais de saúde para a prática de AF	Prevalência e fatores de risco da NSPLBP nível de AF	Cumprimento das recomendações de AF; Barreiras à prática de AF	Níveis de AF, cumprimentos das recomendações *outcomes* fetais à nascença: peso, altura. Índice de *apgar* à nascença
Estatística	Média±DP, qui-quadrado ou teste exato de Fisher, coreção para a continuidade Yates. Análise de medidas repetidas de variância e o teste de Wilcoxon Signed Rank.	Média ±DP qui-quadrado ou teste exato de Fisher, corecção para a continuidade Yates Regressão logistica	Média ±DP Teste McNemar Teste qui-quadrado ou exacto de Fisher	Média ±DP t-test and ANOVA com Bonferroni Mann-Whitney Kruskal-Wallis Chi-square Test ou teste exacto de Fisher

Legenda- T-trimester; **S-** semanas; **PPAQ**-Pregnancy Physical Activity Questionnaire; **NSPLBP**- Dor lombar não específica ; **DP**- desvio padrão; **QFA**-Questionário de Frequência Alimentar

Artigo1_ Physical Activity Patterns during Pregnancy in a Sample of PortugueseWomen: longitudinal prospective study
Artigo2_ Association between Low Back Pain and Physical Activity during Pregnancy: A Longitudinal Prospective Study
Artigo3_ Impact of compliance with different guidelines on physical activity during pregnancy and perceived barriers to leisure physical activity
Artigo4_ Physical activity during pregnancy and its effects on neonatal outcomes

Figura 2: Síntese da metodologia usada em cada um dos artigos

Artigo I

Physical Activity Patterns during Pregnancy in a Sample of Portuguese Women longitudinal prospective study

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Physical Activity Patterns during Pregnancy in a Sample of Portuguese Women longitudinal prospective study

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Abstract

Objective: This paper has the following two goals: (1) to analyze the perception of physical activity (PA) patterns during pregnancy according to weekly time spent on different types of activity; and (2) to determine women's perception about health care providers' PA advisement during pregnancy.

Methods: A longitudinal prospective study was carried out with a cohort of 118 pregnant women. Participants were evaluated in all trimesters. Self-reported questionnaires were used to collect personal and obstetric data. Type, duration and frequency of PA were evaluated using the Pregnancy Physical Activity Questionnaire (PPAQ) and intensity levels were calculated. Repeated measure analysis of variances was performed to access differences between trimesters, and Wilcoxon signed-rank test was performed when appropriate.

Results: A decrease in values of self-reported PA (MET.h.wk-1) was found over the trimesters of pregnancy for respectively total, light and moderate intensity ($p<0.01$, for all). Time spent in most activities remained fairly stable throughout pregnancy. Women spend most of their weekly time during the whole pregnancy in household and caregiving activities, occupational activities and leisure except sport activities. Swimming was the most reported organized PA, reaching its highest proportion (12.7%) in the second trimester. Prenatal exercise classes were reported by 39.8% of women during the 3rd trimester. Pregnant women reported that PA was recommended by health professionals – 53.9% in 1st trimester, 70.4% in 2nd trimester and 56.8% in 3rd trimester.

Conclusions: Self-reported PA decreased during pregnancy especially in total, light and moderate intensity. Women spend most of their weekly time in domestic, occupational and leisure activities, except sports activities. There still are some health care providers that do not recommend physical activity during pregnancy.

1. Introduction

Regular physical activity (PA) is promoted for its overall health benefits, particularly in the prevention of chronic diseases and unhealthy weight gain (World Health Organization, 2010).

During pregnancy, the key components of a health promotion lifestyle include appropriate PA and weight gain (Melzer et al., 2010a). Epidemiologic studies have found that women who are more active during pregnancy may have reduced risk of morbidity such as chronic musculoskeletal conditions gestational diabetes, hypertensive disease (Evenson et al., 2002; Solomon et al., 1997), preeclampsia and urinal incontinence, as well as better psychological adjustment to pregnancy changes (Aittasalo et al., 2008; Borodulin et al., 2008). Moreover, it is suggested that habits adopted during pregnancy could affect a woman's health for the rest of her life (Artal & O'Toole, 2003).

Recommendations concerning exercise during pregnancy have evolved throughout the years (Paisley et al., 2003). The traditional medical advice has been for exercising women to reduce their levels of exertion in pregnancy, based on concerns that exercise could negatively affect pregnancy outcomes or represent a risk of maternal musculoskeletal injury (Duncombe et al., 2009; Paisley et al., 2003).

The American College of Obstetricians and Gynecologists (ACOG) and Centers for Disease Control and Prevention/American College of Sports Medicine (CDC/ACSM) guidelines suggest 30 minutes or more of moderate-intensity activity on most days of the week, but they differ on the type of activity, as ACOG recommends only exercise, and CDC/ACSM recommends any type of PA (ACOG, 2002; ACSM, 2006; Borodulin et al., 2008). However, some retrospective studies suggested that PA among pregnant women declines for recreational, occupational and overall PA. Since pregnancy is a life-changing event associated with social, psychological, behavioral and biological changes, it may not be surprising that it has been identified as a contributing factor to the decline in exercise among women (Borodulin et al., 2008).

However, a current pregnant woman's PA patterns during pregnancy have not been explored in depth and most previous studies lack assessment of variables such as type, frequency, duration and intensity of activity (Borodulin et al., 2009; Borodulin et al., 2008). Besides, less is known about a health care provider's attitude regarding the most recent guidelines. The pertinence of this study lies on the need to understand PA patterns and type of tasks performed by pregnant women so that models of health promotion adjusted to reality and needs of these women can be created. Thus, this study aimed (1) to analyze the perception of PA patterns during pregnancy according to weekly time spent on different types of activity; and (2) to determine women's perception about health care providers' PA advisement during pregnancy.

2. Subjects and Methods

2.1 Study Design and Sample

A longitudinal prospective study was carried out with a cohort draw from a consecutive sample of pregnant women who were seeking prenatal care at 11 heath care centers located in Minho Region, Portugal throughout September 2009 to November 2011. Almost all women (98.7%) in Portugal attend routine prenatal visits in these health maternal centers (Alves, 2005). Women were invited to participate in the study during their first trimester and were reassessed during their second and third trimesters.

The inclusion criteria used in this study comprised: (1) women with confirmed pregnancies and less than 15 weeks of gestation for the first trimester; (2) women with 15 to 28 weeks of gestation for the second trimester; and (3) women with more than 28 weeks of gestation for the third trimester.

Women were considered ineligible if they had any of the following characteristics: diabetes, hypertension, heart disease or chronic disease; no singleton pregnancy; age 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).

One hundred eighty-five women were eligible for inclusion in the present sample (Figure 1). Thirty-seven women were excluded and the net sample consisted of 118 pregnant women. There were no significant differences between the net sample and losses; the two groups had similar baseline characteristics in terms of age, pre-pregnancy body mass index (BMI), educational level, monthly income and number of gestations.

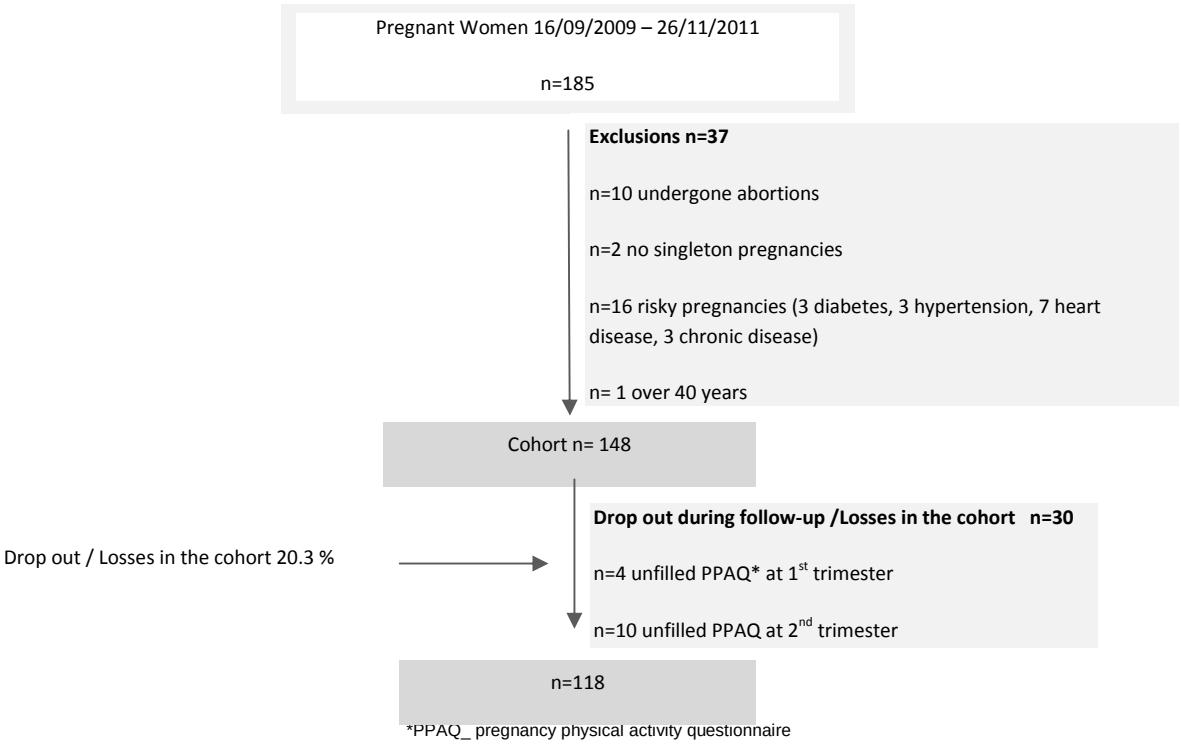

Figure 1 – Chart of Exclusions and Losses in the Cohort

2.2 Assessment Instruments

Data were collected during each trimester of pregnancy by trained nurses who administered structured and self-reported questionnaires. The questionnaires were designed to cover personal and socio-demographic data, lifestyle variables, health status during pregnancy and gynecologic history. The validity of the questionnaires was verified by experts who offered comments that were used to make amendments to the original surveys and generate final versions.

Pre-pregnancy BMI was estimated from self-reported pre-pregnancy weight and height, using the formula *BMI=weight(kg)/height^2(m^2).* Pre-pregnancy BMI was categorized according to the Institute of Medicine guidelines. These guidelines were also used to assign groups by weight gain (IOM, 2009; Simas et al., 2011).

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

The percentage of health professionals who have counseled PA during pregnancy was calculated by affirmative answers to the following question: *During this trimester of pregnancy, were you advised by a health professional to do physical activity (walking, hiking, swimming...)?*

Physical Activity Measurement

PA levels were determined using the Pregnancy Physical Activity Questionnaire (PPAQ), a self-reported questionnaire that evaluates the type, duration and frequency of PA performed by pregnant women. Each activity was classified according to intensity – sedentary (<1.5 METs), light (1.5-3.0 METs), moderate (3.1-6.0 METs) or vigorous (>6.0 METs), and according to type – household/caregiving, occupational and sports/exercise. Questions about two more types of activity were added to the original PPAQ questions: *leisure except sport'* and *transportation* (leisure except sport = sum of [duration * intensity] for questions 11, 12, 13, 14 and transportation = sum of [duration * intensity] for questions 20, 21, 22). Time reportedly spent on each activity was then multiplied by activity intensity to achieve a measure of average weekly energy expended (MET hours.week^1). The PPAQ has been validated by Chasan-Taber (Chasan-Taber et al., 2004).

2.3 Procedures

Eleven local health centers agreed to participate in the present study. Meetings were held with the head nurse of the units' maternal health teams to present the manual of procedures designed to standardize data collection.

The assessment instruments were individually administered during maternal health consultations that were held in each pregnancy trimesters. In the first month, weekly telephone contact was established with the nurses in the field by the main researcher; afterwards, contact was established monthly.

Ethical approval for the present study was obtained from the relevant institutional ethics committees. Participants signed a consent form that was in keeping with the Declaration of Helsinki.

2.4 Statistics

Descriptive data are presented as means and standard deviations or median and Interquartile range, unless otherwise stated. Associations between variables were analyzed via statistical inference – specifically, the Chi-square Test or Fisher's Exact Test. Yates continuity correction was used for analysis of 2x2 contingence tables.

For continuous variables repeated measure analysis of variances was performed to access difference between first, second and third trimesters, and Friedman test was performed when appropriate. When Friedman test was significant we use the Wilcoxon signed-rank test to access the differences between pairs of trimesters.

Statistical significance was defined as a *P*-value <0.05. Statistical analysis was conducted using PASW® statistical v.18 (SPSS, Chicago, Illinois, USA).

3. Results

The baseline characteristics of the sample are shown in Table 1. About half of the women had only mandatory or less education; 86.4% were married or cohabitate; 78.0% were employed full time; and 74.5% had monthly family incomes below 1250€, a figure equivalent to 2.5 times the national minimum wage. Half of the women were primigest and 34.2% were overweight/obese prior to becoming pregnant.

Table 5 – Descriptive characteristic of sample at baseline.

	n	Total n (%)
Age (years)	118	
[18, 30]		76(64.4)
[31, 40]		42(35.6)
Educational level	118	
Mandatory or less		58(49.2)
Secondary		44(37.3)
College/university		16(13.5)
Marital status	118	
Married/ Cohabitate		102(86.4)
Single/ Divorced		16(13.6)
Professional status	118	
Employed /Student		92(78.0)
Unemployed		26(22.0)
Monthly Income (€)	102	
<500		29(28.4)
[500 -1250[		47(46.1)
≥1250		26(25.5)
Pre-pregnancy BMI	117	
Underweight		4(3.4)
Normal Weight		73(62.4)
Overweight/ Obese		40(34.2)
Number of gestations	118	
Primigest		59(50.0)
Multigest		59(50.0)

Results expressed as number (%); BMI – body mass index.

3.1 Intensity and Type of Physical Activity

Mean or median levels of PA by intensity and type are shown in Table 2. We found a decrease in values of self-reported PA over the trimesters of pregnancy for respectively total, light and moderate intensity ($p<0.01$, for all). Regarding type of activity, there was only a significant decrease in household/caregiving and occupational activities. These decreases occurred essentially from the first to the second trimester, and there were no significant differences from the second to third trimester.

Table 2– Mean scores values (MET.h.wk^{-1}) for three self-administered Pregnancy Physical Activity Questionnaires (PPAQs) at 1st, 2nd, 3st trimesters by activity intensity and type **-** among 118 pregnant subjects

	1st trimester	2sd trimester	3st trimester	*P*
Intensity				
Tota[la]	270.915(145.405)	220.541 (117.946)*	210.348 (116.753)*	<0.001[c]
Sedentary[a]	51.904 (35.064)	47.283 (32.184)	46.937 (30.192)	0.053[c]
Light[b]	109.463 (83.13)	95.113 (50.18)*	92.400 (73.24)*	<0.001[d]
Moderate[b]	81.988 (113.14)	50.688 (86.95)*	62.925 (93.86)*	0.002[d]
Vigourous[b]	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	0.895[d]
Type				
Household/Caregiving[a]	115.085 (71.532)	97.530 (60.679)	96.509 (68.502)*	0.001[c]
Occupational[b]	100.713 (55.61)	85.663 (47.34)*	87.763(45.63)	0.034[d]
Sports/Exercise[b]	0.800 (6.51)	1.950 (5.74)	2.925(9.14)	0.105[d]
Leisure Except Sport[a]	24.897 (19.116)	24.439 (18.285)	24.439 (17.710)	0.502[c]
Transportation[b]	19.250 (18.16)	15.750(18.16)	14.000 (20.13)	0.758[d]

[a]Data are mean (standard deviation); [b]Data are median (IQR) * P<0.05, compared to 1st trimester
[c] *P*-values are calculated using the repeated measure analysis of variance.
[d] *P*-values are calculated using the Fridman test.

3.2 Time Spent per Task by Type of Activity

We found that women spend most of their weekly time during the whole pregnancy in household and caregiving activities – preparing meals, shopping and light cleaning –, occupational activities – standing or slowly walking at work not carrying anything and sitting at working or in class – as well as watching TV or video, concerning leisure except sport activities. These were also the tasks in which almost all women reported to spend any time on per week (Table 3).

We also found that women spend very little time in sports/exercise related activities whether for fun, exercise or sport. Walking slowly for fun or exercise was the activity in which most women reported to spend any time on (57.6%, 66.1% and 69.5% of women in the first, second and third trimesters, respectively). However, over half of these women spend less than 0.25(0.375) $h.wk^{1}$ in this activity during pregnancy. Swimming was the most reported organized PA, reaching its highest proportion (12.7%) in the second trimester. Prenatal exercise classes were reported by 39.8% of women during the 3^{rd} trimester.

Time spent in most activities remained fairly stable throughout pregnancy, regardless of type. A significant decrease was found in the amount of time spent in heavier cleaning, walking quickly to go places not for fun or exercise and playing with pets ($p<0.05$ for all). Significant differences were also found in the amount of time spent in walking quickly at work while carrying things as well as driving or riding a car or bus ($p<0.05$). Prenatal exercise classes were the only activity in which women have significantly increased the time spent during the third trimester ($p<0.05$).

Concerning occupational activities, among the 78% female employees, 3 of them were on sick leave in the first trimester, 5 in the second and 12 in the third. Moreover, we found that among the 12 women who were on sick leave in the third trimester, most of them had physically demanding jobs (4 factory workers, 3 cooks and 5 cleaners).

3.3 Women's Perception about Healthcare Providers

We found that at least about a third of health professionals have not yet recommended PA during pregnancy. Among those who recommend PA, they do so mainly in the second trimester (70.4%), followed by the third (56.8%) and first (53.9%). No association was found between heath professionals' PA recommendations and pregnant women who report to spend any time in sports/exercise activities ($p>0.05$) (data not shown).

Table 3 - Median with range in time spend in (h.wk $^{-1}$) per task by type of activity at 1st, 2nd and 3st trimesters and reported values of the percentage of any activity for self-administered Pregnancy Physical Activity Questionnaires (PPAQs)

		1st trimester		2^{sd} trimester		3st trimester	
	Type	Any Activity %[1]	Median (Range) (h.wk^{-1})	Any Activity %[1]	Median (Range) (h.wk^{-1})	Any Activity %[1]	Median (Range) (h.wk^{-1})
I	**Household/Caregiving (h/week)**						
L	4. Preparing meals(Cook, set table, Wash dishes)	97.5	10.50 (21.0)	99.2	10.50 (21.0)	98.3	10.50 (21.0)
L	5. Dressing , bathing, feeding children while you are sitting	44.9	0.00 (17.5)	43.2	0.00 (17.5)	39.8	0.00 (10.5)
M	6. Dressing , bathing, feeding children while you are standing	51.7	0.00 (17.5)	48.3	0.00 (21.0)	49.2	0.00 (17.5)
L	7. Playing with children while you are sitting or standing	64.4	1.75 (21.0)	61.9	1.75 (17.5)	59.3	1.75 (21.0)
M	8. Playing with children while you are walking or running	44.9	0.00 (21.0)	39.0	0.00 (17.5)	38.1	0.00 (21.0)
M	9. Carrying children	42.4	0.00 (21.0)	35.6	0.00 (5.25)	30,5	0.00 (5.25)
M	10. Taking care an older adult	21.2	0.00 (21.0)	20.3	0.00 (21)	19.5	0.00 (21)
L	15. Light cleaning(make beds, laundry, iron, put things away)	98.3	10.50 (21.0)	87.3	10.50 (19.25)	100	5.25 (19.25)
L	16. Shopping(for food, clothes, or other items)	96.5	5.25 (21.0)	99.2	5.25 (21.0)	99.2	5.25 (21.0)
L	17. Heaver cleaning(vacuum m.mop, sweep, wash Windows)	97.5	1.50 (3.0)	95.8	1.50 (3.0)	94.1	0.75 (3.0)*[†]
L	18. Mowing lawn while on a riding mower	4.2	0.00 (0.75)	2.5	0.00 (1.5)	6.8	0.00 (3.0)
M	19. Mowing lawn using a walking mower, raking, gardening	24.6	0.00 (3.0)	20.3	0.00 (3.0)	21.2	0.00 (3.0)
	Occupational (h/week)						
S	32. Sitting at working or in class	73,0	8.75 (42.0)	73.4	8.75 (42.0)	76.9	21.0 (42.0)
M	33. Standing or slowly walking at work while carrying things (heavier than a 1 gallon milk jug)	66.3	1.75 (42.0)	67.1	1.75 (42.0)	67.7	1.75 (42.0)
L	34. Standing or slowly walking at work not carrying anything	85.4	8.75 (42.0)	91.1	8.75 (42.0)	95.4	8.75(42.0)
M	35. Walking quickly work while carrying things (heavier than a 1 gallon milk jug)	40.4	0.00 (42.0)	32.9	0.00 (35.0)*	35.4	0.00 (35.0)[†]
M	36. Walking quickly work not carrying anything	52.8	1.75 (42.0)	59.5	1.75 (42.0)	52.3	1.75 (42.0)

Table 3 – cont.

		1st trimester		2sd trimester		3st trimester	
	Type	Any Activity %[1]	Median (Range) (h.wk^{-1})	Any Activity %[1]	Median (Range) (h.wk^{-1})	Any Activity %[1]	Median (Range) (h.wk^{-1})
	Sports/Exercise (h/week)						
M	23. Walking slowly for fun or exercise	57.6	0.25 (3.0)	66.1	0.25 (3.0)	69.5	0.25 (3.0)
M	24. Walking more quickly for fun or exercise	28.8	0.00 (3.0)	30.5	0.00 (2.5)	28.8	0.00 (3.0)
V	25. Walking quickly up hills for fun or exercise	16.9	0.00 (1.5)	17.8	0.00 (1.5)	22.9	0.00 (1.5)
V	26. Jogging	4.2	0.00 (1.5)	2.5	0.00 (2.5)	2.5	0.00 (0.25)
M	27. Prenatal exercesse classe	4.2	0.00 (1.5)	10.2	0.00 (2.5)	39.8	0.00 (3.0)*†
M	28. Swimming	9.3	0.00 (3.0)	12.7	0.00 (3.0)	8.5	0.00 (3.0)
M	29. Dancing	9.3	0.00 (2.5)	8.5	0.00 (0.75)	8.5	0.00 (1.5)
	Leisure Except Sport (h/week)						
S	11. Sitting and using a computer or writing, while not at work	60.2	1.75 (21.0)	68.6	1.75 (21.0)	78.0	1.75 (21.0)
S	12. Watching TV or a video	98.5	8.75 (21.0)	97.5	8.75 (21.0)	98.3	8.75 (35.0)
S	13. Sitting and reading, talking, or on the phone, while not at work	86.4	1.75 (42.0)	90.7	1.75 (35.0)	92.4	1.75 (21.0)
M	14. Playing with pets	26.3	0.00 (10.5)	17.8	0.00 (5.25)	19.5	0.00 (5.25)
	Transportation (h/week)						
L	20. Walking slowly to go places (such as to bus, work, visiting) not for fun or exercise	80.0	1.75 (21.0)	70.7	1.75 (21.0)	79.7	1.75 (17.5)
M	21. Walking quickly to go places(such as to the bus, work, or school) not for fun or exercise	55.1	1.75 (21.0)	47.5	0.00 (5.25)	39.0	0.00 (10.5)*
S	22. Driving or riding a car or bus	90.7	5.25 (21.0)	89.8	5.25 (17.5)*	90.7	5.25 (21.0)*†

[1]Percentage of participants that reported any physical activity in mode of type * P<0.05, compared to 1st trimester; † P<0.05, compared to 2nd trimester (P- values calculated using the Wilcoxon signed-rank test)
I - Classification of Intensity for each tasks based in PPAQ instructions: L - Light; M - Moderate; V - Vigorous; S - Sedentary

4. Discussion

4.1 Intensity and Type of Physical Activity

The present study showed a significant decrease in total PA levels throughout pregnancy, as previously described by some authors (Borodulin et al., 2009; Borodulin et al., 2008; Clarke et al., 2005).

A progressive decrease in light and moderate self-reported values of PA throughout pregnancy was found. Although this decline can be explained by hormonal, cardiorespiratory and musculoskeletal changes that occur during pregnancy, resulting in a lower tolerance to effort for unconditioned pregnant women (Melzer et al., 2010a), our results might be considered undesirable in terms of public health considering the most recent guidelines of CDC-ACSM (ACSM, 2006). Nonetheless, other authors also found a decrease in "fairly light" intensity category (Borodulin et al., 2008).

Regarding the PA type, there was only a change in household/caregiving and occupational activities, which decreased from first to second trimester. However, household and caregiving activities, as well as occupational activities, were those that most contribute to energy costs until late in pregnancy. On the other hand, sports/exercise related activities were not important contributors to energy expenditure.

Some studies found that mean total domestic activity ratios did not change significantly across pregnancy (Chasan-Taber et al., 2007b; Clarke et al., 2005) while others reported a decrease, as seen in our study (Borodulin et al., 2009; Borodulin et al., 2008; Fell et al., 2009). A decline was also found in occupational (Borodulin et al., 2009; Fell et al., 2009), recreational (Borodulin et al., 2009; Borodulin et al., 2008; Fell et al., 2009), transportation (Borodulin et al., 2009; Fell et al., 2009) and sports and exercise (Fell et al., 2009) activities, although women tend to remain active in occupational and recreational activities (Borodulin et al., 2008).

4.2 Time Spent per Task by Type of Activity

We found that women spend most of their weekly time during the pregnancy in household and caregiving activities such as preparing meals, shopping and light cleaning; occupational activities such as standing or slowly walking at work not carrying anything and sitting at working or in class; and leisure activities except sport activities such as watching TV or videos. These were also the tasks in which almost all women reported to spend some time on per week. Also in other works household and family (Borodulin et al., 2009; Borodulin et al., 2008; Chasan-Taber et al., 2007b), as well as recreational activities (Borodulin et al., 2009; Borodulin et al., 2008), represented a major portion of women's activities.

We also observed that time spent in most activities remained fairly stable throughout pregnancy, regardless of type. In what concerns household and caregiving activities, this trend

was just not there for heavier cleaning, where a decrease in the amount of time spent on it during pregnancy was found. On the other hand, we found that time spent in light cleaning tasks did not change until late in pregnancy.

The same was found in other studies mainly in late pregnancy, which has sometimes been referred to as the "nesting effect" as pregnant women prepare their home for the arrival of a new baby (Clarke et al., 2005; Poudevigne & O'Connor, 2006). Activities involving childcare are referred by about half of women, which is in agreement with the characteristics of the sample (50% primigest).

Regarding occupational activities, we found that time spent in these tasks remained unchanged throughout pregnancy, with the exception of walking quickly at work while carrying things. The number of women on sick leave has quadrupled from the first to the third trimester and most of them had physically demanding jobs (data not show). Indeed, women involved in physically strenuous jobs tend to change their duties to something less intense and were more likely to not work at all during the third trimester compared with women in less physically demanding jobs (Poudevigne & O'Connor, 2006).

Concerning leisure time PA (except sports), we emphasize the high percentage of women who report watching TV or videos as well as the high amount of time spent in this sedentary activity, considering that less than one quarter of the sample is unemployed. These findings are in agreement with other works (Borodulin et al., 2009; Borodulin et al., 2008; Clarke et al., 2005; Evenson & Wen, 2010); and thus, sedentary activities may be the target of intervention towards enhancing PA levels since it is not expected that women change their domestic and occupational tasks (Borodulin et al., 2009; Borodulin et al., 2008).

We found that women do not have sport habits during the whole pregnancy and few are those who engage in structured PA. These findings are consistent with previous studies (Clarke et al., 2005; Hegaard, 2008; Poudevigne & O'Connor, 2006). We also found that despite being a relatively recent practice (Clarke et al., 2005), more than one third of women engage in exercise prenatal classes in the third trimester, which make us think that the main issue relates to generating opportunities for exercise during pregnancy.

4.3 Women's Perception on Health Care Providers and Health Promotion

We conclude that despite CDC-ACSM and ACOG recommendations encouraging pregnant women to exercise there is still a considerable proportion of health care providers that do not recommend PA during pregnancy, mainly in the first and third trimester. However, given the potential benefits of exercise to reduce obstetric risk, reduce postpartum weight retention, improve long-term health, normalize infant birth weight, reduce childhood obesity, (IOM, 2009) and the lack of evidence for harmful effects on the mother and newborn, it is expected a change

in attitude (Borodulin et al., 2009; Gaston & Cramp, 2011; Lewis et al., 2008) that promotes counseling on PA in prenatal and pregnancy services.

We are aware that physiological and anatomical changes that occur during pregnancy could plausibly contribute to PA being less attractive and more difficult to perform. Besides, reductions in PA could be a method for pregnant women to meet the increased energy demands of pregnancy, especially in the third trimester (Poudevigne & O'Connor, 2006). However, pregnant women are particularly concerned about the health of their unborn baby and are in frequent contact with their health care providers, so this may be a powerful “teachable moment” for the promotion of healthy behaviors (Brown, 2002; Lewis et al., 2008; Phelan, 2010). Moreover, women are becoming a role model for their new child and may even positively influence the whole family. Thus, pregnant women become a key element in the promotion of individual, familiar and community health (Phelan, 2010).

4.4 Methodological Considerations

Our study was strengthened by its prospective design and large cohort. We evaluated all the major dimensions of PA. Besides, we quantified routine PA levels of pregnant women in a free-living environment and did not impose a predetermined exercise program. The decline in activity found in our study is unlikely to be attributable to seasonal changes, since the study run from September 2009 to November 2011 and recruitment was staggered over a 12 month period (Chasan-Taber et al., 2004).

Nevertheless, the findings of the study are subject to certain limitations. Firstly, self-reported data may be subject to recall errors and other biases such as social desirability. However, they provide detailed information on the type and duration of specific activities. Secondly, the MET values assigned for each activity were not specific to pregnant women, but rather standardized for an average adult, which likely underestimated the activity levels. Finally, PA during pregnancy may not be stable within a trimester, due to rapid changes in the mother’s body. Thus, it is important to evaluate PA changes during the whole trimesters and not only in a single determined moment.

There is a need for well-designed longitudinal investigations that document pregnancy-related changes in PA at frequent intervals during pregnancy using validated and more precise measures such as accelerometers, and that use non-pregnant controls.

5. Conclusion

Self-reported PA decreased during pregnancy especially in total, light and moderate intensity. Women spend most of their weekly time in domestic, occupational and leisure except sports activities. There still are some health care providers that do not recommend PA during pregnancy.

6. Implications for Clinical Practice

Pregnancy may be a powerful “teachable moment” for the promotion of healthy behaviors. Thus, health care providers should encourage healthy pregnant women to remain active during pregnancy and efforts should be made towards creating opportunities for exercise such as prenatal classes.

7. Acknowledgments

This research is funded by Fundação para a Ciência e Tecnologia (FCT) Grants nos. BD/45375/2008, PROTEC SFRH/BD/50002/2009 and PTDC/DES/116586/2010. BD/44422/2008; PTDC/DES/098309/2008; BPD/65180/2009; SAB/1025/2010.

We greatly appreciate the cooperation health professionals for valuable support during data collection and all the pregnant women who agreed to voluntarily participate in this study.

The authors of this paper reported no financial conflict of interest.

8. References

ACOG. (2002). ACOG committee opinion. Exercise during pregnancy and the postpartum period. Number 267, January 2002. American College of Obstetricians and Gynecologists. *Int J Gynaecol Obstet, 77*(1), 79-81.

ACSM. (2006). ACSM's Guidlines for exercise testing and prescription.

Aittasalo, M., Pasanen, M., Fogelholm, M., Kinnunen, T. I., Ojala, K., & Luoto, R. (2008). Physical activity counseling in maternity and child health care - a controlled trial. *BMC Womens Health, 8*, 14.

Alves, O. M., D. Maciel_Barbosa, A. (2005). Saúde da mulher e da criança: necessidades, comportamentos e atitudes. *Revista Portuguesa de saúde Publica, 23*(1), 69-80.

Artal, R., & O'Toole, M. (2003). Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med, 37*(1), 6-12; discussion 12.

Borodulin, K., Evenson, K. R., & Herring, A. H. (2009). Physical activity patterns during pregnancy through postpartum. In *BMC Womens Health* (Vol. 9, pp. 32). England.

Borodulin, K. M., Evenson, K. R., Wen, F., Herring, A. H., & Benson, A. M. (2008). Physical activity patterns during pregnancy. *Med Sci Sports Exerc, 40*(11), 1901-1908.

Brown, W. (2002). The benefits of physical activity during pregnancy. *J Sci Med Sport, 5*(1), 37-45.

Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Manson, J., & Markenson, G. (2007). Correlates of physical activity in pregnancy among Latina women. *Matern Child Health J, 11*(4), 353-363.

Chasan-Taber, L., Schmidt, M. D., Roberts, D. E., Hosmer, D., Markenson, G., & Freedson, P. S. (2004). Development and validation of a Pregnancy Physical Activity Questionnaire. *Med Sci Sports Exerc, 36*(10), 1750-1760.

Clarke, P. E., Rousham, E. K., Gross, H., Halligan, A. W., & Bosio, P. (2005). Activity patterns and time allocation during pregnancy: a longitudinal study of British women. *Ann Hum Biol, 32*(3), 247-258.

Duncombe, D., Wertheim, E. H., Skouteris, H., Paxton, S. J., & Kelly, L. (2009). Factors related to exercise over the course of pregnancy including women's beliefs about the safety of exercise during pregnancy. *Midwifery, 25*(4), 430-438.

Evenson, K. R., Siega-Riz, A. M., Savitz, D. A., Leiferman, J. A., & Thorp, J. M., Jr. (2002). Vigorous leisure activity and pregnancy outcome. *Epidemiology, 13*(6), 653-659.

Evenson, K. R., & Wen, F. (2010). National trends in self-reported physical activity and sedentary behaviors among pregnant women: NHANES 1999-2006. *Prev Med, 50*(3), 123-128.

Fell, D. B., Joseph, K. S., Armson, B. A., & Dodds, L. (2009). The impact of pregnancy on physical activity level. *Matern Child Health J, 13*(5), 597-603.

Gaston, A., & Cramp, A. (2011). Exercise during pregnancy: a review of patterns and determinants. In *J Sci Med Sport* (Vol. 14, pp. 299-305). Australia.

Hegaard, H. H., M.; Damm, P.; Ottesen, B.; Petersson, K.; Henriksen, TB. (2008). Leisure time physical activity is associated with a reduced risk of preterm delivery. *Am J Obstet Gynecol, 198*(2), 180.e181-185.

IOM. (2009). *Weight gain during pregnancy*: Institute of Medicine and National Research Council.

Lewis, B., Avery, M. J., E., Sherwood, N., Martinson, B., & Crain, A. L. (2008). The Effect of Exercise During Pregnancy on Maternal Outcomes: Practical Implications for Practice. *American journal of lifestyle medicine, 2*(5), 441-455.

Melzer, K., Schutz, Y., Boulvain, M., & Kayser, B. (2010). Physical activity and pregnancy: cardiovascular adaptations, recommendations and pregnancy outcomes. *Sports Med, 40*(6), 493-507.

Ota, E., Haruna, M., Yanai, H., Suzuki, M., Anh, D. D., Matsuzaki, M., Tho le, H., Ariyoshi, K., Yeo, S. A., & Murashima, S. (2008). Reliability and validity of the Vietnamese version of the Pregnancy Physical Activity Questionnaire (PPAQ). *Southeast Asian J Trop Med Public Health, 39*(3), 562-570.

Paisley, T. S., Joy, E. A., & Price, R. J., Jr. (2003). Exercise during pregnancy: a practical approach. *Curr Sports Med Rep, 2*(6), 325-330.

Phelan, S. (2010). Pregnancy: a "teachable moment" for weight control and obesity prevention. *Am J Obstet Gynecol, 202*(2), 135 e131-138.

Poudevigne, M. S., & O'Connor, P. J. (2006). A review of physical activity patterns in pregnant women and their relationship to psychological health. *Sports Med, 36*(1), 19-38.

Simas, T. A., Liao, X., Garrison, A., Sullivan, G. M., Howard, A. E., & Hardy, J. R. (2011). Impact of updated Institute of Medicine guidelines on prepregnancy body mass index categorization, gestational weight gain recommendations, and needed counseling. *J Womens Health (Larchmt), 20*(6), 837-844.

Solomon, C. G., Willett, W. C., Carey, V. J., Rich-Edwards, J., Hunter, D. J., Colditz, G. A., Stampfer, M. J., Speizer, F. E., Spiegelman, D., & Manson, J. E. (1997). A prospective study of pregravid determinants of gestational diabetes mellitus. *JAMA, 278*(13), 1078-1083.

World Health Organization. (2010). *World Health Organization. Global recommendations on physical activity for health*. Geneva: WHO.

Artigo II

Association between Low Back Pain and Physical Activity during Pregnancy: longitudinal prospective study

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Association between Low Back Pain and Physical Activity during Pregnancy: A Longitudinal Prospective Study

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Abstract

Introduction: Pregnancy-related low back pain is an increasingly reported condition, and physical activity (PA) may play an important role. The aim of the present study was to evaluate the proportion of non-specific pregnancy-related low back pain (NSPLBP) and its association with type and intensity level of PA during pregnancy and low back pain pre-pregnancy.

Methods: A longitudinal prospective study was carried out with a cohort of 118 pregnant women. Participants were evaluated in all trimesters. NSPLBP was assessed via self-reported questionnaire, and participants were categorized according to the frequency of its occurrence. Type and intensity of PA were evaluated using the *Pregnancy Physical Activity Questionnaire* and categorized into tertiles. Binary logistic regression models were constructed to verify the relationship between NSPLBP and type and, intensity of PA in all trimesters and low back pain pre-pregnancy.

Results: NSPLBP was reported by 40.7%, 52.2% and 66.7% of subjects in their first, second and third trimesters, respectively. No significant associations were found between NSPLBP and type and intensity of PA. However, women who had low back pain before pregnancy, compared to those who did not, had higher odds of expressing NSPLBP during pregnancy (OR= 3.85, 95% CI: 1.344-11.025)

Conclusions: In this sample, NSPLBP was a common condition. The results of this study suggest that type and intensity of PA is not associated with the emergence of NSPLBP during pregnancy. Furthermore, low back pain before pregnancy is a risk factor for NSPLBP.

1. Introduction

Low back pain is a common condition during pregnancy and can be characterized as axial or para-sagittal discomfort in the lower lumbar region (Sabino & Grauer, 2008). It is called “non-specific low back pain” when it is not attributable to a recognizable, known specific pathology (Airaksinen et al., 2006). Some studies on low back pain have been carried out in Scandinavia, Sweden and Norway (Mogren & Pohjanen, 2005; Morkved et al., 2007); a few have been conducted in Iran (Mousavi et al., 2007), Australia (Smith et al., 2008), and the United States (Wang et al., 2004).

Research shows that pregnancy-related low back pain is a universal problem. Studies report a wide range of prevalence: 24% to 90% (Garshasbi & Faghih Zadeh, 2005; Mogren & Pohjanen, 2005; Mohseni-Bandpei, 2009; Morkved et al., 2007; Mousavi et al., 2007; Smith et al., 2008; Stuge et al., 2003; Vermani et al., 2010; Wu et al., 2004). In pregnant women, low back pain is four times as common as it is amongst non-pregnant women (Kashanian et al., 2009). This condition may occur during the first trimester of pregnancy, but for most women, its onset is around the eighteenth week of gestation (WG), with peak intensity occurring between the twenty-fourth and thirty-sixth WG (Vermani et al., 2010; Wu et al., 2004). Gestational low back pain has considerable implications for women and for society, in terms of quality of life, public health costs and productivity (Garshasbi & Faghih Zadeh, 2005; Mohseni-Bandpei, 2009; Morkved et al., 2007; Stuge et al., 2003; Vermani et al., 2010). According to several studies, the development of low back pain during pregnancy is related to the low physical activity (PA) levels of pregnant women (Mogren, 2008; Schlussel et al., 2008; Vermani et al., 2010; Wolfe et al., 2003). Women with sedentary lifestyles have increased risks of back pain, compared to women who engage in more active lifestyles. Nonetheless, women who have occupations described as ‘mostly active’ and ‘physically demanding’ also have higher risks of developing low back pain during pregnancy, suggesting that extremes of activity are probably not ideal (Sabino & Grauer, 2008). Until a few decades ago, pregnant women were advised to reduce their activities and even interrupt their occupational work during pregnancy. The idea that pregnant women should be less active was based on concerns that exercise would negatively affect pregnancy outcomes by increasing the risk of maternal musculoskeletal injury due to changes in posture and ligamentous laxity (Schlussel et al., 2008; Wolfe et al., 2003). However, since the 1990s, some studies have suggested that exercise provides physiological benefits to healthy pregnant women, without compromising fetal growth or adversely impacting pregnancy, labor and delivery (Mogren, 2008; Polley et al., 2002; Schlussel et al., 2008). Indeed, PA is associated with improved physiological and metabolic parameters and decreased risk of morbidity in people with such conditions as hypertension, gestational low back pain, vascular changes in the lower limbs (swelling and varicosities), gestational diabetes, (Evenson & Wen, 2010), and osteoporosis (Melzer et al., 2010b; Schlussel et al., 2008; Wolfe et al., 2003). Epidemiological studies have shown a consistent decline in the frequency, duration and intensity of PA during pregnancy. This decline becomes more evident as pregnancy progresses, yet few women start exercising during this period (Chasan-Taber et al., 2004; Melzer et al., 2010b; Mogren, 2008).

Pregnancy is a favorable period for behavior modification, and it is known that pregnant women who integrate exercise into their routines are more likely to continue exercising during the postpartum period (Phelan, 2010). Since PA is of the utmost importance to life-long health and PA levels tend to decrease during pregnancy, community health promoters should evaluate whether lack of PA during pregnancy somehow influences the presence of pregnancy-related low back pain, so that appropriate strategies for prevention and treatment can be established (Mogren, 2008; Schlussel et al., 2008).

The evidence for the facts described is scarce, and some studies have had retrospective designs and small samples. Thus, the present study aimed to assess the prevalence of non-specific pregnancy-related low back pain (NSPLBP) and its association with type and intensity of PA during pregnancy.

2. Subjects and Methods

2.1 Study Design and Sample

A longitudinal prospective study was carried out with a cohort drawn from a consecutive sample of pregnant women who were seeking prenatal care at 11 health care centers located in the Minho Region of Portugal from September 2009 to November 2011. Almost all women (98.7%) in Portugal make routine prenatal visits to these maternal health centers (Alves, 2005; Santos et al., 2006). Women were invited to participate in the study during their first trimesters and were reassessed during their second and third trimesters.

The inclusion criteria used in this study were: women with confirmed pregnancies and less than 15 WG for the first trimester, women with 15 to 28 WG for the second trimester and women with more than 28 WG for the third trimester.

Women were considered ineligible if they had any of the following characteristics: diabetes, hypertension, heart disease or chronic disease; no singleton pregnancy; age 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).

One hundred eighty-five women were eligible for inclusion in the present sample (Figure 1). Thirty-seven women were excluded: 10 for having undergone abortions; 2 for not having singleton pregnancies; 16 for having risky pregnancies (Hutchison & Milner, 1994) and 8 for not fitting within the interval limits defined for gestational trimesters. Thirty (20.3%) were dropped during the follow-up period for not completing questionnaires correctly. The net sample consisted of 118 pregnant women.

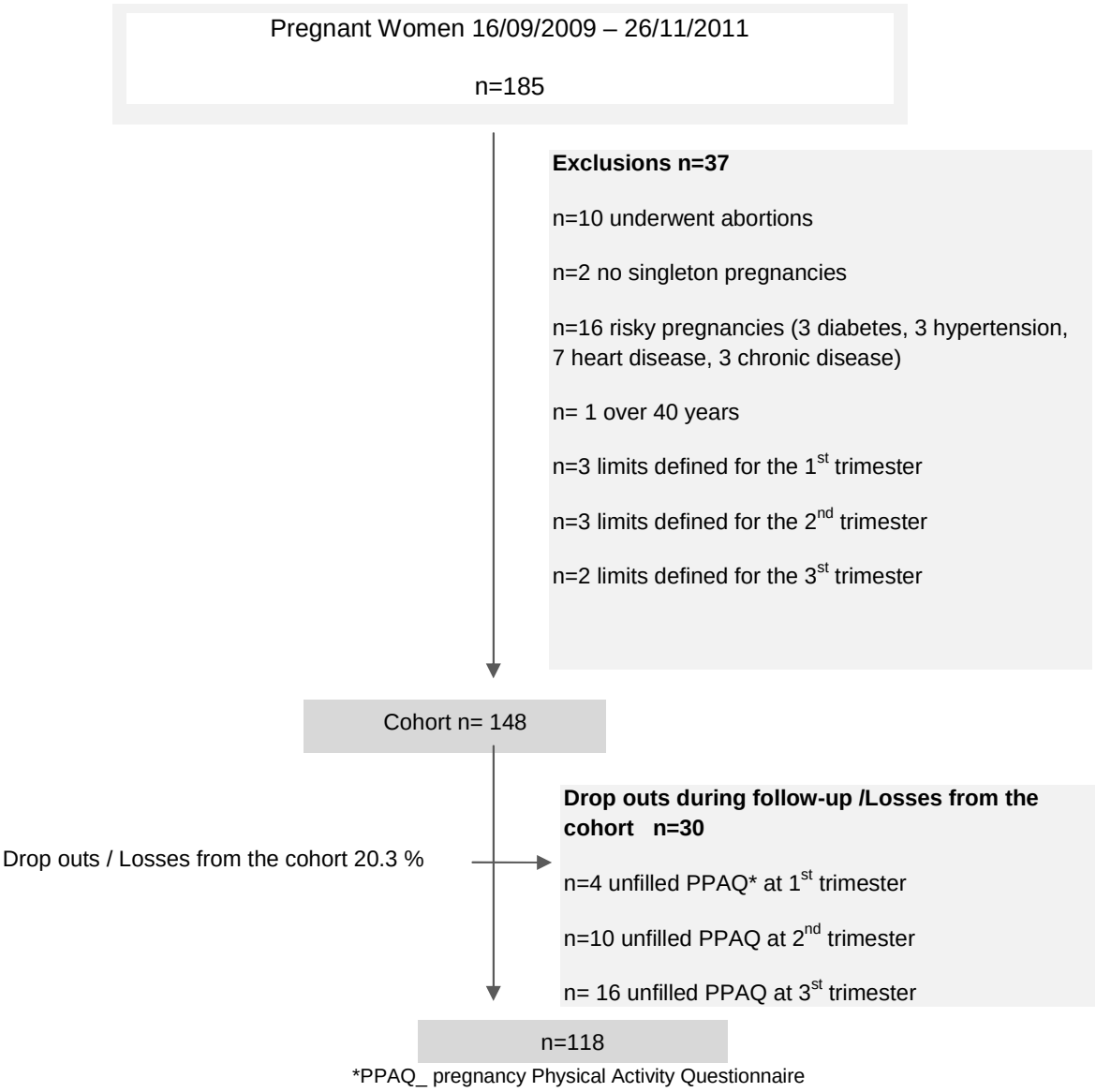

Figure 1 – Chart of Exclusions and Losses from the Cohort

There were no significant differences between the net sample and losses; the two groups had similar baseline characteristics in terms of age (28.8±4.86 vs. 30.8±5.37, p=0.050), pre-pregnancy body mass index (BMI) (24.4±4.11 vs. 26.6±5.63kg/m^2, p=0.050), educational level (mandatory or less: 49.2% vs. 62.5%; secondary: 37.3% vs. 34.4%; college/university: 13.6% vs. 3.1%, p=0.188), monthly income (<500€: 28.4% vs. 30.0%; [500 - 1250€[: 46.1% vs. 40.0%; ≥1250€: 25.5% vs. 30%, p=0.823), number of gestations: (primigest: 50% vs. 42.4%; multigest: 50.0% vs.57.6%, p=0.567), pre-pregnancy low back pain (39.0% vs. 54.5%, p= 0.162) and total activity score on the Pregnancy Physical Activity Questionnaire (270.9±145.41 vs. 249.0±122.31, p= 0.393), respectively.

2.2 Assessment Instruments

Data were collected during each trimester of pregnancy by trained nurses who administered structured and self-reported questionnaires. The questionnaires were designed to cover personal and socio-demographic data, lifestyle variables, health status during pregnancy, gynecologic history and prevalence of and possible risk factors for NSPLBP. The validity of the questionnaires was verified by experts who offered comments that were used to make amendments to the original surveys and generate final versions. A pilot study was conducted with a sample of 14 pregnant women to verify the feasibility of the assessment instruments and procedures used in their administration.

Pre-pregnancy BMI was estimated from self-reported pre-pregnancy weight and height, using the formula: *BMI=weight(kg)/height^2(m^2).* Pre-pregnancy BMI was categorized according to Institute of Medicine (IOM, 2009) guidelines: *underweight*, *normal weight*, *overweight* and *obese*. These guidelines were also used to assign groups by weight gain. The pregnant women were classified as *undergainers*, *appropriate gainers* and *overgainers*, depending on whether they acquired weight below the recommended level, within the recommended level or higher than the recommended level, respectively (Simas et al., 2011).

P*rofessional status* was assessed and subjects were divided into three categories: *employed* (full time), *unemployed* and *student*. Since there were only two subjects in the *student* category, those were pooled with members of the *employed* category. Respondents were asked to estimate 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,* subjects were divided into three categories, reflecting the organization of the Portuguese educational system: *mandatory or less* (≤9 school years), *secondary* (10 to 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.

NSPLBP was assessed using closed-ended questions that had been included in previously reported questionnaires. Prevalence was expressed as the relative frequency of complaints by pregnant women. 'Period NSPLBP' referred to complaints at any time during pregnancy (Wu et al., 2004). A woman was considered to have point NSPLBP if she gave a positive answer to the specific question, *Have you ever felt low back pain (pain in the lower back) during this gestational trimester?* If women answered this question affirmatively, they were asked to report the gestational week in which the pain began. A woman was considered to have period NSPLBP if she gave a positive answer to the previously mentioned question in at least one of the three trimesters of pregnancy. A woman was considered to have pre-pregnancy low back pain if she affirmatively answered the question, *Did you ever feel low back pain (pain in the lower back) in the year before becoming pregnant?*

Physical Activity Measurement

PA levels were determined using the Pregnancy Physical Activity Questionnaire (PPAQ), a self-reported questionnaire that evaluates the type, duration and frequency of PA performed by pregnant women. Respondents were asked to select the category that best approximated the amount of time spent, per day or week, on different activities during their current trimester. Possible durations ranged from 0 to 6 or more hours per day and from 0 to 3 or more hours per week. At the end of the questionnaire, an open-ended section allowed respondents to add activities not already listed. Each activity was classified according to intensity – sedentary (<1.5 METs), light (1.5-3.0 METs), moderate (3.1-6.0 METs) or vigorous (>6.0 METs), and according to type – household/caregiving, occupational or sports/exercise. The PPAQ has been validated by Chasan-Taber (Chasan-Taber et al., 2004) .

Prior to this study, the semantic and content equivalency of the PPAQ and its reproducibility were verified with a sample of 116 pregnant Portuguese women in an unpublished study. Reproducibility was strong with two administrations – 0.86 for total PA. It was highest for sedentary activity 0.92 and ranged from 0.81 to 0.85 for light, moderate and vigorous activity. Regarding activity type, reproducibility was highest for occupational activity (0.99) and was also high for household/caregiving (0.86) and sports/exercise (0.90) activities. According to Portney (1999), intraclass correlation coefficient (ICC) values above 0.75 indicate good reliability (Portney & Watkins, 1999).

2.3 Procedures

Eleven local health centers agreed to participate in the present study. Meetings were held with the head nurse of the units' maternal health teams to explain the relevance and objectives of the study, to present the manual of procedures designed to standardize data collection and to alleviate possible doubts.

The assessment instruments were individually administered during maternal health consultations that were held in each pregnancy trimester. The same nurse at each unit explained the study's aims and procedures to each of the pregnant women there. In the first month, weekly telephone contact was established with the nurses in the field by the main researcher; afterwards, contact was established monthly.

Ethical approval for the present study was obtained from the relevant institutional ethics committees. Oral and written information about the study's aims was given to pregnant women by a designated nurse at each health center; then, participants who were willing to take part were asked to sign a consent form that was in keeping with the Declaration of Helsinki.

2.4 Statistics

Descriptive data are presented as means and standard deviations, unless otherwise stated. Associations between variables were analyzed via statistical inference – specifically, the Chi-square Test or Fisher's Exact Test. Yates continuity correction was used for analysis of 2x2 contingence tables. Binary logistic regression models were constructed to verify the relationship

between NSPLBP and type, intensity of PA in all trimesters and low back pain pre-pregnancy. Statistical significance was defined as a p-value <0.05.

Statistical analysis was conducted using Predictive Analytics Software (PASW), v. 18 (SPSS, Chicago, Illinois, USA).

3. Results

The baseline characteristics of the sample are shown in Table 1. The final sample included 118 pregnant women, with a mean age of 28.8±4.85 years. About half of women had only a primary education, 78.0% were employed full time; and 74.5% had monthly family incomes below 1250€, a figure equivalent to 2.5 times the national minimum wage. Half of women were primigest, and 34.2% were overweight/obese prior to becoming pregnant. There were no significant differences between women with and without low back pain when it came to age, educational level, marital and professional status, monthly income, pre-pregnancy BMI and number of gestations (p>0.05 for all). Groups were only statistically different in terms of pre-pregnancy low back pain (79.2% vs. 28.8%, p<0.001).

Table 6 – Descriptive Characteristic of Sample at Baseline

	n	Total	NSPLBP		*P* value[1]
			Yes(n=48)	no (n=70)	
Age (years)	118				
[18, 30]		76(64.4)	34(70.8)	42(60.0)	0.312
[31, 40]		42(35.6)	14(29.2)	28(40.0)	
Educational Level	118				
Mandatory or Less		58(49.2)	22(45.8)	36(51.4)	
Secondary		44(37.3)	19(39.6)	25(35.7)	0.836
College/University		16(13.6)	7(14.6)	9(12.9)	
Marital Status	118				
Married/ Cohabitating		102(86.4)	41(85.4)	61(87.1)	0.788
Single/ Divorced		16(13.6)	7(14.6)	9(12.9)	
Professional Status	118				
Employed /Student		92(78.0)	39(81.3)	53(75.7)	0.476
Unemployed		26(22.0)	9(18.8)	17(24.3)	
Monthly Income (€)	102				
<500		29(28.4)	11(26.2)	18(30.0)	
[500 -1250[		47(46.1)	22(52.4)	25(41.7)	0.548
≥1250		26(26)	9(21.4)	17(28.3)	
Pre-pregnancy BMI	117				
Underweight		4(3.4)	-	4(5.8)	
Normal Weight		73(62.4)	29(60.4)	44(63.8)	0.424*
Overweight/ Obese		40(34.2)	19(39.6)	21(30.4)	
Pregnancy Weight Gain**	116				
Undergainer		30(25.9)	13(27.7)	17(24.6)	
Appropriate Gainer		42(36.2)	14(29.8)	28(40.6)	0.486
Overgainer		44(37.9)	20(42.6)	24(34.8)	
Number of Gestations	118				
Primigest		59(50.0)	24(50.0)	35(50.0)	1.000
Multigest		59(50.0)	24(50.0)	35(50.0)	
Pre-pregancy Low Back Pain	118				
Yes		46(39.0)	38(79.2)	8(11.4)	<0.001
No		72(61.0)	10(20.8)	62(88.6)	

Results expressed as number (%); NSPLBP– non-specific pregnancy- related low back pain; BMI – body mass index.

[1]Comparison between subjects with and without low back pain, using χ^2 test.

*p value refers only to Normal Weight and Overweight/ Obese

3.1 Non-Specific Pregnancy-related Low Back Pain Prevalence

Pre-pregnancy low back pain was reported by 39.0% of women. There was a progressive increase in the frequency of NSPLBP during pregnancy: 40.7%, 52.2% and 66.7% in the first, second and third trimesters, respectively (Figure 2). The prevalence of period NSPLBP was 76.3%.

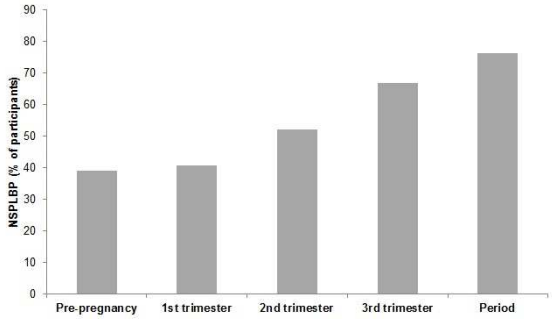

Figure 2 – Prevalence of non-specific pregnancy-related low back pain before and during pregnancy

(Pre-pregnancy: n=118; 1st trimester: n=118; 2nd trimester: n=115; 3rd trimester: n=117)

As regards the incidence of NSPLBP, there were 10, 28 and 24 new cases in the first, second and third trimesters, respectively. Concerning the time during pregnancy at which symptoms of NSPLBP began in new cases, a mean of 5.9±4.73 WG was found in the first trimester, 18.0±6.15 WG in the second trimester and 28±5.32 WG in the third trimester. However, first appearance of pain symptoms was reported throughout pregnancy, from the gestational age of one through 37 WG.

3.2 Non-Specific Pregnancy-related Low Back Pain and Physical Activity

It was found that type (Table 2) and intensity (Table 3) of PA were not associated with NSPLBP, except when it came to *household/caregiving* activities, where there were statistically significant differences between tertiles: during their second trimesters, women who were in the third tertile had less NSPLBP than women in the other tertiles (tertile 1 – 40.0%; tertile 2 – 38.3%; tertile 3 – 21.7%, p= 0.042).

Binary logistic regression models were constructed to verify the relationship between NSPLBP and type and intensity of PA, and no significant results were found in any of the trimesters (data not shown). However, women who had low back pain before pregnancy, compared to those who did not, had higher odds of expressing NSPLBP during pregnancy (OR= 3.85, 95% CI: 1.344-11.025).

Table 7 – Association of Low Back Pain in 1st, 2nd and 3rd Trimesters and Tertile Values (MET-h.wk^{-1}) for Self-administered Pregnancy Physical Activity Questionnaire (PPAQ) by Activity Type

	1st Trimester[1]				2nd Trimester[2]				3rd Trimester[3]			
	n	NSPLBP		*P* value[4]	n	NSPLBP		*P* value[4]	n	NSPLBP		*P* value[4]
		yes	no			yes	no			yes	no	
Physical Activities by Type												
Household/Caregiving	118				115				117			
Tertile 1		17(35.4)	23(32.9)			24(40.0)	16(29.1)			23(29.5)	13(33.3)	
Tertile 2		16(33.3)	21(30.0)	0.802		23(38.3)	15(27.3)	0.042*		27(34.6)	13(33.3)	0.911
Tertile 3		15(31.3)	26(37.1)			13(21.7)	24(43.6)			28(35.9)	13(33.3)	
Occupational	89				77				64			
Tertile 1		13(35.1)	19(36.5)			14(34.1)	12(33.3)			16(34.8)	5(27.8)	
Tertile 2		13(35.1)	18(34.6)	0.990		13(31.8)	12(33.3)	0.989		16(34.8)	6(33.3)	0.785
Tertile 3		11(29.8)	15(28.8)			14(34.1)	12(33.3)			14(30.4)	7(38.9)	
Sports/Exercise	118				115				117			
Tertile 1		20(41.6)	24(34.2)			21(35.0)	22(40.0)			27(34.6)	9(23.1)	
Tertile 2		14(29.2)	23(32.9)	0.718		24(40.0)	11(20.0)	0.051		22(28.2)	19(48.7)	0.088
Tertile 3		14(29.2)	23(32.9)			15(25.0)	22(40.0)			29(37.2)	11(28.2)	

Results expressed as number (%);*3 missing information on NSPLBP variable;** 1missing information on NSPLBP variable

[1]1st Trimester Tertiles: **Household/ Caregiving Activities:** tertile 1 – ≤78.75, tertile 2 – 78.76-123.08, tertile 3 – ≥123.09; **Occupational Activity:** tertile 1 – ≤89.08, tertile 2 – 89.09-142.80, tertile 3 – ≥142.81; **Sport Activity:** tertile 1 – ≤0.00, tertile 2 – 0.01-4.80, tertile 3 – ≥4.81

[2]2nd Trimester Tertiles: **Household/Caregiving Activities:** tertile 1 – ≤63.18, tertile 2 – 63.19-105.18, tertile 3 – ≥105.19; **Occupational Activity:** tertile 1 – ≤76.30, tertile 2 – 76.31-110.43, tertile 3 – ≥110.44; **Sport Activity:** tertile 1 – ≤0.80, tertile 2 – 0.81-4.80, tertile 3 – ≥4.81

[3]3rd Trimester Tertiles: **Household/Caregiving Activities:** tertile 1 – ≤59.28, tertile 2 – 59.19-94.33, tertile 3 – ≥94.34; **Occupational Activity:** tertile 1 – ≤76.83, tertile 2 – 76.84-113.05 , tertile 3 – ≥113.06; **Sport Activity:** tertile 1 – ≤0.88, tertile 2 – 0.89-6.20, tertile 3 – ≥6.21

[4]Comparison between subjects with and without low back pain, using χ^2 test.

Table 3 – Association of Low Back Pain in 1st, 2nd and 3rd Trimester and Tertile Values (MET-h.wk^{-1}) for Self-administered Pregnancy Physical Activity Questionnaire (PPAQ) by Intensity

	1st Trimester[1]				2nd Trimester[2]				3rd Trimester[3]			
	n	NSPLBP yes	no	*P* value[4]	n*	NSPLBP yes	no	*P* value[4]	n**	NSPLBP yes	no	*P* value[4]
Physical Activities By intensity												
Total Activity	118				115				117			
Tertile 1		17(35.4)	23(32.9)			17(28.3)	17(30.9)			19(24.4)	15(38.5)	
Tertile 2		12(25.0)	24(34.3)	0.543		27(45.0)	15(27.3)	0.107		19(38.5)	10(25.6)	0.219
Tertile 3		19(39.6)	23(32.9)			16(26.7)	23(41.8)			29(37.2)	14(35.9)	
Sedentary Activity (<1.5 METs)	118				115				117			
Tertile 1		11(22.9)	21(30.0)			17(28.3)	19(34.6)			21(26.9)	18(46.2)	
Tertile 2		20(41.7)	21(30.0)	0.407		18(50.0)	18(32.7)	0.596		24(30.8)	10(25.6)	0.106
Tertile 3		17(35.4)	28(40.0)			25(41.7)	18(32.7)			33(42.3)	11(28.2)	
Light Activity (1.5 - <3.0 METs)	118				115				117			
Tertile 1		18(37.4)	29(41.4)			19(31.7)	18(32.7)			21(26.9)	15(38.5)	
Tertile 2		15(31.3)	18(25.7)	0.800		24(40.0)	18(32.7)	0.677		29(37.2)	10(25.6)	0.339
Tertile 3		15(31.3)	23(32.9)			17(28.3)	19(34.4)			28(35.9)	14(35.9)	
Moderate Activity (3.0–6.0 METs)	118				115				117			
Tertile 1		17(35.4)	23(32.9)			22(36.7)	15(27.3)			23(29.5)	14(35.9)	
Tertile 2		17(35.4)	23(32.9)	0.843		20(33.3)	17(30.9)	0.375		27(34.6)	11(28.2)	0.716
Tertile 3		14(29.2)	24(34.2)			18(30.0)	23(41.8)			28(35.9)	14(35.9)	

Results expressed as number (%); *3 missing information on NSPLBPvariable; ** 1missing information on NSPLBPLBP variable [1]1st Trimester Tertiles: **Total Activity:** tertile 1 – ≤189.98, tertile 2 – 189.98-294.97, tertile 3 – ≥294.98; **Sedentary Activity:** tertile 1 – ≤25.55, tertile 2 – 25.56-53.03, tertile 3 – ≥53.04; **Light Activity:** tertile 1 – ≤86.98, tertile 2 – 86.98-135.45, tertile 3 – ≥135.46; **Moderate Activity:** tertile 1 - ≤34.93, tertile 2 – 34.93-118.18, tertile 3 - ≥118.19.[2]2nd Trimester Tertiles: **Total Activity:** tertile 1 – ≤148.75, tertile 2 – 148.76-234.75, tertile 3 – ≥234.76; **Sedentary Activity:** tertile 1 – ≤24.15, tertile 2 – 24.16-53.55, tertile 3 – ≥53.56; **Light Activity:** tertile 1 – ≤73.68, tertile 2 – 73.69-111.83, tertile 3 – ≥111.83; **Moderate Activity:** tertile 1 – ≤18.73, tertile 2 – 18.74-62.58, tertile 3 – ≥62.58.[3]3rd Trimester Tertiles: **Total Activity**: tertile 1 – ≤141.75, tertile 2 – 141.75-222.18, tertile 3 – ≥222.18; **Sedentary Activity:** tertile 1 – ≤26.08, tertile 2 – 26.08-55.30, tertile 3 – ≥55.30; **Light Activity:** tertile 1 – ≤67.03, tertile 2 – 67.04-101.50, tertile 3 – ≥101.50; **Moderate Activity**: tertile 1 – ≤19.15, tertile 2 – 19.15-55.18, tertile 3 – ≥55.18. [4]Comparison between participants with and without low back pain, using χ^2 test.

4. Discussion

4.1 Non-Specific Pregnancy-related Low Back Pain Prevalence

Several studies have attempted to understand the extent to which low back pain affects pregnant women and impacts public health (Garshasbi & Faghih Zadeh, 2005; Mogren, 2005, 2008; Mohseni-Bandpei, 2009; Morkved et al., 2007; Mousavi et al., 2007; Smith et al., 2008; Vermani et al., 2010). The present study found the frequency of period NSPLBP to be 76.3%. However, pre-pregnancy low back pain seemed to be a significant risk factor for the development of NSPLBP, possibly increasing NSPLBP prevalence. The musculoskeletal changes found in women with pre-pregnancy low back pain may thus be exacerbated during pregnancy, due to associated physiological changes (Mogren, 2005; Mogren & Pohjanen, 2005; Sabino & Grauer, 2008; Wu et al., 2004).

Recently, Mohseni-Bandpei, Fakhri et al. (2009) and Mousavi, Parnianpour et al. (2007) reported prevalence values that were lower than those found in the present study – 40.2%, n=1100 and 43.5%, n=325, respectively. Nevertheless, their samples mainly included women in their second trimesters of pregnancy (Mohseni-Bandpei, 2009; Mousavi et al., 2007). Mousavi et al. (2007) also reported that 60.6% of pregnant women experienced lumbopelvic pain at some time during their current pregnancies, a value that is, once again, lower than the prevalence of period NSPLBP found in the present study. On the other hand, Mogren (2005) found the prevalence of lumbopelvic pain to be 71.7% (n=639), a value closer to the one found in the present study for period NSPLBP (Mogren, 2005).

The onset of symptoms was reported by Mogren (2005) to occur throughout pregnancy – at 1 WG at the earliest, and at 39 WG at the latest. This finding mirrors those of the present study (Mogren, 2005). Although pregnancy-related low back pain seems to develop during any trimester of pregnancy, the factors underlying it may vary. The biomechanical changes that occur during pregnancy appear to be the main explanation (Vermani et al., 2010) – mainly the anterior displacement of a woman's center of mass, as a consequence of weight gain (Artal & O'Toole, 2003; Garshasbi & Faghih Zadeh, 2005), which increases the momentum of forces applied to the lumbar spine (Sabino & Grauer, 2008). Furthermore, abdominal muscles stretch to accommodate the expanding uterus, and thus their ability to perform their postural functions gradually decreases (Sabino & Grauer, 2008). However, a considerable portion of women first experienced low back pain during their first trimesters, when biomechanical changes are not yet significant (Sabino & Grauer, 2008). This suggests that, in some cases, pain may also be related to hormonal changes – mainly to increased production of the hormone relaxin, which causes the relaxation of connective tissue, leading to greater ligamental laxity (Artal & O'Toole, 2003; Garshasbi & Faghih Zadeh, 2005), particularly in the lumbopelvic joint (Sabino & Grauer, 2008; Stuge et al., 2003; Vermani et al., 2010).

4.2 Non-Specific Pregnancy-related Low Back Pain and Physical Activity

A downward trend in PA levels during pregnancy was observed, as reflected by PPAQ total activity scores. However, PPAQ scores by intensity and type showed that the values found with the present Portuguese sample were higher than those found with other samples in other studies (e.g. in the US, (Chasan-Taber et al., 2004), Vietnam (Ota et al., 2008) and Brazil (Takito, 2008)). This could be due to cultural differences in the samples.

NSPLBP frequency was not proven to be associated with either type or intensity of PA levels during pregnancy. An association was only found between this condition and *household/caregiving*. Some authors have studied the possible influence of organized PA practice during pregnancy on the development of pregnancy-related low back pain, but their conclusions have not been in agreement (Vermani et al., 2010). Recently, Kashanian et al. (2009), Morkved et al. (2007) and (Garshasbi & Faghih Zadeh, 2005) carried out randomized studies to assess the effectiveness of a specific exercise program on the prevention or reduction of pregnancy-related low back pain, and found that it was beneficial . Furthermore, Mogren (2005) concluded in a follow-up study (n=891) that a greater number of years of leisure PA before pregnancy decreased the risk of developing lumbopelvic pain during this period. The author suggested that women's pre-pregnancy physical conditions may be a stronger predictor of the development of lumbopelvic pain during pregnancy than leisure PA during this period, since pregnant women have more time to achieve the inherent benefits of exercise (Mogren, 2005). Moreover, it should be noted that most of the women in the present study reported having back pain before pregnancy, which means that they could have already had muscle imbalances that worsened during pregnancy.

These results suggest that PA itself may lead to health gains in those with specific conditions, such as diabetes, hypertension and, overweight/obesity but may not be enough for those with neuromusculoskeletal conditions, such as NSPLBP. Indeed, pregnant women may need to perform more focused exercise, valuing the biological and methodological principles of training, in particular the principle of specificity – which holds that exercise should be directed toward the muscles responsible for lumbopelvic stability – and the principle of overload. Health promotion campaigns may also be needed to empower pregnant women, helping them choose appropriate strategies for increasing and maintaining their activity levels and social participation without compromising their backs. Health care providers will play key roles in monitoring pregnant women while providing holistic and personalized approaches to care.

4.3 Methodological Considerations

The prospective design of this study, as well as the three evaluations conducted during pregnancy, reduced the possibility of memory bias. The use of a cohort and a consecutive sample is another strength of the present study. Moreover, PA levels were evaluated in a community and free-living environment, and the different parameters that characterize PA – duration, frequency and intensity – were recorded. The use of the same investigator for each evaluation should also be noted.

This study's main limitation is its subjective assessment of PA. Although the PPAQ is a specific, self-administered, quick and inexpensive way to assess PA among pregnant women, and although it possesses good psychometric characteristics, it is only able to measure pregnant women's perceptions of PA. Besides, apart from for walking and some household activities, PPAQ uses the MET intensity levels reported in the Compendium of Physical Activities (Ainsworth et al., 2000), whose values are based on data from men and non-pregnant women and therefore may not be applicable to pregnant women. However, the community context in which the study was carried out made it difficult to use objective instruments.

Thus, future studies should be carried out with larger samples, so that more assertive conclusions can be drawn about the influence of PA during pregnancy on gestational low back pain. There is an explicit need for standardization of terminology related to this condition, an issue that should be considered in later works. The use of objective instruments – such as accelerometers – to yield more accurate assessments of PA is also recommended.

5. Conclusion

Non-specific pregnancy-related low back pain is a common condition among pregnant women and should thus be considered a major public health issue. The present study suggests that this condition is not associated with type and intensity of PA during pregnancy, except when it comes to *household/caregiving* activities during a specific period.

6. Implications for Clinical Practice

Pregnancy is a privileged moment for behavioral change, considered by some authors to be a *teachable moment* (Phelan, 2010). Thus, health care providers should be aware of NSPLBP prevalence rates, as well as the trend toward decreased PA levels during pregnancy, and how these may be related. Heightened awareness of these matters will make providers more capable of deriving focused interventions, based around healthy lifestyles, for pregnant women.

7. Acknowledgments

This research is funded by Fundação para a Ciência e Tecnologia (FCT) Grants nos. SFRH/BD/45375/2008, BD/44422/2008; PROTEC SFRH/BD/50002/2009 and PTDC/DES/116586/2010.

We greatly appreciate the cooperation of Nursing's ULSAM during data collection and the voluntary participation of all the pregnant women in this study.

The authors of this paper reported no financial conflict of interest.

8. References

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., O'Brien, W. L., Bassett, D. R., Jr., Schmitz, K. H., Emplaincourt, P. O., Jacobs, D. R., Jr., & Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc, 32*(9 Suppl), S498-504.

Airaksinen, O., Brox, J. I., Cedraschi, C., Hildebrandt, J., Klaber-Moffett, J., Kovacs, F., Mannion, A. F., Reis, S., Staal, J. B., Ursin, H., & Zanoli, G. (2006). Chapter 4. European guidelines for the management of chronic nonspecific low back pain. *Eur Spine J, 15 Suppl 2*, S192-300.

Alves, O. M., D. Maciel_Barbosa, A. (2005). Saúde da mulher e da criança: necessidades, comportamentos e atitudes. *Revista Portuguesa de saúde Publica, 23*(1), 69-80.

Artal, R., & O'Toole, M. (2003). Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med, 37*(1), 6-12; discussion 12.

Chasan-Taber, L., Schmidt, M. D., Roberts, D. E., Hosmer, D., Markenson, G., & Freedson, P. S. (2004). Development and validation of a Pregnancy Physical Activity Questionnaire. *Med Sci Sports Exerc, 36*(10), 1750-1760.

Evenson, K. R., & Wen, F. (2010). National trends in self-reported physical activity and sedentary behaviors among pregnant women: NHANES 1999-2006. *Prev Med, 50*(3), 123-128.

Garshasbi, A., & Faghih Zadeh, S. (2005). The effect of exercise on the intensity of low back pain in pregnant women. *Int J Gynaecol Obstet, 88*(3), 271-275.

Hutchison, B. G., & Milner, R. (1994). Reliability of the Guide to Pregnancy Risk Grading of the Ontario Antenatal Record in assessing obstetric risk. *CMAJ, 150*(12), 1983-1987.

IOM. (2009). *Weight gain during pregnancy*: Institute of Medicine and National Research Council.

Kashanian, M., Akbari, Z., & Alizadeh, M. (2009). The effect of exercise on back pain and lordosis in pregnant women *Int J Gynaecol Obstet, 107*(2), 160-161.

Melzer, K., Schutz, Y., Soehnchen, N., Othenin-Girard, V., Martinez de Tejada, B., Irion, O., Boulvain, M., & Kayser, B. (2010). Effects of recommended levels of physical activity on pregnancy outcomes. *Am J Obstet Gynecol, 202*(3), 266 e261-266.

Mogren, I. M. (2005). Previous physical activity decreases the risk of low back pain and pelvic pain during pregnancy. *Scand J Public Health, 33*(4), 300-306.

Mogren, I. M. (2008). Physical activity and persistent low back pain and pelvic pain post partum. *BMC Public Health, 8*, 417.

Mogren, I. M., & Pohjanen, A. I. (2005). Low back pain and pelvic pain during pregnancy: prevalence and risk factors. *Spine (Phila Pa 1976), 30*(8), 983-991.

Mohseni-Bandpei, M. F., M.; Ahmad-Shirvani, M.; Bagheri-Nessami, M.; Khalilian, AR.; Shayesteh-Azar, M.; Mohseni-Bandpei, H. (2009). Low back pain in 1,100 Iranian pregnant women: prevalence and risk factors. *Spine J, 9*(10), 795-801.

Morkved, S., Salvesen, K. A., Schei, B., Lydersen, S., & Bo, K. (2007). Does group training during pregnancy prevent lumbopelvic pain? A randomized clinical trial. In *Acta Obstet Gynecol Scand* (Vol. 86, pp. 276-282). Denmark.

Mousavi, S. J., Parnianpour, M., & Vleeming, A. (2007). Pregnancy related pelvic girdle pain and low back pain in an Iranian population. In *Spine (Phila Pa 1976)* (Vol. 32, pp. E100-104). United States.

Ota, E., Haruna, M., Yanai, H., Suzuki, M., Anh, D. D., Matsuzaki, M., Tho le, H., Ariyoshi, K., Yeo, S. A., & Murashima, S. (2008). Reliability and validity of the Vietnamese version of the Pregnancy Physical Activity Questionnaire (PPAQ). *Southeast Asian J Trop Med Public Health, 39*(3), 562-570.

Phelan, S. (2010). Pregnancy: a "teachable moment" for weight control and obesity prevention. *Am J Obstet Gynecol, 202*(2), 135 e131-138.

Polley, B. A., Wing, R. R., & Sims, C. J. (2002). Randomized controlled trial to prevent excessive weight gain in pregnant women. *Int J Obes Relat Metab Disord, 26*(11), 1494-1502.

Portney, L. G., & Watkins, M. P. (1999). *Foundations of Clinical Research: Applications to Practice* (3 ed.): Hardcover.

Sabino, J., & Grauer, J. N. (2008). Pregnancy and low back pain. *Curr Rev Musculoskelet Med, 1*(2), 137-141.

Santos, P. C., Mendonca, D., Alves, O., & Barbosa, A. M. (2006). [Prevalence and impact of stress urinary incontinence before and during pregnancy]. *Acta Med Port, 19*(5), 349-356.

Schlussel, M. M., Souza, E. B., Reichenheim, M. E., & Kac, G. (2008). Physical activity during pregnancy and maternal-child health outcomes: a systematic literature review. *Cad Saude Publica, 24 Suppl 4*, s531-544.

Simas, T. A., Liao, X., Garrison, A., Sullivan, G. M., Howard, A. E., & Hardy, J. R. (2011). Impact of updated Institute of Medicine guidelines on prepregnancy body mass index categorization, gestational weight gain recommendations, and needed counseling. *J Womens Health (Larchmt), 20*(6), 837-844.

Smith, M. D., Russell, A., & Hodges, P. W. (2008). Is there a relationship between parity, pregnancy, back pain and incontinence? *Int Urogynecol J Pelvic Floor Dysfunct, 19*(2), 205-211.

Stuge, B., Hilde, G., & Vollestad, N. (2003). Physical therapy for pregnancy-related low back and pelvic pain: a systematic review. In *Acta Obstet Gynecol Scand* (Vol. 82, pp. 983-990). Denmark.

Takito, M. Y. (2008). Evaluation of the Reproducibility and Validity of a Physical Activity Questionnaire for Pregnant Women. *Rev Bras Med Esporte, 14*(2), 132-138.

Vermani, E., Mittal, R., & Weeks, A. (2010). Pelvic girdle pain and low back pain in pregnancy: a review. In *Pain Pract* (Vol. 10, pp. 60-71). United States.

Wang, S. M., Dezinno, P., Maranets, I., Berman, M. R., Caldwell-Andrews, A. A., & Kain, Z. N. (2004). Low back pain during pregnancy: prevalence, risk factors, and outcomes. In *Obstet Gynecol* (Vol. 104, pp. 65-70). United States.

Wolfe, L. A., Davies, G. A., School of, P., Health Education, D. o. O., Gynaecology, & Physiology, Q. s. U. K. O. C. (2003). Canadian guidelines for exercise in pregnancy. *Clin Obstet Gynecol, 46*(2), 488-495.

Wu, W. H., Meijer, O. G., Uegaki, K., Mens, J. M., van Dieen, J. H., Wuisman, P. I., & Ostgaard, H. C. (2004). Pregnancy-related pelvic girdle pain (PPP), I: Terminology, clinical presentation, and prevalence. *Eur Spine J, 13*(7), 575-589.

Artigo III

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

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

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Abstract

Introduction: Physical activity (PA) has been reported as a protective factor in pregnant women's health. However, PA generally declines during pregnancy, and barriers to PA during pregnancy are not well understood. This study aimed: (1) to analyze PA engagement during the 1st and 2nd trimesters, considering the different guidelines published on PA, (2) to document the individual characteristics associated with the accomplishment of these guidelines and (3) to examine pregnant women's perceived barriers to PA, using a socioecological framework.

Methods: A prospective study was conducted with a sample of 133 pregnant women in two stages: at 10-12 weeks' gestation - T1 and 20-24 weeks' gestation - T2. PA was assessed over 7 consecutive days, by accelerometry, during the T1 and T2 evaluation stages. The pregnant women were divided into four groups, according to different PA guidelines (American College of Obstetricians and Gynecologists-ACOG, Centers for Disease Control and Prevention-CDC, American College of Sports Medicine - ACSM and the United States Department of Health and Human Services-USDHHS). Socio-demographic characteristics, lifestyle factors and barriers to PA were assessed via questionnaire.

Results: A large proportion of women (ranging from 4% - ACOG to 68% - USDHHS) did not reach the levels of PA recommended by the guidelines. There were no significant differences between the 1st and 2nd trimesters with regard to compliance with PA recommendations ($p>0.05$ for all). However, a decrease in PA levels from the 1st to 2nd trimesters was noted for all recommendations. No associations were found between participants' characteristics (sociodemographic, obstetric and behavioural) and adherence to particular types of guidlines/recommendations in the 1st and 2nd trimesters ($p>0.05$ for all). According to the socioecological framework, no statistically significant differences were found in barriers to leisure PA between the 1st and 2nd trimesters ($p>0.05$ for all). The most commonly reported barrier to leisure PA in pregnancy was intrapersonal, not health -related. Among the non-health-related factors reported, lack of time, busyness and dislike of exercise were cited most frequently.

Conclusion: There were no differences between the 1st and 2nd trimesters in compliance with different PA recommendations. Individual characteristics were not associated with PA guidelines' accomplishment. Perceived barriers were similar in both trimesters. Intrapersonal barriers were the most-often perceived barriers to leisure PA.

Key-words: PA, pregnancy, guidelines, barriers, socioecological model.

1. 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 et al., 2011; Clarke & Gross, 2004; Haakstad & Bo, 2011).

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), American College of Sports Medicine (ACSM, 2006) and United States Department of Health and Human Services (USDHHS, 2009) 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 et al., 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 (Borodulin et al., 2008; Haakstad et al., 2009; Petersen et al., 2005). 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 et al., 2007; Lokey et al., 2004; Pivarnik et al., 2006) and long-term health implications for women who have been pregnant (Cramp & Brawley, 2009; Warburton et al., 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, 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 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 et al., 2009) as studies of this topic have some limitations. Since pregnancy is characterized by many physical and behavioral changes, it is plausible that barriers encountered early in pregnancy might be different from those encountered in the last trimester. Thus, it may be pertinent to analyze 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 et al., 1988; Sallis, 2008). Thus, this model may be useful when studying barriers to PA, since interventions designed to change behavior should consider multiple dimensions simultaneously and comprehensively (Evenson et al., 2009). It is recognized that pregnancy may be a critical period for the onset of inactivity in women (Haakstad et al., 2009). The published PA 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; "Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary", 2009). 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 (1) to analyze PA engagement during the 1st and 2nd trimesters of pregnancy, with reference to the different PA guidelines published, (2) to document the individual characteristics associated with adherence to these guidelines and (3) to examine pregnant women's perceived barriers to leisure PA, using a socioecological framework.

2. Methods

2.1 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 three stages. The first stage was between the tenth and twelfth weeks of gestation (at the time of baseline assessment), and the second was between the twentieth and twenty-second 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, prematurity, 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 agreed to take part in the study. Of these, 102 participated in the first and 97 in the second trimester. 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, 13 women were excluded because their data were lost/unusable, in some cases due to problems with their physical activity monitors; 17women were excluded due to non-compliance the requisites for analysis; and eight women dropped out.

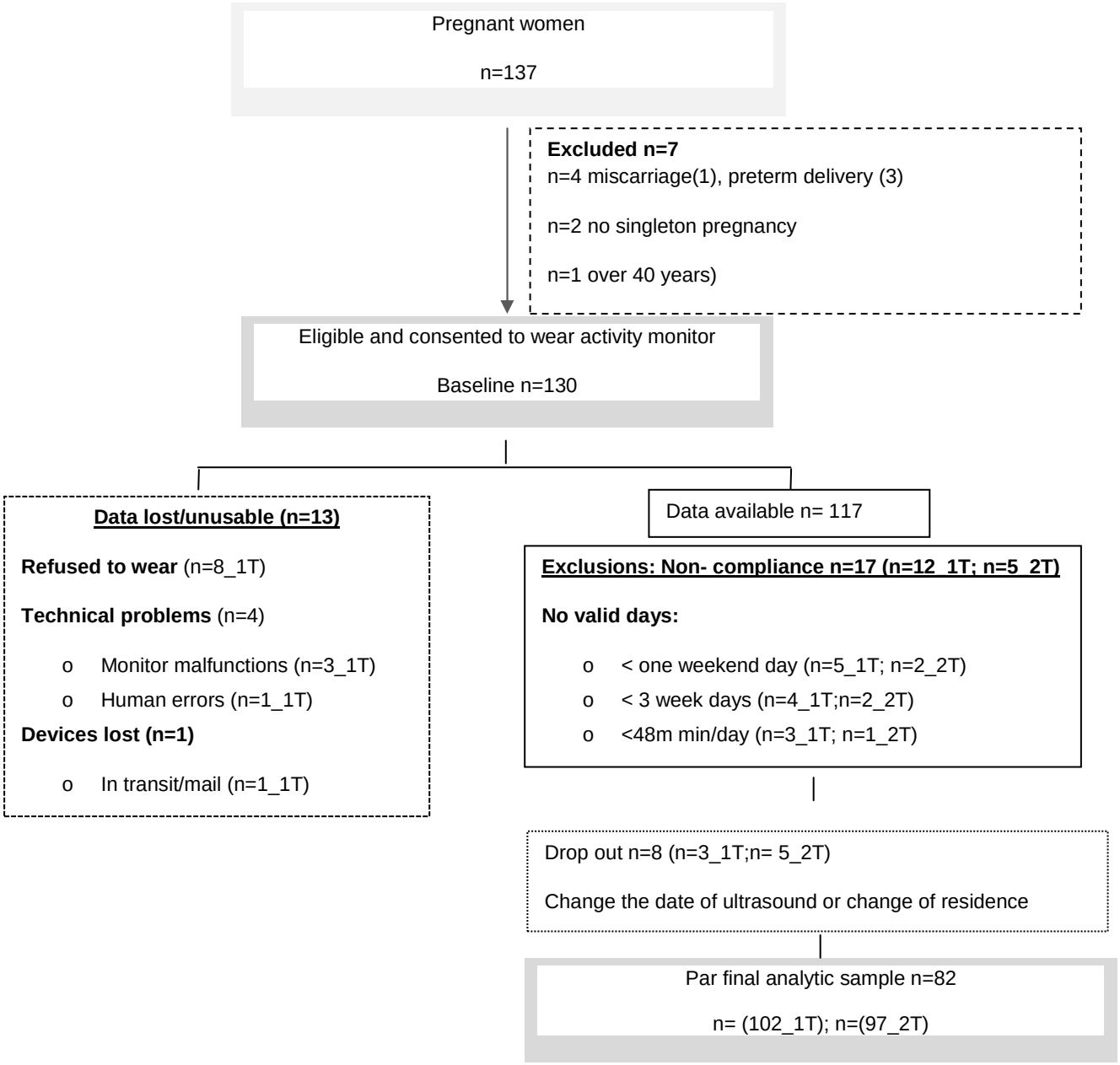

Figure 1 –Flowchart of exclusions/losses and reporting physical activity monitoring results

(T- trimester)

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).

2.2 Assessment Instruments/ Outcome measure

Data were collected at the time of ultrasound by researchers who administered structured and self-reported questionnaires. The questionnaires were designed to cover personal and socio-demographic data, lifestyle variables, health status during pregnancy and gynecologic history.

Anthropometric measures

Height was measured to the nearest mm 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 self-reported weight and height, using the formula: BMI=weight(kg)/height^2(m^2). BMI was categorized according to Institute of Medicine guidelines: underweight, normal weight, overweight and obese (IOM, 2009).

Socio-demographic and Obstetric Variables

Professional status was assessed and participants were divided into three categories: *employed* (full time), *unemployed* and *student*. Since there were only two subjects in the *student* category, those were pooled with members of the *employed* category. Respondents were asked to estimate 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,* subjects were divided into three categories, reflecting the organization of the Portuguese educational system: *mandatory or less* (≤9 school years), *secondary* (10 to 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.

Physical activity 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 et al., 2005). Epoch length was set to 5 seconds to allow a more detailed estimate of PA intensity (Matthews et al., 2012).

Accelerometer data were analyzed by an automated data reduction program (ActiLife v6.1.2© 2009-2012 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 minutes 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 by averaging activity counts over the total wear time only (i.e., 24 h – nonwear time). After screening was completed, the raw activity "counts" were processed to determine time spent on activities of different PA intensities. Activity levels were expressed in mean counts.min^{-1}. The accelerometer cut-points were borrowed from Freedson (1998).

The pregnant women were divided into four groups, according to their adherence to PA recommendations from the ACOG, (CDC), (ACSM) (2006) and (USDHHS) (*Physical activity guidelines for Americans*, 2008).

The ACOG and the CDC/ACSM suggest 30 minutes 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 minutes, three times per week. For pregnant women, USDHHS recommends ≥150 minutes (2 hours and 30 minutes) 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, 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 physical activity (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 1st and 2nd trimesters were asked about their reasons for not performing leisure PA. A table with types of barriers to leisure PA was constructed; 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. The question was open-ended, so that other responses were possible participants' answers were coded according to the previous model (Evenson et al., 2009). The types of barriers were grouped by socioecological framework [i.e., intrapersonal (health and not health related), interpersonal, neighbourhood /environmental and policy] (Sallis, 2008).

2.3 Procedures

The assessment instruments were individually administered: questionnaires, anthropometric measures and accelerometer attachment were performed 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 (1st and 2nd trimesters).

2.4 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 Chi-square Test or Fisher’s Exact Test. Yates’ continuity correction was used for analysis of 2x2 contingence tables. McNemar's test was used to compare paired proportions.

3. 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 categorized as overweight or obese during pre-pregnancy (Table1).

Table 8 – Descriptive characteristic of sample at baseline.

	n	Total 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 BMI	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)

Results expressed as number (%); BMI – body mass index.

Recommend PA levels

The proportion of women reaching ACOG's recommended level of PA during their 1st and 2nd 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%; 57.3% in the 1st and 2nd trimesters, respectively) (Table 2).

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 the 1st and 2nd 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 1st to the 2nd trimesters was noted for all recommendations, except the ACOG.

As regards the different PA recommendation groups, no associations were found between the participants' characteristics (sociodemographic, obstetric and behavioural) in the 1st and 2nd trimesters ($p>0.05$ for all, Table 3).

Barriers to PA, According to the Socioecological Framework

No statistically significant differences were found in the socioecological barriers to leisure PA between the 1st and 2nd trimesters ($p>0.05$ for all).

The most commonly reported barrier to leisure PA in pregnancy was *intrapersonal, not health related* (Table 4). The non-health-related factors most frequently cited for not participating in PA were lack of time, busyness and dislike of exercise. 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 1st and 2nd 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.

Table 2 – The definitions and proportion of pregnant woman who reached the recommended level of physical activity at 10-12wk (1st trimester) and 20-22 wk of gestation (2nd 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 and Human Services (USDHHS)

	Definition			**Reaching recommendation for total sample** n (%)		**Reaching recommendation for pairs sample** n (%)		
	Type of Activity	**Frequency and Duration**	**Intensity** (Fredsson et al. cut points)	**1st trimester** n=102	**2nd trimester** n=97	**1st trimester** n=82	**2nd trimester** n=82	***p*[1]**
ACOG	Exercise	Accelerometry and diary ≥5 days+30 minutes (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 minutes (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 minutes (moderate intensity) or >3 days+20 minutes (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 minutes (2 hours and 30 minutes) 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

na – not applicable; *(Freedson et al., 1998); [1] analysis by McNemar'test.

Table 3 - Association between participant's characteristics and main barriers to physical activity, according to compliance with different physical activity recommendations

	1st Trimester									2nd Trimester								
	n	CDC		p[1]	ACSM		p[1]	USDHHS		p[1]	n	CDC		p[1]	ACSM		p[1]	USDHHS		p[1]
		yes	no		Yes	no		yes	no			yes	no		yes	no		yes	no	
Age (years)	102	n(%)	n(%)		n(%)	n(%)		n(%)	n(%)		97	n(%)	n(%)		n(%)	n(%)		n(%)	n(%)	
[18, 30]		12(26.1)	34(73.9)	0.159	15(32.6)	31(67.4)	0.289	30(65.2)	16(34.8)	0.635		10(23.3)	33(76.7)	0.947	12(27.9)	31(72.1)	0.874	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)	0.930
Educational level	111										97									
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)	0.091
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									
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)	0.430
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									
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)	0.855
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										97									
Non-overweight*		23(39.7)	35(60.3)		25(43.1)	33(56.9)	0.245	43(74.1)	15(25.9)	0.108		14(25.9)	4.(74.1)	0.947	19(35.2)	35(64.8)	0.293	35(64.8)	19(35.2)	0.357
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)	

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 and Human Services.

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

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

Table 3 - (continued).

	1st Trimester									2nd Trimester								
	n	CDC		p^1	ACSM		p^1	USDHHS		p^1	n	CDC		p^1	ACSM		p^1	USDHHS		p^1
		yes	no		yes	no		yes	no			yes	no		yes	no		yes	no	
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)	

na - not applicable; CDC - Centers for Disease Control and Prevention; ACSM - American College of Sports Medicine. USDHHS - United States Department of Health and Human Services.

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

Table 4 - Survey participants' main barriers to physical activity, according to the socioecological framework at 10-12 weeks (1st trimester) and 20-22 weeks of gestation (2nd trimester)

Barriers according to the socioecologic framework	Reasons for not engage in leisure PA	Total sample		Pairs sample		p^1
		1st trimester n=123*	2nd trimester n=105**	1st trimester n=98	2nd trimester n=98	
Intrapersonal		n (%)	n (%)			
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
Neighborhood 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

na - not applicable. *1T_ 12 women did leisure PA;** 2T_ 10 women did leisure PA.[1] Analysis by McNemar's test.

4. Discussion

Recommended PA levels

In this study, there were no significant differences between the 1st and 2nd trimesters in compliance with the PA recommendations of the CDC, ACSM and USDHHS. However, a tendency for PA levels to decrease from the 1st to 2nd trimesters was noticed for all recommendations.

These findings are in line with those of previous studies showing that there is greater adherence to PA during the 1st trimester and a tendency for PA to decrease during pregnancy generally (Poudevigne & O'Connor, 2006). Several studies have indicated that PA declines during pregnancy (Borodulin et al., 2008; Fell et al., 2009; Rousham et al., 2006). Lack of adherence to PA recommendations is mainly due to unawareness (Gouveia et al., 2007; Haakstad et al., 2009), believes (Duncombe et al., 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 weeks and 27-30 weeks in Borodulin's study; 10-12 weeeks 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; in the Borodulin study, it was measured using a questionnaire. However, these two instruments have poor absolute agreement, especially in the third trimester (Harrison et al., 2011). 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.

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 the variables

studied (age, educational level, marital status, professional status, monthly income, pre-pregnancy BMI, parity, smoking, leisure PA pre-pregnancy).

The findings of previous literature on the socio-demographic characteristics and lifestyle factors associated with PA during pregnancy have been inconsistent. According to Camões et al. (2008), with Portuguese pregnant women, there is a relationship between socio-demographic and behavioral 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, 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., 2007b; Mottola & Campbell, 2003; Watson & McDonald, 2007); education level (Chasan-Taber et al., 2007b; Clarke & Gross, 2004); marital status (Fell et al., 2009; Mottola & Campbell, 2003; Mudd et al., 2009); parity (Chasan-Taber et al., 2007b; Petersen et al., 2005); professional status (Fell et al., 2009; Pereira et al., 2007); and pre-pregnancy BMI (Chasan-Taber et al., 2007b; 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 et al. (2001). Nevertheless, some studies have shown that women who are more active prior to pregnancy remain more active during pregnancy (Chasan-Taber et al., 2007b; 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 1st and 2nd trimesters. This is in accordance with Cramp et. al. (2009) finding that barriers were consistent during pregnancy, except for work.

Women reported intrapersonal barriers, both non-health- 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 et al., 2009), as family duties create time conflicts.

Along the same lines, Evenson (2009) found that 85% of a sample of 1,535 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 et al.'s (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 1st and 2nd 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 to 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 & Lepecka-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 primigest mothers. However, studies analyzing the barriers to leisure PA during pregnancy are scarce.

In our study, neighborhood/environmental and policy barriers were infrequently cited as barriers to PA. Neighborhood or environmental barriers to PA have been identified by pregnant women in others 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 two years and, for this reason, involved all seasons. In addition, Portugal has a temperate climate.

On the other hand, lack of time or busyness may lead people to not perceive others' needs. “Nobody needs what we do not know or did not have time to enjoy.” Political issues, including

the high costs and the low bid for the free practice of exercise or leisure PA have also been mentioned as barriers to PA during pregnancy.

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, lacking 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 Freedsson's cutpoints (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.

5. Conclusion

There were no differences between the 1st and 2nd 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.

6. 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.

7. Acknowledgments

This research is funded by Fundação para a Ciência e Tecnologia (FCT) Grants nos. BD/45375/2008, PROTEC SFRH/BD/50002/2009 and PTDC/DES/116586/2010. BD/44422/2008; PTDC/DES/098309/2008; BPD/65180/2009; SAB/1025/2010.

We greatly appreciate the cooperation health professionals for valuable support during data collection and all the pregnant women who agreed to voluntarily participate in this study.

The authors of this paper reported no financial conflict of interest.

8. References

ACOG. (2002). ACOG committee opinion. Exercise during pregnancy and the postpartum period. Number 267, January 2002. American College of Obstetricians and Gynecologists. *Int J Gynaecol Obstet, 77*(1), 79-81.

ACSM. (2006). ACSM's Guidlines for exercise testing and prescription.

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). *Med Sci Sports Exerc, 30*(6), 975-991.

Artal, R., & O'Toole, M. (2003). Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med, 37*(1), 6-12; discussion 12.

Borodulin, K. M., Evenson, K. R., Wen, F., Herring, A. H., & Benson, A. M. (2008). Physical activity patterns during pregnancy. *Med Sci Sports Exerc, 40*(11), 1901-1908. doi: 10.1249/MSS.0b013e31817f1957.

Camões, M., & Lopes, C. (2008). [Factors associated with physical activity in the Portuguese population] *Rev Saude Publica* (Vol. 42, pp. 208-216). Brazil.

Caperchione, C., Mummery, W., & Joyner, K. (2009). Addressing the challenges, barriers and enablers to physical activity participation in priority women's groups: Findings from the WALK Program *J Phys Act Health, 6*, 589-596.

Caperchione, C. M., Kolt, G. S., Tennent, R., & Mummery, W. K. (2011). Physical activity behaviours of Culturally and Linguistically Diverse (CALD) women living in Australia: a qualitative study of socio-cultural influences *BMC Public Health* (Vol. 11, pp. 26). England.

Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Manson, J., & Markenson, G. (2007). Correlates of physical activity in pregnancy among Latina women. *Matern Child Health J, 11*(4), 353-363. doi: 10.1007/s10995-007-0201-8.

Chasan-Taber, L., Schmidt, M. D., Roberts, D. E., Hosmer, D., Markenson, G., & Freedson, P. S. (2004). Development and validation of a Pregnancy Physical Activity Questionnaire. *Med Sci Sports Exerc, 36*(10), 1750-1760.

Clarke, P. E., & Gross, H. (2004). Women's behaviour, beliefs and information sources about physical exercise in pregnancy *Midwifery* (Vol. 20, pp. 133-141). Scotland.

Cramp, A. G., & Brawley, L. R. (2009). Sustaining self-regulatory efficacy and psychological outcome expectations for postnatal exercise: effects of a group-mediated cognitive behavioural intervention. *Br J Health Psychol, 14*(Pt 3), 595-611. doi: 10.1348/135910708X383732.

Cramp, A. G., & Bray, S. R. (2009). A prospective examination of exercise and barrier self-efficacy to engage in leisure-time physical activity during pregnancy. *Ann Behav Med, 37*(3), 325-334. doi: 10.1007/s12160-009-9102-y.

Duncombe, D., Wertheim, E. H., Skouteris, H., Paxton, S. J., & Kelly, L. (2009). Factors related to exercise over the course of pregnancy including women's beliefs about the safety of exercise during pregnancy. *Midwifery, 25*(4), 430-438. doi: 10.1016/j.midw.2007.03.002.

Evenson, K. R., & Bradley, C. B. (2010). Beliefs about exercise and physical activity among pregnant women. *Patient Educ Couns, 79*(1), 124-129. doi: 10.1016/j.pec.2009.07.028.

Evenson, K. R., Moos, M. R., Carrier, K., & Siega-Riz, A. M. (2009). Perceived Barriers to Physical Activity Among Pregnant Women. *Matern Child Health J, 13*(3), 364-375. doi: DOI 10.1007/s10995-008-0359-8.

Evenson, K. R., & Wen, F. (2010). National trends in self-reported physical activity and sedentary behaviors among pregnant women: NHANES 1999-2006. *Prev Med, 50*(3), 123-128. doi: S0091-7435(09)00649-5.

Evenson, K. R. S., D.A.; Huston, S. L. . (2004). Leisure-time physical activity among pregnant women in the US. *Paediatric and Perinatal Epidemiology 18* (6), 400-407.

Eyler, A. E., Wilcox, S., Matson-Koffman, D., Evenson, K. R., Sanderson, B., Thompson, J., Rohm-Young, D. (2002). Correlates of physical activity among women from diverse racial/ethnic groups. *J Womens Health Gend Based Med, 11*(3), 239-253. doi: 10.1089/152460902753668448.

Fell, D. B., Joseph, K. S., Armson, B. A., & Dodds, L. (2009). The impact of pregnancy on physical activity level. *Matern Child Health J, 13*(5), 597-603. doi: 10.1007/s10995-008-0404-7

Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc, 30*(5), 777-781.

Gaston, A., & Cramp, A. (2011). Exercise during pregnancy: a review of patterns and determinants *J Sci Med Sport* (Vol. 14, pp. 299-305). Australia.

Gouveia, R., Martins, S., Sandes, A. R., Nascimento, C., Figueira, J., Valente, S., Silva, L. J. (2007). [Pregnancy and physical exercise: myths, evidence and recommendations. *Acta Med Port, 20*(3), 209-214.

Haakstad, A. H., Voldner, N., Henriksen, T., & BØ, K. (2009). Why do pregnant women stop exercising in the third trimester? *Acta Obstetricia et Gynecologica*(88), 1267-1275.

Haakstad, L. A., & Bo, K. (2011). Effect of regular exercise on prevention of excessive weight gain in pregnancy: a randomised controlled trial. *Eur J Contracept Reprod Health Care, 16*(2), 116-125. doi: 10.3109/13625187.2011.560307.

Harrison, C. L., Thompson, R. G., Teede, H. J., & Lombard, C. B. (2011). Measuring physical activity during pregnancy. *Int J Behav Nutr Phys Act, 8*, 19. doi: 10.1186/1479-5868-8-19.

Hegaard, H. K., Damm, P., Hedegaard, M., Henriksen, T. B., Ottesen, B., Dykes, A. K., & Kjaergaard, H. (2011). Sports and leisure time physical activity during pregnancy in nulliparous women. *Matern Child Health J, 15*(6), 806-813. doi: 10.1007/s10995-010-0647-y.

Hegaard, H. K., Pedersen, B. K., Nielsen, B. B., & Damm, P. (2007). Leisure time physical activity during pregnancy and impact on gestational diabetes mellitus, pre-eclampsia, preterm delivery and birth weight: a review. *Acta Obstet Gynecol Scand, 86*(11), 1290-1296. doi: 781881109.

Hinton, P. S., & Olson, C. M. (2001). Predictors of pregnancy-associated change in physical activity in a rural white population. *Matern Child Health J, 5*(1), 7-14.

IOM. (2009). Weight gain during pregnancy *Reexamining the guidelines*: Institute of Medicine and National Research Council.

Lokey, E., Tran, Z., Wells, C., Myer, B., & Tran, A. (2004). Effects of physical exercise on pregnancy outcomes: A meta-analytic review. *Med Sci Sport Exerc, 23*, 1244-1251.

Maddison, R., Jiang, Y., Hoorn, S. V., Mhurchu, C. N., Lawes, C. M., Rodgers, A., & Rush, E. (2009). Estimating energy expenditure with the RT3 triaxial accelerometer. *Res Q Exerc Sport, 80*(2), 249-256.

Maiese, D. R. (2002). Healthy people 2010--leading health indicators for women. *Womens Health Issues, 12*(4), 155-164.

Matthews, C. E., Hagstromer, M., Pober, D. M., & Bowles, H. R. (2012). Best practices for using physical activity monitors in population-based research *Med Sci Sports Exerc* (Vol. 44, pp. S68-76). United States.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Educ Q, 15*(4), 351-377.

Mottola, M. F., & Campbell, M. K. (2003). Activity patterns during pregnancy. [Research Support, Non-U.S. Gov't]. *Can J Appl Physiol, 28*(4), 642-653.

Mudd, L. M., Nechuta, S., Pivarnik, J. M., & Paneth, N. (2009). Factors associated with women's perceptions of physical activity safety during pregnancy *Prev Med* (Vol. 49, pp. 194-199). United States.

Ning, Y., Williams, M. A., Dempsey, J. C., Sorensen, T. K., Frederick, I. O., & Luthy, D. A. (2003). Correlates of recreational physical activity in early pregnancy. *J Matern Fetal Neonatal Med, 13*(6), 385-393. doi: 10.1080/jmf.13.6.385.393.

Ota, E., Haruna, M., Yanai, H., Suzuki, M., Anh, D. D., Matsuzaki, M., Murashima, S. (2008). Reliability and validity of the Vietnamese version of the Pregnancy Physical Activity Questionnaire (PPAQ). *Southeast Asian J Trop Med Public Health, 39*(3), 562-570.

Pereira, M. A., Rifas-Shiman, S. L., Kleinman, K. P., Rich-Edwards, J. W., Peterson, K. E., & Gillman, M. W. (2007). Predictors of change in physical activity during and after pregnancy: Project Viva *Am J Prev Med* (Vol. 32, pp. 312-319). Netherlands.

Petersen, A., Leet, T., & Brownson, R. (2005). Correlates of exercise among pregnant women in the United States. *Med Sci Sport Exer*(37), 1748 - 1753.

. Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary. (2009) *Nutr Rev* (Vol. 67, pp. 114-120). United States.

Physical activity guidelines for Americans. (2008, Dec-2009 Feb). [2008/12/19]. Okla Nurse, (53, 4).

Pivarnik, J. M., Chambliss, H. O., Clapp, J. F., Dugan, S. A., Hatch, M. C., Lovelady, C. A., Williams, M. A. (2006). Impact of Physical Activity during Pregnancy and Postpartum on Chronic Disease Risk. *Medicine & Science in Sports & Exercise, 38*(5), 989-1006.

Poudevigne, M. S., & O'Connor, P. J. (2006). A review of physical activity patterns in pregnant women and their relationship to psychological health. *Sports Med, 36*(1), 19-38. doi: 3613.

Rousham, E. K., Clarke, P. E., & Gross, H. (2006). Significant changes in physical activity among pregnant women in the UK as assessed by accelerometry and self-reported activity *Eur J Clin Nutr* (Vol. 60, pp. 393-400). England.

Rutkowska, E., & Lepecka-Klusek, C. (2002). The role of physical activity in preparing women for pregnancy and delivery in Poland. *Health Care Women Int, 23*(8), 919-923. doi: 10.1080/07399330290112416.

Sallis, J. O., N. Fisher, EB. (2008). Ecological models of health behavior. In K. R. Glanz, BK.; Viswanath, K. (Ed.), *Health behavior and health education: theory, research, and practic* (4th edn ed., pp. 465–486). San Francisco, CA: Jossey-Bass.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc, 40*(1), 181-188. doi: 10.1249/mss.0b013e31815a51b3.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence *CMAJ* (Vol. 174, pp. 801-809). Canada.

Ward, D. S., Evenson, K. R., Vaughn, A., Rodgers, A. B., & Troiano, R. P. (2005). Accelerometer use in physical activity: best practices and research recommendations. *Med Sci Sports Exerc, 37*(11 Suppl), S582-588. doi: 00005768-200511001-00011.

Watson, P. E., & McDonald, B. W. (2007). Activity levels in pregnant New Zealand women: relationship with socioeconomic factors, well-being, anthropometric measures, and birth outcome. *Appl Physiol Nutr Metab, 32*(4), 733-742. doi: 10.1139/H07-061.

Zhang, J., & Savitz, D. A. (1996). Exercise during pregnancy among US women. *Ann Epidemiol, 6*(1), 53-59. doi: 1047279795000933.

Artigo IV

Physical activity during pregnancy and its effects on neonatal outcomes

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Physical activity during pregnancy and its effects on neonatal outcomes

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Abstract:

Introduction: Physical activity during pregnancy has been reported as a protective factor in maternal and child health. However, its effects on neonatal outcomes are still controversial. **Objective:** This study aimed: (1) to explore whether pregnant women adhered to the physical activity recommendations of the American College of Sports Medicine (ACSM); (2) to verify the relationships between ACSM physical activity recommendations, socio-demographic characteristics and lifestyle factors and (3) to determine the relationship between ACSM physical activity recommendations during pregnancy and neonatal outcomes at birth.

Methods: We conducted a prospective study with a sample of 70 pregnant women in three stages: at 10-12 weeks' gestation - T1, 20-24 weeks' gestation - T2 and in the immediate postpartum period (first 48 hours). Height and weight were determined using standard anthropometric methods. Physical activity was assessed over 7 consecutive days, via accelerometry, during the T1 and T2 evaluation stages. Socio-demographic characteristics and lifestyle factors were assessed by questionnaire. Women were categorized into three groups: inactive, inconsistently active and active, in accordance with the ACSM physical activity recommendations. Postpartum, medical records were examined for neonatal outcomes at birth: weight, length, head circumference and Apgar score.

Results: 52.86% of women were inactive (did not reach ACSM physical activity recommendations at T1 and T2). No significant relationships were found between ACSM physical activity recommendations and socio-demographic characteristics or lifestyle factors ($p>0.05$ for all). No significant differences in neonatal outcomes at birth were observed between the women who did and did not comply with ACSM physical activity recommendations ($p>0.05$ for all outcomes).

Conclusion: Currently, a great number of women do not comply with ACSM physical activity recommendations. However, we did not identify a risk profile for these women. Healthy pregnant women should be encouraged to follow the physical activity recommendations of the ACSM during pregnancy, given that no significant negative associations were found between physical activity and neonatal outcomes.

Key-words: Physical activity, pregnancy, ACSM recommendations, neonatal outcomes.

1. Introduction

The literature has clearly shown that regular physical activity is recommended for pregnant and postpartum women, because it enhances maternal, fetal, and neonatal well-being, including mental health, and confers such health benefits as the prevention of gestational diabetes, preeclampsia, weight gain, and chronic musculoskeletal conditions (ACOG, 2002; ACSM, 2006; Davies et al., 2003).

To foster a normal, healthy pregnancy, the American College of Obstetrics and Gynaecology (ACOG) advocates the continuation of pre-pregnancy exercise activities and recommends that sedentary women start exercising during pregnancy (ACOG, 2002).

Pregnancy causes many changes in the mother's body, which may alter the effects of exercise on the body or limit the body's ability to perform certain types of exercise (Gaston & Cramp, 2011). Many pregnant women would like to exercise during pregnancy, but the consequences to maternal or fetal safety, such as weight loss, premature labor, and neonatal outcome are sources of concern (Gaston & Cramp, 2011; Lumbers, 2002; Weissgerber et al., 2006). Nevertheless, studies have suggested that physical activity positively contributes to both maternal and fetal health, except in a few cases (ACOG, 2002; ACSM, 2006).

The American College of Sports Medicine (ACSM), with the approval of the ACOG, recommends 30 minutes or more moderate-intensity physical activity on most days of the week (5 days), or alternatively, 3 days of vigorous activity for 20 minutes (ACSM, 2006). Consequently, it has been hypothesized that participation in moderate-intensity physical activity during pregnancy has a beneficial effect on neonatal outcomes at birth, including: birth weight, length, head circumference, and Apgar score (Juhl et al., 2010). Behind this hypothesis is the assumption of a likely phenomenon, a type of redistribution that, via an adaptive process, could lead to an increase in placental blood irrigation, raising the capacity for oxygen transport and diffusion and thereby resulting in greater fetal oxygen and nutrient uptake (Hopkins et al., 2011). Nevertheless, studies to date on this subject are too inconsistent to support this theory.

Some studies have reported that birth weight and length are the most reliable morphologic indicators of neonatal and infant well-being (Juhl et al., 2010). Birth weight plays an important role in infant mortality and morbidity, childhood development, and adult health (Hopkins & Cutfield, 2011; Osler et al., 2009). Low birth weight newborns are at increased risk for both short- and long-term morbidities (Clayton, 2007). Another concern is the increasing prevalence of newborns with high birth weight or fetal macrosomia (Bell, 2008; Zhang et al., 2008). Indeed, several studies have shown that a birth weight ≥4000g is associated with acute complications such as prolonged labour and operative delivery (Heiskanen et al., 2006). Regarding head circumference, Juhl et al. (2010) showed that small head circumference correlates with brain size, which in turn is associated with a lower intelligence coefficient and a higher risk of cardiovascular disease and impaired glucose tolerance. Another neonatal parameter of great importance is the Apgar score, an easily obtainable indicator of the clinical status of the newborn ("ACOG Committee Opinion. Number 333, May 2006 (replaces No. 174, July 1996): The Apgar score", 2006). Neonatal outcomes are influenced by several factors, such as parents' anthropometric measures, age of the mother, parity, anxiety,

alcohol and caffeine intake, and parents' socio-economic situation (Elshibly & Schmalisch, 2008; Faden et al., 1997; Gaston & Cramp, 2011).

Given the small number of prospective studies assessing the effects of physical activity during pregnancy on neonatal outcomes and the possible benefits of such activity to maternal-fetal health, it is important to better understand this issue. This study aimed: (1) to explore whether pregnant women adhered to ACSM physical activity recommendations; (2) to verify the relationships between ACSM physical activity recommendations, socio-demographic characteristics and lifestyle factors and (3) to determine the relationship between ACSM physical activity recommendations during pregnancy and neonatal outcomes at birth.

2. Methods

2.1 Study Design and Sample

This is 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 was collected in three stages. The first stage was between the tenth and twelfth weeks of gestation (at the time of baseline assessment), the second was between the twentieth and twenty-second weeks (at the time of second ultrasound), and the last was 48 hours after delivery (at the time of postpartum visit). Each visit lasted approximately 20 minutes.

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: women with 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), age of less than 18 or over 40 years, prematurity or a 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 agreed to take part in the study (participation rate 69.23%) - 105 during their first trimesters, 90 in their second and 70 in post-partum. Some women were subsequently excluded because of miscarriage (n=1); pre-term delivery, as defined by <37 weeks' gestation (n=3); lack of singleton pregnancy (n=2) and age of over 40 years (Figure 1). Furthermore, data for 13 women was lost/unusable due to problems/issues with their physical activity monitors, 17 women were non-compliant with the prerequisites for analysis of the physical

activity data and 20 did not have neonatal outcomes for their children at birth by the time this study ended, because their babies had not been born yet.

Thus, the final sample was composed of the 70 participants who provided physical activity assessments in each trimester of pregnancy and also had information about neonatal outcomes at birth in the immediate post-partum period.

Power analysis of the final sample was calculated post-hoc and was higher than 0.8 for a p-value <0.05 (Faul et al., 2009). There were no significant differences in the variables of interest between the final sample and the baseline assessment.

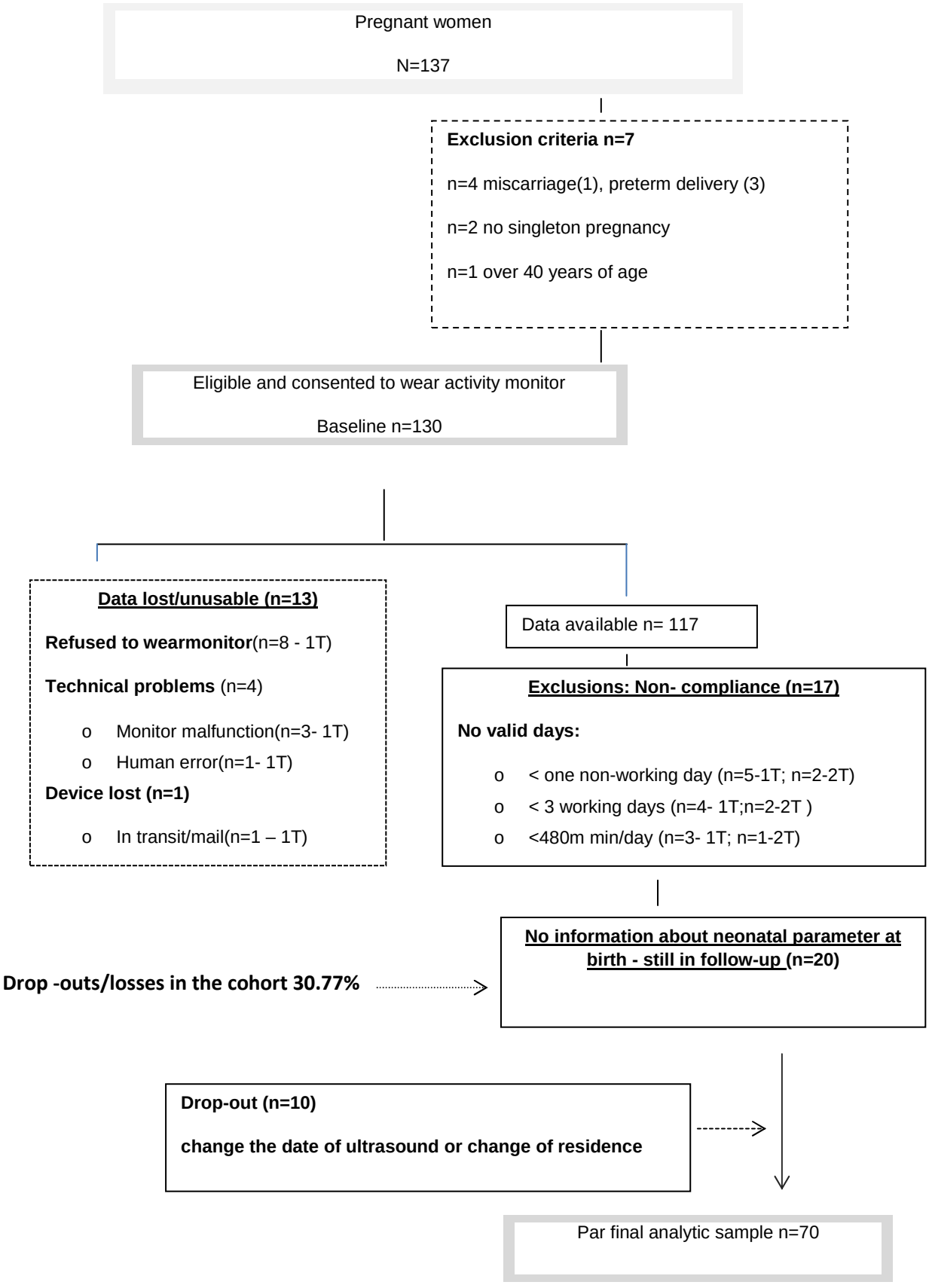

Figure 1 –Flowchart for reporting exclusions, drop-outsand physical activity monitoring results

2.2 Assessment Instruments/ Outcome Measure

Data was collected during the ultrasound evaluations by researchers who administered structured and self-reported questionnaires. The questionnaires were designed to cover personal and socio-demographic data, lifestyle variables, health status during pregnancy, and gynecologic history.

Anthropometric Measures

Height was measured to the nearest mm 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 body mass index (BMI) was estimated from self-reported weight and height, using the formula: $BMI=weight(kg)/height^2(m^2)$.BMI was categorized according to Institute of Medicine guidelines: *underweight*, *normalweight*, *overweight* and *obese*. These guidelines were also used to assign groups by weight gain. The pregnant women were classified as *undergainers*, *appropriategainers* and *overgainers*, depending on whether they acquired weight below the recommended level, within the recommended level or higher than the recommended level, respectively (IOM, 2009).

Socio-demographic and Lifestyle Variables

Professional status was assessed and participants were divided into three categories: *employed* (full time), *unemployed* and *student*. Since there were only two participants in the *student* category, these were pooled with members of the *employed* category. Respondents were asked to estimate 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 organization of the Portuguese educational system: *mandatory or less* (≤9 school years), *secondary* (10 to 12 school years) and *college/university* (>12 school years). *Exercise pre-pregnancy* was assessed by asking the following question, “In the year before you got pregnant, did you practice organized exercise?” Women who answered affirmatively were considered active. Concerning number of gestations, women were considered *primigest* if this was their first gestation and *multigest* if they had at least one previous gestation.

Anxiety

Anxiety was measured using the Zung Self-rating Anxiety Scale (Zung, 1971). This scale is comprised of 20 statements, with 4 answer choices for each question. The total score ranges between 20 and 80. Higher values correspond to worse states of anxiety. A total score of 40 or over suggests a state of anxiety. The scale was translated to Portuguese (Ponciano, 1982).

Dietary Intake

Dietary intake data was obtained using a self-administered, semi-quantitative food frequency questionnaire (FFQ) that covered 86 food items and beverage categories and was validated for use with Portuguese pregnant women (Pinto et al., 2010). Food intake was calculated by weighting each of the nine frequencies of consumption (from never or less than once per month, to six or more times a day) by the weight of the standard portion size of the food item. The FFQ was administered in the immediate post-partum period, to estimate dietary intake during the whole pregnancy.

Physical Activity Measurement

The accelerometer GT3X Actigraph (ActiGraph, Pensacola, Florida, USA) was used to obtain detailed and objectively 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 when sleeping, in accordance with established procedures (Ward et al., 2005). The epoch length was set to 5 seconds, to allow a more detailed estimate of PA intensity (Matthews et al., 2012).

Accelerometer data was analyzed by an automated data reduction program (ActiLife v6.1.2© 2009-2012 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 minutes of consecutive zeros were detected and flagged as times during which the monitor was not worn (Troiano et al., 2008). Participants had to have at least 480 minutes of data on a given day for that day to count as valid and were also required to have at least four valid days to be included in the study (three working days and non-working day). Non-wear time was adjusted for by averaging activity count over the total wear time only (i.e., 24 hours – non-wear time). After screening was completed, the raw activity "count" was processed for determination of time spent performing PA of different intensities. Activity levels were expressed in mean counts.min-1. The established accelerometer cut-points proposed by Freedson (1998) were used.

The pregnant women were divided into three groups, according to the ACSM physical activity recommendations: *inactive* women who have never reached the recommendations (neither in the 1st trimester nor in the 2nd); *inconsistently active* women who complied with the recommendations in the 1st or 2nd trimester; and *active* women who reached the physical activity recommendations in both the 1st and 2nd trimesters.

The sample was also divided into two groups, according to behavioral attitude: woman who were inactive or became inactive (active in the 1st trimester and inactive in the 2nd) were put into the *negative behavior* group, while women who were active in both trimesters or became active (i.e.,

were inactive in the 1st trimester and became active in the 2nd trimester) were put into the *positive behavior* group.

Neonatal outcomes at birth

The postpartum evaluation yielded data on birth weight (measured with an electronic scale to the nearest gram); length; head circumference (measured with tape to the nearest millimetre); Apgar score at 1 and 5 mins after birth, as recorded on labor and delivery records; and gestational age at time of delivery (assessed based on last menstrual period and confirmed by first trimester ultrasound evaluation at 10-12 weeks). The early ultrasound is the most valid estimation of true gestational age (Kramer et al., 1988)

The main outcome measure was infant birth weight. In addition, newborns were grouped according to their birth weight, as follows: low birth weight (< 2,500 g); normal birth weight (2,500-3,999 g) and macrosomia (≥ 4,000 g) (Henriksen, 2008). Secondary outcome measures were gestational age at delivery and Apgar score. Newborn characteristics were obtained from labor and delivery records and interviews with the participants.

2.3 Procedures

The assessment instruments were individually administered: questionnaires were given and anthropometric measures and accelerometer attachment were performed on ultrasound evaluation days. The women received a 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 via the mail.

When a newborn from the study was born, the study team was notified by email by the administrative services of the hospital or by the mothers themselves.

The assessment methods were common to the three evaluation moments and included anthropometric measurements. The questionnaires about socio-demographic characteristics and lifestyle factors were exclusively applied in the baseline assessment, and the accelerometry assessment was done during the 1st and 2nd trimesters.

2.4 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, with a confidence range of 95%, when applicable.

Descriptive data are presented as means and standard deviations, unless otherwise stated. In those cases where normality was assumed, we opted for the parametric sample t-test and ANOVA with Bonferroni corrections for intergroup analysis. Where normality was not assumed, we decided

by the nonparametric tests, using the Mann-Whitney test to compare two groups and the Kruskal-Wallis test for comparisons between more than two groups.

Associations between categorical variables were analyzed via statistical inference – specifically, the Chi-square Test and Fisher's Exact Test. Yates continuity correction was used for analysis of 2x2 contingency tables.

3. Results

The descriptive characteristics of the study sample are presented in Table 1. At baseline, the mean age of the participants was 30.4±5.5 years, and mean height was 1.6±0.1m. Twenty-seven percent of women were shorter than 1.6 m. Forty-seven percent were overweight, and 44.9% were considered over-gainers. More than half of women were primigest, 10.3% were anxious, only one drank alcohol (.50 ml/day), 45.71% drank coffee (1.3±0.6 cup) and 11.43% smoked (3.9±1.7 cigarettes). Concerning educational level, 37.14% of women had a mandatory education or less. Before pregnancy, only 27.14% of women had participated in sports activities.

No differences were found in maternal socio-demographic characteristics and lifestyle factors when it came to adherence to the ACSM physical activity recommendations ($p<0.05$ for all).

Table 1 - Maternal socio-demographic characteristics and lifestyle factors according to ACSM recommendations and Activity behaviour.

Pregnant	n	Total n(%)	ACSM Recommendations				Activity Behavior		
			Inactive n(%)	Inconsistently active n(%)	Active n(%)	p^1	Negative n(%)	Positive n(%)	p^1
Age (years)	70								
[18, 30]		31(44.29)	18(48.6)	8(44.4)	5(33.3)	0.602	23(46.9)	8(38.1)	0.673
[31, 40]		39(55.71)	19(51.4)	10(55.6)	10(66.7)		26(53.1)	13(61.9)	
Educational level	70								
Mandatory or less		26(37.14)	13(35.5)	8(44.4)	5(33.3)	0.495	19(38.8)	7(33.3)	0.284
Secondary		21(30.00)	9(24.3)	7(38.9)	5(33.3)		12(24.5)	9(42.9)	
College/university		23(32.86)	15(40.5)	3(16.7)	5(33.3)		18(36.7)	5(23.8)	
Marital status	70								
Married/Cohabitate		55(78.57)	31(83.8)	11(61.1)	13(86.7)	NA	38(77.6)	17(81.0)	0.751
Single/ Divorced		15(21.43)	6(16.2)	7(38.9)	2(13.3)		11(22.4)	4(19.0)	
Professional status	70								
Employed /Student		58(82.86)	31(83.8)	13(72.2)	14(93.3)	NA	39(79.6)	19(90.5)	0.325
Unemployed		12(17.14)	6(16.2)	5(27.8)	1(6.7)		10(20.4)	2(9.5)	
Monthly Income (€)	64								
<500		18(28.13)	6(17.1)	8(47.1)	4(33.3)	NA	10(21.7)	8(44.4)	0.145
[500 -1250[		27(42.19)	14(40.0)	7(41.2)	6(50.0)		20(43.5)	7(38.9)	
≥1250		19(29.68)	15(42.9)	2(11.8)	2(16.7)		16(34.8)	3(16.7)	
Pre-pregnancy BMI	70								
Non-overweight		37(52.86)	18(48.6)	9(50)	10(66.7)	0.480	24(49.0)	13(69.9)	0.434
Overweight/Obese		33(47.14)	19(59.4)	9(50)	5(33.3)		25(51.0)	8(38.1)	

Results expressed as number (%); BMI – body mass index; NA - not applicable.
[1] Analysis by χ^2 test between groups.

Table 2 - Maternal obstetric and lifestyle factors according to ACSM recommendations and Activity behaviour.

			ACSM Recommendations				Activity Behavior		
Pregnant	n	Total n(%)	Inactive n(%)	Inconsistently active n(%)	Active n(%)	$p^{1,2}$	Negative n(%)	Positive n(%)	$p^{1,3}$
Weight Gain	69								
Undergainer		10(14.49)	4(11.1)	2(11.1)	4(26.7)	0.647	6(12.5)	4(19.0)	0.391
Appropriate gain		28(40.58)	14(44.4)	7(38.9)	5(33.3)		22(45.8)	6(28.6)	
Over gain		31(44.93)	16(44.4)	9(50.0)	6(40.0)		20(41.7)	11(52.4)	
Parity	70								
Primigest		39(55.71)	23(62.2)	11(61.1)	5(33.3)	0.144	29(59.2)	10(47.6)	0.436
Multigest		31(44.29)	14(37.8)	7(38.9)	10(66.7)		20(40.8	11(52.4)	
Previous abortion	64								
Yes		9(14.06)	7(20.6)	2(12.5)	0(0.00)	NA	9(20.0)	0(0.00)	0.048
No		55(85.93)	27(79.4)	14(87.5)	14(100)		36(80.0)	19(100)	
Smoke before pregnancy	70								
Yes		13(18.57)	8(21.6)	2(11.1)	3(20.0)	NA	9(18.4)	4(19.0)	0.947
No		57(81.43)	29(78.4)	16(88.9)	12(80.0)		40(81.6)	17(81.0)	
Smoke*	70								
Yes		8(11.43)	6(16.2)	1(5.6)	1(6.7)	NA	7(14.3)	1(4.8)	0.420
No		62(88.57)	31(83.8)	17(94.4)	14(93.3)		42(85.7)	20(95.2)	
Alcohol intake*	69								
Yes		1(1.45)	1(2.7)	0(0.00)	0(0.00)	NA	1(2.00)	0(0.00)	NA
No		68(98.55)	36(97.3)	17(100)	15(100)		48(98.0)	20(100)	
Coffee intake*	70								
Yes		32(45.71)	16(43.2)	9(50.0)	7(46.7)	0.891	23(46.9)	9(42.9)	0.799
No		38(54.29)	21(56.8)	9(50.0)	8(53.3)		26(53.1)	12(57.1)	
Anxiety*	68								
Yes		7(10.29)	4(11.1)	2(11.1)	1(7.1)	NA	5(10.4)	2(10.0)	NA
No		61(89.71)	32(88.9)	16(88.9)	13(92.9)		43(89.6)	18(90.0)	
Exercise before pregnancy	70								
Yes		19(27.14)	10(27)	4(22.2)	5(33.3)	NA	13(26.5)	6(28.6)	0.860
No		51(72.86)	27(73)	14(77.8)	10(66.7)		36(73.5)	15(71.4)	
Energy intake (kcal/day) [a]	70	1547±628.0	1577.8±694.3	1337.7±505.6	1720.2±575 .4	0.236	1503.4±663.4	1641.2±548.7	0.434

Results expressed as number (%); BMI – body mass index; NA - not applicable.
* Data sample at baseline.
[a] Data are mean ±standard deviation

Fifty-three percent of women were inactive, 25.71% were inconsistently active and 21.42% were active. The majority (70%) of the sample demonstrated negative behavior (data not shown).

Fifty-one percent (n=36) of newborns were female, and 48.57% (n=34) were male. In the 1st minute, four newborns received an Apgar score of <7. Three of the mothers of these babies were inactive, and the other mother was inconsistently active. In the 5th minute, the Apgar score was ≥8 for all babies. The majority (94.3%) of newborns were of normal weight; 1.42% were borderline low birth weight (2475g - the offspring of one active mother), and 4.3% had macrosomia (the offspring of two inactive mothers and one active mother). All macrosomic newborns experienced 40 weeks of gestation.

Table 3 shows that there were no significant differences in neonatal outcomes at birth when comparing adherence to ACSM physical activity recommendations and the overall activity levels of the mothers ($p>0.05$ for all). Despite the majority of newborns being of adequate birth weight, there were no statistically significant differences in the birth weights of babies born to active and inactive mothers ($p<0.05$).

Table 3 - Relationship of neonatal parameters at birth according to the recommended levels of physical activity of ACSM recommendations and Activity behaviour (n=70).

	ACSM				Activity Behavior		
	Inactive n=37	Inconsistently active n=18	Active n=15	*p*	Negative n=49	Positive n=21	*p*
Birth weight (grams)[a]	3304±423	3177±278	3218±532	0.539 [b]	3277±392	3196±473	0.458 [e]
Birth weight Z-score [a]	0.143±0.949	-0.048±0.887	-0.088±1.145	0.669 [b]	0.163±0.905	-0.024±1.090	0.458 [e]
Birth weight Z-score adjusted for gestational age [a]	0.226±0.977	-0.067±0.641	0.027±1.227	0.539 [b]	0.116±0.914	-0.124±1.096	0.346 [e]
Birth weight Z-score adjusted for gestational age and sex [a]	0.183±1.000	-0.116±0.656	-0.020±1.255	0.539 [b]	0.120±0.926	-0.072±1.116	0.458 [e]
Length (cm) [a]	49.7±1.8	48.9±1.6	49.2±2.4	0.317 [b]	49.6±1.8	49.1±2.3	0.324 [e]
Head circumference (cm) c	34.0(1.5)	34.3(2.0)	35.00(3.4)	0.768 d	34.5(1.9)	34.3(2.9)	0.979 f
Head Z score adjusted for gestational agec	-0.193(0.067)	-0.191(0.053)	-0.193(0.101)	0.771 d	-0.193(0.066)	-0.208(0.065)	0.420 f
Head Z score adjusted for gestational age and sexc	-0.295(0.517)	-0.116(1.288)	-0.286(1.596)	0.216 d	-0.280(0.761)	-0.286(0.778)	0.620 f
Apgar score c							
1º minute	9(0)	9(1)	9(1)	0.512 d	9(0)	9(0)	0.972 f
5º minute	10(0)	10(1)	10(0)	0.329 d	10(0)	10(0)	0.811 f

[a]Data are mean ±standard deviation, [b] analysis by Anova between groups ; [c] data are median (interquartile range)
[d] Analysis by Kruskal-Wallis; [e] analysis by student's t-test; [f] analysis by Mann-Whitney's test.

4. Discussion

In this study, the majority of women did not achieve ACSM physical activity targets. Of those who reached these goals during their first trimesters, some abandoned physical activity during their second trimesters, revealing negative behavior.

These findings are in line with previous studies (Evenson & Wen, 2010) showing that there is greater physical activity during the first trimester and a general tendency for physical activity to decrease during pregnancy (Poudevigne & O'Connor, 2006). These authors also conclude that lack of adherence to ACSM physical activity recommendations is mainly due to lack of awareness about the benefits of physical activity during pregnancy (Evenson & Wen, 2010; Hegaard et al., 2011). Consequently, this study explored the socio-demographic characteristics and lifestyle factors that might have been related to the lack of physical activity in a sample of pregnant women, thereby enabling the identification of risk groups. The results showed no significant association between the variables studied (age, educational level, marital status, professional status, monthly income, pre-pregnancy BMI, weight gain, parity, previous miscarriage, smoking, alcohol consumption, coffee intake, anxiety, playing of sports before pregnancy and energy intake).

Previous literature on the socio-demographic characteristics and lifestyle factors associated with physical activity during pregnancy has shown inconsistent findings. According to Camões et al.'s (2008) study of Portuguese pregnant women, there is a relationship between socio-demographic and behavioral factors and adherence to physical activity. The authors reported a greater predisposition to physical activity on the parts of women who were single (not married or with a partner) and had higher monthly incomes and higher educational levels, in contrast to women who had high BMIs, were smokers and were more predisposed to inactivity. Likewise, Fell et al. (2009) and Hegaard et al. (2011) found that, in addition to the factors mentioned above, nulliparousness put younger woman who did not exercise before pregnancy at higher risk of being less active during pregnancy. On the other hand, the findings of some studies have been in line with the results of the present study, reporting no significant associations between physical activity and age (Chasan-Taber et al., 2007b; Mottola & Campbell, 2003; Watson & McDonald, 2007), education level (Chasan-Taber et al., 2007b; Clarke & Gross, 2004), BMI (Ning et al., 2003; Watson & McDonald, 2007), marital status (Fell et al., 2009; Mottola & Campbell, 2003; Mudd et al., 2009), parity (Chasan-Taber et al., 2007b; Petersen et al., 2005) and professional status (Fell et al., 2009; Pereira et al., 2007).

The results of the present study also showed no significant differences in the neonatal outcomes (weight, length, head circumference and Apgar score) of the newborns of inactive, inconsistently active and active mothers. Despite the majority of newborns being of adequate birth weight, there were no statistically significant differences in this variable between the newborns of active and inactive mothers. However, the results showed that when we adjusted birth weight for gestational age and sex, there was a tendency, although not significant, for the

newborns of inactive women to be heavier than the newborns of active women. Along these lines, Lubchenco et al. (1966) noted small but significant differences in the birth weights of boys and girls between 38 and 41 weeks. Thomas (2000) also found that girls, on average, were 95g lighter and 0.6cm shorter and had 0.6cm smaller head circumference.

In agreement with the results of this study, Melzer et al. (2010a) found no relationship between recommended levels of physical activity and birth weight and Apgar score. Juhl et al. (2010), also found no association between leisure physical activity and outcomes such as weight, length and head circumference at birth. Similarly, Barakat et al. (2009a) found no effects of physical activity performed during the second and third trimesters on the weight, length and Apgar score of newborns.

Nevertheless, other studies have reported a significant relationship between physical activity in pregnancy and neonatal outcomes. One, conducted by Clapp et al. (2000), reported mainly on the effects of PA on weight, length and head circumference at birth. However, this was an experimental study in which the experimental group took part in a low- to moderate-intensity exercise program. Perkins et al. (2007), also found a relationship between birth weight and physical activity, but only in association with elevated maternal height. Systematic reviews, which have included some of the studies mentioned so far, have concluded that there is no consensus in the literature on the association between physical activity and neonatal outcomes at birth (Schlussel et al., 2008; Takito et al., 2009).

Since pregnancy is itself a motivation to adopt a healthy lifestyles - according to Edvardsson et al. (2011), women are very receptive to changing their routines when doing so directly benefits their babies, being less interested in adopting behaviors that promote their own health – it is essential to explore, by conducting new studies, the role of physical activity in neo-natal health, in order to encourage women to comply with physical activity recommendations during pregnancy, since following such recommendations during a normal, healthy pregnancy does not seem to harm either the mother or the newborn.

This study has some limitations that we should highlight, such as the fact that it did not analyze the degree of influence of confounding variables, such as demographic and socio-economic factors, as well as lifestyle habits, that could influence neonatal outcomes at birth. While it was important to assess the influence of these variables by conducting a logistical regression, the fact that our sample of neonates was very similar did not allow the formation of groups. Despite this, we did not observe relevant differences between the groups (inactive, inconsistently active and active) whose characteristics we analyzed. In addition, (i) maternal physical activity was measured only during the first two trimesters, which may have influenced the results of this study, and (ii) since changes in physical activity during the third trimester might have interfered with our results, it could be concluded that there were no differences in the second and third trimester (Poudevigne & O'Connor, 2005). Moreover, the sample size in this study did not allow more robust statistical analysis, which could have provided a more detailed explanation of the data, as well as allowed for generalization about the general

population. However, our results showed a tendency for the newborns of inactive women to be heavier than the newborns of active women. This trend is clinically relevant, suggesting a potential link between maternal exercise and the developmental origins of obesity, such that a small reduction in birth weight in the upper normal range or in large for gestational age offspring could reduce these newborns' overall risk of developing childhood obesity (Hopkins & Cutfield, 2011).

It is important to compare neonatal outcomes at birth with curves adjusted for gestational age and sex; however, such curves do not exist for the Portuguese population. Growth curves have been described by Fenton (2003), Kramer et al. (2001) and Olsen et al. (2010). With the exception of Olsen's curves, which take into account gestational age and sex to evaluate some neonatal outcomes (weight, height and head circumference), all the other growth curves are only adjusted for gestational age, not for sex. Hence, the latter are more suitable for the analysis of premature terms (< 37 weeks). We could not apply any of the growth curves currently documented in the literature to our sample, because we only studied newborns (>37 weeks). In addition, the Olsen curves were validated for use with the American population, which is contemporary, large, and racially diverse, and the differences between the American and Portuguese populations might have introduced bias (Olsen et al., 2010).

Our study was strengthened by (i) its prospective design, being one of the few studies to analyze women and their physical activity throughout pregnancy, and (ii) by its assessment of physical activity via accelerometry, which is an objective method, more effective and precise than self-perception questionnaires (Troiano, 2009). It should also be emphasized that physical activity levels were measured during the course of women's daily lives and without the imposition of a physical exercise protocol, which is an asset when the focus is health promotion in the general community. To our knowledge, this is the first study to analyze objectively the physical activity levels of a sample of Portuguese pregnant women.

5. Conclusions

More than half of the women in this study did not adhere to ACSM physical activity recommendations. No significant associations between socio-demographic and lifestyle variables and physical activity during pregnancy were observed. Furthermore, in our study, there were no significant associations between neonatal outcomes at birth and physical activity during pregnancy. Healthy pregnant women should be encouraged to follow physical activity recommendations during pregnancy, given that no significant differences in neonatal outcomes were found between those who met such recommendations and those who did not.

6. Acknowledgements

This research is funded by Fundação para a Ciência e Tecnologia (FCT) Grants nos. BD/45375/2008; PROTEC SFRH/BD/50002/2009; PTDC/DES/116586/2010; BD/44422/2008; PTDC/DES/098309/2008; BPD/65180/2009; SAB/1025/2010 and OE/SAU/UI0617/2011.

We greatly appreciate the cooperation health professionals for valuable support during data collection and all the pregnant women who agreed to voluntarily participate in this study.

The authors of this paper reported no financial conflict of interest.

7. References

ACOG. (2002). ACOG committee opinion. Exercise during pregnancy and the postpartum period. Number 267, January 2002. American College of Obstetricians and Gynecologists. *Int J Gynaecol Obstet, 77*(1), 79-81.

ACOG Committee Opinion. Number 333, May 2006 (replaces No. 174, July 1996): The Apgar score. (2006) *Obstet Gynecol* (Vol. 107, pp. 1209-1212). United States.

ACSM. (2006). ACSM's Guidlines for exercise testing and prescription.

Artal, R., & O'Toole, M. (2003). Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med, 37*(1), 6-12; discussion 12.

Barakat, R., Lucia, A., & Ruiz, J. R. (2009). Resistance exercise training during pregnancy and newborn's birth size: a randomised controlled trial *Int J Obes (Lond)* (Vol. 33, pp. 1048-1057). England.

Bell, R. (2008). Trends in birthweight in the north of England *Hum Fertil (Camb)* (Vol. 11, pp. 1-8). England.

Camões, M., & Lopes, C. (2008). [Factors associated with physical activity in the Portuguese population] *Rev Saude Publica* (Vol. 42, pp. 208-216). Brazil.

Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Manson, J., & Markenson, G. (2007). Correlates of physical activity in pregnancy among Latina women. *Matern Child Health J, 11*(4), 353-363. doi: 10.1007/s10995-007-0201-8.

Chasan-Taber, L., Schmidt, M. D., Roberts, D. E., Hosmer, D., Markenson, G., & Freedson, P. S. (2004). Development and validation of a Pregnancy Physical Activity Questionnaire. *Med Sci Sports Exerc, 36*(10), 1750-1760.

Clapp, J. F., 3rd, Kim, H., Burciu, B., & Lopez, B. (2000). Beginning regular exercise in early pregnancy: effect on fetoplacental growth *Am J Obstet Gynecol* (Vol. 183, pp. 1484-1488). United States.

Clarke, P. E., & Gross, H. (2004). Women's behaviour, beliefs and information sources about physical exercise in pregnancy *Midwifery* (Vol. 20, pp. 133-141). Scotland.

Clayton, P. C., S.; Czernichow, P.; Johannsson, G.; Rapaport, R.; Rogol, A. (2007). Management of the child born small for gestational age through to adulthood: a consensus statement of the International Societies of Pediatric Endocrinology and the Growth Hormone Research Society. *J Clin Endocrinol Metab, 92*(3), 804-810.

Davies, G. A., Wolfe, L. A., Mottola, M. F., & MacKinnon, C. (2003). Joint SOGC/CSEP clinical practice guideline: exercise in pregnancy and the postpartum period. *Can J Appl Physiol, 28*(3), 330-341.

Edvardsson, K., Ivarsson, A., Eurenius, E., Garvare, R., Nystrom, M. E., Small, R., & Mogren, I. (2011). Giving offspring a healthy start: parents' experiences of health promotion and lifestyle change during pregnancy and early parenthood *BMC Public Health* (Vol. 11, pp. 936). England.

Elshibly, E. M., & Schmalisch, G. (2008). The effect of maternal anthropometric characteristics and social factors on gestational age and birth weight in Sudanese newborn infants *BMC Public Health* (Vol. 8, pp. 244). England.

Evenson, K. R., & Wen, F. (2010). National trends in self-reported physical activity and sedentary behaviors among pregnant women: NHANES 1999-2006. *Prev Med, 50*(3), 123-128. doi: S0091-7435(09)00649-5.

Faden, V. B., Hanna, E., & Graubard, B. I. (1997). The effect of positive and negative health behavior during gestation on pregnancy outcome *J Subst Abuse* (Vol. 9, pp. 63-76). United States.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. (2009). Statistical power analyses using G*Power 3.1:Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149-1160. doi: doi:10.3758/BRM.41.4.1149.

Fell, D. B., Joseph, K. S., Armson, B. A., & Dodds, L. (2009). The impact of pregnancy on physical activity level. *Matern Child Health J, 13*(5), 597-603. doi: 10.1007/s10995-008-0404-7.

Fenton, T. R. (2003). A new growth chart for preterm babies: Babson and Benda's chart updated with recent data and a new format *BMC Pediatr* (Vol. 3, pp. 13). England.

Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc, 30*(5), 777-781.

Gaston, A., & Cramp, A. (2011). Exercise during pregnancy: a review of patterns and determinants *J Sci Med Sport* (Vol. 14, pp. 299-305). Australia.

Hegaard, H. K., Damm, P., Hedegaard, M., Henriksen, T. B., Ottesen, B., Dykes, A. K., & Kjaergaard, H. (2011). Sports and leisure time physical activity during pregnancy in nulliparous women. *Matern Child Health J, 15*(6), 806-813. doi: 10.1007/s10995-010-0647-y.

Heiskanen, N., Raatikainen, K., & Heinonen, S. (2006). Fetal macrosomia--a continuing obstetric challenge *Biol Neonate* (Vol. 90, pp. 98-103). Switzerland.

Henriksen, T. (2008). The macrosomic fetus: a challenge in current obstetrics *Acta Obstet Gynecol Scand* (Vol. 87, pp. 134-145). Denmark.

Hopkins, S. A., Baldi, J. C., Cutfield, W. S., McCowan, L., & Hofman, P. L. (2011). Effects of exercise training on maternal hormonal changes in pregnancy. [Randomized Controlled Trial]. *Clin Endocrinol (Oxf), 74*(4), 495-500. doi: 10.1111/j.1365-2265.2010.03964.x.

Hopkins, S. A., & Cutfield, W. S. (2011). Exercise in pregnancy: weighing up the long-term impact on the next generation. *Exerc Sport Sci Rev, 39*(3), 120-127. doi: 10.1097/JES.0b013e31821a5527.

IOM. (2009). Weight gain during pregnancy *Reexamining the guidelines*: Institute of Medicine and National Research Council.

Juhl, M., Olsen, J., Andersen, P. K., Nohr, E. A., & Andersen, A. M. (2010). Physical exercise during pregnancy and fetal growth measures: a study within the Danish National Birth Cohort *Am J Obstet Gynecol* (Vol. 202, pp. 63 e61-68). United States.

Kramer, M. S., McLean, F. H., Boyd, M. E., & Usher, R. H. (1988). The validity of gestational age estimation by menstrual dating in term, preterm, and postterm gestations. *JAMA, 260*(22), 3306-3308.

Kramer, M. S., Platt, R. W., Wen, S. W., Joseph, K. S., Allen, A., Abrahamowicz, M., Fetal/Infant Health Study Group of the Canadian Perinatal Surveillance, S. (2001). A new and improved population-based Canadian reference for birth weight for gestational age. *Pediatrics, 108*(2), E35.

Lubchenco, L. O., Hansman, C., & Boyd, E. (1966). Intrauterine growth in length and head circumference as estimated from live births at gestational ages from 26 to 42 weeks. *Pediatrics, 37*(3), 403-408.

Lumbers, E. R. (2002). Exercise in pregnancy: physiological basis of exercise prescription for the pregnant woman. *J Sci Med Sport, 5*(1), 20-31.

Maddison, R., Jiang, Y., Hoorn, S. V., Mhurchu, C. N., Lawes, C. M., Rodgers, A., & Rush, E. (2009). Estimating energy expenditure with the RT3 triaxial accelerometer. *Res Q Exerc Sport, 80*(2), 249-256.

Matthews, C. E., Hagstromer, M., Pober, D. M., & Bowles, H. R. (2012). Best practices for using physical activity monitors in population-based research *Med Sci Sports Exerc* (Vol. 44, pp. S68-76). United States.

Melzer, K., Schutz, Y., Boulvain, M., & Kayser, B. (2010). Physical activity and pregnancy: cardiovascular adaptations, recommendations and pregnancy outcomes. *Sports Med, 40*(6), 493-507. doi: 10.2165/11532290-000000000-00000.

Mottola, M. F., & Campbell, M. K. (2003). Activity patterns during pregnancy. *Can J Appl Physiol, 28*(4), 642-653.

Mudd, L. M., Nechuta, S., Pivarnik, J. M., & Paneth, N. (2009). Factors associated with women's perceptions of physical activity safety during pregnancy *Prev Med* (Vol. 49, pp. 194-199). United States.

Ning, Y., Williams, M. A., Dempsey, J. C., Sorensen, T. K., Frederick, I. O., & Luthy, D. A. (2003). Correlates of recreational physical activity in early pregnancy. *J Matern Fetal Neonatal Med, 13*(6), 385-393. doi: 10.1080/jmf.13.6.385.393.

Olsen, I. E., Groveman, S. A., Lawson, M. L., Clark, R. H., & Zemel, B. S. (2010). New intrauterine growth curves based on United States data *Pediatrics* (Vol. 125, pp. e214-224). United States.

Osler, M., Lund, R., Kriegbaum, M., & Andersen, A. M. (2009). The influence of birth weight and body mass in early adulthood on early coronary heart disease risk among Danish men born in 1953. *Eur J Epidemiol, 24*(1), 57-61. doi: 10.1007/s10654-008-9301-z.

Ota, E., Haruna, M., Yanai, H., Suzuki, M., Anh, D. D., Matsuzaki, M., Murashima, S. (2008). Reliability and validity of the Vietnamese version of the Pregnancy Physical Activity Questionnaire (PPAQ). *Southeast Asian J Trop Med Public Health, 39*(3), 562-570.

Pereira, M. A., Rifas-Shiman, S. L., Kleinman, K. P., Rich-Edwards, J. W., Peterson, K. E., & Gillman, M. W. (2007). Predictors of change in physical activity during and after pregnancy: Project Viva *Am J Prev Med* (Vol. 32, pp. 312-319). Netherlands.

Perkins, C. C., Pivarnik, J. M., Paneth, N., & Stein, A. D. (2007). Physical activity and fetal growth during pregnancy *Obstet Gynecol* (Vol. 109, pp. 81-87). United States.

Petersen, A., Leet, T., & Brownson, R. (2005). Correlates of exercise among pregnant women in the United States. *Med Sci Sport Exer* (37), 1748 - 1753.

Pinto, E., Severo, M., Correia, S., Silva, I. d. S., Lopes, C., & Barros, H. (2010). Validity and reproducibility of a semi-quantitative food frequency questionnaire for use among Portuguese pregnant women. *Matern Child Nutr, 6*(2), 105-119.

Ponciano, E. S., AV.; Relvas, J. (1982). Aferição da escala de auto-avaliação de ansiedade, de Zung, numa amostra de população portuguesa I : resultados da aplicação numa amostra de população normal. *Psiquiatria Clínica, 3*(4), 191-202.

Poudevigne, M. S., & O'Connor, P. J. (2005). Physical activity and mood during pregnancy. *Med Sci Sports Exerc, 37*(8), 1374-1380. doi: 00005768-200508000-00017.

Poudevigne, M. S., & O'Connor, P. J. (2006). A review of physical activity patterns in pregnant women and their relationship to psychological health. *Sports Med, 36*(1), 19-38. doi: 3613.

Schlussel, M. M., Souza, E. B., Reichenheim, M. E., & Kac, G. (2008). Physical activity during pregnancy and maternal-child health outcomes: a systematic literature review. *Cad Saude Publica, 24 Suppl 4*, s531-544.

Takito, M. Y., Benicio, M. H., & Neri Lde, C. (2009). Physical activity by pregnant women and outcomes for newborns: a systematic review. [Review]. *Rev Saude Publica, 43*(6), 1059-1069.

Thomas, P., Peabody, J., Turnier, V., & Clark, R. (2000). A new look at intrauterine growth and the impact of race, altitude, and gender. *Pediatrics, 106*(2).

Troiano, R. P. (2009). Can there be a single best measure of reported physical activity? *Am J Clin Nutr, 89*(3), 736-737. doi: ajcn.2008.27461.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc, 40*(1), 181-188. doi: 10.1249/mss.0b013e31815a51b3.

Ward, D. S., Evenson, K. R., Vaughn, A., Rodgers, A. B., & Troiano, R. P. (2005). Accelerometer use in physical activity: best practices and research recommendations. *Med Sci Sports Exerc, 37*(11 Suppl), S582-588. doi: 00005768-200511001-00011.

Watson, P. E., & McDonald, B. W. (2007). Activity levels in pregnant New Zealand women: relationship with socioeconomic factors, well-being, anthropometric measures, and birth outcome. *Appl Physiol Nutr Metab, 32*(4), 733-742. doi: 10.1139/H07-061.

Weissgerber, T. L., Wolfe, L. A., Davies, G. A., & Mottola, M. F. (2006). Exercise in the prevention and treatment of maternal-fetal disease: a review of the literature. *Appl Physiol Nutr Metab, 31*(6), 661-674. doi: 10.1139/h06-060.

Zhang, X., Decker, A., Platt, R. W., & Kramer, M. S. (2008). How big is too big? The perinatal consequences of fetal macrosomia *Am J Obstet Gynecol* (Vol. 198, pp. 517 e511-516). United States.

Zung, W. W. (1971). A rating instrument for anxiety disorders *Psychosomatics* (Vol. 12, pp. 371-379). United States.

DISCUSSÃO

Discussão geral/ Reflexão crítica

A metodologia e os resultados inerentes a cada estudo foram discutidos isoladamente em cada artigo. Apresentamos uma reflexão crítica global sobre as opções metodológicas, bem como dos principais resultados.

Discussão da metodologia

Apesar de termos duas amostras independentes, uma da ULSAM e uma do HSJ, ambas são de base comunitária, e referentes a mulheres saudáveis, tendo sido utilizados critérios de inclusão e exclusão semelhantes nas duas amostras.

Verificamos ainda que relativamente às características sociodemográficas (idade, paridade, estado civil, habilitações literárias, e rendimento mensal) não se verificaram diferenças estatisticamente significativas entre as duas amostras, contudo constatamos uma maior tendência para termos mulheres mais jovens, com menor frequência de excesso de peso ou obesidade e multíparas na amostra da ULSAM.

A tipologia de estudo também é comum aos dois estudos - estudo longitudinal prospetivo.

Os momentos de avaliação diferem ligeiramente nos dois estudos. Na ULSAM os momentos são referentes a trimestres de gravidez, no HSJ recolhemos os dados em semanas específicas não diferindo mais de 2 semanas em cada trimestre. Este método permite maior homogeneidade entre as mulheres, uma vez que na gravidez ocorrem rápidas alterações ao longo dos trimestres(Gaston & Cramp, 2011; Haas *et al*., 2004).

Relativamente à avaliação da AF, aplicamos o questionário PPAQ no estudo da ULSAM e o acelerómetro no HSJ. Apesar do PPAQ medir a percepção da AF e o acelerómetro mensurar de forma objectiva a AF, ambos estão correlacionados. A validação do PPAQ foi feita com acelerómetria por Chasan-Taber *et al.* (2004). Neste estudo concluiu-se que o PPAQ é um instrumento

fiável e razoavelmente válido para mensurar AF na gravidez, o que nos permite ter alguma confiança de que a percepção da AF das grávidas nos dá uma estimativa da AF real.

Contudo quer os questionários quer os acelerómetros podem ser limitados na mensuração de níveis baixos de AF, especialmente durante o terceiro trimestre. No estudo de Rousham *et al.* (2006), em que se comparam os níveis de AF auto reportados com os obtidos por acelerómetria ao longo da gravidez, verificou-se que a correlação entre as duas medidas diminuía ao longo da gestação (valor de r variando entre 0.55 e 0.08); a correlação dos acelerómetros com dados auto reportados diminuiu de 90% às 12 semanas, para 47% às 34 semanas (P <0.01). No entanto, no estudo do HSJ não usamos acelerómetro no 3º trimestre e os dados do 2º trimestre foram recolhidos entre as 20-22 semanas. No que concerne à análise dos acelerómetros foram utilizados pontos de corte da Freedsson *et al.* (1998) estabelecidos para adultos, pelo facto de não existirem pontos de corte específicos para a população de grávidas.

O nosso estudo tem como ponto positivo o facto de ser um estudo longitudinal prospectivo. Foram avaliadas as principais dimensões da AF e quantificados os níveis de AF das mulheres grávidas em contexto real. O declínio da atividade encontrado no nosso estudo é improvável que seja atribuível a alterações sazonais, uma vez que os dois trabalhos de campo tiveram a duração superior a um ano.

Os resultados do primeiro trabalho de campo (artigo 1 e 2) estão sujeitos a algumas limitações. Em primeiro lugar, os dados auto reportados podem estar sujeitos a viesses de memória e preconceitos, tais como a desejabilidade social (Ford et al., 1997). No entanto, eles fornecem informações detalhadas sobre o tipo e duração de atividades específicas. Em segundo lugar, os valores atribuídos em MET para cada atividade não eram específicas para as mulheres grávidas, mas sim padronizado para adultos.

Estas limitações foram colmatadas no segundo trabalho de campo, uma vez que usamos medidas objectivas (acelerómetros) e planeamos a recolha de dados para um momento específico do trimestre, de modo a que todas as mulheres fossem avaliadas no máximo com duas semanas de diferença.

A mensuração da AF por acelerómetria pode ter também limitações. Para além dos pontos de corte referidos anteriormente, as mudanças físicas durante a gravidez podem influenciar a recolha de dados (DiNallo et al., 2012). O aumento do perímetro abdominal pode alterar o local de colocação do monitor, bem como, existir uma predisposição para a sua inclinação especialmente no 3º trimestre, contudo no nosso estudo apenas avaliamos os dois primeiros trimestres (DiNallo *et al*., 2012).

Discussão de resultados

A comparação e discussão dos nossos resultados com os estudos anteriores é dificultada pela diversidade de instrumentos de medida usados para mensurar a AF, bem como, pela definição de conceito e classificação de grupos " activo *vs* não ativo"; "sedentário *vs* ativo"; "cumprir *vs* não cumprir as recomendações."

Nesta tese, apesar de termos duas amostras independentes, vamos fazer uma discussão geral relacionando os principais resultados.

Os nossos resultados indicam uma diminuição nos níveis totais de AF no decorrer da gravidez, tal como já descrito por alguns autores (Borodulin et al., 2009; Borodulin et al., 2008; Clarke et al., 2005). A AF auto reportada, de intensidade moderada e leve é aquela que mais decresce ao longo da gravidez, especialmente do 1º para o 2º trimestre.

A mesma tendência, se verificou relativamente ao cumprimento das recomendações da AF segundo CDC, ACSM e USDHHS avaliada por acelerómetria, contudo não se registaram diferenças estatisticamente significativas. Estes resultados são corroborados por vários autores (Borodulin et al., 2008; Fell et al., 2009; Rousham et al., 2006).

Apesar da tendência ser semelhante em todas as recomendações, verificamos uma grande variação percentual relativamente ao cumprimento das mesmas, o que reflete um grau de exigência diferente entre elas. Sendo as da ACOG as mais restritivas com apenas 4% das mulheres a cumprirem as recomendações, e as da USDHHS as mais permissivas (68%). As grandes diferenças devem-se essencialmente ao tipo, frequência e intensidade da AF.

Estes resultados reflectem o padrão relativo ao exercício físico estruturado e à AF das mulheres não grávidas portuguesas. Camões (2008) refere que mais de 90% das mulheres entre os 20 e os 49 anos não fazem exercício estruturado regularmente. Tendais *et al*. (2011) verificou numa amostra de mulheres em idade fértil que 47% delas antes de engravidar apresentavam níveis suficientes de AF segundo as recomendações da ACSM. No nosso estudo, de acordo com as referidas recomendações, apenas 40.9% das gestantes no 1º trimestre e 31.7% no 2º as cumprem.

Apesar das recomendações, a percepção das mulheres relativamente ao aconselhamento por parte dos profissionais de saúde para a prática de AF moderada é ainda insuficiente. Cerca de um terço das mulheres, referem que os profissionais de saúde não recomendaram a prática de AF moderada, especialmente no 1º e 3º trimestre.

Verificamos ainda que os tipos de AF que mais contribuem para os gastos energéticos das mulheres grávidas são a atividade ocupacional, e as atividades domésticas e cuidar da família, sendo estas as atividades onde as mulheres despendem mais tempo semanalmente. O mesmo é referido por outros autores, pois mencionam que apesar da igualdade de género, as mulheres podem despender de 30 minutos a 6 horas por dia em tarefas domésticas e de cuidado com a família (Ainsworth et al., 1999) e de 4 a 16 horas por dia em actividade laboral (Ainsworth, 2000).

No nosso estudo, apenas na AF ocupacional e doméstica se verificou um decréscimo do 1º para o 2ºtrimestre, da mesma forma alguns estudos referem que a AF ocupacional decresce (Borodulin et al., 2009; Fell et al., 2009).

Relativamente à AF doméstica os mesmos autores corroboram os nossos resultados (Borodulin et al., 2009; Borodulin et al., 2008; Fell et al., 2009), contrariamente outros referem que se mantem constante(Chasan-Taber et al., 2007a; Clarke et al., 2005).

Os gastos energéticos nas AF de lazer e transporte mantiveram-se semelhantes ao longo dos três trimestres. Contudo, alguns autores referem um declínio na AF de lazer (Borodulin et al., 2008) e transporte (Borodulin et al., 2009; Fell et al., 2009).

As mulheres dedicam pouco tempo à AF de lazer e o tempo despendido nesta atividade é realizado essencialmente em tarefas sedentárias (ex: ver televisão), o mesmo se verifica noutros estudos (Borodulin et al., 2009; Borodulin et al., 2008; Clarke et al., 2005; Evenson & Wen, 2010).

Ao refletirmos nestes dados compreendemos o papel das barreiras interpessoais para a falta de AF, sendo que a falta de tempo, foi a mais referida pelas grávidas para a realização de AF de lazer associada ao exercício. Apesar de existirem poucos estudos relativos a esta temática, a barreira falta de tempo foi também a mais referida (32%) no estudo de Rutkowska *et al.*(2002). As recomendações da AF mais actuais tiveram em consideração esta barreira, uma vez que contemplam a AF moderada nas actividades da vida diária e não exclusivamente no exercício físico estruturado. De facto, a baixa frequência de exercício físico estruturado é referida por vários autores (Clarke *et al.*, 2005; Hegaard, 2008; Poudevigne & O'Connor, 2006).

Apesar da falta de tempo e da não inclusão de exercício físico estruturado no estilo de vida das mulheres, verificamos que no 3º trimestre de gravidez quando se criam condições e existe aconselhamento por parte dos profissionais de saúde, estas frequentam aulas de preparação para a parentalidade. Contudo as barreiras ambientais (falta de acessibilidade e instalações) e políticas (organização e custos) foram pouco referidas, tal como noutros estudos (Clarke & Gross, 2004; Evenson et al., 2009). As barreiras interpessoais, relacionadas com a saúde, mais referidas foram a dor lombar e a

dor pélvica (aproximadamente 10%). Contudo face à elevada prevalência de período da dor lombar não especificada encontrada no nosso estudo (76.3%), estávamos à espera que estas barreiras fossem mais mencionadas. Provavelmente as mulheres consideram este desconforto inerente à sua condição. Estes resultados confirmam os encontrados noutros estudos (Duncombe et al., 2009; Evenson et al., 2009; Haakstad et al., 2009; Rutkowska & Lepecka-Klusek, 2002).

No presente estudo a dor lombar não especificada, apesar de frequente, não está associada à prática de AF. Mulheres com estilos de vida sedentários aumentam os riscos de dores lombares, em comparação com as mulheres que se dedicam a estilos de vida mais ativos. No entanto, as mulheres que têm ocupações descritas como "mais ativos" e "exigente fisicamente" também têm maiores riscos de desenvolver dor lombar durante a gravidez, o que sugere que os extremos de atividade provavelmente são factores de risco (Sabino & Grauer, 2008). No entanto, a investigação não é consensual, pois autores referem que a AF de lazer associada ao exercício físico organizado tem um efeito protector da dor lombar (Mogren & Pohjanen, 2005).

No que concerne aos parâmetros fetais, o cumprimento das recomendações da AF durante a gravidez não tem associação com o peso, índice de *apgar*, perímetro cefálico e comprimento à nascença. No entanto, os resultados mostraram que, quando ajustamos o peso para a idade gestacional e sexo, verificamos uma tendência, embora não significativa, para os recém-nascidos de mulheres inativas (não cumprem as recomendações da ACSM) serem mais pesados do que os recém-nascidos de mulheres activas. Resultados semelhantes foram observados por outros autores (Barakat et al., 2009a; Juhl et al., 2010; Melzer et al., 2010b), estes resultados apesar de não serem estatisticamente significativos poderão ter relevância clinica. Hopkins *et al.* (2011) refere que uma pequena redução no peso ao nascimento dentro do peso adequado pode reduzir o risco de desenvolvimento da obesidade infantil. Além deste resultado, o nosso estudo vem reforçar que a AF na gravidez não tem efeito negativo nos *outcomes* do recém-nascido.

CONCLUSÃO

Conclusões

Os resultados obtidos neste trabalho permitem-nos tirar as seguintes conclusões:

Uma elevada percentagem de mulheres não cumpre as recomendações de AF durante a gravidez; no entanto as mulheres que cumprem fazem-no essencialmente à custa das actividades da vida diária;

o nível de AF decresce do 1º para o 2º trimestre especialmente na AF Total, baixa e moderada;

a AF doméstica e ocupacional são os tipos de actividade que mais contribuem para o cumprimento das recomendações;

existe ainda uma grande percentagem de profissionais de saúde que não recomenda a prática AF moderada durante a gravidez;

a lombalgia afecta a maioria das mulheres durante a gravidez; a AF não tem influência na lombalgia gravídica;

a principal barreira referidas pelas mulheres para a prática de AF durante a gravidez é a interpessoal, nomeadamente a falta de tempo;

a AF parece não ter efeito negativo nos parâmetros fetais à nascença.

Reflexão/ Recomendações

Este estudo permitiu-nos ter informação sobre os padrões de comportamento relativamente ao tipo e intensidade, bem como ao cumprimento das diferentes recomendações da AF na gravidez; podendo constituir um ponto de partida para a vigilância da saúde materno-infantil. Possibilitou ainda a identificação de barreiras à prática de AF de lazer das mulheres grávidas.

São várias as organizações e instituições reconhecidas (WCPT, ACOG, CDC, ACSM) que recomendam a prática de AF moderada/vigorosa para a população em geral, incluindo o grupo específico das grávidas. A redução da AF moderada na gravidez deve ser visto como um problema de saúde pública, pois uma mudança de comportamento nesta fase poderá condicionar a saúde da mulher, do recém-nascido e de uma comunidade.

Assim os profissionais de saúde devem recomendar a prática de AF moderada durante a gravidez e criar condições para a sua realização. Baseado no modelo de promoção de saúde em que mais que educar é necessário capacitar e *empoderar* as grávidas para que no seu dia-a-dia façam AF moderada de forma a maximizar a sua saúde e a saúde dos recém-nascidos.

Além do exposto, é necessário homogeneizar procedimentos de avaliação bem como instrumentos de avaliação de modo a permitir a comparabilidade de resultados em estudos desenvolvidos em diferentes regiões e países.

Perspetivas para futuras investigações

Avaliar o efeito da AF no desenvolvimento fetal.

Avaliar o efeito da AF ao longo da gravidez na obesidade materna.

Avaliar um programa de promoção da AF na gravidez baseado no modelo cognitivo comportamental, associado a um modelo ecológico.

Desenvolver pontos de corte para acelerómetria para a população específica das grávidas.

REFERÊNCIAS BIBLIOGRÁFICAS

Referências Bibliograficas

ACOG. (1985). *Exercise during pregnancy and postnatal period*. Washington DC: American College of Obstetricians and Gynecologists.

ACOG. (1994). *Women and exercise*. Washington ;DC: American College of Obsttreticians and Gynecologist.

ACOG. (2002). ACOG committee opinion. Exercise during pregnancy and the postpartum period. Number 267, January 2002. American College of Obstetricians and Gynecologists. *Int J Gynaecol Obstet, 77*(1), 79-81.

ACOG Committee Opinion. Number 333, May 2006 (replaces No. 174, July 1996): The Apgar score. (2006). In *Obstet Gynecol* (Vol. 107, pp. 1209-1212). United States.

ACSM. (2006). ACSM's Guidlines for exercise testing and prescription.

Ainsworth, B. E. (2000). Challenges in measuring physical activity in women. *Exerc Sport Sci Rev, 28*(2), 93-96.

Ainsworth, B. E., Haskell, W. L., Whitt, M. C., Irwin, M. L., Swartz, A. M., Strath, S. J., O'Brien, W. L., Bassett, D. R., Jr., Schmitz, K. H., Emplaincourt, P. O., Jacobs, D. R., Jr., & Leon, A. S. (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc, 32*(9 Suppl), S498-504.

Ainsworth, B. E., Irwin, M. L., Addy, C. L., Whitt, M. C., & Stolarczyk, L. M. (1999). Moderate physical activity patterns of minority women: the Cross-Cultural Activity Participation Study. *J Womens Health Gend Based Med, 8*(6), 805-813.

Airaksinen, O., Brox, J. I., Cedraschi, C., Hildebrandt, J., Klaber-Moffett, J., Kovacs, F., Mannion, A. F., Reis, S., Staal, J. B., Ursin, H., & Zanoli, G. (2006). Chapter 4. European guidelines for the management of chronic nonspecific low back pain. *Eur Spine J, 15 Suppl 2*, S192-300.

Aittasalo, M., Pasanen, M., Fogelholm, M., Kinnunen, T. I., Ojala, K., & Luoto, R. (2008). Physical activity counseling in maternity and child health care - a controlled trial. *BMC Womens Health, 8*, 14.

Aittasalo, M., Pasanen, M., Fogelholm, M., & Ojala, K. (2010). Validity and repeatability of a short pregnancy leisure time physical activity questionnaire. *J Phys Act Health, 7*(1), 109-118.

Albert, H., Godskesen, M., Westergaard, J. G., Chard, T., & Gunn, L. (1997). Circulating levels of relaxin are normal in pregnant women with pelvic pain. In *Eur J Obstet Gynecol Reprod Biol* (Vol. 74, pp. 19-22). Ireland.

Althuizen, E., van Poppel, M. N., Seidell, J. C., van der Wijden, C., & van Mechelen, W. (2006). Design of the New Life(style) study: a randomised controlled trial to optimise maternal weight development during pregnancy. [ISRCTN85313483]. In *BMC Public Health* (Vol. 6, pp. 168). England.

Alves, O. M., D. Maciel_Barbosa, A. (2005). Saúde da mulher e da criança: necessidades, comportamentos e atitudes. *Revista Portuguesa de saúde Publica, 23*(1), 69-80.

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). *Med Sci Sports Exerc, 30*(6), 975-991.

Artal, R. (2003). Exercise: the alternative therapeutic intervention for gestational diabetes. *Clin Obstet Gynecol, 46*(2), 479-487.

Artal, R., & O'Toole, M. (2003). Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med, 37*(1), 6-12; discussion 12.

Barakat, R., Lucia, A., & Ruiz, J. R. (2009a). Resistance exercise training during pregnancy and newborn's birth size: a randomised controlled trial. In *Int J Obes (Lond)* (Vol. 33, pp. 1048-1057). England.

Barakat, R., Pelaez, M., Montejo, R., Luaces, M., & Zakynthinaki, M. (2011). Exercise during pregnancy improves maternal health perception: a randomized controlled trial. *Am J Obstet Gynecol, 204*(5), 402 e401-407.

Barakat, R., Ruiz, J. R., Stirling, J. R., Zakynthinaki, M., & Lucia, A. (2009b). Type of delivery is not affected by light resistance and toning exercise training during pregnancy: a randomized controlled trial. *Am J Obstet Gynecol, 201*(6), 590 e591-596.

Bartholomew, L. K. P., G.S.; Gerjo,K.; Gottlieb N.H.; Fernandes, M.E. (2011). *Planning Health Pormotion programs: an intervention mapping approach* (3 ed.). San Francisco.

Bastiaanssen, J. M., de Bie, R. A., Bastiaenen, C. H., Essed, G. G., & van den Brandt, P. A. (2005). A historical perspective on pregnancy-related low back and/or pelvic girdle pain. *Eur J Obstet Gynecol Reprod Biol, 120*(1), 3-14.

Batista, D. C., Chiara, V. L., Gugelmin, S. A., & Martins, P. D. (2003). Atividade física e gestação: saúde da gestante não atleta e crescimento fetal. *Rev. Bras. Saúde Matern. Infant., 3(2)*, 151-158.

Beaglehole, R., Bonita, R., Horton, R., Adams, C., Alleyne, G., Asaria, P., Baugh, V., Bekedam, H., Billo, N., Casswell, S., Cecchini, M., Colagiuri, R., Colagiuri, S., Collins, T., Ebrahim, S., Engelgau, M., Galea, G., Gaziano, T., Geneau, R., Haines, A., Hospedales, J., Jha, P., Keeling, A., Leeder, S., Lincoln, P., McKee, M., Mackay, J., Magnusson, R., Moodie, R., Mwatsama, M., Nishtar, S., Norrving, B., Patterson, D., Piot, P., Ralston, J., Rani, M., Reddy, K. S., Sassi, F., Sheron, N., Stuckler, D., Suh, I., Torode, J., Varghese, C., & Watt, J. (2011). Priority actions for the non-communicable disease crisis. In *Lancet* (Vol. 377, pp. 1438-1447). England.

Bell, R. (2008). Trends in birthweight in the north of England. In *Hum Fertil (Camb)* (Vol. 11, pp. 1-8). England.

Bo, K., & Haakstad, L. A. (2011). Is pelvic floor muscle training effective when taught in a general fitness class in pregnancy? A randomised controlled trial. *Physiotherapy, 97*(3), 190-195.

Borg-Stein, J., Dugan, S. A., & Gruber, J. (2005). Musculoskeletal aspects of pregnancy. *Am J Phys Med Rehabil, 84*(3), 180-192.

Borodulin, K., Evenson, K. R., & Herring, A. H. (2009). Physical activity patterns during pregnancy through postpartum. In *BMC Womens Health* (Vol. 9, pp. 32). England.

Borodulin, K. M., Evenson, K. R., Wen, F., Herring, A. H., & Benson, A. M. (2008). Physical activity patterns during pregnancy. *Med Sci Sports Exerc, 40*(11), 1901-1908.

Both, M. I., Overvest, M. A., Wildhagen, M. F., Golding, J., & Wildschut, H. I. (2010). The association of daily physical activity and birth outcome: a population-based cohort study. *Eur J Epidemiol, 25*(6), 421-429.

Brayshaw, E. (2003). *Exercises in Pregnancy & Childbirth: A Practical Guide for Educators* (1 ed.). Philadelphia: Elsevier Science Limited.

Brown, W. (2002). The benefits of physical activity during pregnancy. *J Sci Med Sport, 5*(1), 37-45.

Brown, W. J., Burton, N. W., & Rowan, P. J. (2007). Updating the evidence on physical activity and health in women. *Am J Prev Med, 33*(5), 404-411.

Brown, W. J., & Trost, S. G. (2003). Life transitions and changing physical activity patterns in young women. In *Am J Prev Med* (Vol. 25, pp. 140-143). Netherlands.

Camões, M., & Lopes, C. (2008). [Factors associated with physical activity in the Portuguese population]. In *Rev Saude Publica* (Vol. 42, pp. 208-216). Brazil.

Caperchione, C., Mummery, W., & Joyner, K. (2009). Addressing the challenges, barriers and enablers to physical activity participation in priority women's groups: Findings from the WALK Program *J Phys Act Health, 6*, 589-596.

Caperchione, C. M., Kolt, G. S., Tennent, R., & Mummery, W. K. (2011). Physical activity behaviours of Culturally and Linguistically Diverse (CALD) women living in Australia: a qualitative study of socio-cultural influences. In *BMC Public Health* (Vol. 11, pp. 26). England.

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Rep, 100*(2), 126-131.

Charlesworth, S. F., J.A.; Burr, F.; Bredin, S.D. . (2011). Evidence-based risk assessment and recommendations for physical activity clearance: pregnancy. *Appl. Physiol. Nutr. Metab. , 36*, 33-48

Chasan-Taber, L., Evenson, K. R., Sternfeld, B., & Kengeri, S. (2007a). Assessment of recreational physical activity during pregnancy in epidemiologic studies of birthweight and length of gestation: methodologic aspects. *Women Health, 45*(4), 85-107.

Chasan-Taber, L., Schmidt, M. D., Pekow, P., Sternfeld, B., Manson, J., & Markenson, G. (2007b). Correlates of physical activity in pregnancy among Latina women. *Matern Child Health J, 11*(4), 353-363.

Chasan-Taber, L., Schmidt, M. D., Roberts, D. E., Hosmer, D., Markenson, G., & Freedson, P. S. (2004). Development and validation of a Pregnancy Physical Activity Questionnaire. *Med Sci Sports Exerc, 36*(10), 1750-1760.

Cioffi, J., Schmied, V., Dahlen, H., Mills, A., Thornton, C., Duff, M., Cummings, J., & Kolt, G. S. (2010). Physical activity in pregnancy: women's perceptions, practices, and influencing factors. *J Midwifery Womens Health, 55*(5), 455-461.

Clapp, J. F., 3rd, Kim, H., Burciu, B., & Lopez, B. (2000). Beginning regular exercise in early pregnancy: effect on fetoplacental growth. In *Am J Obstet Gynecol* (Vol. 183, pp. 1484-1488). United States.

Clapp, J. F., 3rd, Wesley, M., & Sleamaker, R. H. (1987). Thermoregulatory and metabolic responses to jogging prior to and during pregnancy. *Med Sci Sports Exerc, 19*(2), 124-130.

Clarke, P. E., & Gross, H. (2004). Women's behaviour, beliefs and information sources about physical exercise in pregnancy. In *Midwifery* (Vol. 20, pp. 133-141). Scotland.

Clarke, P. E., Rousham, E. K., Gross, H., Halligan, A. W., & Bosio, P. (2005). Activity patterns and time allocation during pregnancy: a longitudinal study of British women. *Ann Hum Biol, 32*(3), 247-258.

Clayton, P. C., S.; Czernichow, P.; Johannsson, G.; Rapaport, R.; Rogol, A. (2007). Management of the child born small for gestational age through to adulthood: a consensus statement of the International Societies of Pediatric Endocrinology and the Growth Hormone Research Society. J *Clin Endocrinol Metab, 92*(3), 804-810.

Conde, A., Figueiredo, B., Tendais, I., Pereira, A. F., Afonso, E., & Nogueira, R. (2008). [Fetal growth and activity at 20 to 24 weeks of gestation (preliminary study)]. *Acta Med Port, 21*(1), 55-64.

Conde, A., Figueiredo, B. (2003). Ansiedade na Gravidez: Factores de risco e implicações para a saúde e bem-estar da mãe. *Psiquiatria Clínica, 24* (3), 197-2009.

Cramp, A. G., & Brawley, L. R. (2009). Sustaining self-regulatory efficacy and psychological outcome expectations for postnatal exercise: effects of a group-mediated cognitive behavioural intervention. *Br J Health Psychol, 14*(Pt 3), 595-611.

Cramp, A. G., & Bray, S. R. (2009). A prospective examination of exercise and barrier self-efficacy to engage in leisure-time physical activity during pregnancy. *Ann Behav Med, 37*(3), 325-334.

Da Costa, D., Rippen, N., Dritsa, M., & Ring, A. (2003). Self-supported leisure-time physical activity during pregnancy and relationship to psychological well-being. *J Psychosom Obstet Gynaecol, 24*(2), 111-120.

Davies, G. A., Wolfe, L. A., Mottola, M. F., & MacKinnon, C. (2003). Joint SOGC/CSEP clinical practice guideline: exercise in pregnancy and the postpartum period. *Can J Appl Physiol, 28*(3), 330-341.

DiNallo, J. M., Downs, D. S., & Le Masurier, G. (2012). Objectively assessing treadmill walking during the second and third pregnancy trimesters. *J Phys Act Health, 9*(1), 21-28.

Downs, D., & Hausenblas, H. (2007). Pregnant women's third trimester exercise behavior, body mass index, and pregnancy outcomes. *Psychology & Health, 22*(5), 545-559.

Duncombe, D., Skouteris, H., Wertheim, E. H., Kelly, L., Fraser, V., & Paxton, S. J. (2006). Vigorous exercise and birth outcomes in a sample of recreational exercisers: a prospective study across pregnancy. In *Aust N Z J Obstet Gynaecol* (Vol. 46, pp. 288-292). Australia.

Duncombe, D., Wertheim, E. H., Skouteris, H., Paxton, S. J., & Kelly, L. (2009). Factors related to exercise over the course of pregnancy including women's beliefs about the safety of exercise during pregnancy. *Midwifery, 25*(4), 430-438.

Edvardsson, K., Ivarsson, A., Eurenius, E., Garvare, R., Nystrom, M. E., Small, R., & Mogren, I. (2011). Giving offspring a healthy start: parents' experiences of health promotion and lifestyle change during pregnancy and early parenthood. In *BMC Public Health* (Vol. 11, pp. 936). England.

Elshibly, E. M., & Schmalisch, G. (2008). The effect of maternal anthropometric characteristics and social factors on gestational age and birth weight in Sudanese newborn infants. In *BMC Public Health* (Vol. 8, pp. 244). England.

Evenson, K. R., & Bradley, C. B. (2010). Beliefs about exercise and physical activity among pregnant women. *Patient Educ Couns, 79*(1), 124-129.

Evenson, K. R., Moos, M. R., Carrier, K., & Siega-Riz, A. M. (2009). Perceived Barriers to Physical Activity Among Pregnant Women. *Matern Child Health J, 13*(3), 364-375.

Evenson, K. R., & Pompeii, L. A. (2010). Obstetrician practice patterns and recommendations for physical activity during pregnancy. *J Womens Health (Larchmt), 19*(9), 1733-1740.

Evenson, K. R., Siega-Riz, A. M., Savitz, D. A., Leiferman, J. A., & Thorp, J. M., Jr. (2002). Vigorous leisure activity and pregnancy outcome. *Epidemiology, 13*(6), 653-659.

Evenson, K. R., & Wen, F. (2010). National trends in self-reported physical activity and sedentary behaviors among pregnant women: NHANES 1999-2006. *Prev Med, 50*(3), 123-128.

Evenson, K. R. S., D.A.; Huston, S. L. . (2004). Leisure-time physical activity among pregnant women in the US. *Paediatric and Perinatal Epidemiology*

18 (6), 400-407.

Eyler, A. E., Wilcox, S., Matson-Koffman, D., Evenson, K. R., Sanderson, B., Thompson, J., Wilbur, J., & Rohm-Young, D. (2002). Correlates of physical activity among women from diverse racial/ethnic groups. *J Womens Health Gend Based Med, 11*(3), 239-253.

Faden, V. B., Hanna, E., & Graubard, B. I. (1997). The effect of positive and negative health behavior during gestation on pregnancy outcome. In *J Subst Abuse* (Vol. 9, pp. 63-76). United States.

Faul, F., Erdfelder, E., Buchner, A., & Lang, A. (2009). Statistical power analyses using G*Power 3.1:Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149-1160.

Fell, D. B., Joseph, K. S., Armson, B. A., & Dodds, L. (2009). The impact of pregnancy on physical activity level. *Matern Child Health J, 13*(5), 597-603.

Fenton, T. R. (2003). A new growth chart for preterm babies: Babson and Benda's chart updated with recent data and a new format. In *BMC Pediatr* (Vol. 3, pp. 13). England.

First-ever federal guidelines for physical activity issued for Americans. Moderate aerobic exercise extends life and reduces the risk of a variety of conditions and diseases. (2009). *Duke Med Health News, 15*(1), 4-5.

Ford, R. P., Tappin, D. M., & Schluter, P. J. (1997). Smoking during pregnancy:how reliable are maternal self reports in New Zealand? *J Epidemiol Commun Health, 51*, 246-251.

Freedson, P. S., Melanson, E., & Sirard, J. (1998). Calibration of the Computer Science and Applications, Inc. accelerometer. *Med Sci Sports Exerc, 30*(5), 777-781.

Fuemmeler, B. F., Anderson, C. B., & Masse, L. C. (2011). Parent-child relationship of directly measured physical activity. In *Int J Behav Nutr Phys Act* (Vol. 8, pp. 17). England.

Garshasbi, A., & Faghih Zadeh, S. (2005). The effect of exercise on the intensity of low back pain in pregnant women. *Int J Gynaecol Obstet, 88*(3), 271-275.

Gaston, A., & Cramp, A. (2011). Exercise during pregnancy: a review of patterns and determinants. In *J Sci Med Sport* (Vol. 14, pp. 299-305). Australia.

Ghodsi, Z., & Asltoghiri, M. . (2012). Does exercise training during pregnancy affect gestational age and gestational weight gain? . *Procedia - Social and Behavioral Sciences, 31*(0), 418-422.

Glouberman, S. (2011). *Towards a New Perspective on Health Policy*: Canadian Policy Research Networks.

Gouveia, R., Martins, S., Sandes, A. R., Nascimento, C., Figueira, J., Valente, S., Correia, S., Rocha, E., & Silva, L. J. (2007). [Pregnancy and physical exercise: myths, evidence and recommendations]. *Acta Med Port, 20*(3), 209-214.

Haakstad, A. H., Voldner, N., Henriksen, T., & BØ, K. (2009). Why do pregnant women stop exercising in the third trimester? *Acta Obstetricia et Gynecologica*(88), 1267-1275.

Haakstad, L. A., & Bo, K. (2011). Effect of regular exercise on prevention of excessive weight gain in pregnancy: a randomised controlled trial. *Eur J Contracept Reprod Health Care, 16*(2), 116-125.

Haas, J. S., Jackson, R. A., Fuentes-Afflick, E., Stewart, A., Dean, M. L., Brawarsky, P., & Escobar, G. J. (2004). Changes in the Health Status of Women During and After Pregnancy. *Journal of General Internal Medicine, 20*, 45-51.

Halvorsen, S. H., L. A. H.; Edvardsen, E.; Bø, K. . (2012). Effect of aerobic dance on cardiorespiratory fitness in pregnant women: A randomised controlled trial. *Physiotherapy*.

Harrison, C. L., Thompson, R. G., Teede, H. J., & Lombard, C. B. (2011). Measuring physical activity during pregnancy. *Int J Behav Nutr Phys Act, 8*, 19.

Hartmann, S. B., P. (1999). Physical exercise during pregnancy - psysiological considerations and recommendations. *Journal of Perinatal Medicine, 27*(23), 204-215.

Hatch, M., Ji, B. T., Shu, X. O., & Susser, M. (1997). Do standing, lifting, climbing, or long hours of work during pregnancy have an effect on fetal growth? In *Epidemiology* (Vol. 8, pp. 530-536). United States.

Hegaard, H. H., M.; Damm, P.; Ottesen, B.; Petersson, K.; Henriksen, TB. (2008). Leisure time physical activity is associated with a reduced risk of preterm delivery. *Am J Obstet Gynecol, 198*(2), 180.e181-185.

Hegaard, H. K., Damm, P., Hedegaard, M., Henriksen, T. B., Ottesen, B., Dykes, A. K., & Kjaergaard, H. (2011). Sports and leisure time physical activity during pregnancy in nulliparous women. *Matern Child Health J, 15*(6), 806-813.

Hegaard, H. K., Pedersen, B. K., Nielsen, B. B., & Damm, P. (2007). Leisure time physical activity during pregnancy and impact on gestational diabetes mellitus, pre-eclampsia, preterm delivery and birth weight: a review. *Acta Obstet Gynecol Scand, 86*(11), 1290-1296.

Hegaard, H. K., Petersson, K., Hedegaard, M., Ottesen, B., Dykes, A. K., Henriksen, T. B., & Damm, P. (2010). Sports and leisure-time physical activity in pregnancy and birth weight: a population-based study. In *Scand J Med Sci Sports* (Vol. 20, pp. e96-102). Denmark.

Heiskanen, N., Raatikainen, K., & Heinonen, S. (2006). Fetal macrosomia--a continuing obstetric challenge. In *Biol Neonate* (Vol. 90, pp. 98-103). Switzerland.

Helmerhorst, H. J., Brage, S., Warren, J., Besson, H., & Ekelund, U. (2012). A systematic review of reliability and objective criterion-related validity of physical activity questionnaires. In *Int J Behav Nutr Phys Act* (Vol. 9, pp. 103).

Henriksen, T. (2008). The macrosomic fetus: a challenge in current obstetrics. In *Acta Obstet Gynecol Scand* (Vol. 87, pp. 134-145). Denmark.

Hinton, P. S., & Olson, C. M. (2001). Predictors of pregnancy-associated change in physical activity in a rural white population. *Matern Child Health J, 5*(1), 7-14.

Hopkins, S. A., Baldi, J. C., Cutfield, W. S., McCowan, L., & Hofman, P. L. (2011). Effects of exercise training on maternal hormonal changes in pregnancy. *Clin Endocrinol (Oxf), 74*(4), 495-500.

Hopkins, S. A., & Cutfield, W. S. (2011). Exercise in pregnancy: weighing up the long-term impact on the next generation. *Exerc Sport Sci Rev, 39*(3), 120-127.

Hutchison, B. G., & Milner, R. (1994). Reliability of the Guide to Pregnancy Risk Grading of the Ontario Antenatal Record in assessing obstetric risk. *CMAJ, 150*(12), 1983-1987.

Impact of physical activity during pregnancy and postpartum on chronic disease risk. (2006). *Med Sci Sports Exerc, 38*(5), 989-1006.

IOM. (2009). *Weight gain during pregnancy*: Institute of Medicine and National Research Council.

Juhl, M., Olsen, J., Andersen, P. K., Nohr, E. A., & Andersen, A. M. (2010). Physical exercise during pregnancy and fetal growth measures: a study within the Danish National Birth Cohort. In *Am J Obstet Gynecol* (Vol. 202, pp. 63 e61-68). United States.

Kashanian, M., Akbari, Z., & Alizadeh, M. (2009). The effect of exercise on back pain and lordosis in pregnant women *Int J Gynaecol Obstet, 107*(2), 160-161.

King, J. C. (2000). Physiology of pregnancy and nutrient metabolism. *Am J Clin Nutr, 71*(5 Suppl), 1218S-1225S.

Kramer, M. S., McLean, F. H., Boyd, M. E., & Usher, R. H. (1988). The validity of gestational age estimation by menstrual dating in term, preterm, and postterm gestations. *JAMA, 260*(22), 3306-3308.

Kramer, M. S., Platt, R. W., Wen, S. W., Joseph, K. S., Allen, A., Abrahamowicz, M., Blondel, B., Breart, G., & Fetal/Infant Health Study Group of the Canadian Perinatal Surveillance, S. (2001). A new and improved population-based Canadian reference for birth weight for gestational age. *Pediatrics, 108*(2), E35.

Langhoff-Roos, J., Lindmark, G., Kylberg, E., & Gebre-Medhin, M. (1987). Energy intake and physical activity during pregnancy in relation to maternal fat accretion and infant birthweight. *Br J Obstet Gynaecol, 94*(12), 1178-1185.

Lewis, B., Avery, M. J., E., Sherwood, N., Martinson, B., & Crain, A. L. (2008). The Effect of Exercise During Pregnancy on Maternal Outcomes: Practical Implications for Practice. *American journal of lifestyle medicine, 2*(5), 441-455.

Liu, J., Blair, S. N., Teng, Y., Ness, A. R., Lawlor, D. A., & Riddoch, C. (2011). Physical activity during pregnancy in a prospective cohort of British women: results from the Avon longitudinal study of parents and children. *Eur J Epidemiol, 26*(3), 237-247.

Lokey, E., Tran, Z., Wells, C., Myer, B., & Tran, A. (2004). Effects of physical exercise on pregnancy outcomes: A meta-analytic review. *Med Sci Sport Exerc, 23*, 1244-1251.

Lubchenco, L. O., Hansman, C., & Boyd, E. (1966). Intrauterine growth in length and head circumference as estimated from live births at gestational ages from 26 to 42 weeks. *Pediatrics, 37*(3), 403-408.

Lumbers, E. R. (2002). Exercise in pregnancy: physiological basis of exercise prescription for the pregnant woman. *J Sci Med Sport, 5*(1), 20-31.

MacLennan, A. H., Nicolson, R., Green, R. C., & Bath, M. (1986). Serum relaxin and pelvic pain of pregnancy. *Lancet, 2*(8501), 243-245.

Maddison, R., Jiang, Y., Hoorn, S. V., Mhurchu, C. N., Lawes, C. M., Rodgers, A., & Rush, E. (2009). Estimating energy expenditure with the RT3 triaxial accelerometer. *Res Q Exerc Sport, 80*(2), 249-256.

Maiese, D. R. (2002). Healthy people 2010--leading health indicators for women. *Womens Health Issues, 12*(4), 155-164.

Matthews, C. E., Hagstromer, M., Pober, D. M., & Bowles, H. R. (2012). Best practices for using physical activity monitors in population-based research. In *Med Sci Sports Exerc* (Vol. 44, pp. S68-76). United States.

McArdle W, K. F., Katch V. (2000). Essentials of exercise physiology. *Philadelphia (PA): Lippincott Williams & Wilkins*.

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Educ Q, 15*(4), 351-377.

McMurray, R. G., Mottola, M. F., Wolfe, L. A., Artal, R., Millar, L., & Pivarnik, J. M. (1993). Recent advances in understanding maternal and fetal responses to exercise. *Med Sci Sports Exerc, 25*(12), 1305-1321.

Melzer, K., Schutz, Y., Boulvain, M., & Kayser, B. (2010a). Physical activity and pregnancy: cardiovascular adaptations, recommendations and pregnancy outcomes. *Sports Med, 40*(6), 493-507.

Melzer, K., Schutz, Y., Soehnchen, N., Othenin-Girard, V., Martinez de Tejada, B., Irion, O., Boulvain, M., & Kayser, B. (2010b). Effects of recommended levels of physical activity on pregnancy outcomes. *Am J Obstet Gynecol, 202*(3), 266 e261-266.

Mens, J. M., Snijders, C. J., & Stam, H. J. (2000). Diagonal trunk muscle exercises in peripartum pelvic pain: a randomized clinical trial. *Phys Ther, 80*(12), 1164-1173.

Mogren, I. M. (2005). Previous physical activity decreases the risk of low back pain and pelvic pain during pregnancy. *Scand J Public Health, 33*(4), 300-306.

Mogren, I. M. (2008). Physical activity and persistent low back pain and pelvic pain post partum. *BMC Public Health, 8*, 417.

Mogren, I. M., & Pohjanen, A. I. (2005). Low back pain and pelvic pain during pregnancy: prevalence and risk factors. *Spine (Phila Pa 1976), 30*(8), 983-991.

Mohseni-Bandpei, M. F., M.; Ahmad-Shirvani, M.; Bagheri-Nessami, M.; Khalilian, AR.; Shayesteh-Azar, M.; Mohseni-Bandpei, H. (2009). Low back pain in 1,100 Iranian pregnant women: prevalence and risk factors. *Spine J, 9*(10), 795-801.

Morkved, S., Salvesen, K. A., Schei, B., Lydersen, S., & Bo, K. (2007). Does group training during pregnancy prevent lumbopelvic pain? A randomized clinical trial. In *Acta Obstet Gynecol Scand* (Vol. 86, pp. 276-282). Denmark.

Motahari Tabari, N. M., S.H.; Khaledan, A.; Ahmad Shirvani, M. (2010). The Effect of Aerobic Exercise on Pregnancy Outcomes. *Iranian Journal of Babol Univ Med Sci, 12*(1), 36-43.

Mottola, M. F. (2008). The role of exercise in the prevention and treatment of gestational diabetes mellitus. *Curr Diab Rep, 8*(4), 299-304.

Mottola, M. F., & Campbell, M. K. (2003). Activity patterns during pregnancy. *Can J Appl Physiol, 28*(4), 642-653.

Mottola, M. F., Giroux, I., Gratton, R., Hammond, J. A., Hanley, A., Harris, S., McManus, R., Davenport, M. H., & Sopper, M. M. (2010). Nutrition and exercise prevent excess weight gain in overweight pregnant women. *Med Sci Sports Exerc, 42*(2), 265-272.

Mousavi, S. J., Parnianpour, M., & Vleeming, A. (2007). Pregnancy related pelvic girdle pain and low back pain in an Iranian population. In *Spine (Phila Pa 1976)* (Vol. 32, pp. E100-104). United States.

Mudd, L. M., Nechuta, S., Pivarnik, J. M., & Paneth, N. (2009). Factors associated with women's perceptions of physical activity safety during pregnancy. In *Prev Med* (Vol. 49, pp. 194-199). United States.

Ning, Y., Williams, M. A., Dempsey, J. C., Sorensen, T. K., Frederick, I. O., & Luthy, D. A. (2003). Correlates of recreational physical activity in early pregnancy. *J Matern Fetal Neonatal Med, 13*(6), 385-393.

O'Sullivan, P. (2005). Diagnosis and classification of chronic low back pain disorders: maladaptive movement and motor control impairments as underlying mechanism. In *Man Ther* (Vol. 10, pp. 242-255). Scotland.

Olsen, I. E., Groveman, S. A., Lawson, M. L., Clark, R. H., & Zemel, B. S. (2010). New intrauterine growth curves based on United States data. In *Pediatrics* (Vol. 125, pp. e214-224). United States.

Osler, M., Lund, R., Kriegbaum, M., & Andersen, A. M. (2009). The influence of birth weight and body mass in early adulthood on early coronary heart disease risk among Danish men born in 1953. *Eur J Epidemiol, 24*(1), 57-61.

Ota, E., Haruna, M., Yanai, H., Suzuki, M., Anh, D. D., Matsuzaki, M., Tho le, H., Ariyoshi, K., Yeo, S. A., & Murashima, S. (2008). Reliability and validity of the Vietnamese version of the Pregnancy Physical Activity Questionnaire (PPAQ). *Southeast Asian J Trop Med Public Health, 39*(3), 562-570.

Paisley, T. S., Joy, E. A., & Price, R. J., Jr. (2003). Exercise during pregnancy: a practical approach. *Curr Sports Med Rep, 2*(6), 325-330.

Pereira, M. A., Rifas-Shiman, S. L., Kleinman, K. P., Rich-Edwards, J. W., Peterson, K. E., & Gillman, M. W. (2007). Predictors of change in physical activity during and after pregnancy: Project Viva. In *Am J Prev Med* (Vol. 32, pp. 312-319). Netherlands.

Perkins, C. C., Pivarnik, J. M., Paneth, N., & Stein, A. D. (2007). Physical activity and fetal growth during pregnancy. In *Obstet Gynecol* (Vol. 109, pp. 81-87). United States.

Petersen, A., Leet, T., & Brownson, R. (2005). Correlates of exercise among pregnant women in the United States. *Med Sci Sport Exer*(37), 1748 - 1753.

Phelan, S. (2010). Pregnancy: a "teachable moment" for weight control and obesity prevention. *Am J Obstet Gynecol, 202*(2), 135 e131-138.

Physical Activity Guidelines Advisory Committee report, 2008. To the Secretary of Health and Human Services. Part A: executive summary. (2009). In *Nutr Rev* (Vol. 67, pp. 114-120). United States.

Physical activity guidelines for Americans.Manuscrito não publicado. (2008).

Pinto, E., Severo, M., Correia, S., Silva, I. d. S., Lopes, C., & Barros, H. (2010). Validity and reproducibility of a semi-quantitative food frequency questionnaire for use among Portuguese pregnant women. *Matern Child Nutr, 6*(2), 105-119.

Pivarnik, J. M., Chambliss, H. O., Clapp, J. F., Dugan, S. A., Hatch, M. C., Lovelady, C. A., Mottola, M. F., & Williams, M. A. (2006). Impact of Physical Activity during Pregnancy and

Postpartum on Chronic Disease Risk. *Medicine & Science in Sports & Exercise, 38*(5), 989-1006.

Polden, M., & Mantle, J. (2000). *Fisioterapia em ginecologia e obstetrícia* (2a ed ed.). São Paulo.

Polley, B. A., Wing, R. R., & Sims, C. J. (2002). Randomized controlled trial to prevent excessive weight gain in pregnant women. *Int J Obes Relat Metab Disord, 26*(11), 1494-1502.

Ponciano, E. S., AV.; Relvas, J. (1982). Aferição da escala de auto-avaliação de ansiedade, de Zung, numa amostra de população portuguesa I : resultados da aplicação numa amostra de população normal. *Psiquiatria Clínica, 3*(4), 191-202.

Portney, L. G., & Watkins, M. P. (1999). *Foundations of Clinical Research: Applications to Practice* (3 ed.): Hardcover.

Poudevigne, M. S., & O'Connor, P. J. (2005). Physical activity and mood during pregnancy. *Med Sci Sports Exerc, 37*(8), 1374-1380.

Poudevigne, M. S., & O'Connor, P. J. (2006). A review of physical activity patterns in pregnant women and their relationship to psychological health. *Sports Med, 36*(1), 19-38.

Rao, S., Kanade, A., Margetts, B. M., Yajnik, C. S., Lubree, H., Rege, S., Desai, B., Jackson, A., & Fall, C. H. (2003). Maternal activity in relation to birth size in rural India. The Pune Maternal Nutrition Study. In *Eur J Clin Nutr* (Vol. 57, pp. 531-542). England.

Rousham, E. K., Clarke, P. E., & Gross, H. (2006). Significant changes in physical activity among pregnant women in the UK as assessed by accelerometry and self-reported activity. In *Eur J Clin Nutr* (Vol. 60, pp. 393-400). England.

Rutkowska, E., & Lepecka-Klusek, C. (2002). The role of physical activity in preparing women for pregnancy and delivery in Poland. *Health Care Women Int, 23*(8), 919-923.

Sabino, J., & Grauer, J. N. (2008). Pregnancy and low back pain. *Curr Rev Musculoskelet Med, 1*(2), 137-141.

Sallis, J. O., N. Fisher, EB. (2008). Ecological models of health behavior. In K. R. Glanz, BK.; Viswanath, K. (Ed.), *Health behavior and health education: theory, research, and practic* (4th edn ed., pp. 465–486). San Francisco, CA: Jossey-Bass.

Sandoval-Rodriguez, T., Partida-Hernandez, C. G., & Arreola-Ortiz, F. (1997). [Diabetes mellitus. Exercise and pregnancy]. *Ginecol Obstet Mex, 65*, 478-481.

Santos, P. C., Mendonca, D., Alves, O., & Barbosa, A. M. (2006). [Prevalence and impact of stress urinary incontinence before and during pregnancy]. *Acta Med Port, 19*(5), 349-356.

Schlussel, M. M., Souza, E. B., Reichenheim, M. E., & Kac, G. (2008). Physical activity during pregnancy and maternal-child health outcomes: a systematic literature review. *Cad Saude Publica, 24 Suppl 4*, s531-544.

Shaikh, H., Robinson, S., & Teoh, T. G. (2010). Management of maternal obesity prior to and during pregnancy. In *Semin Fetal Neonatal Med* (Vol. 15, pp. 77-82). Netherlands.

Simas, T. A., Liao, X., Garrison, A., Sullivan, G. M., Howard, A. E., & Hardy, J. R. (2011). Impact of updated Institute of Medicine guidelines on prepregnancy body mass index categorization, gestational weight gain recommendations, and needed counseling. *J Womens Health (Larchmt), 20*(6), 837-844.

Smith, M. D., Russell, A., & Hodges, P. W. (2008). Is there a relationship between parity, pregnancy, back pain and incontinence? *Int Urogynecol J Pelvic Floor Dysfunct, 19*(2), 205-211.

Solomon, C. G., Willett, W. C., Carey, V. J., Rich-Edwards, J., Hunter, D. J., Colditz, G. A., Stampfer, M. J., Speizer, F. E., Spiegelman, D., & Manson, J. E. (1997). A prospective study of pregravid determinants of gestational diabetes mellitus. *JAMA, 278*(13), 1078-1083.

Sports, P. s. C. o. P. F. a. (2009). Physical Activity During Pregnancy and postpartum: What have we learned? *, 10*(3), 1-8.

Stables, D., & Rankin, J. (2010). *Physiology in Childbearing*: Elsevier Health Sciences.

Stein, A. D., Rivera, J. M., & Pivarnik, J. M. (2003). Measuring energy expenditure in habitually active and sedentary pregnant women. *Med Sci Sports Exerc, 35*(8), 1441-1446.

Sternfeld, B., Quesenberry, C. P., Jr., Eskenazi, B., & Newman, L. A. (1995). Exercise during pregnancy and pregnancy outcome. *Med Sci Sports Exerc, 27*(5), 634-640.

Streuling, I., Beyerlein, A., Rosenfeld, E., Hofmann, H., Schulz, T., & von Kries, R. (2011). Physical activity and gestational weight gain: a meta-analysis of intervention trials. *BJOG, 118*(3), 278-284.

Stuge, B., Hilde, G., & Vollestad, N. (2003). Physical therapy for pregnancy-related low back and pelvic pain: a systematic review. In *Acta Obstet Gynecol Scand* (Vol. 82, pp. 983-990). Denmark.

Takito, M. Y. (2008). Evaluation of the Reproducibility and Validity of a Physical Activity Questionnaire for Pregnant Women. *Rev Bras Med Esporte, 14*(2), 132-138.

Takito, M. Y., Benicio, M. H., & Neri Lde, C. (2009). Physical activity by pregnant women and outcomes for newborns: a systematic review. *Rev Saude Publica, 43*(6), 1059-1069.

Tendais, I., Figueiredo, B., Mota, J., & Conde, A. (2011). Physical activity, health-related quality of life and depression during pregnancy. *Cad Saude Publica, 27*(2), 219-228.

Thomas, P., Peabody, J., Turnier, V., & Clark, R. (2000). A new look at intrauterine growth and the impact of race, altitude, and gender. *Pediatrics, 106*(2).

Troiano, N. H., & Dorman, K. (1992). Mechanical ventilation during pregnancy. *NAACOGS Clin Issu Perinat Womens Health Nurs, 3*(3), 399-407.

Troiano, R. P. (2009). Can there be a single best measure of reported physical activity? *Am J Clin Nutr, 89*(3), 736-737.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc, 40*(1), 181-188.

Tucker, P., van Zandvoort, M. M., Burke, S. M., & Irwin, J. D. (2011). The influence of parents and the home environment on preschoolers' physical activity behaviours: a qualitative investigation of childcare providers' perspectives. In *BMC Public Health* (Vol. 11, pp. 168). England.

United Nations. (2011). High level meeting on prevention and control of non-communicable diseases. General Assembly

Van Raaij, J. M., Schonk, C. M., Vermaat-Miedema, S. H., Peek, M. E., & Hautvast, J. G. (1990). Energy cost of physical activity throughout pregnancy and the first year postpartum in Dutch women with sedentary lifestyles. *Am J Clin Nutr, 52*(2), 234-239.

Vermani, E., Mittal, R., & Weeks, A. (2010). Pelvic girdle pain and low back pain in pregnancy: a review. In *Pain Pract* (Vol. 10, pp. 60-71). United States.

Wang, S. M., Dezinno, P., Maranets, I., Berman, M. R., Caldwell-Andrews, A. A., & Kain, Z. N. (2004). Low back pain during pregnancy: prevalence, risk factors, and outcomes. In *Obstet Gynecol* (Vol. 104, pp. 65-70). United States.

Warburton, D. E., Nicol, C. W., & Bredin, S. S. (2006). Health benefits of physical activity: the evidence. In *CMAJ* (Vol. 174, pp. 801-809). Canada.

Ward, D. S., Evenson, K. R., Vaughn, A., Rodgers, A. B., & Troiano, R. P. (2005). Accelerometer use in physical activity: best practices and research recommendations. *Med Sci Sports Exerc, 37*(11 Suppl), S582-588.

Watson, P. E., & McDonald, B. W. (2007). Activity levels in pregnant New Zealand women: relationship with socioeconomic factors, well-being, anthropometric measures, and birth outcome. *Appl Physiol Nutr Metab, 32*(4), 733-742.

Weissgerber, T. L., Wolfe, L. A., Davies, G. A., & Mottola, M. F. (2006). Exercise in the prevention and treatment of maternal-fetal disease: a review of the literature. *Appl Physiol Nutr Metab, 31*(6), 661-674.

Widmaier E. P., R. H., Strang K. T. . (2007). *Vander's Human Physiology: The Mechanisms of Body Function*. Boston: The McGraw Hill.

Wolfe, L. A., Davies, G. A., School of, P., Health Education, D. o. O., Gynaecology, & Physiology, Q. s. U. K. O. C. (2003). Canadian guidelines for exercise in pregnancy. *Clin Obstet Gynecol, 46*(2), 488-495.

Wolfe, L. A., & Mottola, M. F. (1993). Aerobic exercise in pregnancy: an update. *Can J Appl Physiol, 18*(2), 119-147.

Wolfe, L. A., & Weissgerber, T. L. (2003). Clinical physiology of exercise in pregnancy: a literature review. *J Obstet Gynaecol Can, 25*(6), 473-483.

World Health Organization. (2010). *World Health Organization. Global recommendations on physical activity for health*. Geneva: WHO.

Wu, W. H., Meijer, O. G., Uegaki, K., Mens, J. M., van Dieen, J. H., Wuisman, P. I., & Ostgaard, H. C. (2004). Pregnancy-related pelvic girdle pain (PPP), I: Terminology, clinical presentation, and prevalence. *Eur Spine J, 13*(7), 575-589.

Zhang, J., & Savitz, D. A. (1996). Exercise during pregnancy among US women. *Ann Epidemiol, 6*(1), 53-59.

Zhang, X., Decker, A., Platt, R. W., & Kramer, M. S. (2008). How big is too big? The perinatal consequences of fetal macrosomia. In *Am J Obstet Gynecol* (Vol. 198, pp. 517 e511-516). United States.

Zung, W. W. (1971). A rating instrument for anxiety disorders. In *Psychosomatics* (Vol. 12, pp. 371-379). United States.