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Impacto do estilo de vida no controle do peso durante a gestação e pós-parto

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Tese apresentada como requisito parcial para obtenção do grau de Doutora em Saúde Coletiva, Programa de Pós-graduação em Saúde Coletiva – área de concentração em Epidemiologia, do Instituto de Medicina Social da Universidade do Estado do Rio de Janeiro.

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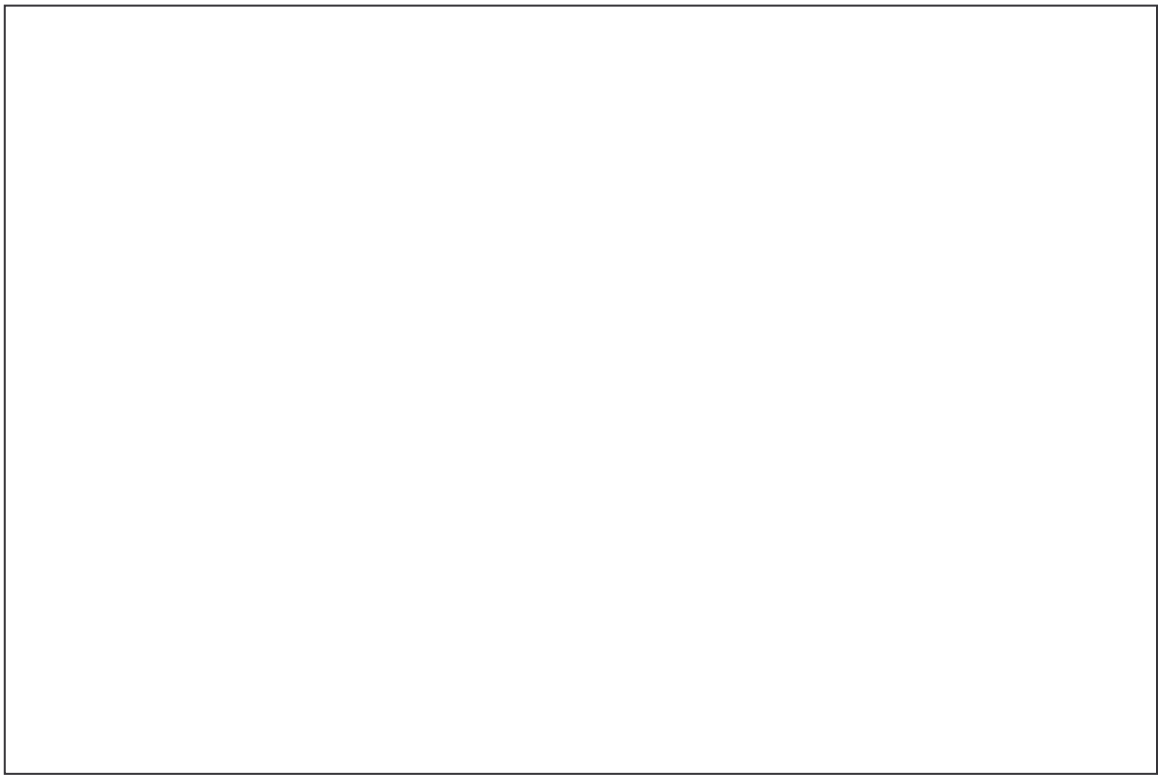

FICHA DE APROVAÇÃO

AMANDA RODRIGUES AMORIM

IMPACTO DO ESTILO DE VIDA NO CONTROLE DO PESO DURANTE A GESTAÇÃO E PÓS-PARTO

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Lista de Abreviaturas

ACOG – The American College of Obstetricians and Gynecologists

ANOVA – Análise de Variância

BPN – Baixo Peso ao Nascer

CDC - Centers for Disease Control and Prevention

CIUR – Crescimento Intra-uterino Restrito

DMP – Diferença de Média Ponderada

ENDEF - Estudo Nacional de Despesa Familiar

EUA – Estados Unidos da América

IBGE – Instituto Brasileiro de Geografia e Estatística

IC – Intervalo de Confiança

IMC – Índice de Massa Corporal

INCA – Instituto Nacional do Câncer

IOM – Institute of Medicine

OMS – Organização Mundial de Saúde

OR – Odds Ratio

PNSN – Pesquisa Nacional sobre Saúde e Nutrição

PPV – Pesquisa sobre Padrões de Vida

RR - Risco Relativo

SUS – Sistema Único de Saúde

UERJ – Universidade do Estado do Rio de Janeiro

WMD - Weighted Mean Difference

Apresentação

A introdução desse documento é composta por oito seções que englobam a definição da obesidade (1.1), sua magnitude e efeitos deletérios (1.2) e seus principais determinantes na população feminina (1.3), entre eles destacam-se o ganho de peso excessivo durante a gravidez e a retenção de peso no pós-parto. Considerações gerais sobre o ganho de peso gestacional são abordadas na seção 1.4. A seção 1.5 abarca as questões referentes às recomendações de ganho de peso durante a gestação. A seção 1.5 está dividida em duas subseções que descrevem os fatores determinantes do ganho de peso excessivo (1.5.1) e as suas conseqüências à saúde materno-infantil (1.5.2). Completando o cenário, na seção 1.6, são expostas algumas considerações sobre a retenção de peso no pós-parto. A seção 1.7 apresenta dados sobre a magnitude do peso retido após a gestação. Pretende-se, nesta seção, oferecer um panorama geral das alterações de peso ocorridas durante o puerpério (1.7.1) e dos principais preditores da retenção de peso no pós-parto (1.7.2). Finalizando a introdução da tese é destacado na seção 1.8 o impacto das modificações do estilo de vida relacionadas à dieta (1.8.1), atividade física (1.8.2) e ao fumo (1.8.3) durante a gestação e o puerpério, sobre o ganho de peso gestacional e perda de peso no pós-parto.

Na seção 2 apresentam-se as justificativas da tese. Aponta-se como a principal justificativa a falta de consenso sobre o efeito do estilo de vida durante a gestação e puerpério em relação ao ganho de peso gestacional, retenção e perda de peso no pós-parto. Na seção 3, relata-se o objetivo geral da pesquisa como sendo a avaliação do impacto do estilo de vida materno no ganho de peso durante a gestação e na sua evolução durante o pós-parto.

Os produtos desta tese (2004-2007) constituem-se de quatro artigos científicos. Os artigos são apresentados, em sua íntegra, no formato e no idioma solicitados pelas revistas às quais foram encaminhados. Como os artigos foram elaborados em inglês, optou-se por apresentá-los na seção de

anexos, respeitando as normas de padronização de projetos e teses do Departamento de Epidemiologia do Instituto de Medicina Social/UERJ. Desta forma, na seção 4 são apresentados apenas os resumos ampliados, em português, de cada artigo incluído na tese.

Subseqüentemente, na seção 5 são expostas algumas considerações finais, acerca dos estudos e do programa de investigação como um todo, ressaltando a importância da identificação precoce de mulheres sob risco de ganho de peso excessivo durante a gravidez e a necessidade de aconselhamento adequado durante o pré-natal para que as mulheres ganhem peso segundo as recomendações. Destaca-se também que o acompanhamento deve ser prolongado durante o pós-parto com intuito de se criar um ambiente favorável à perda de peso. As referências bibliográficas utilizadas na introdução e na seção 4 são apresentadas no final da tese (seção 6), dado que as referências específicas de cada artigo (anexos) encontram-se no final dos mesmos.

O primeiro produto da tese (anexo 1) consiste em um artigo de revisão da literatura sobre os indicadores utilizados na avaliação do ganho de peso gestacional e da retenção de peso no pós-parto. O artigo já foi submetido à revista *Maternal & Child Nutrition* e será publicado em maio de 2007. O segundo manuscrito (anexo 2) é fruto do programa Doutorado Sanduíche, realizado no *Karolinska Institute*, Suécia. O estudo foi baseado no banco de dados sueco sobre a mudança de peso em mulheres a partir a gestação até 15 anos após o parto. O estudo tem como objetivo avaliar o impacto da interrupção do fumo durante o pré-natal no ganho de peso gestacional. O manuscrito ainda está em fase de refinamento e será submetido à revista *Acta Obstetricia et Gynecologica Scandinavica*. Em seguida, é apresentado o terceiro também baseado no banco de dados sueco (anexo 3), cujo objetivo foi explorar o efeito do ganho de peso gestacional, segundo recomendações de IOM, no desenvolvimento do IMC materno a longo prazo. O artigo foi aceito para publicação na revista *Obesity Research*. O quarto produto da tese consiste de uma revisão sistemática sobre efeito da dieta, exercício ou ambos na perda de peso no pós-parto (anexo 5). A revisão foi elaborada

segundo as recomendações publicadas no *Cochrane Reviewers' Handbook*. O protocolo desta revisão está cadastrado no *Cochrane Pregnancy and Childbirth Group* e foi publicado na *Cochrane Library* em 2006. A revisão completa já foi submetida e será publicada no módulo de maio de 2007.

Resumo

Objetivo O objetivo desta tese é avaliar o impacto do estilo de vida materno no ganho de peso durante a gestação e na sua evolução durante o pós-parto. **Método** Inicialmente, foi realizada uma revisão da literatura sobre os indicadores utilizados para computar as mudanças de peso ocorridas durante a gestação e o pós-parto (**artigo I**). Posteriormente, utilizou-se o modelo de regressão logística para avaliar a associação entre a abstinência ao fumo durante o pré-natal e o ganho de peso gestacional (GPG) excessivo, segundo as recomendações do *Institute of Medicine* (IOM), em 1.249 mulheres que deram à luz a recém-nascidos vivos a termo em 1984/85 em Estocolmo, Suécia (**artigo II**). Em seguida, foi utilizado o modelo de regressão linear múltipla para avaliar o efeito do GPG excessivo no índice de massa corporal (IMC) materno 15 anos após o parto. A população elegível para análise foi constituída de 483 mulheres suecas, que foram acompanhadas desde o nascimento da criança índice em 1984/85 até 1999/2000 (**artigo III**). Por último, uma revisão sistemática com a utilização de metanálise foi realizada para apreciar o efeito da dieta, exercício ou ambos na perda de peso no pós-parto (**artigo IV**). **Resultados** A diversidade de indicadores utilizada para computar o GPG e a retenção de peso no pós-parto dificulta a interpretação e comparação dos resultados de pesquisas sobre o tema. A baixa qualidade dos registros obstétricos e a escolha inadequada do indicador são consideradas as possíveis causas da não associação entre o ganho de peso materno e os desfechos gestacionais encontrada em alguns estudos (**artigo I**). Ex-fumantes apresentam 1,8 vezes mais chance de GPG excessivo em relação às mulheres não fumantes, mesmo após o ajuste pelas variáveis de confusão, como o consumo de álcool, atividade física, entre outras (**artigo II**). Mulheres que tiveram GPG excessivo apresentaram maior retenção de peso 15 anos após parto (10,0 kg) do que as mulheres que ganharam peso conforme os limites recomendados pelo IOM (6,7 kg). Mesmo após o controle pelas variáveis de confusão, o GPG excessivo provocou um aumento significativo de 0,72 kg/m^2 no IMC materno (**artigo III**).

Mulheres aconselhadas a praticarem exercícios aeróbicos durante o pós-parto não perderam, significativamente, mais peso que as mulheres alocadas no grupo controle (diferença de média ponderada (DMP): 0,00; IC 95%: -8,63/ 8,63). Mulheres alocadas no grupo dieta (DMP: -1,70; IC 95%: -2,08/ -1,32) ou dieta e exercício (DMP: -2,89; IC 95%: -4,83/ -0,95) perderam, significativamente, mais peso que as mulheres alocadas no grupo controle. Nenhuma das estratégias de intervenção para perda de peso no pós-parto (exercício; dieta; dieta e exercício) provocou efeitos adversos à saúde materno-infantil (**artigo IV**). **Conclusão** Os achados apontam para a importância da identificação precoce de mulheres sob risco GPG excessivo. Os profissionais de saúde devem fornecer aconselhamento adequado durante o pré-natal para o controle do GPG e motivar as mulheres a perderem o peso retido durante o pós-parto. Assinala-se também que os profissionais de saúde devem recomendar programas de modificação do estilo de vida relacionados à dieta combinada ao exercício físico para perda de peso durante o pós-parto e, conseqüentemente, para a prevenção da obesidade associada ao ciclo reprodutivo.

Palavras-chave: gestação, pós-parto, controle de peso, estilo de vida.

Abstract

Objective The aim of this thesis is to evaluate the impact of maternal life style on gestational weight gain (GWG) and maternal weight development during postpartum. **Method** Firstly, an overview of the literature on indicators used to measure weight changes during and after pregnancy was carried out (**article I**). Secondly, a multivariate logistic regression model was used to assess the association between prenatal smoking cessation and excessive GWG, according to the Institute of Medicine (IOM) recommendations, in 1.249 women who delivered a term infant in 1984/85 in Stockholm, Sweden (**article II**). Thirdly, a multivariate linear regression model was used to assess the effect of excessive GWG on maternal body mass index (BMI) at 15 years postpartum. The study population was composed of 483 Swedish women who were followed from delivery date of the index child in 1984/85 to 1999/2000 (**article III**). Finally, a systematic review with meta-analysis was conducted to appraise the effect of diet, exercise or both on postpartum weight loss (**article IV**). **Results** Comparisons among studies and the interpretation of research findings are complicated due to the variety of indicators used to calculate the GWG and postpartum weight retention. The reasons for non-significant associations between GWG and gestational outcomes were probably owing to poor quality of obstetrics records and selection of wrong indicators to compute GWG (**article I**). Former smokers were 1,8 times more likely to gain excessive weight during pregnancy than non-smokers, even after accounting for confounding factors, including alcohol consumption, physical activity to mention a few (**article II**). Postpartum weight retention at 15 years follow-up was higher among women who gained excessive weight during pregnancy (10,0 kg) than who gained weight according to IOM recommendations (6,7 kg). After accounting for confounding factors, women who gained excessive weight during pregnancy had a significant increase of 0.72 kg/m^2 in BMI at 15 years follow-up compared to women who gained within recommendations (**article III**). Women who exercised did not significantly lose more weight than

women in the control group (weighted mean difference (WMD) 0,00; 95% CI –8,63 to 8,63). Women who took part in a diet (WMD –1,70; 95% CI –2,08 to –1,32) or diet plus exercise (WMD –2,89; 95% CI –4,83 to –0,95) program lost significantly more weight than women in the control group. The interventions (diet; exercise; diet and exercise) did not adversely affect the maternal and child health (**article IV**). **Conclusion** The findings indicate the relevance of early identification of women at risk of excessive GWG. Health care providers should give women appropriate advice for controlling GWG and motivate them to lose pregnancy-related weight during postpartum. Additionally, health care providers should recommend women to engage in diet combined with physical activity programs in order to lose postpartum weight and consequently prevent obesity associated with childbearing.

Key words: pregnancy, postpartum, weight control, life style.

1. Introdução

1.1 Definição de obesidade

Definir a obesidade é uma tarefa complexa. Uma definição ideal de sobrepeso e obesidade deveria estar baseada na quantidade de gordura corporal que elevasse o risco de ocorrência de doenças (Flegal et al. 1998). Para simplificar a compreensão do termo, a obesidade pode ser entendida como uma doença crônica multifatorial, definida como o acúmulo excessivo de tecido adiposo no organismo decorrente do balanço energético positivo (OMS 1998; Sichieri 1998).

A Organização Mundial de Saúde (OMS) indica a antropometria como o método mais útil para identificar pessoas obesas, sendo considerado barato, não invasivo, universalmente aplicável e com boa aceitação pela população. O Índice de Massa Corporal (IMC = Peso (kg) / Estatura (m^2)) é o indicador antropométrico mais utilizado em estudos epidemiológicos para classificação do estado nutricional de indivíduos em baixo peso, eutrófico, sobrepeso e obeso. Apesar do IMC apresentar uma boa correlação com a adiposidade corporal total, este não permite avaliar os compartimentos teciduais, tais como: músculo, gordura, ossos e fluídos corporais (OMS 1995; OMS 1998). Entretanto, a facilidade da sua mensuração favorece a sua utilização em estudos epidemiológicos (Anjos 1992).

Há uma variação nos pontos de corte do IMC utilizados na classificação do estado nutricional dos indivíduos. Essa diversidade, possivelmente, influencia as estimativas de prevalência do excesso de peso em populações, dificultando a comparação entre estudos. Em 1998, a OMS definiu os seguintes pontos de corte: sobrepeso, indivíduos com IMC entre 25 e 30 kg/m² e obesos, indivíduos com IMC superior a 30 kg/m² (OMS 1998). Por sua vez, o *Institute of Medicine* (IOM) dos Estados Unidos da América (E.U.A) estabeleceu o ponto de corte de 26,1 – 29 kg/m² para o

sobrepeso e superior a 29 kg/m² para obesidade. Os pontos de corte adotados pelo IOM correspondem a 90, 120 e 135 do percentual de adequação do peso/estatura do *Metropolitan Life Insurance Company* do E.U.A de 1959 (Institute of Medicine 1990). Os pontos de corte do IOM são comumente utilizados na avaliação do estado nutricional de gestantes. Mais detalhes sobre a utilização da classificação do IOM estão descritos na seção 1.5.

1.2 Magnitude e efeitos deletérios da obesidade

Atualmente, a obesidade assume expressão epidêmica em todo o mundo, sendo considerada um importante problema de saúde pública tanto em países desenvolvidos como em desenvolvimento (OMS 1998). Um estudo de base populacional realizado nos E.U.A entre 2003 e 2004 revelou que 31,1% e 33,4% da população masculina e feminina, respectivamente, foi classificada como obesa e que a prevalência de obesidade aumentou significativamente, entre 1999 e 2003/04, principalmente nas camadas populacionais de baixa renda (Ogden et al. 2006). Inquéritos realizados em alguns países da América Latina e Caribe também revelaram altas prevalências de obesidade em adultos de baixa renda, sobretudo em mulheres (OMS 1995).

No Brasil, os inquéritos do Estudo Nacional de Despesa Familiar (ENDEF) e Pesquisa Nacional sobre Saúde e Nutrição (PNSN) nas décadas de 70 e 80, respectivamente, mostraram um aumento de 53% na prevalência de sobrepeso na população geral e um aumento de 70% na prevalência de obesidade entre mulheres (Coitinho et al. 1991). Abrantes e colaboradores (2003) baseados nos dados da Pesquisa sobre Padrões de Vida (PPV), realizada pelo Instituto Brasileiro de Geografia e Estatística (IBGE) em 1996/97 revelaram que a prevalência conjunta de sobrepeso e obesidade é maior no sexo feminino. Aproximadamente 40% das mulheres das regiões Nordeste e Sudeste, com 20 anos ou mais de idade, apresentavam sobrepeso ou obesidade.

Em um estudo de coorte que avaliou o IMC pré-gestacional de mulheres que freqüentaram o Sistema Único de Saúde (SUS) para consultas pré-natais, em seis principais capitais do país, foi estimada uma prevalência de 22,3% de sobrepeso e 6,6% de obesidade (Nucci et al. 2001). Outro estudo de coorte, com mulheres entre 15 e 45 anos, residentes no Município do Rio de Janeiro, revelou uma prevalência, baseada no IMC pré-gestacional de 10,4% de sobrepeso e 6,1% de obesidade (Kac & Velásquez-Meléndez 2005). O acréscimo na prevalência de sobrepeso e obesidade e sua velocidade de aumento são fatores preocupantes devido ao incremento na morbi-mortalidade da população feminina em decorrência de doenças que se associam ao excesso de peso (Kac & Velasquez-Melendez 2003).

A literatura aponta que a obesidade está associada ao desenvolvimento de doenças cardio-vasculares, diabetes, infertilidade, entre outras (Al-Azemi et al. 2004; Conard et al. 2006; Hu 2003). Mulheres obesas, em especial as que possuem concentração de gordura abdominal, desenvolvem irregularidades no ciclo menstrual, amenorréias e apresentam mais problemas durante a gravidez, como a síndrome hipertensiva, toxemia e diabetes gestacional (Catalano & Ehrenberg 2006; Cedergren 2004; Dietl 2005; Linne 2004).

1.3 Fatores relacionados à obesidade feminina

A compreensão acerca da etiologia da obesidade e da suscetibilidade ao aumento excessivo de peso ainda é incompleta, mas sabe-se que envolve a integração de fatores genéticos, metabólicos, fisiológicos, sociais, comportamentais e culturais. Portanto, pode-se assumir que obesidade se desenvolve devido à interação do genótipo com o ambiente (OMS 1995).

Segundo Gigante e colaboradores (1997), os determinantes da obesidade diferem entre os sexos. Na literatura destacam-se alguns fatores possivelmente associados ao ganho de peso em mulheres em idade adulta, incluindo os fatores genéticos (Allison et al. 1997), fatores sociais e

culturais (Kuskowska-Wolk & Bergstrom 1993), a idade (Belahsen et al. 2004), o tabagismo, o estilo de vida sedentário (OMS 1995), o comportamento alimentar (Miller 1991), a auto-imagem (Silva 1995), a paridade (Coitinho et al. 2001), o ganho e a retenção de peso durante e entre as gestações (Coitinho 1998; Gore et al. 2003; Kac et al. 2004; Linne et al. 2002; Linne & Rossner 2003) e a menopausa (Milewicz et al. 2001).

Embora existam diversos fatores de risco para a obesidade feminina, o presente estudo não tem a pretensão de citar, nem tampouco discorrer, sobre todos esses possíveis determinantes, detendo-se, apenas, às considerações acerca dos fatores relacionados à experiência reprodutiva, mais precisamente, ao ganho de peso excessivo durante a gestação e, conseqüentemente, à retenção de peso no pós-parto.

1.4 Ganho de peso gestacional

O ganho de peso gestacional é um indicador antropométrico freqüentemente usado para avaliação nutricional de gestantes. A informação sobre o ganho de peso materno possibilita avaliar o crescimento fetal, uma vez que é mais sensível ao estresse nutricional agudo durante a gestação do que outros indicadores antropométricos (Krasovec & Anderson 1991; OMS 1991; Yekta et al. 2006).

Existem vários indicadores utilizados para avaliar o ganho de peso gestacional na literatura. O ganho de peso total é o indicador mais comumente utilizado, entretanto não permite diferenciar os componentes do ganho de peso, como o peso do feto, as reservas de gordura materna, a massa magra materna, o volume sangüíneo e de água e outros componentes necessários para um bom resultado gestacional (Krasovec & Anderson 1991). Uma apreciação mais detalhada sobre a diversidade de indicadores de ganho de peso, bem como as diferentes medidas utilizadas para

computá-los e suas implicações para os resultados de pesquisas, encontra-se no primeiro produto desta tese (artigo I).

1.5 Recomendações para o ganho de peso durante a gestação

O ganho de peso adequado durante a gestação é fundamental para que se obtenha resultados gestacionais favoráveis, relacionados ao binômio mãe-feto. O ganho de peso deve ser suficiente para cobrir os requerimentos da gestação e favorecer a amamentação e recuperação materna (Krasovec & Anderson 1991). O estabelecimento das recomendações do ganho de peso tem como objetivo principal reduzir o risco de baixo peso ao nascer (BPN) e da mortalidade infantil e favorecer o crescimento do feto sem, contudo, ocasionar trabalho de parto prolongado e retenção de peso no pós-parto (Institute of Medicine 1990).

Na década de 20, as mulheres eram orientadas a ganhar, no máximo, 6,8 kg com o propósito de evitar complicações no parto (Abrams & Laros 1986). Com o passar dos anos, ampliou-se o conhecimento a respeito da associação entre o ganho de peso gestacional e seu efeito no peso do concepto e no padrão de crescimento e desenvolvimento infantil (Singer et al. 1968), conseqüentemente, houve um grande incremento nas recomendações de ganho de peso (Feig & Naylor 1998). Mais recentemente, os estudos confirmaram essa correlação direta entre o ganho ponderal e o peso ao nascer (Scholl et al. 1995; Thorsdottir & Birgisdottir 1998; Thorsdottir et al. 2002). Entretanto, as pesquisas apontaram, também, que essa correlação apresenta um platô, pois o ganho excessivo de peso parece não contribuir para o desenvolvimento e crescimento do feto, ao passo que aumenta o risco de sobrepeso e obesidade materna após o parto (Lawrence et al. 1991; Scholl et al. 1995).

Apesar das recomendações de ganho de peso variarem entre os países, parece haver uma tendência nas pesquisas nacionais e internacionais em utilizar a recomendação proposta pelo IOM, a

qual varia em função da adequação do IMC pré-gestacional. O IOM recomenda um ganho de 11,5 a 16,0 kg para mulheres com o IMC pré-gestacional normal e um ganho de peso maior e menor para as mulheres com baixo peso (12,5 – 18,0 kg) e sobrepeso (7,0 – 11,5 kg) antes da concepção, respectivamente (Institute of Medicine 1990).

Em relação às mulheres obesas, o IOM preconiza um ganho de peso de, no mínimo, 6,8 kg. Devido à escassez de evidências, o IOM não estabelece um limite máximo de ganho de peso, o que dificulta a aplicação clínica das recomendações nesta população. Alguns estudos observacionais têm adotado as recomendações para mulheres com sobrepeso como sendo um limite apropriado de ganho de peso para mulheres obesas (Bianco et al. 1998; Wolff 2005).

Desde sua publicação em 1990, diversos estudos têm avaliado a adequação das recomendações do IOM (Abrams et al. 2000; Cogswell et al. 1995; Keppel & Taffel 1993; Parker & Abrams 1992; Schieve et al. 1998; Schieve et al. 1998; Schieve et al. 2000; Thorsdottir et al. 2002). Ainda que autores refiram que o ganho ponderal preconizado pelo IOM esteja associado a resultados favoráveis relacionados aos recém-nascidos e às gestantes, a recomendação não foi alcançada pela maioria das mulheres estudadas (Abrams et al. 2000; Nucci et al. 2001; Rooney & Schauberger 2002; Schieve et al. 1998). Os estudos indicaram que entre 21% a 53%, das mulheres apresentaram ganho ponderal acima do recomendado (Caulfield et al. 1996; Gunderson et al. 2000; Hedderson et al. 2006; Olson & Strawderman 2003; Strychar et al. 2000).

1.5.1 Fatores relacionados ao ganho de peso excessivo durante a gestação

O ganho ponderal excessivo parece ser atribuído ao desequilíbrio entre o gasto e o consumo de energia durante a gestação (Bergmann et al. 1997; Institute of Medicine 1990). O balanço energético, por sua vez, sofre influência de diversos fatores fisiológicos, constitucionais e

ambientais (Institute of Medicine 1990), alguns modificáveis mediante alterações no estilo de vida, como a dieta adequada e atividade física regular.

A literatura sobre mudanças no estilo de vida ocorridas durante o ciclo reprodutivo revela que a gestação parece ser um fenômeno associado ao abandono ou redução da prática de atividade física (Evenson et al. 2004; Mottola & Campbell 2003; Zhang & Savitz 1996). Os principais fatores relacionados ao abandono da atividade física são: presença de um filho pequeno, apresentar IMC pré-gestacional acima de 25 kg/m^2 ou elevada taxa de ganho de peso e a ocorrência de alterações fisiológicas e posturais durante a gestação (Clarke & Gross 2004; Mottola & Campbell 2003; Symons Downs & Hausenblas 2004) A falta de tempo é a principal justificativa para o abandono da atividade física durante o período de pós-parto (Symons Downs & Hausenblas 2004).

As recomendações nutricionais para as mulheres aumentam durante a gestação (Institute of Medicine 1990; 1992). Portanto, é comum mulheres reportarem, durante esse período, um aumento no consumo energético como resultado do incremento da demanda nutricional. Entretanto, parte desse aumento é proveniente de aspectos culturais relacionados à gravidez, como por exemplo: *"comer por dois*" ou *"comer dobrado"* (Carruth & Skinner 1991; Clark & Ogden 1999), que contribuem para o balanço energético positivo. Desta forma, pode-se conjecturar que a diminuição do nível de atividade física aliada ao aumento do consumo calórico torna a gestação e o puerpério, momentos importantes para o ganho de peso excessivo (Ohlin & Rossner 1994; Rossner 1992).

Convém apontar que o ganho ponderal excessivo não está relacionado apenas ao desequilíbrio energético, mas também às particularidades de cada gestante, tais como: ação hormonal, idade, paridade, entre outras. No caso de ganho de peso excessivo é importante avaliar se este é, realmente, devido ao aumento de massa corporal, à retenção de líquido ou à gestação gemelar, pois cada situação exige intervenções clínicas diferenciadas (Institute of Medicine 1990; 1992).

1.5.2 Conseqüências do ganho de peso gestacional excessivo para a saúde materno-infantil

O ganho ponderal excessivo durante a gestação está associado a complicações maternas e fetais, a saber: macrossomia fetal, a qual está relacionada ao aumento do risco de desproporção cefalopélvica; trabalho de parto prolongado; parto cirúrgico (fórceps ou cesarianas); diabetes gestacional; pré-eclâmpsia; trauma fetal; asfixia e morte (Ray et al. 2001; Scholl et al. 1995; Stotland et al. 2004; Young & Woodmansee 2002). Essas associações parecem ser mais freqüentes em mulheres de baixa estatura (<157 cm), particularmente no que diz respeito à desproporção cefalopélvica (Institute of Medicine 1990).

Além do ganho de peso gestacional excessivo, a obesidade materna também é um fator de risco para os resultados obstétricos indesejáveis citados acima (Cedergren 2004; Dietl 2005; Kabiru & Raynor 2004; Linne 2004; Nucci et al. 2001; Vahratian et al. 2004). O IMC pré-gestacional elevado pode estar associado, ainda, ao desenvolvimento de infecções no pós-parto (Giuliani et al. 2002; Kabiru & Raynor 2004). Todavia, poucos são os trabalhos científicos que avaliaram a associação entre ganho ponderal e IMC pré-gestacional e os desfechos da gestação relacionados à saúde da mulher. Soma-se, ainda, o fato que o principal foco de atenção dos estudos tem sido direcionado às conseqüências do baixo ganho de peso gestacional para a saúde do recém-nascido, como o BPN, crescimento intra-uterino restrito (CIUR) e prematuridade (Krasovec & Anderson 1991; OMS 1991; OMS 1995; OMS 1995).

Somente nas últimas décadas, o ganho de peso excessivo durante a gestação, por estar intimamente associado à retenção de peso no pós-parto, tem sido considerado um importante problema de saúde pública (Butte et al. 2003; Coitinho 1998; Olson et al. 2003; Rooney & Schauberger 2002). Há evidências de que a retenção de peso excessiva no período do pós-parto ocasiona um aumento do peso corporal. Esse aumento pode persistir ou se intensificar com sucessivas gestações, contribuindo para o desenvolvimento da obesidade em mulheres adultas

(Butte et al. 2003; Coitinho et al. 2001; Gore et al. 2003; Linne et al. 2002; Linne et al. 2003; Rooney & Schauberger 2002; Rooney et al. 2005).

1.6 Retenção de peso no pós-parto

Segundo a terminologia em saúde o *pós-parto ou puerpério* refere-se ao "período desde o parto até o retorno dos órgãos reprodutivos ao estágio morfológico normal antes da gestação. Em seres humanos o puerpério, em geral, dura de 6 a 8 semanas" (DeCs 2004). Entretanto, é recomendado estender a definição do período de pós-parto até um ano, pois várias mudanças fisiológicas relacionadas à gestação podem permanecer até um ano após o nascimento da criança, como por exemplo, a lactação (Mottola 2002). Em virtude da utilização de uma definição mais ampla do termo, observa-se que a literatura científica comumente reporta resultados de pesquisa sobre a retenção de peso durante o período de um ano ou mais após o parto (Keppel & Taffel 1993; Linne et al. 2002; Linne & Rossner 2003; Olson et al. 2003; Rooney & Schauberger 2002).

Em geral, entende-se como peso retido a diferença entre o peso no pós-parto e o peso anterior à gestação. Os valores de peso retido podem variar de acordo com o momento da aferição do peso. Medidas de peso próximas ao parto podem ser influenciadas pela presença de edema (Crowell 1995). A referência temporal para o cálculo da retenção de peso varia segundo a conveniência da obtenção das medidas de peso, dificultando a comparação da magnitude do peso retido entre os estudos.

Outra fonte de variação refere-se ao peso materno antes da gestação. Em geral, utiliza-se o peso aferido durante o primeiro trimestre ou o peso pré-gestacional auto-referido como uma aproximação do peso anterior à concepção (Harris & Ellison 1998). Ambas as medidas estão sujeitas a viéses. Embora o ganho de peso durante o primeiro trimestre seja pequeno (1,0 – 2,0 kg), gestantes propensas a náuseas e vômitos podem apresentar perda significativa de peso no primeiro

terço da gestação, em contraposição, outras podem ganhar uma quantidade expressiva de peso durante esse período (Institute of Medicine 1990; 1992; Krasovec & Anderson 1991). Em relação ao peso auto-referido, é importante considerar que mulheres com baixo peso e sobrepeso tendem a superestimar e subestimar, respectivamente, o peso pré-gestacional (Harris & Ellison 1998; Stevens-Simon et al. 1992).

1.7 Magnitude da retenção de peso no pós-parto

A magnitude do peso retido como resultado da gestação pode variar bastante em função de fatores sócio-demográficos e reprodutivos da população estudada (Wolfe et al. 1997). Pesquisas estimaram que, um ano após o parto, as mulheres retêm, em média, de 0,5 a 4,0 kg (AbuSabha & Greene 1998; Butte & Hopkinson 1998; Keppel & Taffel 1993; Linne et al. 2002; Linne & Rossner 2003; Linne & Rossner 2003; Olson et al. 2003). Apesar da média ser modesta, estudos apontaram que a retenção de peso pode variar de –12,3 a +26,5 kg (Ohlin & Rossner 1994; Ohlin & Rossner 1996). Rossner (1992) reportou que 73% das mulheres acompanhadas em uma Unidade de Tratamento da Obesidade na Suécia reteve, um ano após o parto, 10,0 kg ou mais de peso. Em outras pesquisas internacionais, observa-se que entre 14% a 25% das mulheres estudadas apresentaram retenção de 4,5 kg ou mais, seis meses após o parto (Greene et al. 1988; Parham et al. 1990; Schauberger et al. 1992; Scholl et al. 1995). Um estudo realizado no Município do Rio de Janeiro revelou que a retenção média de peso foi de 4,7; 4,1; 3,4 e 3,1 kg aos 15 dias, 2, 6 e 9 meses de pós-parto, respectivamente (Kac et al. 2003).

Ainda não existe consenso sobre o estabelecimento de um ponto de corte para definir o excesso de peso retido ao término da gestação. Estima-se que a média do ganho de peso total durante a gestação seja em torno de 12,0 kg, dos quais 3,0 - 3,5 kg representariam o peso do feto a termo, 3,0 kg seriam referentes ao aumento uterino e das glândulas mamárias, do líquido amniótico

e da placenta, 0,5 a 1,0 kg seriam referentes à retenção de líquido e 3,5 - 4,0 kg referentes ao depósito de tecido adiposo materno (Gueri et al. 1982). Portanto, espera-se que uma mulher retenha, aproximadamente, 4,0 kg do ganho de peso gestacional total após o nascimento do bebê. Acredita-se que parte do peso retido seja utilizada para sustentar o período de lactação (Institute of Medicine 1990; Krasovec & Anderson 1991; OMS 1991). Também existem consideráveis questionamentos quanto à definição de um período ideal para o retorno ao peso pré-gestacional (Gunderson & Abrams 1999). Em geral, espera-se que a mulher retorne ao seu peso habitual por volta do sexto mês pós-parto (Crowell 1995; Worthington-Roberts & Williams 1989). No entanto, apenas 37% das mulheres, em média, conseguem perder o peso ganho durante a gestação ao longo desse período (Rooney & Schauberger 2002).

1.7.1 Perda de peso durante o pós-parto

A perda de peso ao término da gestação é muito variável. Há evidências de que imediatamente após o parto as mulheres perdem de 4,5 a 6,0 kg. Essa perda de peso é atribuída ao nascimento da criança e aos produtos da concepção (Crowell 1995; Worthington-Roberts & Williams 1989). Devido a algumas alterações hormonais as mulheres, freqüentemente, apresentam retenção de líquido durante os três primeiros dias após o parto. Entre o final da primeira e início da segunda semana, as mulheres eliminam o líquido retido através da diurese e da transpiração, apresentando uma perda de peso 2,0 a 3,6 kg (Crowell 1995; Gunderson & Abrams 1999; Singh et al. 1983). Sugere-se que a aferição do peso materno por volta da segunda semana após o nascimento da criança sofra menor influência da retenção de líquido, em relação às medidas de peso mais próximas ao parto (Singh et al. 1983). Em torno da sexta semana de pós-parto, algumas mulheres podem perder metade ou mais do ganho de peso gestacional líquido (Gunderson et al. 2001; Schauberger et al. 1992).

Poucos estudos têm descrito de forma minuciosa a evolução do peso materno após a gestação. De forma geral, observa-se que a perda de peso apresenta o seguinte padrão: acentuada redução de peso durante o período inicial do puerpério e posterior desaceleração na velocidade de perda (Ohlin & Rossner 1990). Pesquisas indicaram que a maior taxa de perda de peso ocorre nos primeiros três meses de pós-parto (Institute of Medicine 1992). Entre o intervalo de 3 a 6 meses essa taxa parece sofrer um relativo decréscimo (Kac et al. 2003; Kramer et al. 1993). Ainda não está bem definido na literatura o padrão da perda de peso a partir do sexto mês de pós-parto.

É conveniente salientar que durante o período do pós-parto o peso corporal materno pode apresentar diversas mudanças. Destacam-se duas principais alterações: a perda do peso retido com retorno ao peso pré-gestacional, ou o insucesso na perda do peso gestacional associado ou não a um ganho de peso adicional durante o pós-parto (Institute of Medicine 1991; Ohlin & Rossner 1990; Parham et al. 1990; Rooney & Schauberger 2002).

1.7.2 Determinantes da retenção de peso no pós-parto

A literatura aponta diversos fatores de risco para retenção de peso no pós-parto. Entre eles destacam-se o nível sócio-econômico, a escolaridade materna, a situação conjugal, a idade, a raça, a paridade, o intervalo interpartal, o estado nutricional anterior à gestação, a magnitude do ganho de peso gestacional, a lactação e os hábitos de vida (Boardley et al. 1995; Kac 2001; Kac et al. 2004; Linne et al. 2002; Ohlin & Rossner 1994). Vale frisar que muitas das associações citadas acima ainda estão sendo investigadas.

Entre os fatores sócio-demográficos, as mulheres de baixo nível socioeconômico e baixa escolaridade (Gore et al. 2003; Kac et al. 2004; Ohlin & Rossner 1994), solteiras (Janney et al. 1997) e com 30 anos ou mais de idade (Kac et al. 2004; Kac et al. 2003; Ohlin & Rossner 1990) apresentam as mais elevadas retenções de peso. Alguns estudos têm dedicado especial atenção à

associação entre raça e retenção de peso no pós-parto (Boardley et al. 1995; Keppel & Taffel 1993; Parker & Abrams 1993). Os resultados desses estudos apontaram que, mesmo após o ajuste por algumas variáveis de confusão como paridade e trabalho materno, as mulheres negras parecem reter mais peso que as brancas. Todavia, cabe ressaltar que mais pesquisas com rigoroso controle das variáveis socioeconômicas são necessárias para que se possa fazer forte inferência sobre tal associação.

Também merece comentário a associação entre a paridade e a retenção de peso, pois os resultados das investigações sobre o tema ainda são contraditórios (Kac 2001). Estima-se que 1,0 kg ou mais de peso seja retido após cada gestação, representado um ganho de peso de 0,4 a 1,8 kg a mais em relação ao esperado devido à idade (Greene et al. 1988; Smith et al. 1994; Wolfe et al. 1997). Em contrapartida, algumas pesquisas apontam que as mudanças de peso após a gestação estão mais relacionadas à idade do que à paridade (Ohlin & Rossner 1990; Rookus et al. 1987). Adicionalmente, é importante considerar que a paridade parece estar relacionada com a ocupação e com o nível de atividade física materna. Mulheres com maior número de filhos praticam menos atividade física e mais freqüentemente estarão desempregadas (Moss & Carver 1993).

No tocante ao intervalo interpartal, embora o IOM (1990) recomende um intervalo de, no mínimo, 24 meses entre as gestações para garantir bons resultados gestacionais, uma publicação recente apontou que o ganho de peso gestacional e a retenção de peso no pós-parto não diferiram segundo as categorias de intervalo inferior e superior a 24 meses entre as gestações (Linne & Rossner 2003).

Parece haver uma associação entre o IMC pré-gestacional e o ganho de peso durante a gestação e a retenção de peso no pós-parto. Em geral, as mulheres com IMC pré-gestacional elevado apresentam maior risco para o ganho de peso gestacional excessivo (Carmichael et al. 1997; Nucci et al. 2001). Pesquisas sugerem, também, que quanto maior o IMC materno, maior o

peso retido no pós-parto (Boardley et al. 1995; Coitinho et al. 2001; Parham et al. 1990). Gunderson e colaboradores (2001) constataram que o IMC pré-gestacional não está relacionado às mudanças de peso no início do puerpério. Todavia, os dados sugeriram que o estado nutricional anterior à gestação está fortemente associado à perda de peso no pós-parto tardio. Mulheres com IMC normal ou baixo peso perderam 4,0 kg a mais quando comparadas às mulheres com sobrepeso ou obesidade dois anos após o parto.

O ganho de peso durante a gestação tem sido descrito como um dos mais importantes determinantes para a retenção de peso no pós-parto. A literatura sobre o tema vem sistematicamente reportando que, quanto maior o ganho ponderal, maior a retenção de peso (Boardley et al. 1995; Butte et al. 2003; Gunderson et al. 2000; Kac et al. 2004; Linne & Rossner 2003; Rossner & Ohlin 1995; Schauberger et al. 1992; Scholl et al. 1995; Thorsdottir & Birgisdottir 1998). Segundo Muscati e colaboradores (1996), não somente o ganho de peso total é um importante preditor da retenção de peso, como também a evolução do mesmo. Os autores revelaram que o ganho de peso durante as primeiras vinte semanas da gestação parece exercer maior influência na retenção de peso no pós-parto.

Há resultados controversos em relação ao papel protetor da lactação sobre a retenção de peso no pós-parto. Se por um lado estudos apontam que a lactação não tem efeito (Rookus et al. 1987) ou possui um efeito mínimo na perda de peso (Coitinho et al. 2001; Janney et al. 1997; Ohlin & Rossner 1996; Olson et al. 2003), por outro lado alguns pesquisadores têm sugerido que as mulheres que amamentam seus filhos durante seis meses apresentam uma perda de peso significativa no período de pós-parto (Dewey 2004; Dewey et al. 1993; Kac et al. 2004; Sarkar & Taylor 2005). Entretanto, essas pesquisas apresentam algumas limitações, tais como a natureza transversal de alguns estudos e a dificuldade de aferição da intensidade da lactação e das mudanças de estilo de vida que, freqüentemente, ocorrem durante a gestação e o pós-parto (Linne 2002).

Alguns autores postulam que as recomendações energéticas diárias para mulheres durante a lactação são muito elevadas e, possivelmente, anulam o efeito protetor da lactação sobre a retenção de peso (Brewer et al. 1989). Os resultados divergentes e os problemas metodológicos encontrados nas pesquisas indicam a necessidade de ampliação dos programas de investigação sobre o tema.

No que diz respeito aos hábitos de vida, diversos autores têm apontado que o aumento da ingestão de alimentos, o sedentarismo e o abandono do tabagismo estão associados ao ganho de peso excessivo durante a gestação e a retenção de peso no pós-parto (Boardley et al. 1995; Lederman 1993; Linne & Rossner 2003; Ohlin & Rossner 1990; Ohlin & Rossner 1996; Schauberger et al. 1992). Bergamann e colaboradores (1997) observaram um ganho de peso gestacional líquido de 4,6 kg, 6,0 kg e 6,1 kg em mulheres que tiveram baixo, moderado e alto consumo diário de energia, respectivamente. Segundo Ohlin & Rossner (1994) mulheres que reportaram aumento no consumo alimentar durante a gestação e nos primeiros seis meses após o nascimento da criança apresentaram maior risco em reter, pelo menos, 5,0 kg um ano após o parto, quando comparadas às mulheres que mantiveram ou reduziram o seu consumo habitual durante o mesmo período.

Durante a gestação, verifica-se que as mulheres que param de fumar ganham mais peso do que as não fumantes ou fumantes persistentes (Mongoven et al. 1996). Também observa-se que o peso retido após o parto é mais elevado em ex-fumantes, intermediário para não fumantes e mais baixo para as mulheres que não pararam de fumar (Linne et al. 2003).

1.8 Modificação do estilo de vida durante a gestação e pós-parto

Estilo ou hábitos de vida é a forma pela qual uma pessoa ou um grupo de pessoas vivenciam o mundo e, em conseqüência, se comportam e fazem escolhas. O estilo de vida é influenciado por fatores socioeconômicos, educacionais e culturais e desempenha um papel central no processo

saúde-doença de indivíduos. Alguns de seus componentes são: tipo de alimentação, padrão de atividade física, consumo de álcool, fumo e estresse. Estes componentes têm sido alvo de programas e políticas de saúde no âmbito da prevenção primárias de uma série de doenças crônicas, incluindo a obesidade. Os programas de modificação de estilo de vida pretendem reforçar a conduta em saúde para que os indivíduos possam proteger, manter ou promover o seu próprio estado de saúde através de uma dieta apropriada, da prática regular de atividade física e do abandono do tabagismo e do consumo excessivo de álcool (Green & Kreuter 1990).

A seguir, procura-se mapear as possíveis repercussões das mudanças no estilo de vida, relacionadas ao padrão de atividade física, à dieta e ao hábito de fumar durante a gestação e puerpério, no ganho de peso gestacional e na retenção e perda de peso no pós-parto.

1.8.1 Atividade física

Freqüentemente considerados como equivalentes, os termos "*atividade física"* e "*exercício físico"* não são sinônimos. Segundo Caspersen e colaboradores (1985) atividade física é qualquer movimento corporal produzido pela musculatura esquelética, que resulte em um gasto energético maior do que os níveis de repouso, enquanto que exercício físico é toda atividade física planejada, estruturada e repetitiva que tem por objetivo a melhoria e a manutenção da aptidão física, como aumento da resistência, da força física e da flexibilidade e mudanças na composição corporal. Entretanto, a separação entre exercício físico intencional e organizado e atividade física é complexa. Caminhar ou andar de bicicleta para ir e voltar do trabalho pode ser definido como atividade física, uma vez que o indivíduo realiza esta ação para executar uma tarefa, ao invés de fazê-la para a aptidão física (Weller & Corey 1998). No entanto, pesquisas têm demonstrado que a aptidão física melhora tanto com a atividade física como com o exercício. Portanto, indivíduos que têm um estilo de vida fisicamente ativo podem estar em boa forma física e apresentar melhor nível de saúde, sem necessariamente realizar o que se entende por exercício. Esta inadequação da definição de exercício

tem levado ao uso cada vez mais amplo da expressão atividade física (Folsom et al. 1985; Weller & Corey 1998).[1]

São reconhecidos os benefícios da prática de atividade física sobre o ciclo vital, sem consenso quanto à gestação e pós-parto (Batista et al. 2003; Dewey & McCrory 1994). Recentemente, muitos relatórios sobre a prática de exercícios físicos durante a gestação e puerpério têm sido publicados (ACOG Committee on Obstetric Practice 2002; Davies et al. 2003; Wolfe et al. 2003), mas não existem recomendações padronizadas de intensidade e freqüência dos exercícios sem prejuízo ao desempenho da gestação (ocorrência de sangramento vaginal, dispnéia, perda de líquido amniótico, trabalho de parto prematuro, diminuição do movimento fetal) e sem comprometimento da lactação. No entanto, na ausência de contra-indicações clínicas recomenda-se a prática de exercícios moderados como natação e caminhada durante 30 minutos/dia ou mais, preferencialmente todos os dias da semana. As atividades recreativas também são recomendadas (ACOG Committee on Obstetric Practice 2002; Davies et al. 2003). Apesar do raro enfoque direcionado ao ganho e à retenção de peso, essas publicações sugerem que a atividade física parece atuar no controle do ganho de peso gestacional e na prevenção da retenção excessiva de peso no pós-parto (ACOG Committee on Obstetric Practice 2002; Davies et al. 2003; Wolfe et al. 2003).

Revisões sistemáticas, com utilização de metanálise, apreciando os efeitos da atividade física durante a gestação, apontaram que o ganho de peso, em média, é inferior no grupo intervenção quando comparado ao grupo controle (Kramer 2003; Lokey et al. 1991). Entretanto, a operacionalização do desfecho nas revisões na forma contínua não permitiu avaliar claramente o

[1] Embora entendendo que exercício e atividade física não são sinônimos é empregado algumas vezes nesta investigação o termo atividade física de uma forma mais abrangente.

impacto das intervenções na prevenção do ganho ponderal excessivo, pois as recomendações de ganho de peso variam de acordo com o IMC pré-gestacional (Institute of Medicine 1990).

Do mesmo modo, ainda existem controvérsias sobre o efeito da atividade física no período de pós-parto. Alguns estudos observacionais apontaram que a prática de atividade física regular após a gestação estava associada a menor retenção de peso um ano após o parto (Linne & Rossner 2003; Olson et al. 2003; Rooney & Schauberger 2002). Por outro lado, estudos de intervenção envolvendo exercícios regulares orientados durante o período do pós-parto não demonstraram benefício quanto à redução de peso e composição corporal quando comparado ao grupo controle. Possivelmente, as mulheres aumentaram o consumo calórico compensando o déficit energético obtido pelo exercício (Dewey et al. 1994; Lovelady et al. 1995). É interessante notar que os estudos podem não ter sido capazes de captar o efeito do exercício em relação às alterações na composição corporal materna, como aumento de massa magra e diminuição do percentual de gordura devido à curta duração da intervenção (Prentice 1994).

Focalizando o impacto do exercício durante a lactação alguns ensaios clínicos não mostraram diferença estatisticamente significativa na composição e no volume do leite entre os grupos controle e intervenção (Dewey et al. 1994; Lovelady et al. 2003). Entretanto, outros estudos experimentais revelaram existir grande concentração de ácido lático no leite após o exercício. O ácido láctico, além de provocar alteração no sabor do leite, possui efeito destrutivo sobre a imunoglobulina A (Wallace et al. 1992; Wallace & Rabin 1991).

1.8.2 Dieta

Apesar do ciclo reprodutivo ser reconhecido como um momento vulnerável ao ganho de peso (Rossner 1992) ainda não foram totalmente estabelecidos os riscos e benefícios do aconselhamento nutricional para o controle de peso durante a gestação e pós-parto.

Alguns autores não recomendam a restrição calórica durante a gestação, mesmo em gestantes obesas. Eles advogam que a gestação não é o melhor momento para a perda de peso e que o controle do ganho ponderal gestacional deve ser feito, apenas, através do aconselhamento nutricional baseado em orientações para uma alimentação saudável e o incentivo à mudança de hábitos alimentares, como o aumento do consumo de alimentos ricos em fibras e diminuição da ingestão de alimentos de alta densidade calórica (Dewey & McCrory 1994; Kramer 1998). Por outro lado, observa-se que, em várias fases do conhecimento obstétrico, tentou-se interferir na dieta das gestantes obesas devido à associação entre o ganho peso excessivo e a ocorrência de pré-eclâmpsia (Abrams & Laros 1986). Mais recentemente, Cedergren (2004) ressalta que os riscos para desfechos adversos associados à obesidade são elevados, justificando o desenvolvimento de programas para a redução do peso antes e durante a gestação. No entanto, outros indicam que gestantes obesas devem ter uma dieta adequada, que não seja hipercalórica para não agravar a condição de obesidade, nem demasiado hipocalórica (≤ 1700 kcal/dia) a ponto de desencadear o jejum celular e a conseqüente produção de corpos cetônicos, situação que pode trazer prejuízo ao desenvolvimento neuropsicomotor do feto (Naeye & Chez 1981) recomendando, portanto uma restrição moderada de energia (Diniz et al. 1995).

Kramer & Kakuma (2004) realizaram uma metanálise avaliando o efeito da restrição calórica em gestantes obesas ou que apresentaram elevado ganho de peso no início da gestação. O estudo constatou que a restrição calórica provocou redução no ganho de peso semanal. Entretanto, a intervenção não teve efeito na prevenção de casos de pré-eclâmpsia e outras complicações associadas ao ganho de peso excessivo. Os autores revelaram, ainda, que a intervenção parece ser prejudicial ao desenvolvimento do feto. É importante notar que o ganho de peso foi tratado como uma variável contínua.

Também existem consideráveis questionamentos sobre qual intervenção é mais efetiva para a perda de peso no pós-parto sem trazer prejuízos à saúde materno-infantil. Alguns estudos indicaram que a dieta combinada ou não à atividade física parece não apresentar efeitos adversos na produção de leite e, conseqüentemente, ao crescimento infantil. (Dusdieker et al. 1994; Leermakers et al. 1998; Lovelady et al. 2000; Lovelady et al. 2001; McCrory et al. 1999). Todavia, Strode e colaboradores (1986) avaliando o impacto da restrição calórica durante o pós-parto encontraram uma redução significativa no número de mamadas em crianças do grupo experimental. Além disso, os autores encontraram redução na produção de leite entre as mulheres que apresentavam consumo energético inferior a 1500 kcal/dia.

Outro aspecto que precisa ser comentado refere-se às recomendações de perda de peso. Apesar do IOM preconizar que nutrizes com sobrepeso ou obesidade não devam perder acima de 2,0 kg/mês (0,5 kg/semana) após o primeiro mês de puerpério, ainda não foi completamente estabelecido o efeito da velocidade da perda de peso no desempenho da lactação (Institute of Medicine 1991; 1992). McCrory e colaboradores (1999) apontaram que a perda de peso de aproximadamente 1,0 kg/semana, em curto prazo, parece não provocar efeitos adversos para saúde materno-infantil. Entretanto, o autor relatou que as conseqüências da rápida perda de peso durante um longo período de tempo ainda não foram totalmente esclarecidas.

1.8.3 Hábito de fumar

A prevalência de mulheres que fumam durante a gestação varia significativamente entre os países (CDC 2004). Em alguns países industrializados como Dinamarca, Suécia e Noruega a prevalência atingiu um pico entre 1983-85 e parece estar declinando de modo constante (Cnattingius 2004). Também nos E.U.A o percentual de mulheres que fumam durante a gravidez caiu de 13,6% em 1996 para 12.9% em 1998. Os maiores percentuais de fumantes foram encontrados entre não-hispânicas, índias americanas e havaianas e em mulheres com baixo nível

socioeconômico e pouca escolaridade. Após o conhecimento da gravidez, 54% das mulheres continuaram fumando (Stratton et al 2001).

No Brasil, o Instituto Nacional do Câncer (INCA) revelou que 90% das mulheres fumantes iniciaram o hábito na juventude e a taxa da incidência de fumar era mais elevada na faixa etária de 20 a 49. O consumo mais elevado de cigarros foi registrado entre os níveis sociais mais baixo, no esdudo de Cabar et al. 2003. Um estudo de coorte realizado em seis capitais brasileiras entre 1991 e 1995 revelou que 17,5% eram fumantes e 22% pararam de fumar durante a gestação (Kroeff et al. 2004).

Pode-se considerar que entre 15% a 30% das mulheres fumantes abandonam o hábito quando engravidam, sem nenhuma intervenção (Cnattingius et al. 1992; Haug et al. 1992; Jane et al. 2000). A taxa de abstinência publicada em ensaios clínicos randomizados em gestantes varia de 5% a 23% (Moner 1994).

Como o fumo aumenta o metabolismo basal em aproximadamente 10%, geralmente ganha-se peso quando se pára de fumar (Filozof et al. 2004; Linne et al. 2002). Este fato desestimula as mulheres a pararem de fumar, levando-as a optar pela manutenção do hábito, pois a expectativa de ganho de peso (3,0 – 5,0 kg), após a suspensão do fumo, geralmente não é tolerado (Gondim et al. 2006; O'Hara et al. 1998; Stratton et al. 2001). Entretanto, durante a gestação as mulheres parecem ser mais susceptíveis a idéia de abandonar um estilo de vida prejudicial à saúde do concepto (Levine et al. 2001).

A conseqüência do fumo durante a gravidez para a saúde materno-infantil está bem registrada na literatura. O fumo é apontado como importante e modificável fator de risco para o baixo ganho de peso gestacional e BPN (Albuquerque et al. 2001; Caulfield et al. 1996; Furuno et al. 2004; Groff et al. 1997; Hellerstedt et al. 1997). Todavia, somente nas últimas décadas, têm-se

abordado o efeito da interrupção do hábito de fumar no ganho de peso gestacional excessivo. As gestantes que param de fumar ganham significativamente mais peso que as não fumantes e fumantes persistentes (Favaretto 2001; Mongoven et al. 1996; Secker-Walker & Vacek 2003) e a interrupção do tabagismo também parece estar associada à retenção de peso no pós-parto (Linne et al. 2003). Vale lembrar que algumas das pesquisas citadas acima não avaliaram o ganho de peso gestacional segundo as recomendações do IOM, que considera o estado nutricional materno anterior à concepção.

A diferença de comportamento, quanto ao ganho de peso na gestação, de mulheres fumantes, não fumantes e daquelas que abandonaram o hábito de fumar, não tem recebido a devida atenção (Favaretto 2001). Supostamente, as mulheres que param de fumar apresentam características peculiares em relação aos outros fatores relacionados ao estilo de vida, como dieta, prática de atividade física e consumo de álcool durante a gestação. O resultado da revisão da literatura sobre os hábitos de vida durante a gestação revela que os estudos não contemplam, de forma conclusiva, as diferenças existentes entre esses grupos de mulheres, classificadas segundo tabagismo, apontando para a necessidade de novos estudos nessa área.

2. Justificativa

Há necessidade de um olhar mais atento aos fatores relacionados ao sobrepeso e obesidade na população feminina dentre os quais, destacam-se o ganho de peso excessivo durante a gestação, a retenção de peso no pós-parto e a manutenção do peso retido ao longo da vida e seu acúmulo nas sucessivas gestações.

Existem diversos indicadores utilizados para computar o ganho de peso gestacional e a retenção de peso no pós-parto. Além da diversidade dos indicadores também existem variações nas medidas utilizadas para compô-los e na qualidade dos procedimentos de aferição e registro do peso materno durante o pré-natal e puerpério. Esses fatores dificultam a interpretação e comparação dos resultados de pesquisas sobre o tema e ressaltam a necessidade do aprofundamento metodológico sobre as questões de aferição das principais variáveis de interesse da tese (ganho de peso durante a gestação, retenção e perda de peso no pós-parto).

Dado que um elevado percentual de mulheres não ganham peso de acordo com as recomendações do IOM, torna-se importante a realização de pesquisas que identifiquem gestantes sob risco de apresentar ganho de peso excessivo. A identificação de fatores de risco passíveis de modificação, por sua vez, auxilia a elaboração de estratégias de adesão às recomendações de ganho de peso gestacional. Estudos revelaram que ex-fumantes ganham mais peso durante a gestação em relação às mulheres não-fumantes e fumantes persistentes. Entretanto, as diferenças existentes entre esses grupos de mulheres classificadas, segundo tabagismo, em relação aos demais hábitos de vida, como consumo de álcool, hábito alimentar e atividade física não foram totalmente exploradas na literatura. Ademais, vale apontar que muitos dos estudos observacionais e experimentais que avaliaram o efeito do estilo vida durante a gestação utilizaram o ganho de peso total desconsiderando o IMC pré-gestacional. Conseqüentemente, os estudos prévios não foram capazes

de diferenciar mulheres que necessitavam ganhar mais peso daquelas que deveriam ganhar menos peso. Essa abordagem limitou a avaliação da relevância clínica dos hábitos de vida (dieta, atividade física e fumo) na gênese do ganho de peso excessivo durante a gestação.

Sabe-se que o ganho de peso durante a gestação acima dos limites preconizados pelo IOM é fator de risco para diversos resultados gestacionais negativos, incluindo a retenção de peso entre 6 e 12 meses de pós-parto. Todavia, a importância do ganho de peso, segundo as recomendações do IOM no desenvolvimento do peso materno em longo prazo, ainda precisa ser adequadamente avaliada.

A dieta e a atividade física são estratégias reconhecidas para o controle do peso na população geral, sem consenso quanto ao seu uso em nutrizes. Apesar das tentativas de algumas pesquisas em sumarizar as evidências disponíveis, ainda pesam controvérsias sobre qual estratégia de intervenção é mais efetiva para o tratamento da retenção de peso no pós-parto, sem trazer prejuízos à saúde materno-infantil. Não existem revisões sistemáticas, com utilização de metanálise, abordando o efeito das intervenções isoladas (dieta ou exercício) ou combinadas (dieta e exercício) na perda de peso durante o período de pós-parto. Tendo em vista os resultados contraditórios tanto dos estudos experimentais envolvendo exercícios físicos ou dieta, quanto de ambos, torna-se oportuno e relevante a realização de uma revisão sistemática, com a utilização de metanálise, com a finalidade de buscar evidências para discutir a efetividade das intervenções. Além disso, a avaliação crítica e sistemática da produção científica neste campo pode permitir a compreensão das inconsistências observadas nos achados dos diferentes estudos e fornecer direções para pesquisas futuras.

3. Objetivo

3.1 Objetivo geral

- Avaliar o impacto do estilo de vida materno no ganho de peso durante a gestação e na sua evolução durante o pós-parto.

3.2 Objetivos específicos

- Descrever os diversos indicadores antropométricos utilizados na avaliação do ganho de peso gestacional e da retenção de peso no pós-parto, bem como a diferente medidas utilizadas para computá-los e analisar suas implicações nos resultados de pesquisas (artigo I).

- Avaliar o impacto da interrupção do fumo durante o pré-natal no ganho de peso gestacional e a inter-relação entre a dieta, atividade física e consumo de álcool, segundo o hábito de fumar materno (artigo II).

- Analisar o efeito do ganho de peso gestacional, segundo as recomendações do IOM, sobre a evolução do IMC materno a longo prazo (**artigo III**).

- Avaliar o efeito da dieta, exercício ou ambos na perda de peso no pós-parto, na composição corporal e aptidão cardiorespiratória materna e no desempenho da lactação (artigo IV).

4. Artigos

Originalmente, os artigos foram escritos em inglês devido ao programa de intercâmbio (Doutorado Sanduíche) realizado na Suécia. No corpo da tese, os artigos de forma resumida estão apresentados em português. Nos anexos, encontram-se os artigos na íntegra.

4.1 Artigo I

Título. Avaliação das mudanças de peso durante e após a gestação: abordagem prática

Amorim AR; Linné Y; Kac G; Lourenço PM

Introdução

A utilidade clínica das medidas de peso coletadas durante a rotina pré-natal para a predição de resultados gestacionais adversos ainda é contestável. A literatura aponta que o ganho de peso gestacional é considerado um indicador antropométrico de baixo custo e de fácil mensuração para o acompanhamento do estado nutricional materno e fetal e para a identificação de mulheres sob risco de apresentarem resultados gestacionais negativos (Institute of Medicine 1990; Schieve et al. 1998). Entretanto, alguns autores advogam que a correlação entre o ganho peso materno e os resultados gestacionais não é forte o suficiente para torná-lo um indicador sensível e específico para a identificação de mulheres sob risco (Dawes & Grudzinskas 1991; Ellison et al. 1997; Honest et al. 2005).

Dawes e Grudzinkas (1991) revelaram que entre as diversas medidas de peso coletadas durante a gestação apenas o peso aferido durante a primeira consulta pré-natal estava significativamente associado ao peso da criança ao nascer. Os autores aconselharam que o peso materno deve ser aferido apenas durante o início do pré-natal e advertiram que o procedimento de

pesagem durante as vistas subseqüentes não é recomendado, pois provoca ansiedade materna. Após a divulgação desses resultados alguns obstetras e enfermeiras britânicas mudaram sua conduta em relação a utilidade clínica do acompanhamento do ganho de peso durante a rotina pré-natal (Ellison & Holliday 1997). No entanto, é importante interpretar os resultados de pesquisas cuidadosamente levando em consideração a qualidade da informação e tratamento dos dados.

Vale destacar que a variedade de indicadores utilizada para computar o ganho de peso gestacional e a retenção de peso no pós-parto encontrada na literatura, a qualidade dos procedimentos de aferição e registro do peso materno durante o pré-natal e o método utilizado para estimar a idade gestacional dificultam a interpretação e comparação dos resultados de pesquisas sobre o tema. O objetivo deste artigo é descrever os diversos indicadores de ganho de peso gestacional e de retenção de peso durante o pós-parto, bem como suas vantagens e limitações. Ademais, o artigo discute a qualidade e disponibilidade das medidas de peso materno aferidas durante a gestação e o pós-parto.

Revisão da literatura

Este estudo consiste de uma revisão narrativa da literatura sobre os indicadores antropométricos utilizados para computar as mudanças no peso materno durante a gestação e o pós-parto. Os artigos relevantes foram identificados pelo processo de busca eletrônica através de bancos de dados do MEDLINE e LILACS. Estudos sobre os procedimentos de pesagem materna durante o pré-natal e puerpério também foram considerados. Apenas as publicações em inglês, espanhol e português foram incluídas. Adicionalmente, as listas de referência dos estudos relevantes foram consultadas.

Conclusão

Foram identificados na literatura quatro diferentes indicadores para computar o ganho de peso gestacional, entre eles: o ganho de peso total, a taxa de ganho de peso, o ganho de peso total líquido e a taxa líquida de ganho de peso. O ganho de peso total é determinado pela diferença entre o peso no final da gestação e o peso no início da gestação; a taxa de ganho de peso é definida como ganho de peso total dividido pela idade gestacional em semanas e o ganho de peso total líquido é determinado pela diferença entre ganho de peso total e o peso da criança ao nascer. Por fim, a taxa líquida de ganho de peso é calculada pela divisão do ganho de peso total líquido pela idade gestacional em semanas.

Foram identificados três indicadores utilizados para avaliar as alterações no peso materno durante o pós-parto, tais como: a retenção, o ganho e a perda de peso. Entende-se como peso retido (PR) a diferença entre o peso no pós-parto e o peso anterior à gestação. Assumindo que o peso no pós-parto foi mensurado logo após o nascimento da criança, pode-se dizer que essa medida refere-se ao ganho de peso total líquido. O ganho de peso no pós-parto é calculado pela diferença entre o peso nas primeiras semanas após o parto (Peso t_0) e o peso aferido ao longo do pós-parto (Peso t_1). Resultados positivos indicam ganho de peso e resultados negativos indicam perda de peso. A perda de peso durante o pós-parto, por sua vez, pode ser expressa como: redução absoluta de peso (Peso t_1 - Peso t_0), redução relativa de peso ((Peso t_1 - Peso t_0)/ Peso t_0) , perda percentual do peso retido ((Peso t_1 - Peso t_0)/ PR) e taxa de redução na retenção de peso ((Peso t_1 - Peso t_0)/ Δt).

A escolha do indicador depende fundamentalmente da disponibilidade e qualidade dos dados, dos problemas metodológicos inerentes a cada medida e do custo de sua coleta. Portanto, a interpretação dos resultados de pesquisas que envolvem o ganho de peso gestacional deve levar em consideração as medidas utilizadas como peso inicial e final da gestação, a acurácia do método

empregado para o cálculo da idade gestacional e a inclusão ou não do peso fetal como parte do ganho de peso materno.

O peso aferido durante o primeiro trimestre gestacional deve ser, preferencialmente, utilizado como peso inicial. Na impossibilidade de se coletar esta informação, o peso pré-gestacional auto-referido pode ser empregado como uma medida alternativa (Harris & Ellison 1998). É recomendável a utilização do peso aferido no momento da internação na maternidade como medida do peso final. Na ausência desta informação, o peso aferido até duas semanas antes do parto pode ser utilizado. É questionável a acurácia da data informada sobre a última menstruação quando utilizada para o cálculo da idade gestacional, devido a possibilidade de sangramento no primeiro trimestre ser confundido com a última menstruação e a ocorrência de ciclos longos e/ou irregulares ampliar as diferenças entre idade da gestação e idade da concepção. Em função desses fatores, recomenda-se o uso da ultra-sonografia para a estimação da idade gestacional do recém-nascido (Kramer et al. 1988).

Em relação aos indicadores utilizados para computar as mudanças de peso após o parto, é importante considerar a medida utilizada como *proxy* do peso pré-gestacional, a referência temporal para o cálculo da retenção de peso e a presença do viés *part-whole correlation*. Este viés ocorre quando o ganho de peso gestacional é incluído como variável independente e também é um componente da variável dependente (retenção de peso no pós-parto) (Gunderson & Abrams 1999).

A baixa qualidade dos registros obstétricos é uma das possíveis causas da não associação entre o ganho de peso materno e os desfechos gestacionais encontrada em alguns estudos (Brown, 1996; Ellison et al. 1997; Ellison & Holliday 1997; Harris et al. 1997). Desta forma, é aconselhável que os profissionais de saúde passem por um treinamento para aferição e registro adequado do peso materno e para conscientização sobre a importância clínica do monitoramento do peso ao longo da gestação.

Em suma, para obtermos resultados válidos nas pesquisas, é necessário analisar de maneira crítica a acurácia das medidas de peso coletadas durante a rotina pré-natal e a escolha dos indicadores utilizados para expressar as alterações no peso materno ocorridas durante e após a gestação.

4.2 Artigo II

Título. Ganho de peso excessivo e a interrupção do hábito de fumar durante o pré-natal: a influência dos fatores de estilo de vida modificáveis durante a gestação

Amorim AR; Rössner S; Neovius M; Lourenço PM; Linné Y

Introdução

A associação do hábito de fumar com o ganho de peso gestacional tem sido descrita, embora poucos estudos avaliaram o ganho de peso de gestantes que deixaram de fumar (Mongoven et al. 1996). O hábito de fumar durante a gestação associou-se ao baixo ganho de peso materno (Albuquerque et al. 2001; Furuno et al. 2004), enquanto a interrupção do fumo tem sido considerada fator de risco para ganho de peso gestacional excessivo (Mongoven et al. 1996). Entretanto, alguns estudos avaliaram a correlação entre o hábito de fumar e outros fatores relacionados ao estilo de vida, como dieta e atividade física, e o efeito independente desses fatores no ganho de peso durante a gestação. Apenas um estudo apreciou o efeito da interação entre a interrupção do hábito de fumar e a dieta materna no ganho de peso gestacional. Oposto aos achados anteriores, a abstinência ao fumo durante a gestação não foi significativamente associada ao ganho de peso excessivo (Olafsdottir et al. 2006). Dado a inconsistência dos resultados e a escassez de estudos que abordam o tema, parece oportuno explorar a relação entre o estilo de vida e ganho de peso durante a gestação.

Os objetivos deste estudo foram analisar a associação entre a abstinência ao fumo e o ganho de peso gestacional excessivo, avaliar a relação do hábito de fumar durante a gestação com a dieta, atividade física e o consumo de álcool, e avaliar a contribuição do estilo de vida materno para o ganho de peso gestacional.

Método

Este é um subprojeto inserido em um estudo longitudinal sobre desenvolvimento do peso em mulheres a partir da gestação até 15 anos após o parto. A população do estudo foi constituída de 1.249 mulheres que deram à luz a recém-nascidos vivos a termo em 1984/85 em 14 maternidades na região metropolitana de Estocolmo, Suécia.

Durante a primeira consulta do puerpério, as enfermeiras e obstetras das maternidades selecionadas convidaram as mulheres a participarem do estudo. As mulheres que aceitaram participar do estudo, 6 e 12 meses após o parto, responderam um questionário contendo informações referentes ao estilo de vida antes, durante e após a gestação, tais como: tabagismo, consumo de álcool, atividade física e qualidade e regularidade das refeições. Nestas ocasiões (6 e 12 meses de pós-parto) o peso corporal materno também foi aferido.

O modelo de regressão logística foi utilizado para apreciar a associação entre a interrupção do hábito de fumar e o ganho de peso gestacional excessivo. O ganho de peso excessivo foi definido, segundo as recomendações do IOM, baseado no IMC pré-gestacional materno. Foi calculado o pseudo R^2 para avaliar a capacidade explicativa do modelo.

Resultados

O grupo de fumantes persistente era mais jovem que o grupo de não fumantes e ex-fumantes e apresentou uma alta proporção de mulheres solteiras e com baixa qualidade no padrão alimentar

durante o desjejum. As gestantes não fumantes eram mais velhas e apresentaram maior uma proporção de mulheres casadas e possuíam um estilo de vida mais saudável, quando comparadas com às demais. As mulheres que pararam de fumar durante a gestação também adotaram outros hábitos de vida saudáveis, como o incremento no nível de atividade física e qualidade do desjejum. A abstinência ao fumo foi significativamente associada ao ganho de peso gestacional excessivo, mesmo após o controle pelas variáveis de confusão (OR: 1,8; IC 95%: 1,1/ 3,0; p = 0,023). A capacidade explicativa do modelo foi de 14,0% (pseudo R^2). A contribuição relativa dos fatores relacionados ao estilo de vida para o modelo final foi modesta (13,3%). O IMC pré-gestacional foi a variável que apresentou o maior efeito no modelo. O sobrepeso ou obesidade anterior à concepção triplicou a chance das mulheres ganharem peso acima das recomendações do IOM (OR: 3,3; IC 95%: 1,73/ 6,30; p = 0,000).

Conclusão

Os resultados indicam que ex-fumantes estão sob risco de ganho de peso excessivo durante a gestação e, portanto necessitam de aconselhamento nutricional adicional para manterem o peso conforme os limites recomendados pelo IOM.

4.3 Artigo III

Título. Ganho de peso gestacional excessivo constitui um importante fator de risco para o aumento do IMC a longo prazo – As recomendações são adequadas?

Amorim AR; Rössner S; Neovius M; Lourenço PM; Linné Y

Introdução

O peso corporal aumenta gradualmente durante a vida adulta (Lissner et al. 2000). Entretanto, para algumas mulheres, a gestação pode alterar significativamente a trajetória do ganho de peso (Rossner 1992). Diversos estudos têm confirmado a adequação das recomendações do IOM para desfechos gestacionais positivos (Abrams et al. 2000). Os estudos também revelaram que o ganho de peso gestacional acima dos limites estabelecidos pelo IOM está associado com a retenção de peso durante o pós-parto (Olson et al. 2003; Scholl et al. 1995; Taffel 1986). Em geral, os estudos avaliaram o efeito do ganho ponderal gestacional na retenção de peso durante 6 ou 12 meses após o parto. Apenas dois estudos apreciaram a relação entre o ganho de peso gestacional e a evolução do peso corporal materno a longo prazo (Rooney & Schauberger 2002; Rooney et al. 2005).

No primeiro estudo, Rooney e Schauberger (2002) estimaram o impacto do ganho de peso excessivo durante a gestação na retenção de peso no pós-parto e no IMC materno durante 8-10 anos de seguimento, após o ajuste pela perda de peso durante os primeiros 6 meses de pós-parto. Todavia, a análise não foi ajustada pelo IMC inicial. No segundo estudo, as mulheres foram acompanhadas, em média, por 14,7 anos (10,1 – 16,3 anos). Os autores superaram a limitação do estudo inicial controlando a análise pelo IMC pré-gestacional. Os resultados demonstraram que o ganho de peso gestacional excessivo e a retenção de peso 6 após o parto constituem importantes

fatores de risco para a obesidade durante a meia idade (Rooney et al. 2005). Apesar das contribuições dos estudos anteriores, informações mais detalhadas sobre a evolução do peso materno durante o período de pós-parto ainda são necessárias.

O objetivo deste estudo é avaliar a relevância das recomendações do IOM para o ganho de peso gestacional na evolução do IMC materno a longo prazo, levando em consideração os potenciais fatores de confusão, tais como, o IMC pré-gestacional e a retenção de peso no pós-parto.

Método

A população do estudo foi constituída de 483 mulheres que deram à luz a recém-nascidos vivos a termo, em 1984/85, em 14 maternidades da região metropolitana de Estocolmo, Suécia e foram acompanhadas durante 15 anos (1999/2000), após o nascimento da criança índice.

Durante a primeira consulta após o parto as enfermeiras e obstetras das maternidades selecionadas convidaram as mulheres a participarem do estudo. Até este estágio, o estudo foi considerado retrospectivo, uma vez que as informações sobre o ganho de peso durante a gestação foram coletadas do prontuário médico. Após o nascimento da criança, as mulheres foram monitoradas prospectivamente. As mulheres que aceitaram participar do estudo responderam um questionário, durante 6 e 12 meses do pós-parto, contendo informações referentes ao hábito de fumar, padrão de atividade física e dieta, antes, durante e após a gestação. Também foram incluídas questões sobre o aleitamento materno. Quinze anos após o nascimento da criança, as mulheres foram convidadas a comparecerem ao centro de pesquisa para a aferição do peso corporal e coleta de outras variáveis antropométricas e novamente foram solicitadas a responderem um questionário referente aos hábitos de vida.

Análise de variância (*mixed* ANOVA) foi utilizada para avaliar as mudanças no peso materno anterior à gestação e durante 6 meses, 12 meses e 15 anos após o nascimento da criança. O

modelo de regressão linear multivariado foi utilizado para avaliar a associação entre o ganho de peso gestacional excessivo e o IMC materno a longo prazo.

Resultados

O incremento de peso a partir do *baseline* (peso pré-gestacional) até 15 anos de seguimento foi respectivamente 6,2 kg, 6,7 kg e 10,0 kg para as mulheres que apresentaram ganho de peso gestacional insuficiente, adequado e excessivo (grupo), segundo as recomendações do IOM (p <0,01). A ANOVA revelou um efeito significativo de tempo, grupo e interação entre grupo e tempo. O peso de mulheres que apresentaram ganho ponderal excessivo durante a gestação, quando comparado com o peso das mulheres que apresentaram o ganho ponderal conforme as recomendações, foi significativamente mais elevado em todos os momentos de acompanhamento do estudo (6 meses, 12 meses e 15 anos de pós-parto). O ganho de peso gestacional excessivo permaneceu significativamente associado ao IMC a longo prazo, mesmo após o ajuste por diversos fatores de confusão. O modelo revelou que ganho ponderal excessivo provocou um aumento de 0,72 kg/m^2 no IMC materno após 15 anos de seguimento.

Conclusão

Os achados apontam para adequação das recomendações de ganho de peso gestacional do IOM não apenas para prevenção de resultados gestacionais adversos, mas também para a prevenção da retenção de peso no pós-parto a longo prazo. Possivelmente, as mulheres mais propensas a ganhar peso o fazem na gestação, após e ao longo do tempo e, portanto requerem acompanhamento nutricional. Com o intuito de prevenir a obesidade subseqüente à gestação, os profissionais de saúde devem aconselhar as mulheres a controlarem o ganho de peso gestacional e motivá-las a perderem o peso retido durante o pós-parto.

4.4 Artigo IV

Título. Dieta, exercício ou ambos para a redução de peso em mulheres após o parto

Amorim AR; Linné Y; Lourenço PM

Introdução

A retenção do peso ganho durante a gestação é um fator de risco para a obesidade em mulheres em idade reprodutiva (Linne 2002; Rooney & Schauberger 2002). Sabe-se que dieta e o exercício físico são estratégias reconhecidas para o controle do peso na população geral (OMS 1998). Entretanto, o efeito da perda de peso através dessas estratégias em mulheres durante o pós-parto ainda não foi adequadamente avaliado.

O objetivo primário desta revisão sistemática é avaliar o efeito da dieta, exercício ou ambos na redução de peso em mulheres durante o pós-parto. O objetivo secundário é avaliar o impacto dessas estratégias de intervenção na composição corporal materna, na aptidão cardiorespiratória materna, no desempenho da lactação e em outros desfechos relacionados à saúde materno-infantil.

Método

Estratégia de busca

As seguintes fontes eletrônicas foram incluídas no processo de busca: Cochrane Controlled Trials Register (CENTRAL) e LILACS. Para aumentar a abrangência da revisão, as listas de referência dos ensaios clínicos identificados e das revisões sobre o tema também foram consultadas. Os autores de estudos relevantes e especialistas no assunto foram contatados na tentativa de se obter referências adicionais e ensaios clínicos não publicados.

Critério de seleção

Foram elegíveis para inclusão nesta revisão ensaios clínicos randomizados ou quasi-randomizados, com a utilização de controles concorrentes, sobre programas de intervenção envolvendo dieta e/ou exercício durante o pós-parto.

Foram elegíveis os estudos que incluíram mulheres com idade maior ou igual a 18 anos, sem gestação gemelar, sem doenças crônicas e sem uso freqüente ou regular de medicação que interfira no efeito da intervenção.

Seleção dos estudos e extração de dados

A seleção dos estudos foi realizada de forma independente por três revisores (ARA, YL, LPM) dividida em duas fases. A primeira compreendeu a avaliação dos títulos e resumos de todos os estudos identificados, verificando se cada estudo encontrado cumpriu os critérios para inclusão: tipo de estudo, de participante, de intervenção e tipo de desfecho. Na dúvida sobre a inclusão ou não de um estudo durante a primeira fase, a decisão foi tomada durante a segunda fase que consistiu na avaliação cuidadosa do texto completo dos artigos. Após a implementação dessas duas fases de seleção foi criada uma coleção de estudos para serem realizados os processos de extração de dados e de avaliação da qualidade.

A extração dos dados também foi realizada de forma independente por três revisores utilizando um formulário para a transcrição dos dados, elaborado pelo primeiro autor da revisão (ARA). Diferenças na extração e entrada dos dados entre os revisores foram resolvidas mediante discussão e reavaliação do artigo original.

Avaliação da qualidade

Os estudos foram avaliados segundo os critérios de qualidade especificados no Cochrane Handbook (Alderson et al. 2004). Os critérios de qualidade incluídos foram: o procedimento de

radomização, o mascaramento e o quantitativo das perdas. É conveniente ressaltar que a natureza das intervenções analisadas (dieta e exercício) não permitem a realização de estudos duplo-cegos.

Baseado nos critérios acima especificados, os estudos foram subdivididos em três categorias: A) todos os critérios de qualidade foram obedecidos - baixo risco de viés; B) um ou mais critérios de qualidade foram parcialmente obedecidos - risco moderado de viés; e C) um ou mais critérios de qualidade não foram obedecidos - alto risco de viés.

Análises

Para analisar a magnitude do efeito da intervenção nos desfechos contínuos foram utilizadas diferenças de médias ponderadas (DMP) com intervalo de confiança (IC) de 95% para os valores pós-intervenção ou para as diferenças entre os valores do *baseline* e pós-intervenção. Para as variáveis dicotômicas o tamanho do efeito da intervenção foi expresso como risco relativo (RR) e seu respectivo IC de 95%. Os dados foram inicialmente analisados utilizando o modelo de efeito fixo. Na presença de heterogeneidade entre os estudos, que não foi totalmente explicada pelas análises de subgrupos e de sensibilidade, foi aplicado o modelo de efeito randômico.

Resultados

Mulheres aconselhadas a praticar exercícios aeróbicos durante o pós-parto não perderam, significativamente, mais peso que as mulheres alocadas no grupo controle (DMP: 0,00; IC 95%: -8,63/ 8,63). Entretanto, o exercício aumentou expressivamente a aptidão cardiorespiratória materna (DMP: 7,08; IC 95%: 4,03/ 10,13). Mulheres alocadas no grupo dieta (DMP: -1,70; IC 95%: -2,08/ -1,32) ou dieta e exercício (DMP: -2,89; IC 95%: -4,83/ -0,95) perderam, significativamente, mais peso que as mulheres alocadas no grupo controle. Não houve diferença na magnitude da perda de peso entre grupos dieta e exercício versus dieta (DMP: 0,30; IC 95% -0,60/ 0,66). Nenhuma das

estratégias de intervenção para perda de peso no pós-parto (exercício; dieta; dieta e exercício) provocou efeitos adversos no desempenho da lactação e na saúde materno-infantil.

Conclusão

Os resultados sugerem que é aconselhável a perda de peso durante o pós-parto através da combinação da dieta com exercício físico ao invés da dieta isolada, pois o exercício associado à dieta preserva a massa magra materna e melhora o condicionamento cardiorespiratório, enquanto que a dieta isolada provoca redução da massa magra.

5. Considerações finais

Esta seção foi elaborada com o objetivo de salientar alguns aspectos gerais relacionados ao conjunto de estudos que compõem a tese e também de apresentar algumas reflexões sobre a importância do estreitamento dos laços entre a geração do conhecimento e a elaboração de propostas de ação em saúde para prevenção da obesidade associada ao ciclo reprodutivo.

Baseado na revisão da literatura sobre o ganho de peso gestacional e suas repercussões para a saúde materno-infantil, pode-se afirmar que embora grande parte das pesquisas nessa área apresentem limitações metodológicas, existem evidências substanciais que o ganho de peso adequado está associado a desfechos gestacionais positivos. Destaca-se, que a baixa correlação encontrada em alguns estudos entre ganho de peso e resultados gestacionais é possivelmente fruto da baixa qualidade dos dados. Parece ser fundamental melhorar o monitoramento do ganho de peso durante a rotina pré-natal.

No âmbito da pesquisa, tem-se a expectativa que esta tese contribua para fomentar o debate sobre os hábitos de vida durante o ciclo reprodutivo entre pesquisadores e profissionais que atuam em programas de saúde materno-infantil e para aumentar o conhecimento sobre o tema, que ainda é controverso. Os resultados apontam que mulheres classificadas como obesas ou com sobrepeso anterior à concepção, que pararam de fumar e que não praticaram atividade física apresentam maior risco de ganho ponderal excessivo durante a gestação. O estudo destaca que a identificação oportuna de mulheres sob risco de ganho de peso excessivo possibilita a aplicação de condutas adequadas a cada caso, visando melhorar o estado nutricional materno e suas condições para o parto.

No contexto de elaboração de propostas de ação para a prevenção do ganho de peso excessivo, o estudo aponta que os profissionais de saúde devem encorajar as mulheres a

continuarem ou iniciarem a prática de atividade física durante a gestação e oferecer acompanhamento nutricional às ex-fumantes. É oportuno afirmar que a taxa e o período de abstinência ao tabagismo aumentariam, se as ex-fumantes recebessem atenção diferenciada para o controle de peso durante a gestação e pós-parto.

Dado que as mulheres durante a gestação estão, em geral, mais predispostas a adotar hábitos de vida saudáveis e mais receptivas às orientações fornecidas pelos profissionais de saúde, o pré-natal é visto como um excelente momento para a realização de programas de intervenção. Por conseguinte, os profissionais envolvidos na rotina pré-natal devem utilizar as várias oportunidades de contato com as gestantes para implementação de programas de modificação de estilo de vida e esclarecimento sobre a importância da adesão às recomendações de ganho de peso.

No âmbito dos serviços de saúde é importante destacar que, apesar das conseqüências imediatas do ganho de peso excessivo já serem, de certa forma, conhecidas por grande parte dos profissionais envolvidos no acompanhamento pré-natal, as conseqüências mais tardias relacionadas ao desenvolvimento do peso corporal traduzidas pelo IMC materno ainda merecem atenção. O estudo indica, que mesmo após o controle pelas variáveis de confusão, mulheres que ganharam peso acima dos limites recomendados pelo IOM, quando comparadas às mulheres que ganharam peso segundo as recomendações, apresentaram um aumento de 0,72 kg/m^2 no IMC 15 anos após o parto. Os resultados indicam a relevância das recomendações do IOM, tanto para prevenção de desfechos gestacionais negativos, quanto para a prevenção do sobrepeso materno a longo prazo.

A literatura aponta que as mulheres que ao final da gestação ganharam peso acima do limite recomendado devem ser motivadas a perder o peso retido após o parto. Como sugerido pela metanálise, a dieta aliada à atividade física é a estratégia mais efetiva para perda de peso durante o pós-parto. Esta proposta de incentivo à perda de peso traz como conseqüência a necessidade do prolongamento da atenção à saúde da mulher. Em muitos países, como no Brasil, o pré-natal é

bastante valorizado, mas o foco de atenção no período pós-parto é voltado para o recém-nascido. Portanto, o acompanhamento durante o puerpério deve objetivar tanto o bem-estar do recém nascido, quanto a manutenção da saúde da mulher. Aliado a isto, pode-se conjecturar que as mudanças de estilo de vida adotadas durante o pós-parto podem persistir durante todo ciclo de vida das mulheres. Pelo fato das mulheres possuírem um papel importante nos hábitos alimentares e estilo de vida da família, estratégias de ação para a prevenção e tratamento da obesidade focalizadas nas mulheres podem, em última instância, levar os demais membros da família a adotarem hábitos de vida saudáveis.

Por fim, ressalta-se que as estratégias de ação sanitária devem ser baseadas em atividades de educação em saúde e aconselhamento nutricional adequadas às características maternas passíveis de mudanças. Os profissionais de saúde devem procurar conhecer a estrutura familiar para sugerirem alternativas viáveis de modificação do estilo de vida. As mulheres, após o nascimento da criança, freqüentemente referem falta de tempo para cuidarem da sua própria saúde e para praticarem algum tipo de atividade física. Diante deste cenário, puérperas que possuem, além do recém-nascido, outros filhos na primeira infância, devem ser orientadas a praticar atividade física dentro casa e auxiliadas a matricularem seus filhos em creches. Esta abordagem chama atenção sobre a necessidade de se integrar diferentes profissionais durante o período do pré-natal e do puerpério, através da formação de equipes multidisciplinares envolvendo nutricionistas, obstetras, enfermeiros, profissionais de educação física e assistentes socais, para a prevenção e tratamento da obesidade associada ao ciclo reprodutivo.

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7. Anexos

Review Article

Assessment of weight changes during and after pregnancy: practical approaches

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Abstract

The usefulness of routine prenatal weight measurements in predicting pregnancy outcomes is still a controversial issue. Comparisons among studies and the interpretation of research findings are complicated due to the variety of indicators applied to express maternal weight changes during and after pregnancy. A review of literature was conducted to clarify the definitions and examine the strengths and limitations of methods for measuring gestational weight gain (WG) and postpartum weight changes. The reasons for weak correlations or non-significant associations between gestational WG and maternal and neonatal outcomes were probably owing to poor quality of obstetrics records and selection of wrong indicators to compute gestational WG. The choice of an indicator depends on clinical and research purpose, availability and reliability of data and cost. Considering the health implication of gestational WG, it is necessary to take into account the measurements used as initial and final weight, accuracy of gestational age estimation and the inclusion of fetal weight as part of maternal WG. Regardless of the indicators used to compute the weight changes after delivery, attention is drawn to the approach for designating prepregnancy weight, the time frame of postpartum weight measurements and the use of overlapping variables, which results in bias (part–whole correlation). It is necessary to address criticisms on the accuracy of prenatal weight measurements and the way of expressing the maternal weight changes during and after pregnancy in order to have reliable results from research.

Keywords: pregnancy, postpartum, weight gain, quality of obstetric records.

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Introduction

The clinical utility of gestational weight gain (WG) is still a controversial issue. The growing body of literature indicates that WG during pregnancy is an inexpensive anthropometric indicator to monitor

maternal and fetal nutritional status, predict pregnancy outcomes and identify women at risk (Institute of Medicine 1990; Parker & Abrams 1992; Keppel & Taffel 1993; Schieve *et al.* 1998; Thorsdottir *et al.* 2002). However, some authors have argued that the relationship between maternal WG and pregnancy outcomes is not strong enough to make WG a sensitive or specific screening tool for identifying undesirable outcomes (Dawes & Grudzinskas 1991; Ellison *et al.* 1997; Honest *et al.* 2005).

Dawes & Grudzinskas (1991) showed that among several weight measurements recorded during pregnancy, only maternal weight at booking was significantly associated with infant birthweight. The authors advocated that maternal weight needs to be recorded only at first prenatal visit and the subsequent routine weighing of patients may produce unnecessary anxiety and should cease (Dawes & Grudzinskas 1991). As a result of these findings, British midwives and physicians have changed their attitude towards the usefulness of routinely monitoring WG during gestation (Ellison & Holliday 1997). Caution is advised in interpreting research results. The possible reasons for weak correlations or non-significant associations between gestational WG and maternal and neonatal outcomes are due to the poor quality of obstetrics records and selection of wrong indicators to compute gestational WG (Ellison & Holliday 1997; Ellison *et al.* 1997; Harris *et al.* 1997).

The variety of indicators applied to express maternal weight changes during and after pregnancy, and the quality of prenatal measurements practice, complicate the interpretation of research findings and comparison between studies. This paper will take particular care in clarifying the definition of gestational WG, postpartum weight retention (PWR), gain and loss in examining the strengths and limitations of indicators for measuring maternal weight changes, and their potential use as predictors of pregnancy outcomes. Further, the quality and availability of prenatal weight measurements will be discussed.

Review of literature

This paper consists of a narrative overview of the literature bearing on anthropometric indicators used to compute maternal weight changes during and after pregnancy. Searches of electronic databases (MEDLINE and LILACS) were conducted to identify the relevant articles. Studies about weighing practice during ante and post-natal care were also considered. Publications written in English, Spanish and Portuguese were included. In addition, the citation lists of relevant publications were searched.

Recommendations of gestational WG

In 1990, the Institute of Medicine (IOM) published guidelines on gestational WG based on prepregnancy body mass index [BMI = weight (kg)/height $(m)^2$]. Women with BMI of 19.8–26.0 should gain 11.5–16 kg (25–35 lb) during pregnancy. The target range for desirable gestational WG is higher for underweight women and lower for overweight women (Institute of Medicine 1990).

Recommendations for gestational WG vary according to countries. However, since the release of the IOM guidelines, several studies have demonstrated the appropriateness of gaining weight within IOM recommendations for good pregnancy outcomes in different populations (Parker & Abrams 1992; Keppel & Taffel 1993; Schieve *et al.* 1998; Thorsdottir *et al.* 2002; Yekta *et al.* 2006). The literature on this issue shows a clear tendency of IOM recommendations being broadly adopted, not only in the United States, but also in other countries.

Pattern and composition of gestational WG

Pregnancy is usually divided into three trimesters: first (less than 14 complete weeks' gestation), second (from the 14th to 27th week gestation), and third (from 28th week until delivery). The WG during the first trimester is relatively small and non-linear. After this period, the rate of gain increases significantly and reach a peak in the second trimester. During the third trimester, the rate slows down slightly, then remains constant until the date of delivery (Institute of Medicine 1990; Abrams *et al.* 1995; Carmichael *et al.* 1997b).

Studies concerning the pattern of gestational weight suggested associations with infant outcomes. The studies have found positive relationships between second- or third-trimester WG and birthweight and gestational length (Hickey *et al*. 1996; Carmichael *et al*. 1997a). The composition of WG may also affect gestational outcomes (Butte *et al*. 2003), and distinction between the components of WG should be considered. High rates of gestational WG can be attributed to high fat mass accretion or excessive fluid retention. Each cause is associated with distinct negative outcomes and requires different clinical interventions. The maternal fat accumulation during pregnancy seems to act as a reserve to protect the fetus against nutritional deprivation and ensure lactation after childbirth. Although fat accretion is correlated to fetal size, excessive WG does not greatly enhance fetal growth and pregnancy duration. Instead, it contributes to retention of adipose tissue during postpartum (Lawrence *et al*. 1991; Scholl *et al*. 1995), which is an important predictor of long-term obesity (Kac *et al*. 2004; Linne *et al*. 2004; Rooney *et al*. 2005).

Gestational WG indicators

Total weight gain (TWG) is the most common indicator referenced by literature, which is determined by subtracting initial gestational weight from the weight in late pregnancy. The other indicators are: rate of weight gain (RWG), net weight gain (NWG) and net rate of gain (NRG). The RWG is calculated dividing the TWG by gestational age. NWG is defined as the difference between TWG and infant weight, and NRG is expressed by dividing the NWG by gestational age. Apart from the diversity of indicators, there are also different types of measurements used to compose each indicator. As an illustration, TWG can be computed using as initial measurement self-reported prepregnancy weight or weight recorded during the first gestational trimester. Weight collected at the day of delivery or at the last prenatal visit can be used as a final measurement. Table 1 presents the different ways of measuring and expressing gestational WG.

Decision on which indicator should be applied depends on the outcome of interest. Decision on which measurements should be used relies on the availability and quality of data and particular problems that arise from them.

Taking the association between insufficient WG and low birthweight (LBW) as an example, first, it is essential to bear in mind that LBW can be attributed to prematurity or intrauterine growth restriction (IUGR) (Kramer 1987). Additionally, it is crucial to certify that the WG was calculated considering the last weight measurement during pregnancy, ensuring that women did not gain significant additional weight after that. If the gestational duration was 37 weeks and the total weight was calculated by the 32nd week, the association could be underestimated because of the interval between the last measurement and the date of delivery. Women may experience additional WG which would not be accounted for. This is of great concern, as weight at admission to the maternity unit is not commonly accessible and gestational age at last prenatal visit can be less than gestational age at delivery. Under this circumstance, it is recommended to calculate RWG using gestational age up to the date of last prenatal visit, instead of TWG. Another reason for using RWG is the fact that premature delivery shortens the time of WG. Thus, WG should be expressed independently of the gestational length.

Because the pattern of WG might have an impact on neonatal outcomes (Hickey *et al*. 1996; Carmichael *et al*. 1997a), RWG, particularly for a specific trimester of gestation, may provide a better understanding of fetal growth. However, the data that are needed to calculate trimester weekly WG are difficult to collect.

In addition to adjustment for gestational duration, it is necessary to separate nutritional and non-nutritional contributors, distinguishing the changes in fat stores or lean body mass from weight increase as a result of increase in the size of fetus, placenta and amniotic fluid (Institute of Medicine 1990). Net maternal WG removes spurious association related to part–whole correlation, when the weight of the newborn is included in the dependent (birthweight) and independent (maternal WG) variables (Selvin & Abrams 1996; Gunderson & Abrams 1999). The IOM emphasizes that the use of TWG may provide biased

Table 1. Description of different indicators expressing gestational weight gain and comments on strengths and limitations of measurements used to compose them

Indicator	Total weight gain (TWG)	Rate of weight gain (RWG)
General formula	TWG = Final weight – Initial weight • The most commonly used indicator. It is easy to calculate • This indicator is not able to identify the pattern of maternal WG during pregnancy • Useful to monitor WG because it is computed at the late stage of gestation and intervention cannot be implemented • The total amount of WG depends on gestational length • Used in research and nutritional surveillance	RWG = (Weight T_2 – Weight T_1)/(GA2 – GA1) • Allows to calculate the velocity of WG between two dates • This formula does not require prepregnancy weight • Removes time dependence • Requires an accurate estimate of gestational length • Used in research and nutritional surveillance. Potentially useful for screening and clinical practice when the rate is calculated at a stage of pregnancy that allows interventions
Measurements	1. TWG = Final weight – Prepregnancy weight • Prepregnancy weight is generally difficult to obtain • Allows to assess the amount of WG since the beginning of gestation • Self-reported prepregnancy weight tends to be biased 2. TWG = Final weight – Weight at first prenatal visit • Weight at first prenatal visit is commonly available • Sometimes this measurement cannot be considered as a proxy of prepregnancy weight • May affect the calculation of the total amount of WG when the measurement is recorded after the first trimester 3. TWG = Weight at delivery – Initial weight • Weight at delivery is not commonly collected • Quantifies the total amount of WG during pregnancy • This information is important for research 4. TWG = Weight at last prenatal visit – Initial weight • Weight at last prenatal visit is routinely available • May underestimate the total amount of WG when the measurement is collected several weeks before delivery 5. Adjusted TWG = (Last recorded weight – Prepregnancy weight) + [Weekly 3rd-trimester weight gain × (GA at delivery – GA at last weight)]* • Alternative to calculate TWG when GA at last recorded weight is less than GA at delivery • Requires information about 3rd-trimester WG 6. TWG = Self-reported delivery weight – Initial weight • Is subject to recall bias	1. RWG = (Weight at last recorded 1st trimester visit – Prepregnancy weight)/GA at last recorded 1st-trimester weight* • Used to calculate the 1st-trimester weekly WG† • Two measurements of weight at the 1st trimester are not commonly available 2. RWG = Weight at the end of trimester – Weight at the beginning of trimester/GA at the end of trimester – GA at the beginning of trimester • Weight at the beginning and the end of trimester is not commonly available 3. RWG = TWG/GA at the end of gestation • Assumes linear pattern; however, during the first trimester, WG is non-linear • GA computed at the end of gestation may not coincide with GA at last recorded weight and hence underestimate the rate 4. RWG = TWG/GA at the last weight • Assumes linear pattern; however, during the first trimester, WG is non-linear • Minimize the risk of underestimation of rate

results, as it can overestimate the association between insufficient WG and IUGR (Institute of Medicine 1990). Although NWG can remedy this problem, the best solution is to adjust birthweight for gestational age, by dividing the NWG by the length of gestation (NRG).

In spite of the methodological constraints of published data which inflated the association between gestational WG and IUGR, some high-quality studies still report a positive correlation of WG with gestational age-adjusted birthweight (Kramer 1987; Kramer 2003). This suggests that, although overestimation occurs, true association exists.

In contrast, WG seems to have no impact on length of gestation (Honest *et al.* 2005). According to Kramer *et al.* (1992), previous studies suggesting that low gestational WG increases the risk of preterm birth have suffered from several methodological shortcomings, including use of TWG rather than

Table 1. *Cont.*

Indicator	Net weight gain (NWG)	Net rate of gain (NRG)
General formula	NWG = TWG – Birthweight • Measurements are normally available and it is easy to calculate • Removes the part–whole correlation with birthweight and provides maternal WG • Used in research and nutritional surveillance. However, it is not useful for clinical practice, as birthweight cannot be estimated before delivery and corrections cannot be made during gestation	NRG = NWG/GA • This indicator is not commonly used • Removes part–whole correlation and time dependence of WG • Requires accurate estimation of GA • Used in research
Measurements	1. NWG = TWG – Weight of products of conception • Although birthweight is commonly available, the weights of other components (placenta and amniotic fluid) are not available 2. NWG = Postpartum weight – Prepregnancy weight • Postpartum weight is not often available • It is time dependent of postpartum weight. Weight measured immediately after delivery can be influenced by oedema	1. NRG = NWG/GA at the end of gestation • GA at the end of gestation may not coincide with GA at last recorded weight and hence underestimate the rate 2. NRG = NWG/GA at the last weight • Is recommended to use GA at last weight when NWG is derived from TWG

Table adapted from Institute of Medicine (1990). WG, weight gain; T, time; GA, gestational age; *Formula proposed by Nucci *et al.* (2001); †The same procedure is applied to calculate 2nd- and 3rd-trimester weekly gain: weight gain between two dates within trimester divided by weeks in the interval of measurements. TWG for trimester can be estimated by multiplying specific trimester weekly weight gain by number of weeks during trimesters: 14 for first and second trimester and 12 for third trimester.

NRG, inclusion of induced preterm deliveries and error-prone gestational age measurements based solely on menstrual dates. The authors attempted to carry out a study, based on obstetric database, to overcome these constraints, which showed that TWG was significantly associated with spontaneous preterm birth. Although the relation persisted when WG was expressed as an overall rate, it disappeared when the analysis was based on NRG (Kramer *et al.* 1992).

Not only the diversity of WG indicators, but also the variety of unit used to present results may complicate comparison between studies. While some research findings are shown in kilograms, others are in pounds. Further, there are studies that present results which alternate both units. Of course, one unit of weight can be converted to another, but it would be helpful to communicate results in both units or in a consistent way. This practice would improve the clarity of results and enable easy comparison of the magnitude of gestational WG and PWR among studies.

Gestational age

Although the World Health Organization (WHO) recommends the use of reported last menstrual period (LMP) to estimate gestational age (Alexander *et al.* 1990), some authors contest that this information might be prone to errors due to irregular cycles, delayed ovulation and memory bias. Apart from that, vaginal bleeding during first trimester of gestation can be confused with last menstruation. Estimation of gestational age based on maternal recollection of the LMP results in misclassification of term, preterm and post-term deliveries and incorrect diagnosis of IUGR. This misclassification can, for example, overestimate the RWG in women, who had delivered at term but whose LMP suggests preterm births and underestimates the rate of gain when women delivered their infants at term, but their LMP dates indicate post-term births. For these reasons, gestational age estimated by early ultrasound examination seems to be more accurate (Kramer *et al.* 1988; Savitz *et al.* 2002).

Techniques for estimating prepregnancy weight

In compliance with IOM, weight recorded during a recent preconception visit is the best measurement of calculating weight increase during pregnancy (Institute of Medicine 1990). Nevertheless, this information is not frequently available, and weight recorded in early gestation or self-reported weight is often viewed as a proxy of preconception weight.

Maternal weight recorded during the first trimester of gestation is commonly used to estimate gestational WG. Nevertheless, this measurement does not necessarily reflect prepregnancy weight. Even though WG during the first trimester is relatively small, 1–2 kg (2.2–4.4 lb), compared with other periods, inter-individual variation should be considered. Some women are susceptible to nausea and vomiting at early gestation and may experience significant weight loss during this period, while others can gain a considerable amount of weight (Institute of Medicine 1990). Harris & Ellison (1998) observed mean maternal WG in eight studies that measured bodyweight prior to conception and during early gestation, and showed that WG can range from −3 kg (−6.6 lb) at 9 weeks to +4.5 kg (9.9 lb) at 15 weeks. Moreover, many women book late into prenatal care, so the first prenatal visit, and therefore the first weight measurement, may not be taken during the first trimester (Chng *et al.* 1980).

Harris *et al.* (1997, 1998) have proposed two alternatives to estimate prepregnancy weight. The first one is based on corrections to adjust weight measured at first trimester. This technique consists of calculating standardized estimates of WG during pregnancy and subtracting the weight gained prior to the first measurement. However, this approach assumes that there is little variation among subjects. The second is based on retrospective extrapolation using two measurements of bodyweight taken early in pregnancy to estimate the bodyweight at conception. The most remarkable limitation of this technique is the usual lack of two measurements of weight during the first trimester (Harris & Ellison 1998).

Maternal self-reported weight can also be used as proxy of prepregnancy weight. Although self-reported and measurements of bodyweight are highly correlated, the accuracy of recalled weight varies with socio-demographic characteristics and BMI. Overweight women tend to underestimate their prepregnancy weight, whereas underweight women tend to overestimate it (Stevens-Simon *et al.* 1992). Women with ideal bodyweight are also susceptible to misreport their prepregnancy weight owing to errors from inaccurate scales and inadequate weighing practices (Harris *et al.* 1998).

The errors associated with self-reported weight are diverse: poor weight practice (Ellison & Holliday 1997), inaccurate scales (Harris *et al.* 1998), and recall and prestige bias, which arises from the desire of women to state a weight which conforms to perceived norms (Harris & Ellison 1998). In the face of such limitations, Harris & Ellison (1998) advocate that self-reported weight is inappropriate for use in research, but is probably adequate for use in clinical settings. In contrast, validation studies showed an error of around 1–2 kg (2.2–4.4 lb), and stated that self-reported weight is valid to be used in large epidemiological studies (Gunderson *et al.* 2001). As the appropriateness of self-reported weight is still a controversial issue, it is extremely advisable that research validate the prepregnancy weights in a subsample of women before using this measurement in the main study.

Olson & Strawderman (2003) proposed a procedure to estimate initial weight for women who have started prenatal care in the second trimester. This method is useful when the first prenatal visit occurs after the first trimester of gestation and self-reported weight seems suspect or women do not remember it. The procedure for adjustment consists of categorizing subjects according to trimester of initial weight measurement. All subjects with measured weights at the first trimester are used to develop a linear regression model. The initial weights for those women joining the study in the second trimester are predicted by the resulting equations based on their first measured weight and their weeks of gestation at the time of entry. In order to evaluate the potential bias of this procedure, the authors compared measures (self-reported weights, weights at early gestation and imputed initial weights), using them to calculate BMI category. Within low, normal and obese determined

by measured weight, more than 90% of women self-reported a weight resulting in the same BMI category. However, among those classified in the high-BMI group, 35% self-reported a weight that they were categorized as normal. Among women with imputed weight, 89% had agreement between BMI groups calculated from self-reported and imputed weights, with little variation by BMI categories. Due to the bias in self-reported weight in the high-BMI group, the authors decided to use imputed first-trimester weight for determining gestational WG and BMI category instead of recalled prepregnancy weight (Olson & Strawderman 2003).

Maternal height

In order to calculate the prepregnancy BMI, it is necessary to obtain information about women's height. Maternal height should be measured at first prenatal visit. Nevertheless, the measurement could be undermined by postural changes if it is taken after 20 weeks of gestation (Institute of Medicine 1990). Self-reported height can also be used, but it is subject to bias. In contrast to weight, height is generally over-reported (Stewart 1982; Nawaz *et al*. 2001). The IOM called attention to the negative bias in the self-reported weight, and positive bias in the recalled height can underestimate the BMI to a greater extent (Institute of Medicine 1990).

Pregnancy delivery weight

With the intention of minimizing errors of estimation, it is possible to define delivery weight as the last weight taken within the 2 weeks immediately preceding childbirth (Scholl *et al*. 1995). Another criterion for defining delivery weight is to use measurements taken after 36 weeks' gestation (Fescina 1983). Although after this time point the rate of WG decreases significantly, when considering post-term pregnancy, the interval between measured weight and delivery date can be very large, and consequently underestimates the TWG. In this case, the first option seems to be more appropriate. However, maternal weight at 2 weeks before delivery is not usually available.

Because weight at delivery is not frequently measured and weight at last prenatal visit can be taken a long time before childbirth, self-reported pregnancy delivery weight can also be an alternative to calculate WG. Schieve *et al*. (1999) examined the validity of self-reported delivery weight and found that women reported delivery weight, on average, 0.45 kg (0.98 lb) less than their measured weight registered in medical records. The magnitude of error is less than reported in validation studies of self-reported prepregnancy weight, but likewise, the accuracy of report varied with socio-demographic characteristics and BMI. The level of underreporting increased significantly with increases in prepregnancy BMI, current BMI, pregnancy WG, and weight change from delivery to recall. The authors used this measurement to calculate and categorize WG, and reported that 30 40% of women were incorrectly classified, which ultimately might attenuate the association between WG and birthweight (Schieve *et al*. 1999).

Impact of lack of information on research results

Another relevant issue is that in studies for calculating gestational WG, women are excluded for not having records of all required weight measurements or due to the lack of information on gestational age at birth. The lack of information is because they usually return infrequently to prenatal visits for further care. It may be that excluded women have lower socioeconomic status and are prone to inadequate gestational WG and poor neonatal and maternal outcomes. This exclusion could confound the results.

Furthermore, several studies provide no information about the percentage of adolescents included in the sample. Inclusion of adolescents in the analysis may result in inaccurate estimations of WG, because maternal growth can account for weight increase during pregnancy. According to Gunderson & Abrams (1999), the magnitude of the error depends on the proportion of young teenagers included in the study. In order to have more accurate results, it is advisable to separate adolescents and adults in the analysis.

Accuracy of prenatal weight measurement

Bodyweight is subject to variation, owing to the content of bladder and bowel, amount of clothes and shoes worn, and presence of oedema. Weight taken at delivery is especially influenced by status of the membranes, whether or not they have ruptured. The rupture of the membranes results in raginal discharge of amniotic fluid. All these sources of variation enhance the probability of measurement errors (Institute of Medicine 1990, 1992).

Harris *et al*. (1998) assessed whether the weight data recorded during prenatal care are sufficiently precise for clinical and epidemiological use. The authors investigated the accuracy of weighing equipment and measurements practice recorded in obstetrics notes in 45 prenatal clinics in London. The study showed that beam balance had the highest reliability and validity, whereas scales with spring mechanisms were the least accurate. Nevertheless, only 40% of clinics surveyed had access to beam balance, and the majority of clinics only had bathroom-type scales with spring mechanisms. It is plausible to think that this situation could be worse in other regions or counties, where healthcare resources are scarce to purchase and maintain accurate weighing equipment. The authors also demonstrated that there was a huge variation of scales in use at the clinics, which suggested that there was a lack of standardization in the type of weighing equipment used and, consequently, extensive variation in the accuracy of maternal weight measurements recorded. Most of the maternal weight measurements were inaccurate by around 1–1.5%. Because measurements were taken by trained researchers, the errors were modest. In practice, careless techniques carried out by busy and untrained midwives may be even more inaccurate (Harris *et al*. 1998).

Despite the fact that inaccuracy may damage the usefulness of weight measurements collected during prenatal care in identifying a high-risk mother and determining the recommended WG during pregnancy, the authors postulated that it is still possible that serial weight measurements recorded on invalid scales can offer a useful measure of WG during pregnancy, provided that the scales used are highly reliable and the same set of scales are used on each occasion (Harris *et al*. 1998). Notwithstanding, studies reported that prenatal clinics have more than one set of scales that are routinely used; hence it is unlikely that weight measurements of each woman would be recorded always on the same scale (Ellison & Holliday 1997; Harris *et al*. 1997; Harris *et al*. 1998).

Weighing practice was considered inconsistent and careless, in relation to women's position in weighing platform, and removing heavy external clothes or shoes. Weight measurements collected during routine prenatal care are also prone to seasonal changes due to external clothing worn at different stages of pregnancy. Besides that, there is an extensive variation in recording procedures among midwives (Ellison & Holliday 1997; Harris *et al*. 1998). The quality of recorded data depends on whether variables were self-reported or directly measured. Self-reported variables were subject to selective omission and subjective bias, whereas measured variables, as previously mentioned, were susceptible to inaccurate equipment and poor measurement practice (Harris *et al*. 1997).

Definitions of postpartum weight change

During postpartum, it is possible to calculate three different indicators: weight retention, WG and weight loss. PWR is defined as the difference between weight at some time after delivery and weight prior to pregnancy. The period of time when postpartum weight is collected varies according to the purposes of studies and availability of measurements. It is possible to find studies reporting weight retention at early postpartum (2–6 weeks after delivery) or 6, 9 and 12 months later. The wide range of time frame complicates the comparison between studies and estimation of the magnitude of weight retention (Gunderson & Abrams 1999).

Considering the measurements recorded at late stage of postpartum, it is necessary to make a distinction between pregnancies-related weight and additional WG after delivery. Thus, PWG is calculated as the difference between weight at some time after

delivery and weight immediately after delivery (Gunderson *et al*. 2001). Negative results from this formula imply weight loss. In this case, this indicator is called, absolute reduction (AR) in weight retention. In addition to this indicator, there are other ways of expressing postpartum weight loss, such as: relative reduction (RR), percentage of weight reduction (%WR) (Kac *et al*. 2003), and rate of weight reduction (RWR) (Leermakers *et al*. 1998). The limitations of postpartum weight indicators are the availability of medical records and the difficulty of recruiting postpartum women to research. In order to overcome these drawbacks, some researches use self-reported postpartum weight, which is subject to bias. Tables 2 and 3 provide a description of indicators used to compute PWR and gain/loss, respectively.

Several studies have described that gestational WG has a strong positive correlation with weight retention after delivery (Scholl *et al*. 1995; Kac *et al*. 2004; Linne *et al*. 2004). Gestational WG and PWR are normally derived from the same baseline measurements (prepregnancy weight). Therefore, gestational weight is an intrinsic part of postpartum weight. The use of overlapping variables results in bias due to the part–whole correlation that is similar to correlation between TWG and birthweight. However, there is not yet a satisfactory alternative to amend this statistical problem. Although the association is necessarily inflated by using overlapping variables in a linear regression model, it is a matter of fact that correlation between gestational WG and PWR exists, but the magnitude may be smaller than estimated (Gunderson & Abrams 1999).

Another postpartum weight indicator, proposed by Gunderson *et al*. (2001), called net postpartum weight change, is considered a reasonable option to quantify postpartum WG or loss, when weight at early postpartum is not available. First, it is necessary to calculate the net delivery weight, which is defined as delivery weight (weight at the end of gestation) minus infant birthweight. Then, net postpartum weight change is calculated by subtracting net delivery weight from postpartum weight (Gunderson *et al*. 2001). It is also possible to calculate net gestational gain using these formulae, by subtracting prepregnancy weight from net delivery weight.

Positive results from the net postpartum weight change formula imply weight gain, and negative results imply weight loss. It is important to emphasize that a negative result does not mean that women did not retain weight. The woman might be slightly slimmer at 6 or 12 months postpartum than immediately

Table 2. Description of the indicator expressing postpartum weight retention and comments on strengths and limitations of measurements used to compose it

Indicator	Postpartum weight retention (PWR)
General formula	PWR – Postpartum weight – Weight prior to gestation
	• Affected by the interval of time between measurements
	• Used in research and surveillance
Measurements	1. PWR = Postpartum weight – Reported prepregnancy weight
	• Self-reported prepregnancy weight is generally difficult to obtain and tends to be biased
	2. PWR = Postpartum weight – Weight at first prenatal visit
	• Weight at first prenatal visit is commonly available. However, sometimes this measurement cannot be considered as a proxy of prepregnancy weight
	• May underestimate the amount of PWR when measurement is recorded after the first trimester
	3. PWR = Postpartum weight (t_0)* – Weight prior to gestation
	• Early postpartum weight (t_0)* may be affected by oedema
	• This measurement is influenced by time since delivery (diereses). Weight measured 15 days after delivery seems to be the best time measurement to calculate PWR
	4. PWR = Postpartum weight (t_1)† – Weight prior to gestation
	• E.g. weight measured 1 year after delivery. Late postpartum weight may be affected by weight changes (weight loss/gain)

*Weight measured immediately after delivery; †Weight collected at some time after delivery.

Table 3. Description of the indicator expressing postpartum weight gain and loss and comments on their applications

Indicator	General formula
Postpartum weight gain (PWG)	PWG = Postpartum weight (t_1)* – Postpartum weight (t_0)† • Weight after delivery is not often available • Affected by interval of time between measurements • Positive results imply weight gain. Negative results indicate weight loss. In this case, the indicator is called absolute reduction (AR) • The variants of this indicator are: time when which weight measurement was taken, and use of self-reported weight, which is subject to recall bias • Used in research and surveillance
Absolute reduction (AR)	AR = Postpartum weight (t_1)* – Postpartum weight (t_0)† • This indicator has the same characteristics and applications of the previous one (PWG)
Relative reduction (RR)	RR = [Postpartum weight (t_1)* – Postpartum weight (t_0)†]/Postpartum weight (t_0)† • Affected by the interval of time between early and late postpartum weights • Used in intervention programmes and research
Percentage of weight reduction (%WR)	%WR = [Postpartum weight (t_1)* – Postpartum weight (t_0)†]/PWR • This method indicates the percentage of total amount of weight retained after pregnancy was lost • 100% indicates that the amount of weight retention was totally lost • Used in intervention programmes and research
Rate of weight reduction (RWR)	RWR = [Postpartum weight (t_1)* – Postpartum weight (t_0)†]/Δt‡ • Denotes the velocity of weight loss • Used in intervention programmes and research

*Weight collected at some time after delivery; †Weight measured immediately after delivery; ‡Interval between two postpartum measurements in months.

after delivery, but still be over her prepregnancy weight, especially when weight after delivery is derived from mathematical calculations (weight at delivery – birthweight) instead of directly measured.

Because infant birthweight is part of both total gestational gain and early postpartum weight loss, this approach avoids part–whole correlation bias by removing infant birthweight contribution, enabling the assessment of the amount of weight primarily attributed to maternal bodyweight change (Gunderson *et al.* 2001). However, the limitation of this indicator is the scarce availability of weight measurement at delivery and the no consideration of the weight of the products of conception and oedema. Besides that, the formula is a little more complicated than the previous indicators (e.g. PWG or AR).

Conclusion

To obtain a thorough understanding of the consequence of gestational WG for both mothers and infants, it is crucial to evaluate the total amount of weight gained, the composition and pattern of gain. Therefore, the interpretation of research results requires careful attention on the definitions of gestational duration, period when weight changes are recorded, and the inclusion or not of newborn weight as part of maternal WG (Institute of Medicine 1990; Harris *et al.* 1998). Clinicians and researchers must be familiar with the different indicators available to compute pregnancy WG and their limitations.

Although measurements of bodyweight recorded during the first trimester or self-reported prepregnancy weight may provide an acceptable indication of preconception weight, the best alternative is to recruit and weigh women before they become pregnant (Harris & Ellison 1998). It is worth noting that this alternative might be unreasonable, considering the limited financial support given to research. In addition, 28–50% of pregnancies are unplanned, which restricts prepregnancy recruitment (Henshaw 1998; Matteson *et al.* 2006; Sedgh *et al.* 2006). Likewise, although weight measured within 2 weeks of delivery or after 36 weeks' gestation can minimize errors of WG estimations (Institute of Medicine 1992; Scholl *et al.* 1995), the best option still is to encourage

healthcare providers to measure all parturient women at hospital admission, which is a standard procedure in some countries, for example in Sweden.

Many of the measurements and estimations of weight are subject to errors owing to inaccurate equipment and poor measurement practice and recording procedures. Complex indicators may result in errors of larger magnitude, and these sources of errors probably undermine the utility of weight measurements for clinical and epidemiological use (Ellison & Holliday 1997; Ellison *et al*. 1997; Harris *et al*. 1997, 1998), and may explain why some studies based on obstetrics database found a weak association between gestational WG and some obstetrics and neonatal outcomes. Even though misleading records may underestimate study results, it does not mean that the true association does not exist. Compelling evidences from meta analysis representing information on over 111 000 births in 25 studies from 20 countries indicated the strength of maternal anthropometry in predicting fetal outcomes and its relative weakness in predicting maternal outcomes. Some important maternal outcomes, however, were not assessed, such as: lactation performance, PWR and general morbidity (WHO 1995). It is important to highlight the necessity of adequate weighing equipment and trained healthcare providers capable of measuring and recording accurately changes in maternal bodyweight during and after pregnancy. Elaboration of a meticulous guideline providing information to midwives about the usefulness of weight measurements during prenatal, and on how to measure and register maternal bodyweight changes correctly, might improve the quality and utility of obstetrics records. Although the implementation of weighing training imposes an additional cost to the healthcare system, this training is not onerous (Villar & Bergsjø 2002) compared with the potential benefits of the early identification of women at increased risk of negative pregnancy outcomes.

A number of practical implications can be drawn from this review: (1) beam balances should be preferably used instead of scales with spring mechanisms; (2) women should be weighed without heavy clothes and shoes; (3) bodyweight recorded up to 13 weeks' gestation should be used as an initial weight in the equation of total gestational WG; (4) when lacking information about maternal weight at early gestation, self-reports can be used after appropriate validation; (5) preferably, weight at delivery should be used as a final measurement; and (6) when delivery weight is not available, maternal weight recorded at 2 weeks before delivery can be used.

In summary, it is necessary to address criticisms on the accuracy of weight measurements during prenatal care and the way of expressing the maternal weight changes during and after pregnancy, in order to have reliable results from research, screening, intervention policy and clinical practices bearing these issues.

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Anexo II. Excessive weight gain and prenatal smoking cessation: the influence of modifiable lifestyle factors during pregnancy (Artigo II)

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Abstract

Objectives The objectives of this study are to appraise the association between smoking cessation and excessive gestational weight gain (GWG); to evaluate the relationships between diet, physical activity and alcohol consumption and smoking during pregnancy and; to assess the contribution of these modifiable lifestyle factors to excessive GWG. **Methods** This is a follow-up study of 1.249 women who delivered children in 1984/85 in Stockholm, Sweden. Multivariate logistic models were used to evaluate the association between smoking cessation and excessive GWG according to the Institute of Medicine (IOM) recommendations, based on pre-pregnancy BMI. **Results** Smokers were younger, more likely to be single mothers and reported low quality of breakfast. Non-smokers were older, more likely to be married and had a healthier lifestyle. Quitters also adopted other healthy practices during pregnancy (e.g. improvement in their physical activity level and their breakfast quality). Smoking cessation was significantly associated with excessive GWG even after controlling for potential confounding factors (OR: 1.8; CI: 1.1, 3.0; p = 0.023). The relative contribution of lifestyle factors to the pregnancy weight gain was modest (13.3%). Pre-pregnancy BMI had the strongest effect on pregnancy weight development in the model. Being overweight/obese prior to conception triplicated the likelihood of excessive weight gain during pregnancy. **Conclusions** These findings suggest that quitters are at risk of excessive GWG and require additional dietary advice to follow IOM recommendations of weight gain.

Key words: lifestyle factors, smoking, pregnancy, weight gain

Introduction

Gestational weight gain (GWG) within Institute of Medicine (IOM) recommendations has been found to decrease the risk of negative pregnancy outcomes in different populations (1). Studies have systematically shown that excessive weight gain is associated with fetal macrosomia, pre-eclampsia, gestational diabetes and more frequent cesarean sections (2-7).

Although the recommendations have been widely adopted in the United States and other countries, research findings indicate that a large number of women gain weight outside the IOM guidelines during pregnancy. The percentage of women who had excessive GWG varied from 21.0% to 53.0%, according to the characteristics of the studied population (6, 8-11). Nonetheless, few studies have investigated the reasons why the majority of women are not able to adhere to IOM guidelines (12). Previous studies showed that lifestyle factors have an impact on GWG (9, 13). The studies also suggested that physical activity level, food habits and consumption of alcohol tend to be different according to smoking status during pregnancy (14, 15). However, the complex relationships between these factors on GWG are not fully understood. Apparently, all pregnant women who quit smoking do so because of concerns about fetal well-being (16) and they might also be further motivated to adopt other healthy lifestyle practice during pregnancy.

Studies regarding smoking habits during pregnancy have mostly focused on the comparison between smokers and non-smokers and only a few analyses have considered women who quit smoking. Earlier studies have identified smoking during gestation as a risk factor for insufficient maternal weight gain (17-20), and others have found smoking cessation upon pregnancy as a potential predictor of excessive GWG (15, 21). Few studies have appraised the correlates of diet, physical activity and smoking status and their potentially independent effects on subsequent gestational weight development. Only one study was identified in the literature, which has

considered the relationship between smoking cessation and maternal nutrition on GWG (22). Opposite to previous findings (15, 21), smoking cessation was not significantly associated with excessive GWG (22).

Given this conflicting finding and the scarcity of studies addressing this issue, it seems appropriate to explore the relationship of lifestyle factors on weight gain. The identification of risk factors for excessive weight gain in different populations may help identifying groups that could be targeted for interventions. The purposes of this study are: (1) to appraise the association between smoking cessation and excessive gestational weight gain; (2) to describe maternal characteristics associated with prenatal smoking and (3) to evaluate the relationship between diet, physical activity and smoking during pregnancy and the contribution of these modifiable lifestyle factors to excessive weight gain.

Method

Study design and procedures

The Stockholm Pregnancy and Weight Development Study (SPWDS) is a follow-up study of women who delivered children in 1984/85 in Stockholm (23). Two series of studies examining weight development in women and their children were derived from SPWDS: the Stockholm Pregnancy and Women's Nutrition (SPAWN) a 15-year follow-up study and Stockholm Weight Development study (SWEDES) a 17-year follow-up study. The data shown in this article are restricted to the year-long study (SPWDS).

In the original study, women living in the southern metropolitan district of Stockholm, who gave birth in 14 maternity units, with similar clinical routines, were identified after their child had been delivered. Staffs of the maternity units invited women to join the study. Women who agreed to participate attended two weigh-in sessions at 6 months and 1 year postpartum in addition to

postnatal care. On these occasions, they filled out questionnaires about physical activity, eating and smoking habits and other lifestyle factors before, during and after pregnancy. Information about weight development, presence of symptoms or diseases during pregnancy and gestational age was retrospectively collected from routine obstetrics records. Detailed information about the basic year-long study is described elsewhere (24-26). The study was approved by the Ethics Committee of the Karolinska University Hospital. All women provided written informed consent.

Population

The final sample size was 1.249 subjects. Initially, 2.342 women agreed to participate in the study in SPWD. Forty-seven women were excluded due to twin pregnancy, diabetes mellitus, severe energy losses by vomiting or diarrhea and lack of pre-pregnancy weight report, leaving a sample of 2.295 women. After 872 dropouts, 1.423 subjects completed the initial year-long study. For the purpose of this study 174 women were excluded owing to premature delivery (gestational age < 37 weeks), missing information about gestational weight gain, infant birth-weight and smoking habits and age below 18 year.

Drop-outs

An analysis of the characteristics of the women who dropped out was performed and revealed no significant differences between participants and drop-outs concerning pre-pregnancy weight, previous fecundity, high blood pressure, edema, delivery methods, and dietary advice during pregnancy (23). There was a small, but statistically significant difference in age; participants were 29.7 years old and drop-outs were 29.2 years old. However, this small difference is unlikely to be clinically significant. About 38% of the drop-out group and 30% of participants were smokers before pregnancy (24).

Definition of gestational weight gain and lifestyle factors

GWG was calculated by subtracting maternal weight measured at the end of gestation from self-reported pre-pregnancy weight and categorized as: insufficient, recommended or excessive weight gain according to IOM guidelines, which state that underweight women (BMI < 19.8) should gain 12.5 – 18.0 kg, normal weight women (BMI 19.8 -26.0) 11.5 -16.0 kg, overweight women (BMI 26.1 – 29.0) 7.0 – 11.5 kg and obese women (BMI > 29.0) gain at least 6.8 kg (1). Due to few numbers of obese women and lack of recommended upper IOM limit of gestational weight gain for them, overweight and obese women were collapsed into one category. The dependent variable was defined as weight above versus within or below IOM guidelines.

Prenatal cigarette smoking and alcohol consumption were assessed by questionnaires. Women were classified into: non-smokers (who had never smoked), quitters (who had stopped smoking during month 1-3 of pregnancy) and smokers (who had smoked throughout pregnancy). Regarding alcohol consumption the sample was divided into three groups: none (never drinkers), quit (occasional drinkers, who quit drinking socially during pregnancy), yes (drinkers, who continued drinking socially throughout pregnancy). No women reported problems with alcohol consumption or use of illicit drugs.

Dietary patterns were evaluated according to self-perceived meal-time regularity as regards frequency of breakfast, lunch and snacks. Dietary quality was evaluated as frequency of cooked meals and breakfast quality. Breakfast quality was based on food groups consumed and classified into three levels: high (including the three food groups: bread, milk and fruit/vegetables), medium (maximum two of the food groups) and low (maximum one of the food groups). Women were asked about any special food cravings during pregnancy and dietary advice. Women were also questioned if they would like to have received more information about their diet during pregnancy. This question measured the maternal perceived lack of nutritional attention during pregnancy.

Physical activity during leisure time before and during pregnancy was ranked into three levels: inactive (reading or watching TV only), medium (4-6 hours of light activity/wk – walking, cycling or gardening) and high (regular jogging/gymnastics or vigorous exercise). Since there was no significant difference between women who had a medium and high level of physical activity during pregnancy in the univariate and multivariate models predicting excessive weight gain, the variable was collapsed into two levels (active and inactive women). More details about the food habits questionnaire and physical activity assessment can be found elsewhere (25).

Data analysis

Descriptive statistics include means and standard deviations (SD) for continuous variables and frequency distributions for categorical variables. Relationships between categorical variables and gestational weight gain groups were determined by chi-square test. Fisher's exact test was performed where the frequency was low. One-way ANOVA was used to compare means where more than two groups were formed.

The impact of smoking status on excessive gestational weight gain was assessed by multiple logistic regressions. The first procedure in the analysis was to screen all potential predictors individually for relationship to the dependent variable. Variables, which showed p-value ≤ 0.25 in the univariate models, were selected. The selected variables were then gradually introduced into the model. The logistic regression model was also used to calculate the relative contribution of each group of covariates (distal, intermediate and proximal variables) to the full model. The relative contribution of each category was the marginal change in the model chi-square when the category of covariates was introduced to the model. The analyses were performed using Stata 9.0 (StataCorp, Texas).

Results

The mean (SD) age at baseline was 29.7 (4.6), ranging from 18 to 45 years. The majority of women was Nordic citizens (98.4%) and had a normal delivery (89.1%). The mean gestational age and infant birth-weight was 39.7 (1.3) weeks and 3.5 (0.5) kg, respectively. Pre-pregnancy BMI and total weight gain was on average 21.4 (2.6) kg/m^2 and 14.2 kg (4.1), respectively. Of the total sample, 27.4% gained weight above IOM recommendations.

In the study sample, 24.4% of the women identified themselves as current smokers and 8.2% reported smoking cessation during pregnancy. As shown in Table 1, smokers were significantly younger and had the highest frequency of fatigue during pregnancy and being single. In addition, smokers delivered infants with the lowest birth-weight. Quitters had the highest GWG, but delivered infants with the same mean birth-weight as non-smokers.

Table 2 compares the lifestyle characteristics of women according to prenatal smoking status. Non-smokers were more likely to be physically active before and during pregnancy and had more regular eating habits (breakfast and lunch). Smokers had the highest frequency of low breakfast quality score.

The group of women who quit smoking during pregnancy also showed the highest proportion of changing other lifestyle practices. About 4.3% of quitters were inactive before pregnancy and started to practice physical activity during pregnancy compared to 1,4 % and 3.3% among non-smokers and smokers, respectively. However, the group of quitters also had the highest proportion of women (18.5%) who were previously active, but stopped exercising during pregnancy. Furthermore, quitters reported the highest frequency (4.6%) of improvement in their breakfast quality (from low quality before pregnancy to medium or high quality during pregnancy). Conversely, the percentage of women who consumed alcohol throughout pregnancy was higher

among former smokers compared to the others. Interestingly, smokers reported the highest frequency (69.9%) of alcohol abstinence during pregnancy (58.7% and 61.2% for non-smokers and quitters, respectively).

A series of univariate analyses showed that the likelihood of excessive gain declined with increasing maternal age (OR: 0.96; CI: 0.94, 0.99; $p = 0.009$), while the likelihood of gaining more than recommended increased with each additional week of pregnancy (OR: 1.10; CI: 1.0, 1.21; $p = 0.046$) and pre-pregnancy BMI (OR: 1.24; CI: 1.18, 1.30; $p = 0.000$). The univariate analyses also indicated that women who ate snacks or sweets ≥ 3 times/ day, had lunch up to 4 times/ week and reported back pain, fatigue or food craving during pregnancy were more likely to gain above the IOM ranges ($p \leq 0.25$). However, these variables were not retrieved in the final model.

Table 3 displays the results of the full logistic regression model adjusted for several confounding factors. Having a previous child was protective against excessive weight gain. The model indicated that gaining more than recommended was significantly associated with infant birth-weight. Among the biological/ anthropometric factors, overweight/obese women were more likely to exceed the IOM recommendations than normal weight women. In contrast, being underweight was a protective factor against excessive GWG. Women who would like to have received more information about diet during pregnancy were more likely to gain weight above the IOM ranges than women not requesting more information.

Although smoking had no effect on excessive GWG, women who quit smoking during pregnancy had a higher likelihood of over-gaining weight compared to women who never smoked. Moderate consumption of alcohol during pregnancy was not associated with gaining weight above recommendations, but abstinence was a significant protective factor against excessive gain. Finally, the model showed that inactive women were more likely to gain weight above IOM guidelines than women who were physically active.

The explanatory capacity of the model was 14.0% (pseudo R^2). Table 3 shows the relative contribution of each group of factors to the full model. The anthropometric factor (pre-pregnancy BMI) had the strongest effect in the model and its relative contribution (44.3%) was larger than that of the other factors. The relative contribution of lifestyle factors was 13.3%.

Discussion

Smoking cessation was significantly associated with excessive GWG, also after controlling for several other lifestyle factors. This finding is consistent with other studies (15, 21), but not all (22). In the latter study, the authors found that smoking cessation in connection to pregnancy was no longer associated with excessive weight after adjustment for dietary factors. In our study, we examined the relationship among dietary factors and smoking status and GWG extensively, but we did not find any dietary variables to be strongly related to excessive gestational weight gain. It remains uncertain if the lack of association was due to limitations of the questionnaire in capturing maternal food habits.

The results of the multivariate model corroborate earlier research that has verified that women who were overweight/obese before pregnancy, inactive and reported insufficient nutritional counseling during pregnancy were more likely to gain excessive weight (10, 27, 28). Consistent with other studies, parity was protective against excessive weight gain (8, 27). Similar to our findings, Wells et al. showed that drinking moderates amounts of alcohol had a protective effect against gaining weight above IOM recommendations, but this effect was not significant in the multivariate model (27). Another previous research indicated that “social drinkers” had a slight better weight development during pregnancy than abstainers. The study also reported that excessive use of alcohol by pregnant women or their partners was associated with poor gestational weight gain (29). High alcohol intake in pregnancy has been linked to abnormal fetal development as well (30). In this study, we found a significant protective effect of maternal alcohol abstinence against excessive

GWG. However, the effect of suspension and moderate alcohol consumption during pregnancy deserves more detailed investigation.

The specific interest of this study was to identify factors that affect weight gain at a time when they are modifiable or at least susceptible to intervention. Hence, factors such as type of delivery, sex of the infant or receiving dietary advice for weight control after delivery were not considered in the analysis. Even though parity is not modifiable after onset of a given pregnancy, we consider that the identification of non-modifiable factors at early gestation allows health care providers to pay special attention to women at potential risk of excessive weight gain

Although infant birth-weight cannot be directly measured before pregnancy, the rationale for introducing birth-weight as a control variable in the model arose from the existence of part-whole correlation between infant birth-weight and GWG (31). The greater the GWG, the greater the infant birth-weight. In addition, it is important to note that GWG and consequently infant birth-weight is time dependent. The longer the duration of pregnancy the greater the weight gain. In this study, gestational age was associated with excessive GWG, but the variable was no longer significant after controlling for birth-weight.

Among social-demographic characteristics, no variable was significant in the univariate analyses, except age. However, the variable did not remain significant in the multivariate model after controlling for parity. In the IOM report on nutrition during pregnancy is listed several potential confounders and determinants of GWG (1). However, this study has not managed to control for all possible confounders and consequently the contribution of the included variables to the explanatory capacity of the model was somewhat limited (14.0% pseudo R^2).

This study has the advantage of calculating GWG using the weight at the end of gestation measured at the maternity unit. This procedure ensures that the women did not experience additional weight

gain, which was not accounted for. Although one important limitation was the use of self-reported pre-pregnancy weight, which is prone to bias, our previous validation study showed that the information was of good quality (24). Smoking status was also self-reported. However, women were invited by theirs midwives to take part in this study and the staff at the maternity clinic administrated the questionnaires. This procedure probably increased the validity of the answers.

Another limitation of this study was the dropout rate. However, the extensive dropout analyses from previous publications showed that regarding the clinical parameters and social factors there were no significant differences between completers and non-completers. Even though age differed significantly, the clinical importance of this difference is debatable. The sample was reasonably representative of the original cohort (23, 32).

Maternal characteristics differed significantly according to pre-natal smoking status. As in previous studies, smokers were younger and more likely to be single (33, 34). In addition, smokers did not have a regular eating style and were more likely to report low quality of breakfast. It has been reported that smoking is associated with less healthy diets by both pregnant and non-pregnant women (35). Non-smokers were slightly older and were more likely to have a healthier lifestyle. As expected, quitters had adopted other healthy lifestyles, such as: improved physical activity and breakfast quality. Contrary to data from Olafsdottir et al, characteristics of former smokers did not resemble those of non-smokers (22). Surprisingly, smokers were more likely to stop consuming alcohol during pregnancy. There are two likely interpretations of this finding. The first is that smokers underreported their consumption alcohol and the second is that they were concerned about fetal health. Smoking is a well-known risk factor for negative pregnancy outcomes and smoking mothers possibly tried to avoid another risk factor by suspending alcohol consumption.

These findings suggest the limited importance of modifiable pregnancy factors including lack of dietary advice and sedentarism. But, it is important to consider that interventional studies have

shown that nutritional counseling and physical activity are effective strategies to prevent excessive GWG (36, 37).

In this study, about one third of women reported that they would like to have received more information about diet during pregnancy. It is unclear whether the advice given was ineffective, or whether women did not accurately recall the advice they actually received. Because women were asked about dietary advice after delivery, the reverse causality is also a potential concern. Women who gained excessive weight might be inclined to report lack of nutritional attention during pre-natal care. On the other hand, being overweight/obese greatly increased the likelihood of excessive GWG, which underscores the expressive contribution of modifiable factor prior to conception. In terms of early prevention, the findings suggest that women should be encouraged to lose weight before trying to get pregnant.

If the weight increases during pregnancy in former smokers was to the same extent as in non-smokers, the weight gain would not cause physiological and psychological complications. However, this study indicated that smoking cessation almost doubled the likelihood of excessive GWG, which ultimately increases the risk of postpartum weight retention and long-term obesity (38). On the other hand, the literature shows that smoking cessation might reduce the risks of infertility, spontaneous abortion, premature delivery and long-term risks of developing smoking-related cancers and cardiovascular diseases (16). Therefore, the increased weight gain among former smokers does not override the potential benefits of smoking cessation during pregnancy.

This study highlights that women who quit smoking during pregnancy require additional dietary advice to the general population of pregnant women to follow IOM recommendations of weight gain. If caregivers identify women who quit smoking in early pregnancy and give them effective advice to control weight, it might reduce women's fear of excessive GWG related to smoking

cessation and increase the number of quitters (39, 40) and probably postpone the resumption of smoking during postpartum (41).

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Table 1: Maternal characteristics according to smoking status during pregnancy

	Non-smokers	**Quitters**	**Smokers**	*p*
	N = 842	N = 102	N = 305	
Socio-demographic characteristics				
Age (years) [a]	30.1 (4.5)	29.7 (4.6)	28.8 (4.8)	0.000
Nationality [b]				0.658
Nordic	98.1%	99.0%	99.0%	
Non-Nordic	1.9%	1.0%	1.0%	
Civil Status [c]				0.000
Married/ live with someone	95.5%	91.0%	87.7%	
Single/ other	4.5%	9.0%	12.3%	
Occupation during pregnancy [c]				0.293
Employed	90.0%	85.3%	90.5%	
Unemployed/student	10.0%	14.7%	9.5%	
Biologic and reproductive characteristics				
Parity				0.082
No previous child	50.5%	60.8%	55.1%	
Previous child	49.5%	39.2%	44.9%	
Fatigue during pregnancy [c]				0.014
No	83.0%	79.4%	75.4%	
Yes	17.0%	20.6%	24.6%	
Gestational age (wks) [a]	39.8 (1.3)	39.5 (1.4)	39.5 (1.3)	0.002
Infant birth weight (kg) [a]	3.5 (0.5)	3.5 (0.5)	3.3 (0.4)	0.000
Anthropometric characteristics prior to pregnancy				
Height (m) [a]	1.67 (0.6)	1.66 (0.7)	1.66 (0.6)	0.354
Pre-pregnancy BMI kg/m^2 [a]	21.5 (2.6)	21.3 (2.2)	21.4 (2.6)	0.723
Weight gain during pregnancy				
Total weight gain (kg) [c]	14.1 (3.9)	15.4 (4.5)	14.1 (4.3)	0.007
Excessive Weight gain [c]				0.170
No	73.2%	64.7%	73.8%	
Yes	26.8%	35.3%	26.2%	

[a] ANOVA [b] Fisher's exact test [c] Chi-square test

Table 2: Maternal lifestyle characteristics according to smoking status during pregnancy.

	Non-smokers	**Quitters**	**Smokers**	*p*
	N = 842	N = 102	N = 305	
Physical activity				
Level before pregnancy				0.001
Inactive	13.8%	22.1%	20.2%	
Medium	49.9%	50.5%	55.1%	
High	36.3%	27.4%	24.7%	
Level during pregnancy				0.044
Inactive	26.9%	36.1%	34.1%	
Medium	60.1%	55.7%	57.2%	
High	13.0%	8.2%	8.7%	
Activity practice before and during pregnancy*				0.025
Inactive before and during pregnancy	12.6%	17.4%	17.8%	
Active before and inactive during pregnancy	14.9%	18.5%	16.7%	
Inactive before and active during pregnancy	1.4%	4.3%	3.3%	
Active before and during pregnancy	71.1%	59.8%	62.2%	
Food habits				
Breakfast frequency during pregnancy				0.043
0 – 4 times/wk	3.8%	6.0%	7.3%	
≥ 5 times/wk	96.2%	94.0%	92.7%	
Lunch frequency during pregnancy				0.000
0 – 4 times/wk	10.3%	13.7%	25.4%	
≥ 5 times/wk	89.7%	86.7%	74.6%	
Consumption of snacks or sweets between meal during pregnancy				0.788
0 – 2 times/day	62.5%	64.7%	61.0%	
≥ 3 times/day	37.5%	35.3%	39.0%	
Food craving during pregnancy				0.130
No	49.2%	38.6%	47.5%	
Yes	50.8%	61.4%	52.5%	
Frequency of cooked meals during pregnancy				0.540

0 – 1 time/day	40.6%	41.2%	44.3%	
≥ 2 times/day	59.4%	58.8%	55.7%	
Breakfast quality during pregnancy				0.000
Low	22.4%	23.9%	36.3%	
Medium	49.6%	41.3%	42.3%	
High	28.0%	34.8%	21.4%	
Breakfast quality before and during pregnancy*				0.000
Low quality before and during pregnancy	21.0%	20.4%	32.3%	
Medium/high quality before and low during pregnancy	1.1%	1.1%	2.3%	
Low quality before and medium/high during pregnancy	1.2%	4.6%	3.9%	
Medium/high quality before and during pregnancy	76.7%	73.9%	5.5%	
Alcohol consumption during pregnancy				0.000
No	26.3%	15.3%	17.8%	
Quit	58.7%	61.2%	69.9%	
Yes	15.0%	23.5%	12.3%	
Dietary advice during pregnancy				
Dietary advice				0.096
Yes	62.3%	51.0%	61.0%	
No	37.7%	49.0%	39.0%	
Lack of information about diet during pregnancy				0.914
No	69.4%	69.4%	70.7%	
Yes	30.6%	30.6%	29.3%	

Chi-square test performed.

Table 3. Multivariate logistic model for predicting excessive weight gain

Maternal Characteristics	Excessive weight gain		
	OR (95% IC)	*p*	Relative contribution to the model
Parity			Reproductive factors
No previous child	Reference		40.4%
Previous child	0.54 (0.40, 0.73)	0.000	
Birth-weight	3.13 (2.22, 4.40)	0.000	
Pre-pregnancy BMI			Anthropometric factor
Underweight	0.22 (0.14 – 0.34)	0.000	44.3%
Normal weight	Reference		
Overweight/obese	3.30 (1.73, 6.30)	0.000	
Lack of information about diet during pregnancy			Nutritional attention during pregnancy
No	Reference		2.0%
Yes	1.54 (1.13, 2.12)	0.006	
Smoking			Life style factors
Non- Smokers	Reference		13.3%
Quitters	1.80 (1.10, 3.00)	0.023	
Smokers	1.30 (0.89, 1.89)	0.166	
Alcohol consumption during pregnancy			
No	Reference		
Quit	0.60 (0.42, 0.86)	0.005	
Yes	0.74 (0.46, 1.20)	0.225	
Physical activity during pregnancy			
No	1.64 (1.20, 2.25)	0.002	
Yes	Reference		
Pseudo R^2	14.0%		100%

Anexo III. Excess pregnancy weight gain constitutes a major risk for increasing long-term BMI: Are recommendations adequate? (Artigo III)

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Excess Pregnancy Weight Gain Constitutes a Major Risk for Increasing Long-Term BMI: Are Recommendations Adequate?

Amanda R. Amorim,† Stephan Rössner,* Martin Neovius,* Paulo M. Lourenço,† and Yvonne Linné**

Abstract

AMORIM, AMANDA R., STEPHAN RÖSSNER, MARTIN NEOVIUS, PAULO M. LOURENÇO, AND YVONNE LINNÉ. Excess pregnancy weight gain constitutes a major risk for increasing long-term BMI: are recommendations adequate? *Obesity.* 2007;15:?–?.

Objective: The objective was to assess the relevance of the recommendations of the Institute of Medicine (IOM), regarding gestational weight gain (GWG) for long-term BMI development.

Research Methods and Procedures: The Stockholm Pregnancy and Women's Nutrition is a follow-up study of 483 women who delivered children in 1984 to 1985. ANOVA was used to examine the change in body weight before pregnancy, at 6 months, and 1 year postpartum and 15 years after childbirth. Multiple linear regression was used to assess the predictors of BMI at 15-year follow-up.

Results: The weight increase from baseline to 15-year follow-up was 6.2 kg for IOM-insufficient, 6.7 kg for IOM-recommended, and 10.0 kg for IOM-excessive weight gain ($p < 0.01$). ANOVA showed a main effect of time, group and group by time interaction. The weight of the women who had excessive GWG was significantly greater at each time-point of follow-up of those who gained within or below recommendations. GWG was related to BMI at 15-year follow-up even after accounting for several confounders. Women who gained excessive weight during pregnancy had an increase of 0.72 kg/m^2 in long-term BMI compared with women who gained within recommendations.

Discussion: The findings support the adequateness of IOM guidelines, not only for the pregnancy-related health matters, but also for preventing long-term weight retention after delivery. Healthcare providers should give women appropriate advice for controlling GWG and motivate them to lose pregnancy-related weight during postpartum to prevent future overweight.

Key words: BMI, weight change, women's health, pregnancy

Introduction

Weight increases gradually during adult life (1), but for women, pregnancy can significantly alter the future weight gain trajectory (2). A large body of literature has supported the appropriateness of gestational weight gain (GWG)[1] guidelines for positive pregnancy outcomes, suggested by the Institute of Medicine (IOM) (3). Studies have shown that GWG above the range recommended by IOM is associated with postpartum weight retention (4–6). In general, the studies have assessed postpartum weight retention at 6 months or 1 year after delivery. Only two studies have appraised the relationship between GWG and long-term weight development (7,8).

Fn1

In the first study, Rooney and Schauberger estimated the impact of excess pregnancy weight gain on weight retention and BMI at 8 to 10 years follow-up after controlling for weight loss by 6 months postpartum. However, the analysis was not adjusted for initial BM (7). In the second study, women were followed, on average, for 14.7 years (range, 10.1 to 16.3 years). The authors overcame the limitation of the initial study by controlling the analysis for pre-pregnancy BMI. They concluded that excessive gestational weight gain and failure to lose pregnancy-related weight by 6 months postpartum constitute important predictors of obe-

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[1] Nonstandard abbreviations: GWG, gestational weight gain; IOM, Institute of Medicine; SPAWN, Stockholm Pregnancy and Women's Nutrition; PPW, pre-pregnancy weight.

sity in midlife (8). Despite the contribution of their findings, more detailed information on maternal weight changes after pregnancy is warranted. It is also important to consider that the postpartum period may comprise up to the first 12 months after delivery because many physiological changes due to pregnancy remain up to 1 year (9). After delivery, women may experience many social and behavioral changes (10–12), and 6 months might be a too short period to return to pre-pregnancy weight.

The most important limitations of analyzing the role of excessive GWG on long-term weight development are the time interval between the weight measurements and the wide variation of weight changes during the follow-up period. It is paramount to determine if maternal weight at long-term follow-up represents pregnancy weight retention or weight cycling, a regain of weight after an initial loss.

The objective of the present study is to explore the effect of GWG according to IOM recommendations on long-term BMI, accounting for several potentially confounding factors, including postpartum weight changes and pre-pregnancy BMI.

Research Methods and Procedures

Study Design

The Stockholm Pregnancy and Women's Nutrition (SPAWN) is a longitudinal study of women who delivered children in 1984 to 1985 in 14 maternity units in Stockholm, Sweden. In the maternity unit, the staff invited the women to take part in the study at the first control visit after delivery. Up to that point, this study was retrospective in that information about weight development during pregnancy was collected from obstetrics records. Women were then prospectively monitored up to 1 year postpartum and 15 years later. Detailed information about the yearlong study is described elsewhere (13–15). The study comprised the follow-up period from delivery (1984 to 1985) to 15 years postpartum (1999 to 2000).

Participants

The final population was composed of 483 women. The initial population comprised 2342 women but after exclusions and dropouts, 1423 subjects completed the yearlong study. Fifteen years after childbirth, women were tracked by using the national identity number. A total of 269 subjects could not be found. Thus, invitation letters were sent to 1154 subjects, and 563 of these women agreed to participate. Of these, 80 women were excluded due to preterm delivery and lack of information about weight measurements during pregnancy and at follow-up occasions.

A dropout analysis, based on the total sample (n = 2342), showed no significant differences between completers and non-completers in relation to the circumstance of pregnancy, such as fecundity history, high blood pressure, edema, delivery methods, dietary advice during pregnancy, and social factors. However, the completers were older (29.4 vs. 30.0 years) and non-response was more common among non-Nordic citizens. More information about the background of SPAWN and the dropout analyses are published in related articles (16–19).

Definition of Variables

The main outcome variable was BMI at 15-year follow-up and was used as a continuous variable. The major independent variable was total GWG categorized as insufficient, recommended, and excessive weight gain according to IOM guidelines, which are based on pre-pregnancy BMI (20). The IOM suggests that women of normal BMI before pregnancy should aim for a weight gain between 11.5 and 16.0 kg. A slightly higher and lower target range is recommended for underweight and overweight women, respectively. In our study, overweight and obese women were collapsed into one category, because few women were obese and there is no recommended upper limit of GWG for them. Self-reported pre-pregnancy weight (PPW) at first prenatal visit was used to calculate pre-pregnancy BMI. Women were classified according to IOM definitions as: underweight (<19.8), normal (19.8−26.0), and overweight/obese (≥26.1) (20).

Seven different variables were created to explore the postpartum weight changes. The variables are shown in Table 1. Duration and intensity of lactation were expressed in scores (0 to 48 points). Every month with full lactation was given 4 points and every month with mixed feeding was given 2 points (15). This score was used as a rough estimate of the total energy expenditure for milk production but has been suggested to be a reasonable estimate (13,16). The lactation score was explored as a continuous and categorical variable (0 to 9, 10 to 19, 20 to 29, ≥30). Physical activity during leisure time was defined as inactive, 4 to 6 hours of light activity/wk and regular exercise (e.g., jogging, gymnastics). Women were asked about frequency of breakfast, lunch, and snacks; frequency of cooked meals; breakfast quality; and self-perceived change of meal sizes. More details about the food habits questionnaire can be found elsewhere (14). Questions concerning physical activity, eating, and smoking habits were answered for five study periods: before and during pregnancy and 6 months and 1 and 15 years after. T1

Analysis

The analyses were performed using SPSS 11.0 for Windows (SPSS Inc., Chicago, IL) and Stata 9.0 (StataCorp LP., College Station, TX). A mixed ANOVA was applied to examine the change in weight at the four time-points of assessment (before pregnancy, 6 months, 1 and 15 years after pregnancy; within-subjects factor). Between-subjects factor was based on GWG according to IOM guidelines.

Table 1. Definition of postpartum weight variables

Variable	Definition
Δ weight at 6 mo postpartum	Weight at 6 mo postpartum − PPW
Δ weight at1 yr postpartum	Weight at 1 yr postpartum − PPW
Δ weight at 6 mo to1 yr postpartum	Weight at 1 yr − weight at 6 mo
Δ weight at 15 yr	Weight at 15 yr postpartum − PPW
Weight change at 6 mo postpartum*	Derived from Δ weight values at 6 mo postpartum
Below PPW	<−0.5kg
Returned to PPW	Between −0.5 and 0.5 kg
Above PPW	>0.5 kg
Weight change at 1 yr postpartum*	Derived from Δ weight values at 1 yr postpartum
Below PPW	<−0.5 kg
Returned to PPW	Between −0.5 and 0.5 kg
Above PPW	>0.5 kg
Weight changes up to 1 yr postpartum	
Below PPW weight at 6 mo and 1 yr	Below PPW at both time points
Below at 6 and returned to PPW at 1 yr	Below PPW weight at 6 mo and able to return to their PPW by 1 yr postpartum
Kept PPW at 6 mo and 1 yr	Able to return to PPW at 6 mo and maintained their weight up to 1 yr
Above at 6 mo and returned to PPW at 1 yr	Above PPW at 6 mo and able to return to their PPW at 1 yr
Kept over PPW at 6 mo and 1 yr	Above PPW at both time points

* A cut-off point of ±0.5 kg was used because few women who lost weight during postpartum returned to the exactly the same prepregnancy weight at 6 months or 1 year follow-up.

Furthermore, the association between IOM recommended GWG and BMI at 15-year follow-up was assessed by multiple linear regression. The first procedure in the analysis was to screen all potential predictors individually for relationship to the dependent variable. Variables that showed p value ≤0.25 in the univariate analysis were selected. The selected variables were gradually introduced in the model in hierarchical causal position: first, the distal variables; second, the intermediate variables; and last, the proximal variables. To appraise if pre-pregnancy BMI moderates the relationship between GWG and long-term BMI, three different models were fitted. Model I included all significant predictors without considering pre-pregnancy BMI. Model II was similar to Model I except for the inclusion of initial BMI as a continuous variable. Model III accounted for pre-pregnancy BMI as a component of the outcome variable, which was no longer long-term BMI, but the difference between BMI at 15-year follow-up and pre-pregnancy BMI − Δ long-term BMI.

The study was approved by the Ethics Committee of the Karolinska University Hospital, and all participants gave written informed consent.

Results

Characteristics of Women

The socio-demographic and other characteristics of the sample are shown in Table 2. The mean (± standard deviation) age at baseline was 30.0 ± 4.6 years, and 52% of the women had no child before the index pregnancy. The mean gestational length, total GWG, and birth weight were 39.8 ± 1.3 weeks, 14.2 ± 4.1 kg, and 3506 ± 470 g, respectively. The pre-pregnancy BMI was 21.5 ± 2.4 kg/m^2. T2

Postpartum Weight Retention

The mean postpartum weight retention was 1.3 ± 3.5 kg and 0.5 ± 1.3 kg at 6-month and 1-year follow-up, respectively. Thus, women lost a further 0.9 ± 2.2 kg from 6 months to 1 year postpartum. Although the average weight loss was modest, the weight change between 6 months and 1 year postpartum ranged markedly from −8.9 to 7.9 kg. After 6 months 15.1% and after 1 year 33.3% of the women had returned to PPW. All women who returned to PPW at 6 months were able to maintained this weight up to 1-year postpartum (Table 3). T3

Table 2. General characteristics of the sample

Subject characteristics	*N*	%
During pregnancy		
Nationality	483	
Nordic	476	98.5
Non-Nordic	7	1.5
Education	478	
Elementary or high school	256	53.6
University	222	46.4
Civil status	477	
Married/live with someone	449	94.1
Single/other	28	5.9
Prepregnancy BMI	483	
Underweight	108	22.4
Normal weight	355	73.5
Overweight/obese	20	4.1
IOM GWG groups	483	
Insufficient	134	27.7
Recommended	205	42.5
Excessive	144	29.8
At 15 yr follow-up		
Age	483	
<40 yr	48	9.9
40–50 yr	349	72.3
≥50 yr	86	17.8
Lactation score	483	
0–9	58	12.0
10–19	81	16.8
20–29	220	45.6
≥30	124	25.7
Total parity	472	
1 child	50	10.6
2–3 children	378	80.1
≥4 children	44	9.3

Table 3. Postpartum weight changes at 6 and 12 months of follow-up

Weight changes	*N*	%
At 6 mo postpartum	483	
Below PPW	119	24.6
Returned to PPW	73	15.1
Above PPW	291	60.2
At 1 yr postpartum	483	
Below PPW	87	18.0
Returned to PPW	161	33.3
Above PPW	235	48.7
Up to 1 yr postpartum	483	
Below PPW weight at 6 mo and 1 yr	87	18.0
Below at 6 mo and returned to PPW at 1 yr	32	6.6
Kept PPW at 6 mo and 1 yr	73	15.1
Above at 6 mo and returned to PPW at 1 yr	56	11.6
Kept over PPW at 6 mo and 1 yr	235	48.2

The 15-year weight increase was, on average, 7.6 ± 7.5 kg. Table 4 presents the unadjusted mean of long-term weight retention and BMI by subject characteristics. Age, civil status during pregnancy, income at 15-year follow-up, parity, and physical activity at 6 months and 1 year postpartum were not significantly associated with weight development (data not shown).

Educational level was significantly associated with weight retention. Less educated women retained 2 kg more than women who had a university degree. Women with a higher lactation score retained less weight at the three follow-up periods. The *p* values of ANOVA for Δ weight at 6 months, 1 and 15 years and the lactation score were 0.049, 0.039, and 0.002, respectively (data not shown). Women who gained excessive weight during pregnancy had the greater weight increase (10.3 kg) at long-term follow-up and retained 4.1 kg and 3.6 kg more at 15-year follow-up than women who gained less or recommended weight, respectively ($p = 0.00$).

Women who were above their PPW at 6 months or 1 year postpartum retained more weight at 15-year follow-up than women who were able to lose pregnancy-related weight. Women who returned to PPW at 1 year retained 0.3 kg more than those who returned to PPW at 6 months, but the difference was not significant ($p = 0.38$). Likewise, although women who were above PPW at 6 months but were able to return to their PPW at 1 year postpartum retained 1.7 kg more than women who returned to PPW at 6 months, the difference was not statically significant ($p = 0.08$).

The results regarding long-term BMI were similar, with the exception of pre-pregnancy BMI and physical activity at 15-year follow-up, which showed significant effect: women who were inactive and overweight/obese before pregnancy had higher long-term BMI than active and normal or underweight women.

Weight Development After Index Pregnancy

A mixed ANOVA with one repeated measures factor, time (weight before pregnancy, 6 months, 1 and 15 years after), and one between-subjects factor (insufficient, recommended, and excessive GWG) showed a main effect of time [$F(9.024) = 113.728$, $p = 0.000$] and a significant time

Table 4. Maternal long- term weight retention and BMI by subject characteristics

Subject characteristics	Δ weight 15 years (kg)		Long-term BMI (kg/m^2)	
	Mean ± SD	F (*p*)	Mean ± SD	F (*p*)
Education*		3.00		2.67
Elementary/high school	8.6 ± 8.2	0.001	24.7 ± 4.0	0.008
University	6.5 ± 6.7		23.8 ± 3.2	
Prepregnancy BMI		0.34		87.93
Underweight	7.3 ± 6.0	0.715	21.5 ± 2.4	0.000
Normal weight	7.8 ± 7.6		24.8 ± 3.2	
Overweight/obese	6.6 ± 12.5		30.5 ± 5.1	
IOM GWG groups		13.35		22.59
Insufficient	6.2 ± 6.8	0.000	23.5 ± 3.7	0.000
Recommended	6.7 ± 6.8		23.6 ± 3.0	
Excessive	10.3 ± 8.5		25.9 ± 3.9	
Lactation score		5.10		4.93
0–9	10.2 ± 8.6	0.002	25.6 ± 4.7	0.002
10–19	9.2 ± 8.0		25.0 ± 4.0	
20–29	6.9 ± 7.1		23.8 ± 3.4	
≥30	6.6 ± 7.1		24.0 ± 3.2	
Physical activity at 15 yr postpartum		1.41		5.29
Inactive	8.2 ± 8.8	0.246	25.4 ± 4.1	0.005
4–6 hours of light activity/wk	7.9 ± 7.4		24.3 ± 3.7	
Regular activity	6.7 ± 6.8		23.8 ± 3.2	
Weight change at 6 mo postpartum		15.93		9.56
Below PPW	4.8 ± 6.4	0.000	23.6 ± 3.5	0.000
Returned to PPW	6.3 ± 6.6		23.2 ± 3.3	
Above PPW	9.1 ± 7.8		24.9 ± 3.7	
Weight change at 1 yr postpartum		14.26		9.93
Below PPW	5.0 ± 6.7	0.000	23.8 ± 3.5	0.000
Returned to PPW	6.6 ± 6.73		23.5 ± 3.5	
Above PPW	9.4 ± 7.9		25.0 ± 3.7	
Weight changes up to 1 yr postpartum		8.32		5.82
Below PPW weight at 6 mo and 1 yr	4.9 ± 6.7	0.000	23.8 ± 3.5	0.000
Below at 6 mo and returned to PPW at 1 yr	4.7 ± 5.6		22.9 ± 3.6	
Kept PPW at 6 mo and 1 yr	6.3 ± 6.6		23.2 ± 3.3	
Above at 6 mo and returned to PPW at 1 yr	8.0 ± 7.3		24.2 ± 3.6	
Kept over PPW at 6 mo and 1 yr	9.4 ± 7.9		25.0 ± 3.7	

One-way ANOVA was used to compare means.
* Student's *t* test performed.

group interaction [$F(6.129) = 77.237$, $p = 0.000$]. The weight of the women who gained excessive weight during pregnancy was significantly greater at each time-point [main effect of group: $F(10.550) = 870.023$ $p = 0.000$]. The analysis was adjusted for pre-pregnancy BMI.

Long-term BMI

The mean BMI increased significantly from 21.5 ± 2.4 before gestation to 24.3 ± 3.7 kg/m^2 at 15-year follow-up. Fifty-two percent of women remained within the normal range at both time-points, 21.7% of under or normal weight

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women became overweight/obese by the end of follow-up, 1.2% of initially overweight/obese subjects became normal weight, and 3% of women were overweight/obese at both time-points.

In the multivariate regression model, GWG was a significant predictor of BMI at long-term follow-up, even when pre-pregnancy BMI was accounted for as a covariate in Model II or as part of the outcome variable (Δ long-term BMI) in Model III. When adjusting for pre-pregnancy BMI, the effect of GWG on long-term BMI was greatly attenuated but still significant. The Models I and II showed that women who gained excessive weight had an increase of 1.81 and 0.72 kg/m^2, respectively, in long-term BMI compared with women who gained within recommendations. The adjusted R^2 increased significantly from Model I to Model II. The main final model (Model II) was statistically significant and explained 51.3% of the variance in long-term BMI (Table 5).

T5

Women who gained weight above IOM recommendations and had a low educational level had a significantly higher long-term BMI than women who gained within or below recommendations and had a university degree. A higher lactation score was inversely associated with lower long-term BMI. Greater the initial BMI, postpartum retention at 1 year, and weight gain between 6 months and 1 year postpartum, was associated with a greater the long-term BMI.

AQ: B

Other potential confounding variables were tested, but they were not retained in the final model. Age, civil status, nationality, smoking habits, and physical activity at 6 months postpartum and frequency of breakfast and lunch at 15-year follow-up were not significantly associated with long-term BMI in the univariate analyses ($p > 0.25$). Parity, hypertension during pregnancy, frequency of snacks at 1 year postpartum, and physical activity at 1 and 15 years postpartum were significant in the univariate analyses ($p \leq 0.25$); however, they did not show significant effect in the multivariate model. No interaction effect was found between variables.

Discussion

This study shows that excess weight gain during pregnancy is related to higher BMI at 15-year follow-up even after controlling for education, lactation score, pre-pregnancy BMI, weight retention at 6 months postpartum, and weight gain between 6 months and 1 year postpartum. The analysis found that the inclusion of pre-pregnancy BMI in the Model II attenuates the association between GWG and long-term BMI and reduced the coefficient regression from Model I to Model II by more than one-half. Although the GWG was not the major predictor in multivariate model, it still was significantly associated with long-term BMI.

AQ: C

It is argued that total number of children and subsequent gestations after the index pregnancy may have an impact on long-term BMI. However, this effect was not verified in this study. Corroborating our findings, Rooney and Schauberger did not find a significant effect of parity in the multivariate model predicting long-term BMI (7,8).

In addition, the results revealed that high-intensity and frequency of breastfeeding is associated with less postpartum weight retention on all follow-up occasions. However, lactation seems to have a more significant effect at long-term follow-up than short-term. Rooney and Schauberger have found similar results (7). Their study revealed that, although breastfeeding may not have an impact on short-term weight loss, women who breast-fed their infants for at least 3 months had a significantly lower weight gain at 8-year follow-up (7). They also found that short breastfeeding duration is related to high BMI at 15-year follow-up (8). It is possible that women with intensive and lengthy lactation have a high health consciousness and dietary habits that facilitates the long-term weight control, rather than the early energy losses caused by milk production.

Although in the previous publications of the yearlong study Ohlin and Rossner found a weak association between trends in eating and exercising patterns and weight retention (13,14), these behavioral aspects seem have no relationship with long-term BMI. Boardley et al. demonstrated that caloric intake and postpartum physical activity were not significantly associated with weight change over 12 months postpartum in a multivariate model (21). In contrast, Rooney and Schauberger found that participation in aerobic exercise has a nonsignificant effect on short-term weight loss but has a significant impact on long-term BMI (7). Hence, it remains controversial whether lifestyle factors during pregnancy and postpartum period play a role in long-term weight development.

Several methodological problems are involved in the present study, which limited the appreciation of real effect of diet and physical activity. Data were based on reported rather than recorded behaviors. Women are prone to underreport some important behaviors related to weight gain (e.g., alcohol and sweets consumption) (22,23). In addition, the crude questionnaires could not measure such small changes in everyday lifestyle, which still have significant impact on long-term weight development (18).

The other limitation of this study is the use of self-reported PPW. Although women are prone to underestimate their PPW, the validation study showed that the information was reasonable and probably had a minor impact on pre-pregnancy BMI classification (13). Thirty-three percent of the sample lived too far away from the clinic to attend in person and weight and height at 15 years were self-reported rather than objectively measured. However, there were no differences between those who sent in forms and those who visited our unit with respect to pre-pregnancy BMI, weight gain during pregnancy, infant weight, gestational length, weight at 1-year follow-up, age, and BMI at follow-up (18).

Table 5. Multivariate regression of predictor factors of long-term BMI and Δ long-term BMI

	Long-term BMI				Δ long-term BMI	
	Model I		Model II		Model III	
Variable	Regression coefficient (β)	p	Regression coefficient (β)	p	Regression coefficient (β)	p
IOM GWG groups		0.000		0.033		0.042
Insufficient	−0.05 (−0.81, 0.72)		0.01 (−0.56, 0.59)		0.02 (−0.56, 0.59)	
Recommended	Reference		Reference		Reference	
Excessive	1.81 (1.07, 2.57)		0.72 (0.15, 1.30)		0.68 (0.11, 1.24)	
Education		0.028		0.014		0.015
Elementary or high school	0.70 (0.76, 1.33)		0.59 (0.12, 1.06)		0.59 (0.11, 1.06)	
University	Reference		Reference		Reference	
Lactation score	−0.03 (−0.06, −0.01)	0.046	−0.03 (−0.06, −0.01)	0.010	−0.03 (−0.05, −0.01)	0.010
Δ weight at 6 mo postpartum	3.29 (1.35, 5.23)	0.001	2.12 (0.64, 3.57)	0.005	2.06 (0.60, 3.52)	0.006
Δ weight at 6 mo to 1 yr postpartum	4.87 (1.85, 7.89)	0.002	2.96 (0.68, 5.24)	0.011	2.89 (0.61, 5.16)	0.013
Prepregnancy BMI			0.96 (0.86, 1.06)	0.000		
Adjusted R^2	14.0		51.3		14.3	

Model I: Dependent variable (long-term BMI), controlled for gestational weight gain, education, lactation, weight retention at 6 months postpartum and weight gain between 6 months and 1 year postpartum. Model II: Dependent variable (long-term BMI), controlled for gestational weight gain, education, lactation, weight retention at 6 months postpartum, weight gain between 6 months and 1 year postpartum, and prepregnancy BMI. Model III: Dependent variable (Δ long-term BMI), controlled for gestational weight gain, education, lactation, weight retention at 6 months postpartum, and weight gain between 6 months and 1 year postpartum.

The self-reported data were furthermore compared with national self-report data and found to be representative (1).

It has been argued that total GWG, defined by subtracting pre-pregnancy from the weight in late pregnancy, is highly influenced by the interval between the last measurement and the date of delivery. In Sweden, all women have their weight measured and recorded at the maternity unit admission. This procedure ensures that the women did not experience additional, unaccounted weight gain.

The availability of weight at 6 months and 1 year postpartum enabled us to assess the weight cycling during this period. It is worth noting that some women may continue losing pregnancy weight after 1-year follow-up. However, the data on weight change after 1 year postpartum were unavailable. Weight measurements collected in between 1 and 15-year follow-up would help to better understand the maternal weight cycling.

In this study, it would be possible to assess the long-term weight retention using Δ weight at 15 years in a multivariate model. However, GWG and Δ weight are overlapping variables since they were derived from the same baseline measurements (PPW). The use of overlapping variables results in part-whole bias (24,25).

An additional concern in interpreting our study is the large number of dropouts. However, the extensive dropout analyses indicated that, for most variables under study, the remaining women were representative for the initial sample (16–19). Nonetheless, the prevalence of overweight/obesity at baseline in this study was lower than the national prevalence (1). It seems that the higher risk group (overweight/obese women) was not recruited in the follow-up study, which probably underestimated our findings.

The prevalence of obesity in Sweden is lower than prevalences seen in many other Western countries. Meanwhile, it is worrying the increasing trend of obesity before and during pregnancy in Sweden (1). Thus, pre-pregnancy BMI is probably much higher nowadays than in 1984 to 1985. Furthermore, the weight gain data were recorded before the release of IOM guidelines. By that time, there were no formal recommendations for gestational weight gain in Sweden. In light of these particularities, it is unknown if these results could be generalized to other populations.

To our knowledge, the SPAWN is the longest follow-up study regarding weight development after childbirth, in which the whole sample was monitored for 15 years. This is a unique study that evaluated the impact of excessive GWG on long-term weight development accounting for two important factors, such as pre-pregnancy BMI and postpartum weight changes.

In summary, IOM recommendations, designed to ensure a healthy pregnancy outcome, also seem appropriate for preventing the later development of maternal overweight. The findings indicated that women who gained excess weight during pregnancy by IOM standards have a higher BMI at 15-year follow-up than women who gained within or below IOM recommendations, even after accounting for several confounding factors. More attention should be given to a health policy concerning effective strategies for controlling GWG and preventing postpartum weight retention. It seems advisable that women should lose pregnancy-related weight gradually during the postpartum period and reach their PPW within 1 year. The effects of lifestyle factors during and after pregnancy on long-term weight development warrant further studies.

Acknowledgments

AQ: D

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AQ: E

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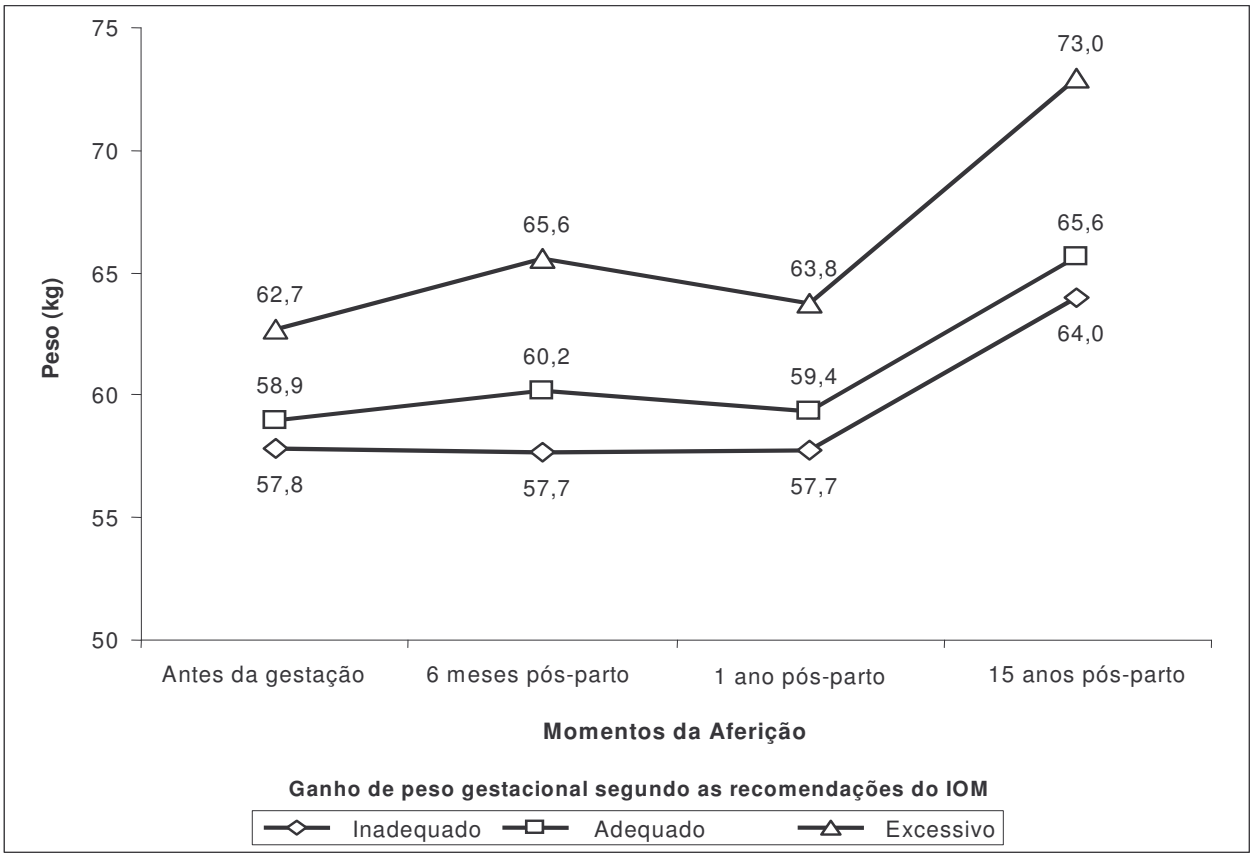
Referência	Texto	Correção
Página: 2 Parágrafo: 5 Linha: 2	The initial population comprised 2342 women but after exclusions (…)	The initial population comprised 2342 women. After exclusions (…)
Página: 3 Parágrafo: 4 Linha: 9	(…) at 6 months were able to maintained this weight up to 1-year.	(…) at 6 months were able to maintain this weight up to 1-year.
Página: 8 Parágrafo: 8 Linha: 11	It seems advisable that women should lose pregnancy related weight gradually (…)	It seems advisable that women lose pregnancy related weight gradually (…)

Anexo IV. Evolução do peso materno ao longo de 15 anos de seguimento, segundo o ganho de peso gestacional (dados do estudo SPAWN).



Análise ajustada pelo IMC pré-gestacional (ANOVA)

Anexo V. Diet or exercise, or both, for weight reduction in women after childbirth (Artigo IV)

Cover sheet

Title

Diet or exercise, or both, for weight reduction in women after childbirth

Reviewers

Amorim AR, Linne YM, Lourenco PMC

Dates

Date edited: 30/01/2007
Date of last substantive update: 09/10/2006
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Date next stage expected / /
Protocol first published: Issue 1, 2006
Review first published:

Contact reviewer

Amanda Amorim

Contribution of reviewers

Amanda Amorim developed the protocol and the review and was responsible for revising the drafts in response to editorial comments. Yvonne Linne and Paulo Lourenco commented on the drafts and participated in the data extraction and quality assessment of the selected studies.

Contact details for co-reviewers

Yvonne Linne MD, Obesity Unit, KI

Mr Paulo Mauricio C Lourenço Professor Epidemiology, UERJ

Internal sources of support

None

External sources of support

None

What's new

Dates

Date review re-formatted: / /
Date new studies sought but none found: / /
Date new studies found but not yet included/excluded: / /
Date new studies found and included/excluded: / /
Date reviewers' conclusions section amended: / /
Date comment/criticism added: / /
Date response to comment/criticisms added: / /

Synopsis

Diet or exercise, or both, for weight reduction in women carrying excess weight after childbirth

Women naturally gain weight during pregnancy and many gradually lose it afterwards. Some women, though, find it difficult to lose the pregnancy-related weight during postpartum and there is concern that this may be a health risk. The retention of weight gained during pregnancy contributes to maternal obesity. Obesity in the general population increases the risk of diabetes, heart disease and high blood pressure. It is suggested that women who return to their pre-pregnancy weight by about six months have a lower risk of being overweight ten years later. The review looked for studies to assess the impact of dieting or exercise, or both, on women's weight loss in the months after giving birth. It paid particular attention to breastfeeding women to be sure that breastfeeding was not compromised. The review of trials found six studies involving only 245 women. Preliminary findings suggest that diet combined with exercise or diet alone compared to usual care seemed to enhance weight loss during postpartum. Thus, there is potential for this to play a role in preventing future maternal obesity. However, there was insufficient evidence to be sure and a lack of sufficient data for women who are breastfeeding. In addition, it seems preferable to lose weight through a combination of dieting and exercise to dieting alone because exercise is thought to improve heart fitness and to preserve lean body mass.

Abstract

Background
Weight retention after pregnancy may contribute to obesity. It is known that diet and exercise are recommended components of any weight loss programme in the general population. However, strategies to achieve healthy body weight among postpartum women have not been adequately evaluated.

Objectives
The objectives of this review were to evaluate the effect of diet, exercise or both for weight reduction in women after childbirth, and to assess the impact of these interventions on maternal body composition, cardiorespiratory fitness, breastfeeding performance and other child and maternal outcomes.

Search strategy
We searched the Cochrane Pregnancy and Childbirth Group's Trials Register and LILACS. We scanned secondary references and contacted experts in the field.

Selection criteria
All published and unpublished randomised controlled trials (RCT) and quasi-randomised trials of diet or exercise or both, among women during the postpartum period.

Data collection & analysis
Trial quality assessment and data extraction were done independently by three review authors. Results are presented using relative risk (RR) for categorical data and weighted mean difference (WMD) for continuous data. Data were analysed with a fixed-effect model. A random-effects model was used in the presence of heterogeneity.

Main results
Six trials involving 245 women were included. Women who exercised did not lose significantly more weight than women in the usual care group (one trial; n = 33; WMD 0.00 kg; 95% confidence interval (CI) -8.63 to 8.63). Women who took part in a diet (one trial; n = 45; WMD -1.70 kg; 95% CI

-2.08 to -1.32), or diet plus exercise programme (four trials; n = 169; WMD -2.89 kg; 95% CI -4.83 to -0.95), lost significantly more weight than women in the usual care. There was no difference in the magnitude of weight loss between diet and diet plus exercise group (one trial; n = 43; WMD 0.30 kg; 95% CI -0.60 to 0.66). The interventions seemed not affect breastfeeding performance adversely.

Reviewers' conclusions

Preliminary evidence from this review suggests that dieting and exercise together appear to be more effective than diet alone at helping women to lose weight after childbirth, because the former improves maternal cardiorespiratory fitness level and preserves fat-free mass, while diet alone reduces fat-free mass. For women who are breastfeeding, more evidence is required to confirm whether diet or exercise, or both, is not detrimental for either mother or baby. Due to insufficient available data, additional research, with larger sample size, is needed to confirm the results.

Background

Obesity related to childbearing
There is evidence suggesting that retention of weight gained during pregnancy contributes to female overweight and obesity (Gore 2003; Linne 2002; Linne 2003a; Rooney 2002). In women, being overweight or obese substantially raises the risk of serious diet-related chronic disorders, including diabetes mellitus, heart disease and hypertension (Linne 2004; Manson 1990).

Postpartum weight retention
The weight retained after pregnancy is defined as the difference between postpartum and pre-pregnancy weight (IOM 1990). The Health Sciences Descriptor of Virtual Health Library states that postpartum or puerperium is "a period from delivery of the placenta until return of the reproductive organs to their normal non-pregnant morphologic state. In humans, the puerperium generally lasts for six to eight weeks" (DeCs 2004). However, it is recommended to increase the definition of the postpartum period to one year, because many physiologic changes due to pregnancy remain up to one year after childbirth, such as the duration of breastfeeding (Mottola 2002).

Despite growing concern about weight-related problems among postpartum women, neither cut-off point defining excess weight retention after childbirth, nor an ideal time to return to prepregnancy weight has been established in the literature. Linne et al carried out a study, which aimed to examine long-term weight development after pregnancy in a 15-year follow-up study. The authors found that by 6 months postpartum, 56.3% of women who did not become overweight at 15-year follow-up had returned to within 1.5 kg of their prepregnancy weight, compared to 27.7% of who became overweight. By one year, these figures had risen to 60.4% in the non-overweight women and only 34.6% in the overweight group (Linne 2003b). Rooney and Schauberger reported that women who lost all pregnancy weight by six months postpartum, regardless of breastfeeding status, were only 2.4 kg heavier 10 years after childbirth, while women who retained postpartum weight were 8.3 kg heavier at 10-year follow up. The authors argued that failure to lose pregnancy weight by six months postpartum is considered an important predictor of long-term obesity. Although it seems beneficial that women return to pregestational weight by six months after childbirth, only 37% of women were able to lose the weight gained during pregnancy at this point (Rooney 2002). Studies estimated that, about one year after delivery, women may retain 0.5 to 4.0 kg on average (AbuSabha 1998; Keppel 1993; Linne 2002; Linne 2003c; Ohlin 1990; Olson 2003). The average amount of weight retained as a result of pregnancy is relatively small; however, there is a subset of women that seems to be at greater risk of gaining significant amounts of weight with childbearing (Rossner 1992; Rossner 1995). In longitudinal studies, the proportion of women retaining 4.5 kg or more during postpartum ranges from 14% to 25% (Greene 1988; Olson 2003; Rossner 1995; Schauberger 1992). Women who retain a considerable amount of weight after delivery have a higher risk of doing so in subsequent gestations (Linne 2003c).

Postpartum weight retention might be determined by many factors, including low socio-economic status, parity and high prepregnancy body mass index (BMI) (Crowell 1995; Schauberger 1992). However, excessive weight gain during pregnancy is the strongest predictor of postpartum weight retention. Various studies showed that the greater the gestational weight gain, the greater the postpartum weight retention (Gunderson 1999; Kac 2003; Linne 2003c; Rossner 1995). According to Olson et al, lower income women who gain more weight in pregnancy than the Institute of Medicine (IOM) recommends are at high risk for major gain with childbearing (Olson 2003). Apart from that, the postpartum period might be related to an increase in food intake and a decrease in physical activity (Clark 1999; Sadurkis 1988; Symons Downs 2004). Consequently, it is considered a vulnerable period for gaining weight (Leermakers EA 1998). Thus, although gestational weight gain has a strong correlation with postpartum weight retention, gaining additional weight after delivery may also have a significant role in maternal obesity (Greene 1988).

Returning to prepregnancy weight

Although it is expected that breastfeeding women lose weight gradually, findings related to breastfeeding and postpartum weight loss are inconsistent (Crowell 1995; Schauberger 1992). Decline in physical activity and increase in caloric intake above the ordinary demand of lactation may explain why some breastfeeding women fail to return to prepregnancy weight. It is argued that Recommended Dietary Allowance (RDA) for breastfeeding women is too high, and the need for increased calories for milk production may be offset by the reduction in physical activity and basal metabolic rate in breastfeeding women (Crowell 1995).

Since behavioural change may also explain why some women fail to lose pregnancy-related weight or gain additional weight, or both, in the first postpartum year (Olson 2003; Schauberger 1992), postpartum weight loss seems to be a critical issue for women who were overweight or obese before pregnancy. However, help strategies for returning pre-pregnancy weight is also an important issue for normal-weight women who gained excessive weight during pregnancy.

Crowell highlights that a period of at least six months postpartum is necessary to facilitate weight loss with the purpose of helping women to return to prepregnancy weight without posing any risk to maternal and child health (Crowell 1995). Even though the Institute of Medicine (IOM) states that gradual weight loss during lactation (0.5 kg/week) appears safe for overweight women (IOM 1991), the best strategy in achieving postpartum weight reduction and the effect of high weight loss rate has not been critically evaluated.

It is known that diet and exercise impose energy deficit, therefore they are recommended components of any weight loss programme in the general population (WHO 1998). Nonetheless, the effects of negative energy balance during the postpartum period, achieved by energy restriction intake, increased energy expenditure or the combination of both are still not fully understood. Since the growth rate of exclusively breastfed infants depends on the energy provided by maternal breastmilk, it is paramount to assess the impact of diet and exercise on lactation performance (Wood 2004).

Diet and exercise among breastfeeding women

Observational studies demonstrated that long-term and severe under-nutrition was associated with milk volume reduction and lower nutrient concentration, whereas mild under-nourishment had a weak correlation with change in milk volume and composition. These results suggest that when food intake is limited for a short period of time, maternal prolactin concentration level increases, which appears to ensure milk production (Coward 1984; Prentice 1994). However, the findings of dietary intervention studies are controversial. While some studies suggested that a calorie-restricted diet had no impact on milk quantity and quality (Dusdieker 1994; McCrory MA 1999), other research reported that well-nourished mothers who had consumed less than 1500 kcal/day experienced a decrease in milk volume and put the growth rate of their babies at risk (Strode 1986).

Likewise, the effect of exercise during postpartum in relation to lactation performance is still a contentious issue. Some trials, including exclusively breastfeeding mothers, indicated that exercise performed during postpartum had no adverse effect on lactation (Dewey KG 1994; Lovelady 1995). Nevertheless, another study aimed to observe the infant acceptance of postexercise breastmilk demonstrated a significant difference in acceptance of pre-exercise and postexercise milk. Women had a significant increase in lactic acid level in breastmilk collected at 10 minutes and 30 minutes after the exercise period. The increase in lactic acid level might affect milk palatability, making it have a sour taste that babies disliked. Furthermore, the lactic acid may have a degradative effect on milk immunoglobulin A concentration (Wallace JP 1992), an important factor which confers protection against most infectious agents (Mestecky 1986).

Apart from the effect of postpartum weight loss programme on lactation performance, it is important to examine the changes in maternal body composition imposed by different intervention strategies. It is desirable that women reduce the percentage of body fat and increase or preserve their lean mass during the intervention programme (Wood 2004). In order to identify which intervention optimises weight loss and fat reduction, while preserving or enhancing fat-free mass, the results of some experimental studies should be pooled in a systematic manner.

The diversity in magnitude of weight loss, body composition and effects on lactation performance found in the literature may be as a result of different study designs, selection criteria of control groups, sample sizes, type of participants and intervention strategies, duration of follow up, dropout rates and quality of weight measurements. Before the results of such studies can be applied in a clinical setting by healthcare professionals to determine an appropriated prescription of diet or exercise, or both, for postpartum women, these data must be selected using high-quality criteria and summarised in an objective fashion.

Objectives

The primary objective of this review was to evaluate the effect of diet, exercise or both for weight reduction in women carrying excess weight after childbirth. Secondary objectives were to examine the impact of these interventions on maternal body composition; breastfeeding performance; cardiorespiratory fitness; infant weight gain and growth; and other child and maternal outcomes.

Criteria for considering studies for this review

Types of studies

Randomised controlled trials (RCT) and quasi-randomised trials of diet or exercise or both, with a concurrent comparison group, in women during the postpartum period were considered for inclusion.

Types of participants

To be eligible, studies must have included women recruited to the intervention programme up to 12 months after childbirth. The participants were women who had given birth to a singleton healthy term infant, were aged at least 18 years, and were overweight or obese or had gained excessive weight during pregnancy, or both. Normal-weight women were eligible if, during pregnancy, they had gained weight above the Institute of Medicine's recommendations or whose current weight had significantly exceeded their prepregnancy weight. Women who were underweight before pregnancy were not included. Participants were required not to be taking any medication that significantly interfered with body weight. There was no restriction in relation to maternal breastfeeding status.

Types of interventions

Interventions in postpartum women involving diet or exercise, or both, were accepted.

The nutritional interventions included in this review were:
(a) dietary advice intended to produce weight reduction delivered through group meetings, by telephone calls or by mail correspondence;
(b) individualised dietary counselling;
(c) prescription of a calorie-restricted diet.

Exercise interventions included in this review were:
(a) any type of exercise counselling that encouraged women to engage in regular recreational exercises (for example, walking, jogging, sports) in order to promote weight loss or improve physical fitness;
(b) structured exercise programmes, in which women participated in supervised exercise sessions.

Training programmes with exercise for preventing or treating pelvic or back pain and urinary incontinence were not considered. Trials in which the stated objectives were not weight loss were included only if they involved one of the interventions mentioned above and assessed at least one relevant outcome measure.

There was no restriction concerning who delivered the interventions. Type, intensity, frequency, duration and timing (postpartum period at beginning and end) of the interventions varied between studies. Trial duration was defined according to the numbers of months over which each was conducted: short-term (less than three months), medium-term (from three to six months) and long-term (longer than six months). Frequency, intensity, duration and timing of the intervention were extracted from the reports and described in the 'Characteristics of included studies' table. Any type of intervention in combination with medication was not considered in this review.

Comparisons
- Diet versus usual care;
- exercise versus usual care;
- diet plus exercise versus usual care;
- diet versus exercise;
- diet plus exercise versus exercise alone;
- diet plus exercise versus diet alone.

Types of outcome measures

Primary outcomes
- Change in body weight (kg), defined as body weight at the end minus body weight at the beginning of study (negative change implies postpartum weight loss);
- percentage of women who returned to pre-pregnancy weight or lost weight retained after childbirth;
- percentage of women who achieved healthy weight, according to WHO 1998 definitions (based on BMI classification).

Secondary outcomes
- Change in percentage of body fat (%);
- change in fat-free mass (kg);
- change in cardiorespiratory fitness (VO_2 max, mL/kg/minute);
- change in basal plasma prolactin concentration (µg/mL);
- change in milk volume (g/day);
- milk immunoglobulin (Ig) A concentration (µg/mL);
- number of mothers who stop breastfeeding;
- duration of breastfeeding (exclusive or predominant, according to WHO 1991 definitions);
- infant length gain (cm);
- infant weight gain (g);
- maternal morbidity (for example, anaemia, readmission to hospital);
- adverse events (for example, exercise-induced injuries, side-effects of very low-calorie diets);
- maternal satisfaction with interventions;
- compliance with interventions.

The outcome measures related to milk volume, plasma prolactin concentration and infant length and weight gain were appreciated only among trials, which included exclusively lactating women.

Search strategy for identification of studies

We searched the Cochrane Pregnancy and Childbirth Group Trials Register by contacting the Trials Search Co-ordinator (July, 2006).

The Cochrane Pregnancy and Childbirth Group's Trials Register is maintained by the Trials Search Co-ordinator and contains trials identified from:
(1) quarterly searches of the Cochrane Central Register of Controlled Trials (CENTRAL);
(2) monthly searches of MEDLINE;
(3) handsearches of 30 journals and the proceedings of major conferences;
(4) weekly current awareness search of a further 37 journals.

Details of the search strategies for CENTRAL and MEDLINE, the list of handsearched journals and conference proceedings, and the list of journals reviewed via the current awareness service can be found in the 'Search strategies for identification of studies' section within the editorial information about the Cochrane Pregnancy and Childbirth Group.

Trials identified through the searching activities described above are given a code (or codes) depending on the topic. The codes are linked to review topics. The Trials Search Co-ordinator searches the register for each review using these codes rather than keywords.

In addition, we searched LILACS (1983 to 2006) using the following search strategy.

((Pt randomized controlled trial OR Pt controlled clinical trial OR Mh randomized controlled trials OR Mh random allocation OR Mh double-blind method OR Mh single-blind method) AND NOT (Ct animal AND NOT (Ct human and Ct animal)) OR (Pt clinical trial OR Ex E05.318.760.535$ OR (Tw clin$ AND (Tw trial$ OR Tw ensa$ OR Tw estud$ OR Tw experim$ OR Tw investiga$)) OR ((Tw singl$ OR Tw simple$ OR Tw doubl$ OR Tw doble$ OR Tw duplo$ OR Tw trebl$ OR Tw trip$) AND (Tw blind$ OR Tw cego$ OR Tw ciego$ OR Tw mask$ OR Tw mascar$)) OR Mh placebos OR Tw placebo$ OR (Tw random$ OR Tw randon$ OR Tw casual$ OR Tw acaso$ OR Tw azar OR Tw aleator$) OR Mh research design) AND NOT (Ct animal AND NOT (Ct human and Ct animal)) OR (Ct comparative study OR Ex E05.337$ OR Mh follow-up studies OR Mh prospective studies OR Tw control$ OR Tw prospectiv$ OR Tw volunt$ OR Tw volunteer$) AND NOT (Ct animal AND NOT (Ct human and Ct animal)))

AND
Tw postpartum OR Tw post-partum OR Tw puerperium OR Tw mother$ OR Tw postpartal OR Tw post-partal OR Tw lactating women OR Tw nursing women OR Tw breastfeeding OR Tw breast-feeding

AND
Tw exercis$ OR (Tw physic$ activ$) OR Tw exert$ OR (Tw physic$ fit$) OR Tw sport$ OR Tw training OR (Tw physical education) OR Tw fat$ OR Tw energ$ OR Tw calori$ OR Tw carbohydrate$ OR diet OR Tw diet-therapy OR Tw dietary-carbohydrates OR Tw dietary-fats

We searched the citation lists of relevant publications, review articles and included studies. We did not apply any language restrictions. After the identification of studies, the primary author contacted some experts in the field via electronic mail. The list of potential included trials was sent to them. They were asked if they were aware of additional trials, published, unpublished or ongoing, that have been conducted in this area (postpartum weight loss).

Methods of the review

Trial selection

Three independent authors (AR Amorim, PM Lourenco and Y Linne) considered studies for inclusion. The selection process was divided into two stages. Initially, we scanned titles, abstracts and keywords of every article retrieved to determine whether each article met the predetermined eligibility criteria, such as: included postpartum women involved at least one of the selected interventions and assessed one or more relevant clinical outcomes. In the presence of doubt about article inclusion, the decision was taken at the next stage. In the second stage, we obtained the full text of the article to clarify doubts about eligibility criteria. The discrepancies in selecting studies were solved by discussion. Excluded studies were detailed in the ´Characteristics of excluded studies` table.

Data extraction

The three authors independently extracted information from the included studies and entered data into the Review Manager software (RevMan 2002). Data extraction forms, developed by the primary author were tested in a pilot study. When needed, we requested further information or data from trial authors. We solved differences in data extraction by consensus, referring back to the original article.

Multiple publications

In order to identify instances of multiple publication, we extracted information about characteristics of the participants, type of intervention, time period and place of study from all papers. Additionally, the primary review author contacted the trial authors to confirm if the articles reported results of the same study. They were asked if participants, type of intervention and time period of study were exactly the same. In case of multiple publications, we considered the most complete articles, such as those including greater numbers of outcomes and more methodological information, as primary reference.

Quality assessment

We assessed methodological quality of each included study according to the criteria described in the Cochrane Reviewers' Handbook (Alderson 2004). Methods used for generation of the randomisation sequence were described for each trial.

Quality scores for concealment of allocation:
(A) adequate: assignment to groups was determined by central off-site randomisation, sequentially numbered, sealed, opaque envelopes or other appropriate schemes and so could not be influenced by the investigators;
(B) unclear;
(C) inadequate: alternation, the use of case record numbers, dates of birth or day of the week, tossing a coin, and any procedure that is entirely transparent before allocation;
(D) not used.

For completeness of follow up:
(A) adequate: less than 20% of withdrawal or loss to follow up;
(B) unclear;
(C) inadequate: more than 20% of withdrawal or loss to follow up.

For blinding of outcome assessment:
(A) adequate: the investigator who assesses the results did not know the allocated treatment;
(B) unclear;
(C) no blinding: the investigator knew the allocated treatment.

Double blinding was impossible in these kinds of trials, as the participants knew which intervention they received. Blinding of those assessing the results (single blinding) was however highlighted and planned to be considered in a separate sensitivity analysis.

Based on these quality criteria, studies were broadly subdivided into the following three categories:
(A) low risk of bias: all quality criteria met;
(B) moderate risk of bias: one or more of the quality criteria only partly met;
(C) high risk of bias: one or more criteria not met.

Three independent authors evaluated methodological quality of trials. We did not assess trials blindly, as we knew the names of trial authors, institutions and the source of publication. Differences highlighted here were resolved through consultation with the other authors, and a judgment was made based on consensus. We did not exclude studies on the basis of a low-quality score. Thus, this classification was used as the basis of a sensitivity analysis.

Data analysis

When data were available, sufficiently similar and of sufficient quality, statistical analyses were performed using the Review Manager software (RevMan 2002). For continuous outcomes, results were expressed as weighted mean difference (WMD) between the postintervention values, or the difference between baseline values and postintervention values. When all trials assessed the same outcome, but measured it in a variety of ways or in different scales, the standardised mean difference (SMD) was used as a summary statistic. For dichotomous outcomes, results for each study were expressed as relative risks (RR). Both dichotomous and continuous outcomes were presented with 95% confidence intervals (CI). When information was provided in the article, an intention-to-treat analysis was planned to be performed.

Assessment of heterogeneity

Firstly, all data were analysed with a fixed-effect model. The I^2 statistic was applied to describe the proportion of total variation in study estimates that was due to heterogeneity. An I^2 of more than 50% was considered as notable heterogeneity. When high level of heterogeneity was found, we performed subgroup and sensitivity analyses, excluding the trials most susceptible to bias. Whether pooling of results seemed appropriate, heterogeneity that was not explained by subgroup and sensitivity analyses was modelled using a random-effects analysis, which assumes that the effect size varies across studies.

Subgroup analyses

These analyses aimed to assess whether particular groups of subjects could obtain more benefit from an intervention than other groups could or evaluate if the treatment effect varies with different intervention characteristics.

Our pre-specified subgroups were based on:
- Dietary advice versus prescription of caloric restriction;
- exercise counselling (self-supervised exercise) versus structured exercise programme (supervised exercise sessions);

- duration of intervention: short-term and medium-term versus long-term.

We did not conduct all subgroup analyses, due to insufficient data. We only carried out the analyses for postpartum weight loss in the comparison group of diet plus exercise versus usual care. These analyses will be included in future updates, once sufficient data are available. Only the primary outcomes listed above will be included in the subgroup analyses.

Sensitivity analyses

Sensitivity analyses aimed to assess robustness of results to allocation concealment, blinding of outcome assessors, losses to follow up and other study characteristics. These analyses were planned to be performed in order to explore the influence of the following factors on effect size:

- Repeating the analysis, excluding unpublished studies;
- repeating the analysis, taking account of study quality, as previously specified in quality assessment section. The results of high quality studies will be compared with those of poorer quality studies, where studies rated A for all quality criteria will be compared with those rated B or C;
- repeating the analysis, excluding quasi-randomised trials;
- repeating the analysis, excluding any very large or long-term trials to establish how much they dominate the result.

Our pre-specified sensitivity analyses have not been completely conducted, due to the small number of studies included in the meta-analysis. We repeated only the analysis excluding any very large or long-term trials in the comparison group of diet plus exercise versus usual care. The entire analysis will be included in future updates, when sufficient data become available.

Funnel plots and a simple graphical test were planned to be used to assess for evidence of bias (Egger 1997). However, the number of eligible studies was too few to allow adequate assessment.

Description of studies

We found eleven reports of studies, which were qualified for inclusion in this review. Some papers reported results of the same study. We considered reports by Dewey 1994, Prentice 1994 and Lovelady 1995, which described the effects of aerobic exercise among women during lactation, as a single study. Likewise, the articles by Lovelady 2000, Lovelady 2001, Lovelady 2006 and Mukherjea R 2000, which described the effect of energy restriction and exercise among breastfeeding women, were considered as a single study. After this procedure, the review included data of six studies. One article contributed information for three comparison groups: diet versus usual care; diet plus exercise versus usual care; diet plus exercise versus diet alone (McCrory 1999).

We were able to get outcome data for all trials expect one. O`Toole et al stated that fat-free mass was measured, but data were not available in the article (O'Toole 2003).

The trials were primarily conducted in the United States (Dewey 1994; Leermakers 1998; Lovelady 2000; McCrory 1999; O'Toole 2003), but one was conducted in Australia (Armstrong 2003). Most trials were classified as short and medium-term study, and only one trial provided long-term outcome data. The long-term trial comprised a one-year intervention programme (O'Toole 2003). Majority of trials involved a prescription of calorie-restricted diet, the trial by Leermakers 1998 involved nutritional education. All trials involved aerobic exercise programmes; three were based on supervised exercise sessions (Armstrong 2003; Dewey 1994; Lovelady 2000) and the rest focused on self-monitored sessions (Leermakers 1998; McCrory 1999;O'Toole 2003).

Armstrong 2003 recruited women between 6 weeks and 12 months postpartum. No information about BMI and breastfeeding status was available. Dewey 1994 recruited exclusively breastfeeding women between 6 and 8 weeks postpartum. No information about BMI at baseline was available. Leermakers 1998 recruited, between 3 and 12 months postpartum, non-breastfeeding women who exceeded their prepregnancy weight by at least 6.8 kg. The mean (± SD) BMI at baseline was 29.1±3.7 and 30.6 ±5.0 in the diet plus exercise and usual care group, respectively. Lovelady 2000 recruited exclusively breastfeeding women who were overweight at 4 weeks postpartum. The mean BMI at baseline was 27.6 ±2.4 and 28.0 ±2.1 in the diet plus exercise and usual care group, respectively. McCrory 1999 recruited, between 8 and 6 weeks postpartum, exclusively breastfeeding women. The mean BMI at baseline was 25.3 ±4.8, 25.4 ±4.1 and 24.9 ±3.8 in the diet, diet plus exercise and usual care group, respectively. O'Toole 2003 recruited non-breastfeeding women between 6 weeks and 6 months postpartum. The mean BMI at baseline was 29.8 ±2.0 and 29.9.4 ±2.9 and 24.9 ±3.8 in diet plus exercise and usual care group, respectively.

Of the 19 excluded reports, four articles were related to the same study (Fahrenwald NL 2002; Fahrenwald NL 2003; Fahrenwald 2004; Fahrenwald NL 2005). These articles were considered as a single study, leaving the number of 16 excluded studies. We found only one ongoing trial. Details for each trial can be found in the following tables: 'Characteristics of included studies'; 'Characteristics of excluded studies' and Characteristics of ongoing studies'.

Methodological quality of included studies

In four of six studies, the method of randomisation was adequate Armstrong 2003; Dewey 1994; Lovelady 2000; McCrory 1999. In the remaining two studies, it is stated that intervention was randomly assigned, but the method was not reported (Leermakers 1998; O'Toole 2003). Allocation concealment was adequate in all trials, except one (Leermakers 1998) in which allocation process was unreported. Follow up attrition rates were less than 20% in most trials, but two (Leermakers 1998; O'Toole 2003). Outcome data were not collected by investigators blinded to group allocation in any trial.

Results

Six trials involving 245 women were included. All included studies were identified by the Cochrane Pregnancy and Childbirth Group's Trials Register and none of them were indexed within the LILACS database.

Initially, the results about heterogeneity assessment are presented, and then findings are shown in sequential order, starting with comparison one and the primary outcomes followed by the secondary outcomes.

Heterogeneity

A fixed-effect model was used to analyse these data. Significant heterogeneity was found in two outcomes included in comparison three (diet plus exercise versus usual care). The results of postpartum weight loss using a fixed-effect model showed an I^2 value of 83.1% (Chi^2 = 17.78; df = 3; p-value = 0.0005). When analysed using a random-effects model the WMD changed from -1.59 (95% CI -1.90 to -1.28) to -2.89 (95% CI -4.83 to -0.95). Similarly, the results of change in percentage of body fat using a fixed-effect model showed an I^2 value of 74.6% (Chi^2 = 7.87; df = 2; p-value = 0.02). The random-effects model showed that WMD changed from -1.93 (95% CI -2.63 to -1.22) to -2.21(95% CI -4.03 to -0.40).

There was no overlapping between the confidence ICs estimation in the Lovelady`s and McCrory`s trials (Lovelady 2000; McCrory 1999), this might have resulted in statistical heterogeneity. The heterogeneity disappeared in both outcomes after repeating the analysis, excluding McCrory`s trials (*see* subgroup analyses). When excluding Lovelady`s trial from the analysis the heterogeneity reduced from 83.1% to 31.4% in the primary outcome (postpartum weight loss) and disappeared in the secondary outcome (results not shown). We believe that this meta-analysis may have been affected by low magnitude of weight loss and body fat reduction reported in McCrory's trial compared to others (McCrory 1999). The low magnitude of these outcomes might be explained by the short duration of the intervention (11 days). However, the assessment of heterogeneity was limited to aid the decision regarding pooling the results due to the few number of studies included. It seems more appropriate to summarise the results using a random-effects model, instead of excluding the potential influential study from the meta-analysis.

(1) Diet versus usual care

Primary outcomes
Only one trial, involving only exclusively breastfeeding women, contributed data for this comparison group. Women who followed a calorie-restricted diet lost significantly more weight than women who received a usual care (n = 45; WMD -1.70; 95% CI -2.08 to -1.32, kg). The other primary outcome measures were not assessed.

Secondary outcomes
Data were available for the following prespecified outcomes: change in percentage of body fat, fat-free mass, basal plasma prolactin concentration and milk volume. Women allocated in the diet group lost significantly more fat-free mass than women in the usual care (WMD -0.90; 95% CI -1.38 to -0.42, kg). There were not significant differences between the diet and control groups in relation to body fat (WMD -0.40; 95% CI -1.15 to 0.35, % body fat), plasma prolactin concentration (WMD 2.24; 95% CI -13.95 to 18.43, µg/mL) and milk volume (WMD 18.00; 95% CI -63.87 to 27.87, g/day).

(2) Exercise versus usual care

Primary outcomes
Data were available for only for one primary outcome, which showed that exercise was not significantly associated with postpartum weight loss among exclusively breastfeeding women (one trial; n = 33; WMD 0.00; 95% CI -8.63 to 8.63, kg).

Secondary outcomes
No significant differences were found between the exercise and usual care groups regarding change in percentage of body fat (one trial; n = 33; WMD 0.20; 95% CI -5.40 to 5.80, % body fat), fat-free mass (one trial; n = 33; WMD 0.30; 95% CI -3.78 to 4.38, kg), plasma prolactin concentration (one trial; n = 33; WMD -6.73; 95% CI -54.62 to 41.16, µg/mL), milk volume (one trial; n = 33; WMD 40.00; 95% CI -109.16 to 189.16, g/day) and infant weight gain (one trial; n = 33; WMD 26.17; 95% CI -756.15 to 808.49, g). Two studies reported significant improvement in cardiorespiratory fitness in the exercise group (n = 53; WMD 7.08; 95% CI 4.03 to 10.13, mL/kg/minute).

(3) Diet plus exercise versus usual care

Primary outcomes
Diet combined with exercise was significantly associated with postpartum weight loss (four trials; n = 169; WMD -2.89; 95% CI -4.83 to -0.95, kg). Women who followed a dietary and exercise

programme were significantly more likely to return to prepregnancy weight (two trials; n = 102; relative risk (RR) 2.55; 95% CI 1.20 to 5.41) and achieve healthy weight (two trials; n = 63; RR 4.68; 95% CI 1.32 to 16.32) than women who received usual care.

Secondary outcomes
Diet combined with exercise significantly reduced the percentage of body fat (three trials; n = 107; WMD -2.21; 95% CI -4.03 to -0.40, % body fat) and improved cardiorespiratory fitness (two trials; n = 63; WMD 3.76; 95% CI 1.46 to 6.07, mL/kg/minute) among postpartum women compared to the usual care. No significant differences were found between the diet plus exercise and usual care groups regarding change in fat-free mass (two trials; n = 84; WMD -0.20; 95% CI -0.67 to 0.27, kg), plasma prolactin concentration (one trial; n = 43; WMD 3.40; 95% CI -6.77 to 13.57, µg/mL), milk volume (one trial; n = 45; WMD -33.00; 95% CI -81.25 to 15.25, g/day) and infant length gain (one trial; n = 30; WMD 0.50; 95% CI -0.65 to 1.65, cm) and infant weight gain (one trial; n = 30; WMD 64.00; 95% CI -271.87 to 399.87, g).

(4) Diet versus exercise

No study reporting this comparison group was identified.

(5) Diet plus exercise versus exercise alone

No study reporting this comparison group was identified.

(6) Diet plus exercise versus diet alone

Primary outcomes
Only one trial, involving only exclusively breastfeeding women, contributed data for this comparison group. There was no significant difference in weight loss between the diet and diet plus exercise groups (n = 43; WMD 0.30; 95% CI -0.06 to 0.66, kg). The other primary outcome measures were not assessed.

Secondary outcomes

Women allocated in the diet plus exercise group lost more body fat than women in the diet group (WMD -0.70; 95% CI -1.44 to 0.04, % body fat). On the other hand, the diet group lost significantly more fat-free mass than the diet plus exercise group (WMD 0.70; 95% CI 0.24 to 1.16, kg). Nonsignificant results were observed regarding plasma prolactin concentration (WMD 1.16; 95% CI -13.86 to 16.18, µg/mL) and milk volume (WMD -15.00; 95% -62.34 to 32.34, g/day).

Discussion

Postpartum weight loss

The results suggest diet or diet plus exercise are effective strategies in reducing body weight. Exercise seems have no effect on weight loss, body fatness and fat-free mass, but significantly improved maternal cardiovascular fitness. These results about weight loss require confirmation because they are based primarily on one single study, including only 33 subjects. However, the effect of exercise programmes on cardiovascular fitness seems consistent across two trials (Armstrong 2003; Dewey 1994). One possible reason for no difference on body weight between the exercise and usual care groups is that women who exercised could have increased their energy consumption. Thus, they did not reach the energy deficit required to impose weight loss. However, Dewey et al reported that the difference in energy intakes at baseline remained

unaltered during the study period. The authors suggested that the mothers who exercised compensated their increased energy expenditure by reducing other daily activity (Dewey 1994). Conversely to our finding, meta-analysis evaluating the effect of exercise, with or without dieting, on the body composition of overweight subjects found that aerobic exercise without dietary restriction among women caused a modest but significant weight loss (1.4 kg in 12 weeks) compared with sedentary controls. Similar to our results, the study showed a little effect of aerobic exercise on fat-free mass. The meta-analysis demonstrated that resistance exercise had little effect on weight loss, but increased significantly fat-free mass (Garrow 1995). We could not test this hypothesis because all trials involved only aerobic exercises.

Both diet and diet combined with exercise were significantly associated with postpartum weight loss when compared to the usual care group. Women assigned to the combined intervention were significantly more likely to return to pre-pregnancy weight and achieve healthy weight, which may help to prevent women from becaming overweight/ obesity after childbearing. There was no difference in the magnitude of weight loss and change in percentage of body fat between the diet and diet plus exercise groups. However, the decrease in fat-free mass was significantly higher in diet group than in the diet plus exercise group. According to the preliminary results, it seems advisable to lose weight by a combination of dieting and exercise than by dieting alone, because the former improves cardiovascular fitness level of the mothers and preserves fat-free mass while diet alone reduces maternal fat-free mass. This finding corroborates other meta-analyses, which found that exercise provides some conservation of fat-free mass during weight loss by dieting (Ballor 1994; Garrow 1995). Although this review showed that change in body weight was statistically significant in the diet plus exercise group, the magnitude of postpartum weight loss was moderate (approximately 3 kg). Due to lack of information about maternal health outcomes related to excess body weight and the small number of studies included in the meta-analysis, it remains unclear the clinical importance of the intervention programme, particularly for women who were already overweight or obese before pregnancy. Once the data were available only in affluent countries, it is unknown if these findings can be applied to other populations.

It is important to note that there was considerable clinical heterogeneity between trials (in comparison 03), probably because of differences in the type or length/period of the intervention and differences in the participant's characteristics. Statistical heterogeneity was also identified. Due to the small number of trials all explanations for the observed heterogeneity remain highly speculative. Therefore, overall effects were calculated using a random-effects model.

Effect of interventions on breastfeeding performance

Results on breastfeeding performance were limited to trials that included exclusively breastfeeding women (three studies). The findings indicated that none of the interventions adversely affected milk volume and plasma prolactin concentration. Due to lack of data we could only evaluate impact on both the infant length and weight gain among women who followed a diet plus exercise intervention. The results showed no significant difference in both outcomes. Milk Ig A concentration, number of women who stopped breastfeeding and breastfeeding duration was not assessed in any trial. Within these limits and those imposed by small sample sizes, the results seem reasonably consistent, showing that the interventions appear safe for breastfeeding women.

Reviewers' conclusions

Implications for practice

Preliminary findings suggest that exercise alone improves cardiovascular fitness, but does not increase the rate of postpartum weight loss. Furthermore, diet combined with exercise or diet alone

compared to usual care enhance weight loss during postpartum and play a role in preventing future maternal obesity. However, it may be preferable to lose weight through a combination of dieting and exercise to dieting alone, because the former improves maternal cardiovascular fitness level and preserves lean body mass. Diet or exercise, or both, appears safe for breastfeeding women. Unfortunately, the available data are insufficient to infer important risks or other potential benefits for the mother or infant. Methodological shortcomings of some trials, especially the small sample size, the small number of studies reviewed for each outcome, and the diversity in the nature, duration and frequency of the interventions argue caution in applying these encouraging results.

Implications for research

Future trials will require much larger sample sizes to detect potential effects on milk volume, plasma prolactin concentration and infant length and weight gain. In addition, the studies should assess the potential impacts on milk Ig A concentration, number of women who stopped breastfeeding and breastfeeding duration. Other outcomes, such as, maternal morbidity and adverse events should also be studied. In addition, it would be interesting to examine the impact of weight-loss programmes on maternal self-image and self-esteem.

The suggestion that regular aerobic exercise may not affect weight loss and body composition also merits further study. Likewise, additional trials should attempt to confirm the limited evidence suggesting that diet alone or diet plus exercise enhance postpartum weight loss. It is still not clear if diet plus exercise is an effective strategy in low income women, which suggests this as an area for future study. Future trials should ensure strict and concealed randomisation, intention-to-treat analysis, and adequate blinding of examiners. Finally, since adherence to weight loss programmes requires considerable effort, more information is necessary on women's satisfaction and compliance with such interventions. These outcomes should be evaluated in a systematic fashion.

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We thank Adesola Adegboye for helping with grammar and spelling.

Potential conflict of interest

None known.

Characteristics of included studies

Study	Methods	Participants	Interventions	Outcomes	Notes	Allocation concealment
Armstrong 2003	Intervention was randomly assigned. The procedure was based on a four block randomised sequence (information not published). Allocation using sealed opaque envelopes. Completeness of follow up (A), blinding of outcome assessment (C) and final classification (C).	20 women who had a child between the ages of 6 weeks and 12 months and were experiencing depressive symptomatology.	Intervention: social support and aerobic exercise. The exercise programme consisted of supervised pram walking group sessions 3 times per week for 30-40 minutes at an intensity of 60-75% of age - predicted heart rate for 12 weeks. Control: the control group was not involved in the multi-intervention programme. Trial duration: medium-term.	VO2 max and adherence to intervention.	Data suggested good follow up (no drop outs) and no differences between groups at baseline. A total of 36 exercise sessions were offered and the mean number of sessions attended was 23.7 (66% of adherence).	A
Dewey 1994	Randomisation using a random number table. Allocation using sealed opaque envelopes (information not published). Completeness of follow up (A), blinding of outcome assessment (C) and final classification (C).	33 sedentary, nonsmoking women, without chronic disease, whose infants were being exclusively breastfed	Intervention: 45 minutes of supervised aerobic exercise session at an intensity of 60-70% of maximal heart rate reserve, 5 times per week for 12 weeks, beginning at 6-8 weeks postpartum. Control: no regular aerobic exercise during the same time period. Trial duration: medium-term	Postpartum weight loss, body fat, fat-free mass, VO2 max, milk volume, infant weight gain and plasma prolactin concentration.	A total of 38 women enrolled in the study. Five women did not complete the study (4 in the control group). These women had similar characteristics to those who remained, however their infants had significantly lower birth weights. There was a higher proportion of female infants in the exercise group (65%) than in control (46%). Women in the exercise group reported significantly higher energy intakes than control subjects at baseline. All subjects were able to exclusively breastfeed their infants during the study period. Research assistants visited the homes at each exercise session to assure compliance. Data concerning fat free mass were extracted from Lovelady et al, 1995.	A
Leermakers 1998	Randomisation stated, but method not reported. Completeness of follow up (C), blinding of outcome assessment (B) and final classification (C).	62 women who had given birth in the past 3-12 months and whose weight exceed their prepregnancy weight by at least 6.8 kg. Women who were breastfeeding	Intervention: 2 group sessions, held at the beginning of intervention and at month 2. Women were instructed in the group sessions to follow a diet of 1000-1500 kcal per day, begin an aerobic programme and self-monitor. Correspondence	Postpartum weight loss, percentage of women who returned to prepregnancy weight and adherence to intervention.	A total of 90 women enrolled in the study. 28 women dropped out of the study (11 in the intervention group and 17 in the control). The drop outs were significantly heavier at baseline and retained significantly more weight after pregnancy than	B

		their infant were excluded from the study.	material consisted of 16 lessons focused on low-fat and low-caloric eating habits and increasing physical activity, delivered over 6 months. Telephone contacts were made weekly or biweekly, depending on participants request during 6 month intervention period. Control: the control group did not receive any treatment, but participants were given an informational brochure about healthy eating and exercise. Trial duration: medium-term		completers. The intervention group was significantly older and had a greater percentage of married women, compared to control group. Women returned 10.1 self-monitoring records (40.4% of adherence) and 7.6 homework assignments (50.7% of adherence). They received an average of 10.3 telephone contacts during the 6-month programme.	
Lovelady 2000	Women were randomly assigned using a random-number table, after stratification according to the sex of their infants. Allocation using sealed, opaque envelopes. Completeness of follow up (A), blinding of outcome assessment (C) and final classification (C).	40 healthy, sedentary, nonsmoking and exclusively breastfeeding women, who were overweight at 4 weeks` postpartum and had delivered a full-term infant weighing at least 2500 g and had not delivered by cesarean section.	Intervention: restriction of 500 kcal from the average of reported daily energy intake and estimated energy requirements. 45 minutes of supervised aerobic exercise 4 times per week at an intensity of 65-80% of maximal heart rate reserve for 10 weeks, beginning at 4 weeks postpartum. Control: usual dietary intake and not exercise more than once per week for 10 weeks. All women were given a multivitamin supplement containing at least 50% of the recommended dietary allowances for lactating women. Trial duration: short-term	Postpartum weight loss, percentage of women who achieved a BMI below 25, percentage of women who were within 1 kg of their prepregnancy weight, body fat, fat-free mass, VO2 max, infant weight gain and infant length gain	A total of 48 women enrolled in the study. 8 women dropped out of the study (6 in the intervention group and 2 in the control). The drop outs were significantly heavier before pregnancy; tend to have higher BMI and heavier infants at birth and lower level of cardiovascular fitness compared to women who complete the study. Research assistants visited the homes at each exercise session to assure compliance. All participants, but one were able to exercise 4 days per week.	A
McCrory 1999	Random assignment of subjects was computer based using Moses-Oakford algorithm with variables block size. Completeness of follow up (A), blinding of outcome assessment (C) and final classification (C).	67 nonsmoking, exclusively breastfeeding women, who had no chronic illnesses, were not taking medication regularly and had delivered a single healthy, term infant. Participants were randomised at 8-16 weeks postpartum.	Intervention I: diet group - 35% of energy deficit for 11 days. Intervention II: diet plus exercise group - 35% of net energy deficit for 11 days (60% by dietary restriction and 40% by additional exercise). Women in this group performed aerobic exercises during 86 minutes per session at an intensity of 50–70% of maximal heart rate on 9 of the 11 days. Exercise sessions were	Postpartum weight loss, body fat, fat-free mass, milk volume and plasma prolactin concentration.	2 of 68 participants enrolled discontinued study. Both were assigned to the diet plus exercise group. 1 withdrew after assignment, but before the beginning of intervention. The other did not continue with the intervention after day 8. Data for the latter participant were included in the analysis. Data suggested good compliance with the intervention.	A

			self-supervised. Control: no energy restriction and exercise. Trial duration: short-term			
O'Toole 2003	Interventions were randomly assigned, but method not reported. Allocation using blinded drawing of labels containing group assignment. Completeness of follow up (C), blinding of outcome assessment (B) and final classification (C).	23 postpartum women, who were overweight prior to pregnancy, had gained more than 15 kg during pregnancy and were more than 5 kg heavier than prepregnancy at the time of enrolment. Participants were randomised between 6 weeks` and 6 months` postpartum.	Intervention I: structured diet and physical activity group, which included individualized diet prescriptions derived from baseline measurements, daily food and activity diaries, healthy cooking demonstration. A specific, individualised activity plan consisting of moderate intensity activity and guided by heart rate was developed for each participant. The intervention also included educational group sessions held once a week for 12 weeks, biweekly for the following 2 months, and monthly up to 1 year postpartum. Intervention II: self-directed group based on general advice about diet and exercise. This group participated in a single 1-hour educational session about healthy diet and exercise practices. Participants were given some brochures about nutrition and food guide pyramid. Trial duration: long-term	Postpartum weight loss, percentage of women who achieved a BMI below 25, body fat, fat-free mass (values not available) and VO2 max.	40 women enrolled in the study, but 23 remained up to 1 year postpartum (58% of retention). There were no differences between those who finished the study and those who dropped out. Percentage of body fat was significantly higher in the self-directed group than in the structured group at baseline.	A

Characteristics of excluded studies

Study	Reason for exclusion
Armstrong 2004	1. Inclusion of women over 12 months postpartum.
Bopp 2005	1. Non-clinical trial. The participants were grouped according to their exercise habits into exercise or sedentary group. The experimental part of the study consisted of returning, of a subsample of exercise group, to the laboratory 2 additional times for rest and exercise sessions. 2. The experimental part of the study did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level.
Carey 1997	1. The intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. The intervention consisted of only 4 laboratory visits to perform exercise at 100%, 50% and 70% of VO2max and nonexercise control session to determine if breastmilk composition changed following exercise conducted at different intensities. 2. The study did not involve sedentary women as a control group. Every woman served as both an exercising volunteer and a nonexercising control subject during the rest session.
Duckman 1968	1. Intervention for postpartum weight control involved medication.
Fahrenwald 2004	1. Inclusion of women over 12 months postpartum and younger than 18 year of age.
Fly 1998	1. The intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. The intervention consisted of 2 laboratory visits for a maximal graded exercise test and resting control period. 2. The study did not involve sedentary women as a control group. Every woman served as both an exercising volunteer and a nonexercising control subject during the rest session on different days.
Gregory 1997	1. The intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. 2. The study did not involve sedentary women as a control group. Every woman served as both an exercising volunteer and a non-exercising control subject on different days.
Koltyn 1997	1. Did not assess any outcome of interest.
Krummel 2004	1. Cross-sectional data collected at baseline, of "Mother's Overweight Management Study," a randomised controlled trial for weight gain prevention. 2. Inclusion of women over 12 months postpartum.
Lovelady 2003	1. Non-clinical trial. The participants were grouped according to their exercise habits into exercise or sedentary group. The experimental part of the study consisted of returning, of a subsample of exercise group, to the laboratory 2 additional times for rest and exercise sessions. 2. The experimental part of the study did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level.
Ostbye 2003	1. Nonintervention study. The purpose of this study was to better understand the attitudes and preferences for weight loss among postpartum women. 2. The study refers to a planned trial. It is stated in the article that an intervention study is being designed; however no more information was provided.
Quinn 1999	1. The comparison groups (high carbohydrate diet plus exercise versus moderate carbohydrate diet plus exercise) are not included in this review. 2. Dietary intervention involved no change in energy intake or dietary advice for weight reduction. 3. Exercise intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. The exercise programme consisted of 4 laboratory visits: 1 for maximal graded exercise test, 2 exercise sessions at different intensities and 1 rest session.
Wallace 1991	1. The intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. The intervention consisted of a maximal graded exercise test. 2. The study did not involve sedentary women as a control group. Every woman was assigned to an exercise test. The study compared data from pre-exercise rest, exercise test and postexercise period. 3. Inclusion of women who had delivery over 12 months.
Wallace 1992a	1. The intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. The intervention consisted of a maximal graded exercise test. The women were randomly assigned to group E which nursed prior to maximal exercise test and group F which did not nurse.

	2. The study did not involve sedentary women as a control group. Every woman was assigned to exercise test.
Wallace 1992b	1. The intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. The intervention consisted of a maximal graded exercise test to assess the infant acceptance of postexercise breastmilk. 2. The study did not involve sedentary women as a control group. Every woman was assigned to exercise test.
Wright 2002	1. The intervention did not intend to create a caloric deficit for weight control, improve cardiorespiratory fitness or encourage women to increase their physical activity level. The intervention consisted of 4 laboratory visits: one for instructions, two for performing a maximal intensity and moderate exercise test, respectively and one rest session. 2. The study did not involve sedentary women as a control group. Every woman served as both an exercising volunteer and a nonexercising control subject during the rest period on different days.

Characteristics of ongoing studies

Study	Trial name or title	Participants	Interventions	Outcomes	Starting date	Contact information	Notes
Peterson 2002	Enhanced Expanded Food and Nutrition Education Program (EFNEP).	700 postpartum women from 2 urban areas who are WIC eligible.	Participants are randomised to the usual WIC care or Enhanced EFNEP intervention arm. The usual WIC care consists of nutrition education and breastfeeding consultation at the first postpartum and follow up visits up to 12 months from delivery. The Enhanced EFNEP intervention consists of usual WIC care plus a sustained, multi-component intervention including home visits, group classes and monthly telephone counselling in the first 12 months postpartum and after 6 months of maintenance. The purpose of the study is to test the efficacy of an educational model in improving diet, activity and weight loss among new mothers.	BMI, fat mass and body fat distribution.	Not stated.	Peterson KE, Departments of Maternal and Child Health, and Nutrition, Harvard School of Public Health, Boston, MA - USA.	

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Table of comparisons

Comparison or outcome	Studies	Participants	Statistical method	Effect size
01 diet versus usual care				
01 postpartum weight loss (kg)	1	45	WMD (fixed), 95% CI	-1.70 [-2.08, -1.32]
02 change in % body fat	1	45	WMD (fixed), 95% CI	-0.40 [-1.15, 0.35]
03 change in fat-free mass (kg)	1	45	WMD (fixed), 95% CI	-0.90 [-1.38, -0.42]
04 change in basal plasma prolactin concentration (µg/mL)	1	45	WMD (fixed), 95% CI	2.24 [-13.95, 18.43]
05 change in milk volume (g/day)	1	45	WMD (fixed), 95% CI	-18.00 [-63.87, 27.87]
02 exercise versus usual care				
01 postpartum weight loss (kg)	1	33	WMD (fixed), 95% CI	0.00 [-8.63, 8.63]
02 change in % body fat	1	33	WMD (fixed), 95% CI	0.20 [-5.40, 5.80]
03 change in fat-free mass (kg)	1	33	WMD (fixed), 95% CI	0.30 [-3.78, 4.38]
04 change in VO2max (ml/ kg/ min)	2	53	WMD (fixed), 95% CI	7.08 [4.03, 10.13]
05 change in basal plasma prolactin concentration (µg/mL)	1	33	WMD (fixed), 95% CI	-6.73 [-54.62, 41.16]
06 change in milk volume (g/day)	1	33	WMD (fixed), 95% CI	40.00 [-109.16, 189.16]
07 infant weight gain (g)	1	33	WMD (fixed), 95% CI	26.17 [-756.15, 808.49]
03 diet plus exercise versus usual care				
01 postpartum weight loss (kg)			WMD (random), 95% CI	Subtotals only
02 % of women who returned to pre-pregnancy weight or lost weight retained after childbirth	2	102	RR (fixed), 95% CI	2.55 [1.20, 5.41]
03 % of women who achieved healthy weight	2	63	RR (fixed), 95% CI	4.68 [1.32, 16.62]
04 change in % body fat			WMD (random), 95% CI	Subtotals only
05 change in fat-free mass (kg)	2	84	WMD (fixed), 95% CI	-0.20 [-0.67, 0.27]
06 change in VO2max (ml/ kg/ min)	2	63	WMD (fixed), 95% CI	3.76 [1.46, 6.07]
07 change in basal plasma prolactin concentration (µg/mL)	1	43	WMD (fixed), 95% CI	3.40 [-6.77, 13.57]
08 change in milk volume (g/day)	1	45	WMD (fixed), 95% CI	-33.00 [-81.25, 15.25]
09 infant length gain (cm)	1	40	WMD (fixed), 95% CI	0.50 [-0.65, 1.65]
10 infant weight gain (g)	1	40	WMD (fixed), 95% CI	64.00 [-271.87, 399.87]
06 diet plus exercise versus diet alone				
01 postpartum weight loss (kg)	1	43	WMD (fixed), 95% CI	0.30 [-0.06, 0.66]
02 change in % body fat	1	43	WMD (fixed), 95% CI	-0.70 [-1.44, 0.04]
03 change in fat-free mass (kg)	1	43	WMD (fixed), 95% CI	0.70 [0.24, 1.16]
04 change in basal plasma prolactin concentration (µg/mL)	1	43	WMD (fixed), 95% CI	1.16 [-13.86, 16.18]
05 milk volume (g/day)	1	44	WMD (fixed), 95% CI	-15.00 [-62.34, 32.34]

Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 01 diet versus usual care
Outcome: 01 postpartum weight loss (kg)

Study or sub-category	N	diet Mean (SD)	N	usual care Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	22	−1.90(0.70)	23	−0.20(0.60)		100.00	−1.70 [−2.08, −1.32]
Total (95% CI)	22		23			100.00	−1.70 [−2.08, −1.32]

Test for heterogeneity: not applicable
Test for overall effect: Z = 8.73 (P < 0.00001)

Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 01 diet versus usual care
Outcome: 02 change in % body fat

Study or sub-category	N	diet Mean (SD)	N	usual care Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	22	−0.90(0.90)	23	−0.50(1.60)		100.00	−0.40 [−1.15, 0.35]
Total (95% CI)	22		23			100.00	−0.40 [−1.15, 0.35]

Test for heterogeneity: not applicable
Test for overall effect: Z = 1.04 (P = 0.30)

Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 01 diet versus usual care
Outcome: 03 change in fat-free mass (kg)

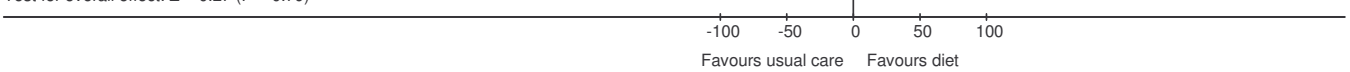
Study or sub-category	N	diet Mean (SD)	N	usual care Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	22	−0.70(0.60)	23	0.20(1.00)		100.00	−0.90 [−1.38, −0.42]
Total (95% CI)	22		23			100.00	−0.90 [−1.38, −0.42]

Test for heterogeneity: not applicable
Test for overall effect: Z = 3.68 (P = 0.0002)

Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 01 Diet versus usual care
Outcome: 04 Change in basal plasma prolactin concentration (µg/mL)

Study or sub-category	N	Diet Mean (SD)	N	Usual care Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	22	−3.03(32.98)	23	−5.27(20.77)		100.00	2.24 [−13.95, 18.43]
Total (95% CI)	22		23			100.00	2.24 [−13.95, 18.43]

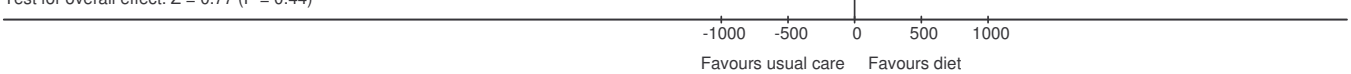
Test for heterogeneity: not applicable
Test for overall effect: Z = 0.27 (P = 0.79)



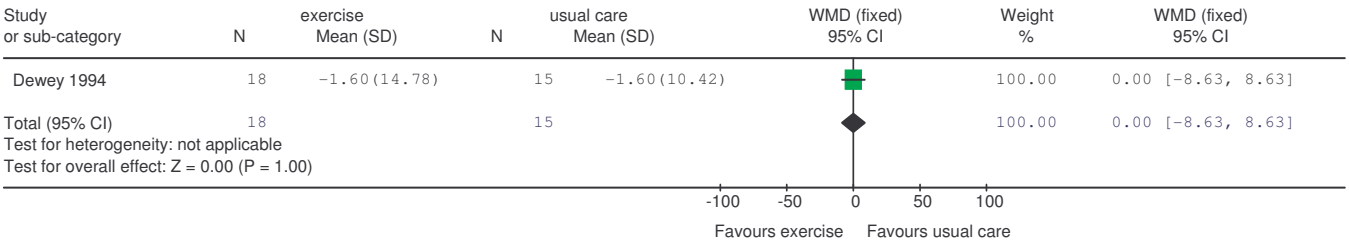
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 01 Diet versus usual care
Outcome: 05 Change in milk volume (g/day)

Study or sub-category	N	Diet Mean (SD)	N	Usual care Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	22	−1.00(76.00)	23	17.00(81.00)		100.00	−18.00 [−63.87, 27.87]
Total (95% CI)	22		23			100.00	−18.00 [−63.87, 27.87]

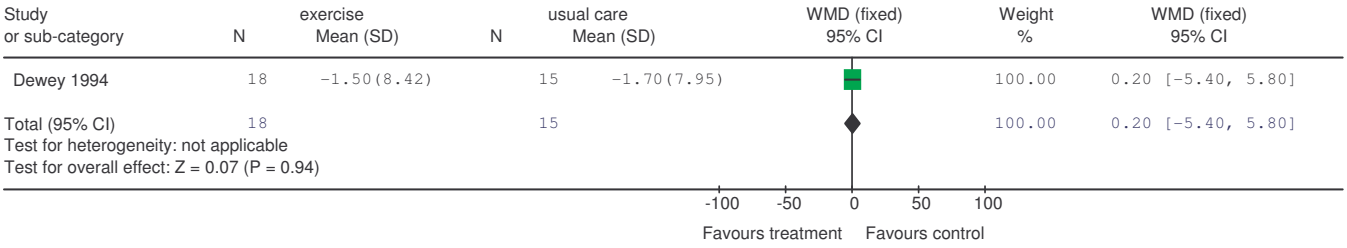
Test for heterogeneity: not applicable
Test for overall effect: Z = 0.77 (P = 0.44)



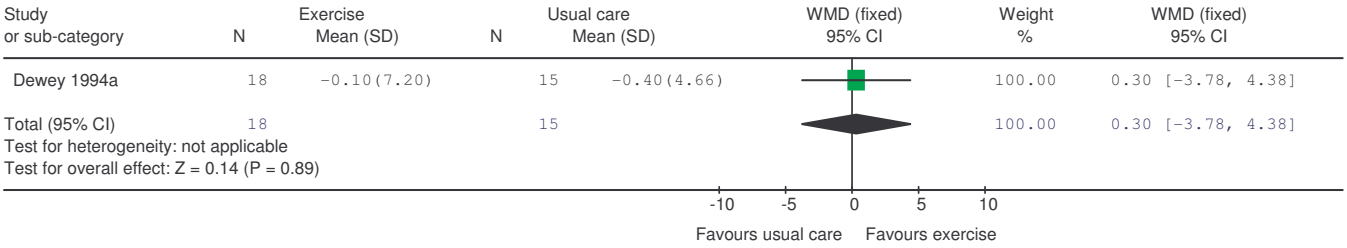
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 02 exercise versus usual care
Outcome: 01 postpartum weight loss (kg)



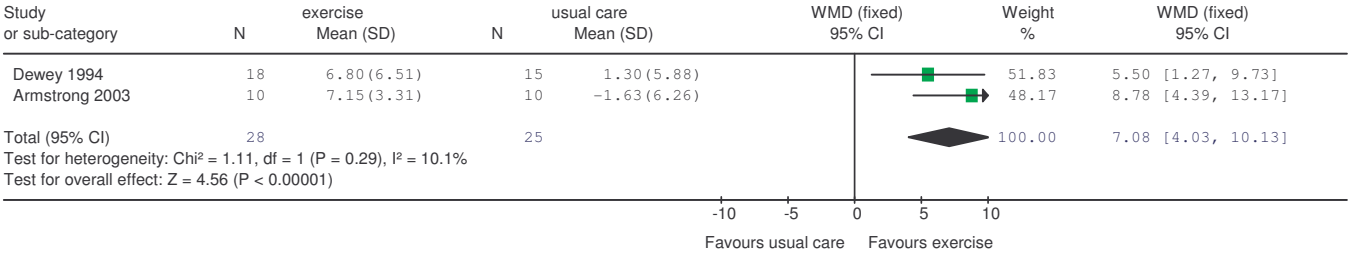
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 02 exercise versus usual care
Outcome: 02 change in % body fat



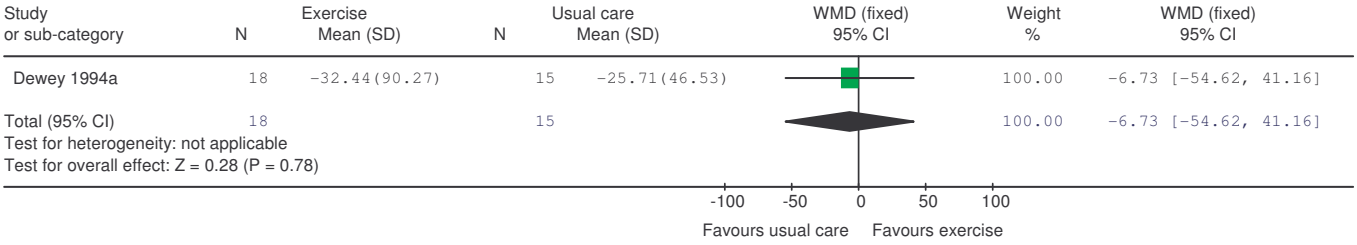
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 02 Exercise versus usual care
Outcome: 03 Change in fat-free mass (kg)



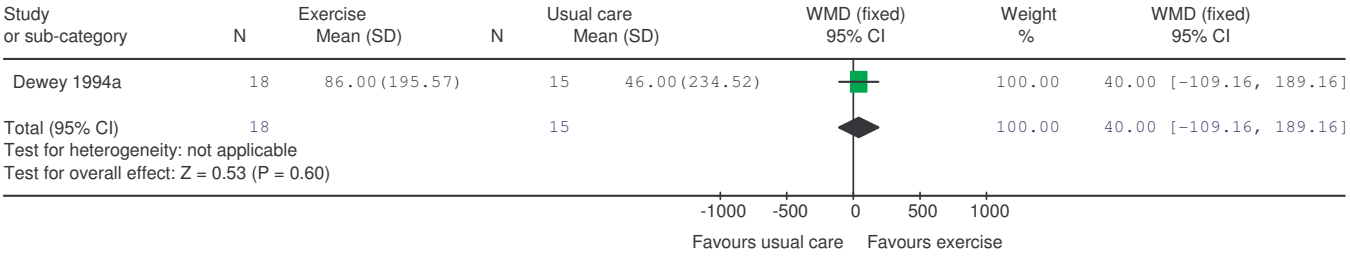
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 02 exercise versus usual care
Outcome: 04 change in VO2max (mL/ kg/ min)



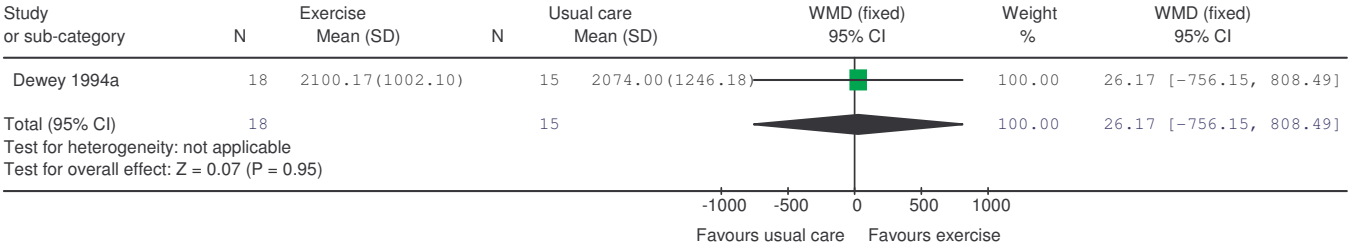
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 02 Exercise versus usual care
Outcome: 05 Change in basal plasma prolactin concentration (µg/mL)



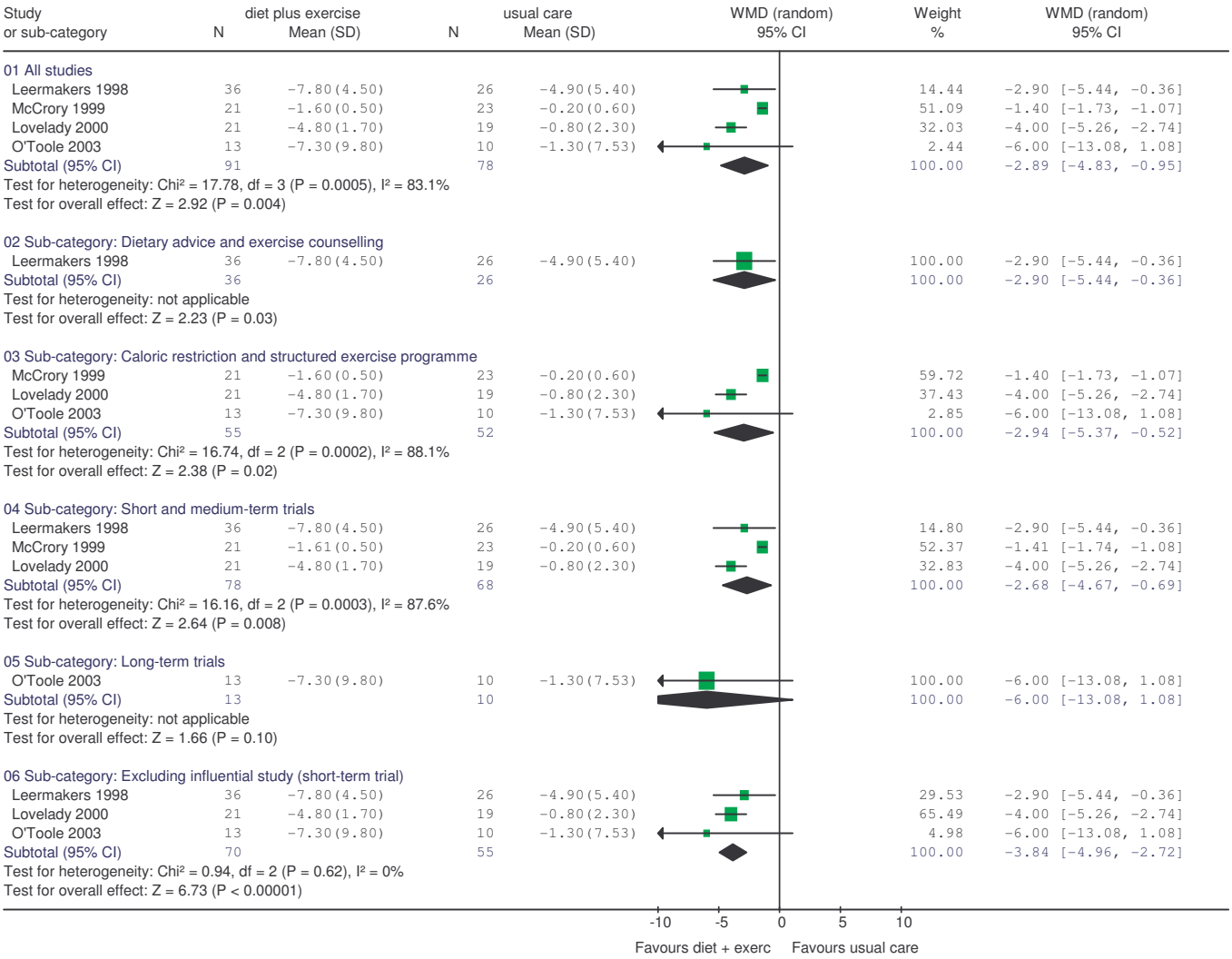
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 02 Exercise versus usual care
Outcome: 06 Change in milk volume (g/day)



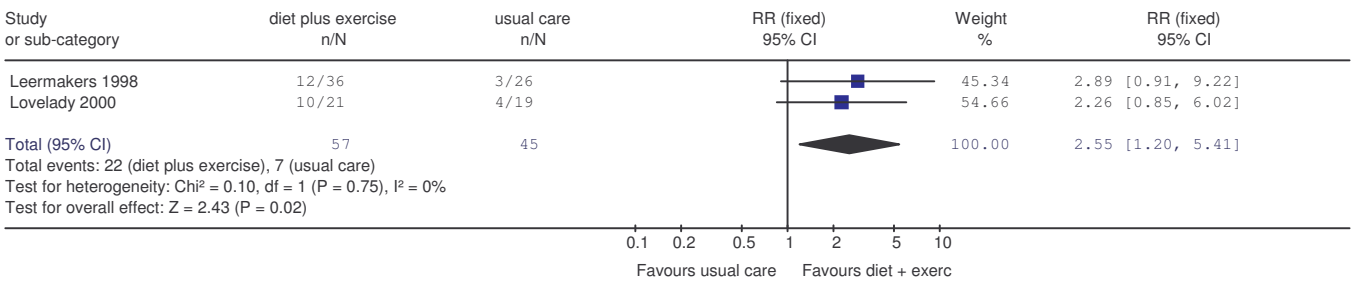
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 02 Exercise versus usual care
Outcome: 07 Infant weight gain (g)



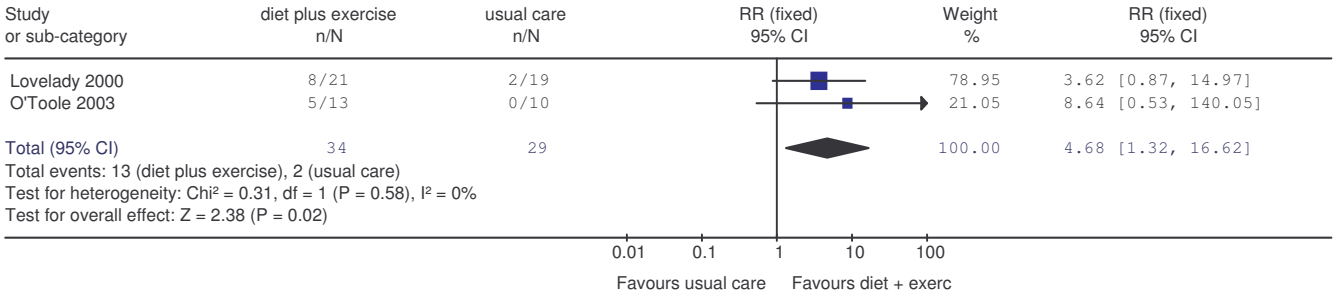
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 03 diet plus exercise versus usual care
Outcome: 01 postpartum weight loss (kg)



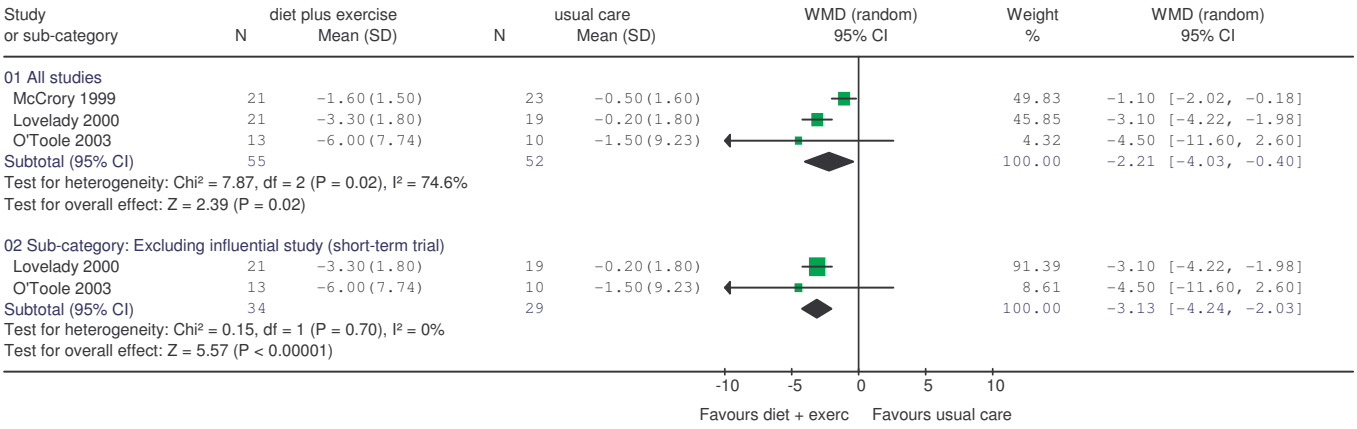
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 03 diet plus exercise versus usual care
Outcome: 02 % of women who returned to pre-pregnancy weight or lost weight retained after childbirth



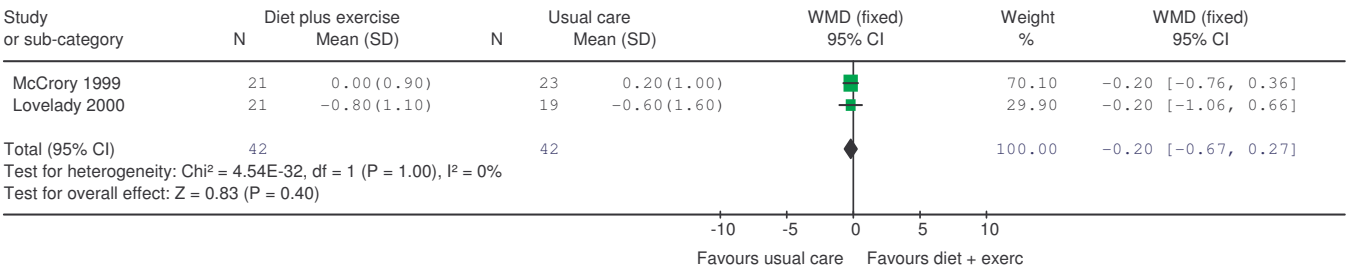
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 03 diet plus exercise versus usual care
Outcome: 03 % of women who achieved healthy weight



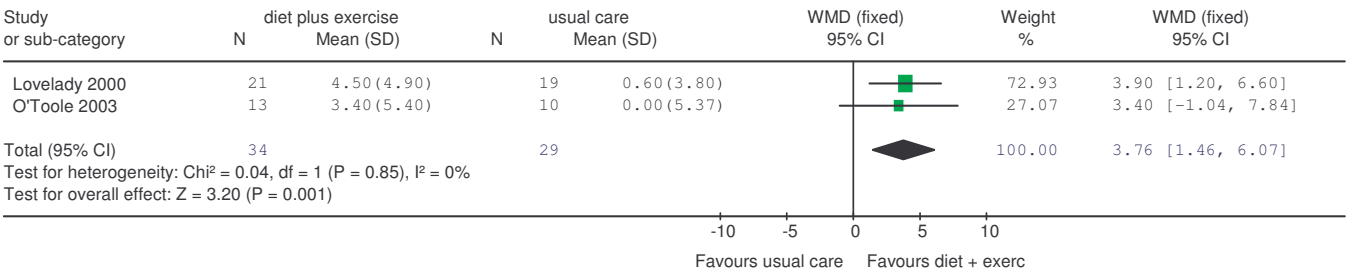
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 03 diet plus exercise versus usual care
Outcome: 04 change in % body fat



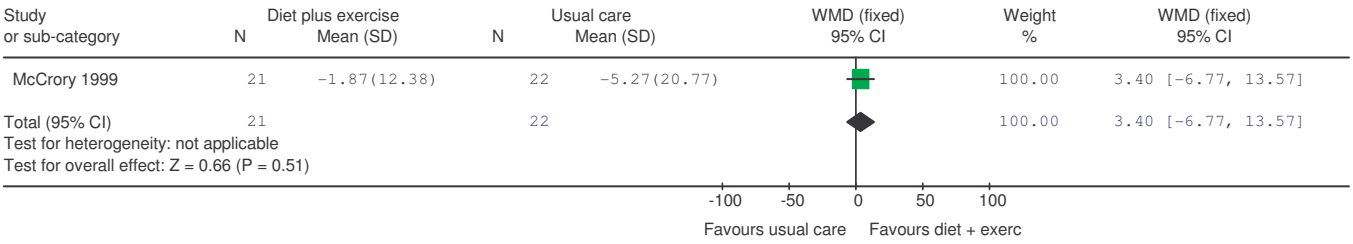
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 03 Diet plus exercise versus usual care
Outcome: 05 Change in fat-free mass (kg)



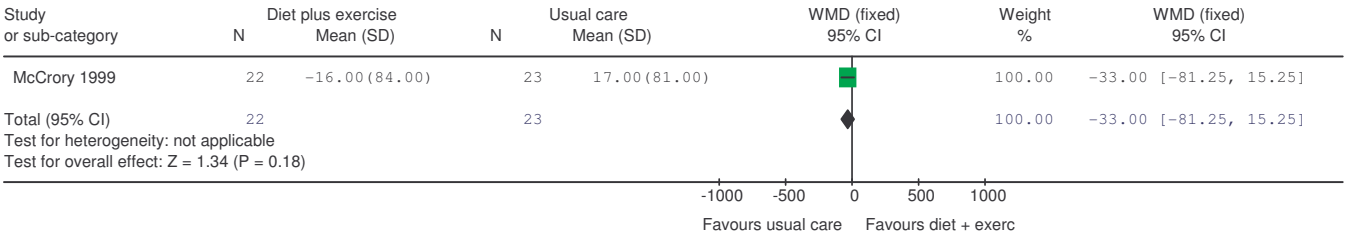
Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 03 diet plus exercise versus usual care
Outcome: 06 change in VO2max (mL/ kg/ min)



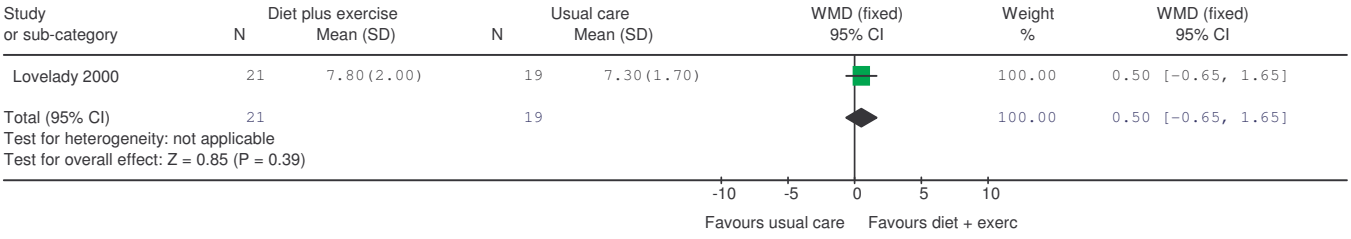
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 03 Diet plus exercise versus usual care
Outcome: 07 Change in basal plasma prolactin concentration (µg/mL)



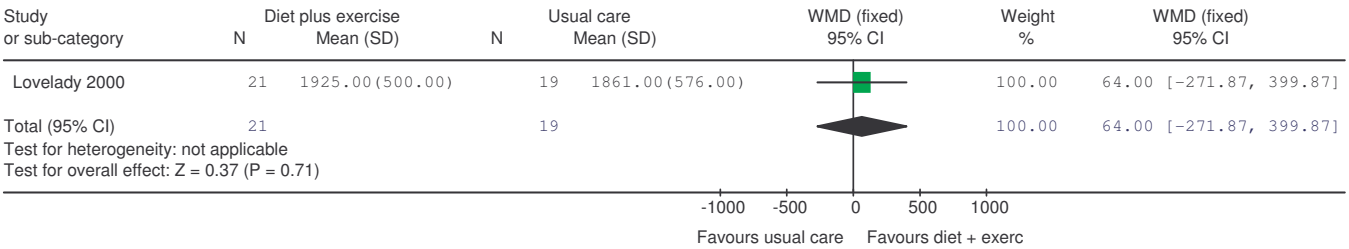
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 03 Diet plus exercise versus usual care
Outcome: 08 Change in milk volume (g/day)



Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 03 Diet plus exercise versus usual care
Outcome: 09 Infant length gain (cm)



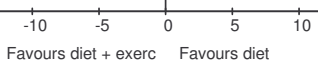
Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 03 Diet plus exercise versus usual care
Outcome: 10 Infant weight gain (g)



Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 06 diet plus exercise versus diet alone
Outcome: 01 postpartum weight loss (kg)

Study or sub-category	diet plus exercise N	Mean (SD)	diet N	Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	21	−1.60(0.50)	22	−1.90(0.70)		100.00	0.30 [−0.06, 0.66]
Total (95% CI)	21		22			100.00	0.30 [−0.06, 0.66]

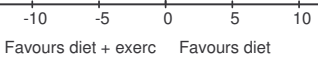
Test for heterogeneity: not applicable
Test for overall effect: Z = 1.62 (P = 0.10)



Review: Diet or exercise, or both, for weight reduction in women after childbirth
Comparison: 06 diet plus exercise versus diet alone
Outcome: 02 change in % body fat

Study or sub-category	diet plus exercise N	Mean (SD)	diet N	Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	21	−1.60(1.50)	22	−0.90(0.90)		100.00	−0.70 [−1.44, 0.04]
Total (95% CI)	21		22			100.00	−0.70 [−1.44, 0.04]

Test for heterogeneity: not applicable
Test for overall effect: Z = 1.84 (P = 0.07)



Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 06 Diet plus exercise versus diet alone
Outcome: 03 Change in fat-free mass (kg)

Study or sub-category	Diet plus exercise N	Mean (SD)	Diet N	Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	21	0.00(0.90)	22	−0.70(0.60)		100.00	0.70 [0.24, 1.16]
Total (95% CI)	21		22			100.00	0.70 [0.24, 1.16]

Test for heterogeneity: not applicable
Test for overall effect: Z = 2.99 (P = 0.003)

Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 06 Diet plus exercise versus diet alone
Outcome: 04 Change in basal plasma prolactin concentration (µg/mL)

Study or sub-category	Diet plus exercise N	Mean (SD)	Diet N	Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	22	−1.87(12.38)	21	−3.03(32.98)		100.00	1.16 [−13.86, 16.18]
Total (95% CI)	22		21			100.00	1.16 [−13.86, 16.18]

Test for heterogeneity: not applicable
Test for overall effect: Z = 0.15 (P = 0.88)

Review: Diet or exercise, or both, for weight reduction in women after childbirth (Version 13)
Comparison: 06 Diet plus exercise versus diet alone
Outcome: 05 Milk volume (g/day)

Study or sub-category	Diet plus exercise N	Mean (SD)	Diet N	Mean (SD)	WMD (fixed) 95% CI	Weight %	WMD (fixed) 95% CI
McCrory 1999	22	−16.00(84.00)	22	−1.00(76.00)		100.00	−15.00 [−62.34, 32.34]
Total (95% CI)	22		22			100.00	−15.00 [−62.34, 32.34]

Test for heterogeneity: not applicable
Test for overall effect: Z = 0.62 (P = 0.53)

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