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Impacto de um programa de atualização em alimentação infantil para profissionais de saúde em desfechos dietéticos, antropométricos e de saúde entre crianças de baixa condição socioeconômica

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RESUMO

Objetivos: O objetivo geral desta tese foi avaliar o impacto de um programa de atualização em alimentação infantil para profissionais de saúde em desfechos dietéticos, antropométricos e de saúde entre crianças de baixa condição socioeconômica. Assim, desenvolveram-se três artigos científicos que objetivaram: 1) Avaliar o impacto de um programa de atualização em alimentação infantil para profissionais de saúde na prevalência de constipação entre crianças aos seis anos de idade; 2) Verificar o impacto de um programa de atualização em alimentação infanti, para profissionais de saúde no consumo de energia e adiposidade entre crianças aos seis meses, doze meses, três anos e seis anos de idade; 3) Identificar o período critíco de ganho de peso excessivo em crianças de até seis anos de idade e verificar a associação entre o momento de maior ganho de peso e padrões dietéticos precedentes. **Métodos:** O estudo original foi um ensaio de campo randomizado em Unidades de Saúde (US), na cidade de Porto Alegre, Brasil. As US foram alocadas nos grupos intervenção (n=9) ou controle (n=11). Nas unidades intervenção, os profissionais de saúde participaram de sessões de treinamento, baseado nos "Dez Passos para uma Alimentação Saudável para Crianças Menores de Dois Anos". Gestantes no último trimestre de ambos os grupos foram identificadas, convidadas a participar e inscritas no estudo como mães em potencial para receber o aconselhamento dietético, fornecido por meio dos profissionais de saúde. Foram realizadas visitas domiciliares aos seis meses, doze meses, três anos e seis anos de idade das crianças. Dados dietéticos e antropométricos foram coletados em todas as idades. Aos seis anos, foi realizado questionário para avaliação de constipação funcional. **Resultados:** 1) Aos seis anos de idade, a probabilidade de ter constipação funcional foi 38% menor no grupo intervenção (RP = 0,62; IC95% 0,44-0,87; P<0,01), quando comparado ao grupo controle. 2) O consumo de energia não diferiu entre os grupos intervenção e controle aos seis e doze meses de idade. Aos três anos, as crianças do grupo de intervenção consumiram menos calorias quando comparadas àquelas do grupo controle (IC95% -154,3 a -30,8; P=0,03). Também encontramos menor consumo de energia provenientes de biscoitos

(Diferença média -22.2kcal/dia; IC95% -40.6 a -3.7; P=0.02) e chocolate em pó (Diferença média -17.5kcal/dia; IC95% -30.2 a -4.8; P<0,01) nas crianças do grupo de intervenção aos três anos de idade e novamente aos seis anos (Diferença média -22,2kcal/dia; IC95% -40,6 a -3,7 e Diferença média -13,0kcal/dia; IC95% -22,6 a 3,3, P<0,05, respectivamente). Em relação à antropometria, as diferenças significativas entre os grupos foram encontradas aos seis anos. Os valores de circunferência da cintura (Diferença -1,3cm; IC95% -2,7 a -0,0; P = 0,04), dobras cutâneas tricipital e subescapular (Diferença -1,3mm; IC95% -2,5 a -0,0; P = 0,04 e Diferença -1,3 mm, IC 95% -2,6 a -0,0, P = 0,04, respectivamente) foram menores para as crianças do grupo de intervenção. 3) A maior prevalência de ganho de peso excessivo ocorreu no segundo semestre de vida, sem diferença entre intervenção ou controle. Aos seis meses, receber leite materno foi protetor contra o ganho de peso excessivo entre seis e doze meses. Ao passo que padrões alimentares não saudáveis na mesma idade estavam associados a um risco aumentado de ganho de peso excessivo. **Conclusões**: O treinamento de profissionais de saúde para promover práticas alimentares adequadas para lactentes foi eficaz na redução da prevalência de constipação e de indicadores de adiposidade aos seis anos de idade. Futuras intervenções devem focar na redução de ingestão excessiva de alimentos com alta densidade energética no início da vida para combater o consumo excessivo de calorias, como uma estratégia potencial para prevenir a obesidade infantil.

Palavras-chave: Crianças. Antropometria. Consumo de alimentos. Ingestão de energia. Estudos randomizados.

ABSTRACT

Objective: The general aim of this thesis was to evaluate the impact of health worker training on infant feeding practices on dietary, anthropometric and health outcomes among children from low-income families. Thus, we developed three papers that aimed to: 1) assess the impact of health worker training on infant feeding practices on the prevalence of functional constipation among children at six years of age; 2) assess the long-term impact of a primary care intervention to promote the Brazilian guideline for infant feeding practices on the energy intake and adiposity during a follow up from six months to six years of age; and 3) identify the critical period of excessive weight gain in children up to six years of age and to verify the association between the moment of greater weight gain and previous dietary patterns. **Methods:** The original study was a cluster randomized controlled trial carried out in Health Care Centers in Porto Alegre, Brazil. Health centers were randomly allocated into intervention (n=9) or control (n=11) groups. In intervention sites, health workers joined training sessions on the "Ten Steps for Healthy Feeding for Children from Birth to Two Years of age". Pregnant women in the last trimester of both groups were identified, invited to participate and enrolled in the study as the potential mothers to receive the dietary counselling provided by the health workers. Dietary and anthropometric data were collected at six months, twelve months, three years and six years of age. At six years of age, a questionnaire was performed to evaluate functional constipation. **Results:** The results showed that 1) The probability of being constipated was 38% lower in the intervention group (PR=0.62; 95% CI 0.44-0.87; P <0.01) compared to the control group; 2) Energy intake did not differ between intervention and control group at six and twelve months of age. At three years of age, children from the intervention group consumed approximately 92 kcal/day (95% CI -154.3 to -30.8; P=0.03) less than those of the control group. We also found a lower consumption of energy from cookies (Difference -22.2kcal/day; 95% CI -40.6 to -3.7; P=0.02) and chocolate powder (Difference -17.5kcal/day; 95% CI -30.2 to -4.8; P<0.01) for children in the intervention group at three years of age and again at six years of age (Difference -22.2kcal/day; 95% CI -40.6 to -3.7 and Difference -13.0kcal/day; 95% CI -22.6 to 3.3; P<0.05, respectively). Regarding adiposity

measures, waist circumference (Difference -1.3cm; 95% CI -2.7 to -0.0; P=0.04), triceps and subscapular thickness skinfold (Difference -1.3mm; 95% CI -2.5 to -0.0; P=0.04 and Difference -1.3mm; 95% CI -2.6 to -0.0; P=0.04, respectively) were lower for children in the intervention group at six years of age. 3) Our findings showed that the highest prevalence of excessive weight gain occurred in the second semester of life. At six months of age, receiving no breast milk as a source of milk feeding type and unhealthy dietary patterns were associated with an increased risk of excessive weight gain at twelve months of age. **Conclusions:** The health workers training to promote the 'Ten Steps' was an effective way to reduce the prevalence of constipation and adiposity measures at six years of age. Future interventions should address the risk of excessive intake of energy-rich foods early in life to combat excessive calories consumption as a potential strategy to prevent childhood obesity.

Keywords: Children. Anthropometry. Food consumption. Energy intake. Randomized trials.

SUMÁRIO

APRESENTAÇÃO

Este trabalho consiste na Tese de doutorado intitulada: *"Impacto de um programa de atualização em alimentação infantil para profissionais de saúde em desfechos dietéticos, antropométricos e de saúde entre crianças de baixa condição socioeconômica"*, a ser apresentada no Programa de Pós-graduação em Ciências da Saúde da Universidade Federal de Ciências da Saúde de Porto Alegre no ano de 2018. O trabalho foi elaborado a partir da análise de dados de projeto maior denominado *"Implementação dos Dez Passos para Alimentação Saudável para Crianças Menores de Dois Anos em Unidades de Saúde"*, e suas continuações intituladas *"Impacto da intervenção na atenção primária à saúde nas condições nutricionais de crianças em idade pré-escolar: segunda fase de avaliação de ensaio de campo randomizado por conglomerados",* e *"Impacto nas condições nutricionais e de saúde de crianças na idade de 6-7 anos que participaram de um ensaio de campo randomizado por conglomerados no primeiro ano de vida".* O projeto iniciou em 2008, na cidade de Porto Alegre, Rio Grande do Sul, e foi desenvolvido pelo Núcleo de Pesquisa em Nutrição (NUPEN), sob coordenação da Profª. Drª. Márcia Regina Vitolo. O NUPEN desenvolve estudos, especificamente, na área de nutrição materno infantil, com os temas obesidade e hábitos alimentares de crianças.

Essa tese é composta pelas seguintes partes: apresentação, revisão da literatura, objetivos, e três artigos científicos. O primeiro, intitulado: *"Infant feeding practices and the effect in reducing functional constipation 6 years later: a randomised field trial"*, foi desenvolvido em parceria com o Professor Dr. Mauro Batista de Morais, da Universidade Federal de São Paulo, publicado no periódico *Journal of Pediatric Gastroenterology & Nutrition*. Os demais manuscritos intituados *"The long term impact of a primary care intervention to promote healthy infant feeding practices on children adiposity at six years old in Brazil: a cluster randomised controlled trial"*, e *"The early origin of childhood obesity: dietary patterns and excessive weight gain"* estão sendo desenvolvidos em parceria com o Professor Dr. Lambert Lumey, da *Columbia University*. O primeiro deles será submetido para apreciação do corpo editorial do periódico *The Lancet*, e o segundo será submetido para apreciação do corpo editorial do periódico *Pediatrics.*

1 REVISÃO DE LITERATURA

1.1 Práticas alimentares na infância

As preferências alimentares envolvem uma complexa interação de fatores genéticos, familiares e ambientais (BIRCH, 1998; SKINNER et al., 2002). A conhecida predisposição genética para aceitar o sabor doce e rejeitar os sabores ácido e amargo pode ser explicada como proteção, quando a criança identifica o doce como fonte de nutrientes e energia (como alimentos maduros), enquanto que ácido e amargo são associados às toxinas (BEUCHAMP; MENNELLA, 2011; BIRCH, 1998). Apesar desta característica inata contribuir para a baixa aceitação de frutas e vegetais, as preferências podem ser modificadas por meio do ambiente e das experiências precoces com os alimentos (BIRCH L., 1990; SKINNER et al., 2002).

Os sabores já experimentados são mais facilmente aceitos pelas crianças devido a familiarização. Durante o período pré-natal, o bebê é exposto a aromas e gostos provenientes da alimentação materna, presentes no fluído amniótico (MENNELLA; JAGNOW; BEAUCHAMP, 2001). Após o nascimento, a escolha de oferecer leite materno ou fórmula infantil continuam a expor o bebê aos sabores, seja pela infinidade de gostos e aromas provenientes do leite humano ou a monotonia da fórmula (BEAUCHAMP; MENNELLA, 2009; MENNELLA et al., 2009; MENNELLA; KENNEDY; BEAUCHAMP, 2006).

O processo de formação das preferências continua com a introdução da alimentação complementar (BIRCH et al., 1998, 2004). O consumo alimentar durante a infância é intimamente relacionado às primeiras experiências alimentares. Em uma coorte de quase 8.000 crianças, estudo demonstrou a associação positiva entre o consumo de frutas e vegetais aos seis meses e a maior freqüência no consumo desses alimentos aos sete anos de idade (COULTHARD *et al.*, 2010), demonstrando que hábitos alimentares adquiridos precocemente tendem a se manter.

A literatura vem destacando modificações no consumo alimentar nos últimos 30 anos, tanto em países em desenvolvimento como nos desenvolvidos, com ênfase para aumento do consumo de alimentos com alta densidade de energia, excesso de gorduras totais e saturadas, e maiores concentrações de açúcar e/ou sódio. Este aumento é concomitante com a diminuição no consumo de frutas, verduras e

legumes (BACHMAN et al., 2008; LEVY-COSTA et al., 2005; PIERNAS; POPKIN, 2010).

Dados dos estudos *Infant Feeding Practices Study 2 (IFPS2)* e *Year 6 Follow-Up Study (Y6FU)* demonstraram que lactentes com padrões alimentares mais elevados na ingestão de frutas e vegetais aos nove meses de idade, tiveram maior consumo desses alimentos aos seis anos. Logo, os bebês com padrão alimentar caracterizado por alimentos com alta densidade energética (frituras e doces) mantiveram maior consumo destes alimentos aos seis anos (ROSE; BIRCH; SAVAGE, 2017).

No Brasil, estudo transversal realizado com 1.282 crianças em idade escolar, demonstrou que quase 65% precisavam melhorar sua alimentação, sendo que, destas, 41% apresentavam um consumo alimentar de baixa qualidade (MOLINA et al., 2010) Outro Estudo de base populacional, com 3.817 crianças menores de cinco anos da Bahia, identificou padrões alimentares monótonos, com baixo consumo de frutas, verduras e legumes (MATOS et al., 2014).

Em relação à introdução de alimentos, um estudo multicêntrico realizado no Sul do Brasil com 1.567 crianças de doze a 59 meses de idade, de baixa condição socioeconômica, revelou que a prevalência de introdução de açúcar antes dos quatro meses foi de 35,5% (n= 497; IC95%: 33,1-38,0). Além disso, as prevalências de introdução de biscoitos (doce ou salgado), queijo *petit suisse* e gelatina antes do sexto mês, foram de 20,4% (n= 287; IC95%: 18,3-22,3), 24,8% (n= 349; IC95%: 22,4-27,1) e 13,8% (n= 192; IC95%: 12,0-15,7), respectivamente (DALLAZEN et al., 2018). Ainda no Sul do Brasil, estudo realizado com crianças menores de doze meses de idade mostrou que 40% delas na idade de seis meses, e 80% na idade de doze meses, já tinham consumido refrigerante, bala ou pirulito, e biscoito recheado. A prevalência de consumo de açúcar de adição, queijo *petit suisse* e gelatina nas duas idades foi superior a 70% (VITOLO et al., 2013).

As decisões precoces sobre o tipo de alimentação a ser oferecida no primeiro ano de vida, pode prever padrões alimentares e também o risco de desenvolver excesso de peso e obesidade. Esses dados são alarmantes uma vez que as práticas alimentares inadequadas estão associadas com desfechos negativos imediatos de saúde, como o excesso de peso (BAKER et al., 2004; DE ONIS; BLÖSSNER; BORGHI, 2010; MICHAELSEN; GRUMMER-STRAWN; BÉGIN, 2017; ROSE;

BIRCH; SAVAGE, 2017) e a constipação intestinal (AGUIRRE et al., 2002; DELGADO-AROS et al., 2004; KRANZ et al., 2012; MISRA; LEE; GENSEL, 2006; PASHANKAR, 2005).

1.2 Desfechos negativos de saúde: constipação funcional, excesso de peso e obesidade

Constipação Funcional

A constipação intestinal é um dos distúrbios gastrointestinais mais persistentes na infância, sendo a principal queixa entre consultas pediátricas nesta área (MUGIE; BENNINGA; DI LORENZO, 2011). Atualmente, a doença representa um encargo de saúde nos orçamentos já sobrecarregados de muitos países em relação ao atendimento ao paciente, despesas com investigações e prescrições (RAJINDRAJITH et al., 2016). Além disso, a constipação funcional em crianças está relacionada à baixa qualidade de vida (BONGERS et al., 2009; RAJINDRAJITH et al., 2012; VARNI et al., 2015) e ao desempenho escolar ruim (RAJINDRAJITH et al., 2016), podendo persistir até a idade adulta em aproximadamente 25% destas crianças (KHAN et al., 2007; VAN GINKEL et al., 2003).

A prevalência de constipação funcional infantil varia de 0,7% a 29,6%, dependendo dos critérios utilizados para avaliação (BENNINGA, 2004; MUGIE; DI LORENZO; BENNINGA, 2011). O critério diagnóstico mundialmente aceito é o Roma III (RASQUIN et al., 2006), que considera em crianças maiores de quatro anos, ter dois ou mais dos seguintes sintomas: ≤ 2 evacuações por semana; ao menos um episódio de incontinência fecal por semana; história de postura retentiva ou retenção fecal voluntária excessiva; história de movimentos intestinais dolorosos; presença de extensa massa fecal no canal retal; história de fezes que podem obstruir o vaso sanitário. Os sintomas devem estar presentes pelo menos uma vez por semana num intervalo de dois meses. Esses critérios são, entretanto, considerados por alguns especialistas muito restritivos (RAJINDRAJITH et al., 2016). As diretrizes da ESPGHAN (Sociedade Europeia de Gastroenterologia, Hepatologia e Nutrição Pediátrica) e NASPGHAN (Sociedade Norte-Americana de Gastroenterologia, Hepatologia e Nutrição Pediátrica) recomendam que sejam usados os critérios de Roma III, exceto pela duração dos sintomas, uma vez que o intervalo de dois meses

recomendado para crianças mais velhas pode contribuir para atraso no tratamento (YOUSSEF, NADER N; LANSEDER, ANNETTE L; VERGA, BARBARA J; MONES, RICHARD L; ROSH, 2005). O Roma IV, lançado em 2016, manteve os critérios diagnósticos para constipação funcional em criaças maiores de quatro anos (HYAMS et al., 2016). Contudo, para o diagnóstico, os sintomas devem estar presentes pelo menos uma vez por semana durante um mês.

No Brasil não há unanimidade em relação aos critérios diagnósticos, que incluem variáveis do hábito intestinal, isoladas ou em conjunto, ou sinais e sintomas associados à constipação funcional. Além disso, são escassos os estudos de acompanhamento que caracterizam a idade em que este problema começa a se manifestar (MOTA et al., 2012). Estudo envolvendo 275 lactentes entre 6 e vinte e quatro meses, atendidos em uma Unidade Básica de Saúde, mostrou que a prevalência de constipação funcional mais frequente foi no primeiro semestre de vida (15,1%, $p<0,01$). Por outro lado, os resultados demonstraram o aleitamento materno como fator protetor em relação à doença (AGUIRRE et al., 2002). A análise evidenciou que, no primeiro semestre de vida, os lactentes em aleitamento artificial demonstraram chance 4,5 vezes maior de apresentar constipação do que aqueles em aleitamento predominante.

A influência da alimentação na infância no desenvolvimento da constipação, além do período de amamentação e desmame, é relativamente pouco investigada. Estudo de coorte com crianças de quatorze meses de idade (n=2.420) mostrou que a adesão a um padrão alimentar com alta ingestão de guloseimas e bebidas açucaradas foi associada a uma maior prevalência da doença até os quarenta e oito meses (IC95% 1,39; 1,02-1,87), que não foi mediada por excesso de peso ou comportamento sedentário (KIEFTE-DE JONG et al., 2013). A adesão ao padrão alimentar caracterizado pela alta ingestão de frutas, verduras, legumes e peixes foi associado apenas a curto prazo, com menor prevalência de constipação aos vinte e quatro meses (IC 95% 0,65; 0,44-0,96). Os resultados deste estudo sugeriram que padrões alimentares específicos na primeira infância podem estar associados a riscos maiores ou menores de desenvolver constipação tempo.

Excesso de peso e obesidade em crianças

A etiologia da obesidade é multifatorial e é sustentada por complexas interações de fatores genéticos, psicossociais e ambientais. A literatura científica sugere que a infância é um período crítico para o ganho de peso excessivo, desenvolvimento da obesidade e seus resultados de saúde relacionados (ZHENG et al., 2018). Dessa forma, o excesso de peso infantil é considerado problema de saúde pública, tanto em países desenvolvidos, como nos que estão em desenvolvimento (THOMPSON, 2012; ZHENG et al., 2018). Segundo a Organização Mundial de Saúde, aproximadamente 42 milhões de crianças com idade inferior a cinco anos são classificadas em sobrepeso e/ou obesidade, das quais 31 milhões vivem em países em desenvolvimento (WHO 2016).

Dados do *National Health and Nutrition Examination Survey III* (NHANES 1988 - 1994), e *IV* (NHANES 2013 – 2014) mostraram que entre crianças e adolescentes norte americanos, 17,0% eram obesos e 5,8% eram obesos extremos (OGDEN et al., 2016). Estudo de revisão cujo objetivo foi investigar a evolução do excesso de peso entre as crianças nos anos de 1980 a 2013, revelou que as prevalências de excesso de peso variaram de 8 para 24%. A investigação incluiu 1.769 estudos realizados em 188 países. No Brasil, a prevalência de excesso de peso aumentou de 16% para 24%, nos períodos estudados (NG et al., 2014). Além disso, dados da última Pesquisa de Orçamento Familiar (POF 2008/ 2009) mostrou prevalências de excesso de peso variando entre 32 a 40%, entre crianças de cinco e nove anos (IBGE, 2011).

O excesso de peso na infância está associado ao desenvolvimento de doenças cardiovasculares, elevação dos níveis de pressão arterial, colesterol total, triglicerídeos, lipoproteína de baixa densidade (LDL) e da glicemia de jejum a curto e longo prazo (BACHA et al., 2016; BASS; ENELI, 2015; LI et al., 2016). Além disso, esta condição está associada à redução dos níveis de Lipoproteína de alta densidade (HDL), desenvolvimento precoce de aterosclerose, comprometimento da resistência cardiovascular, e outras complicações metabólicas (BACHA; GIDDING, 2016; GENONI et al., 2017; YANG et al., 2016). A literatura científica indica que 60% dos indivíduos obesos na primeira década de vida, concomitante ou não ao diagnóstico de disfunção metabólica, irão apresentar pelo menos uma alteração metabólica anos mais tarde (SRINIVASAN; MYERS; BERENSON, 2002).

1.3 Estudos de intervenção no primeiro ano de vida

Considerando a importância dos primeiros anos de vida, em razão da formação dos hábitos alimentares e da relação entre alimentação e saúde, intervenções para promover práticas alimentares saudáveis são estratégias fundamentais na saúde pública (ARIKPO et al., 2018). Em geral, as intervenções no início da vida focam na promoção do aleitamento materno exclusivo e contínuo, preparações com alimentos específicos ou seu uso como fonte de nutrientes, consistência da alimentação e higiene na preparação e armazenamento dos alimentos (BHUTTA et al., 2008; DEWEY; ADU-AFARWUAH, 2008).

Desfechos positivos são observados em evidências com enfoque em práticas alimentares nos primeiros anos de vida (BHUTTA et al., 2013; PENNY et al., 2005; SHI et al., 2010), como efeitos na promoção do aleitamento materno (FU et al., 2014; EKSTRÖM; KYLBERG; NISSEN, 2012; HAROON, 2013), melhoras nas práticas de alimentação complementar (DANIELS et al., 2014; MS, 2013; SHI et al., 2010), e no estado nutricional das crianças (IMDAD; YAKOOB; BHUTTA, 2011; LASSI et al., 2013). Em relação a este período, estudo de revisão concluiu que faltam estudos randomizados controlados que evidenciem os efeitos a longo prazo de aleitamento materno e adequada introdução dos alimentos na prevalência de obesidade, especialmente em países em desenvolvimento (YANG e HUFFMAN, 2013). Revisão recente identificou 27 estudos de intervenção com foco em reduzir o risco de excesso de peso, muitos dos quais melhoraram práticas de alimentação e estilo de vida. Entretanto, a revisão ressaltou lacunas de estudos com acompanhamento maior que dois anos (REDSELL et al., 2016).

No Brasil, VITOLO e cols., 2005 realizaram estudo randomizado com o objetivo de orientar mães com base no manual “Dez passos para alimentação saudável para crianças menores de 2 anos”, no primeiro ano de vida de seus filhos. As recomendações dos "dez passos" consistem em: (1) dar somente leite materno até aos seis meses, sem oferecer água, chás ou qualquer outro alimento; (2) a partir dos seis meses, oferecer, de forma lenta e gradual, outros alimentos, mantendo o leite materno até os dois anos de idade ou mais; (3) a partir dos seis meses, dar alimentos complementares (cereais, tubérculos, carnes, leguminosas, frutas e legumes) três vezes ao dia, se a criança receber leite materno, e cinco vezes ao dia,

se estiver desmamada; (4) a alimentação complementar deve ser oferecida sem rigidez de horários, respeitando-se sempre a vontade da criança; (5) a alimentação complementar deve ser espessa desde o início e oferecida de colher, começar com consistência pastosa (papas/purês) e, gradativamente, aumentar a consistência até chegar à alimentação da família; (6) oferecer à criança diferentes alimentos ao dia (uma alimentação variada é uma alimentação colorida); (7) estimular o consumo diário de frutas, verduras e legumes nas refeições; (8) evitar açúcar, café, enlatados, frituras, refrigerantes, balas, salgadinhos e outras guloseimas nos primeiros anos de vida e usar sal com moderação; (9) cuidar da higiene no preparo e manuseio dos alimentos e garantir o armazenamento e conservação adequados; (10) estimular a criança doente e convalescente a se alimentar, oferecendo seus alimentos preferidos, respeitando a sua aceitação.

Os resultados deste aconselhamento dietético mostraram melhoras na prevalência de aleitamento materno exclusivo e na redução de alimentos de alta densidade energética (balas, refrigerantes, salgadinhos e chocolates) no grupo intervenção controle (VITOLO et al., 2010). A qualidade da dieta foi avaliada na mesma população e o estudo mostrou que a alimentação das crianças do grupo intervenção apresentou maior escore de qualidade em relação àquelas que pertenciam ao grupo controle (VITOLO et al., 2010). A eficácia do aconselhamento dietético a longo prazo foi observada entre 7 e 8 anos de idade das crianças no que se refere ao perfil sérico de lipídeos, onde as meninas do grupo intervenção apresentaram maiores valores de HDL-colesterol e menores concentrações de triglicerídeos (LOUZADA et al., 2012).

Estes resultados reforçam que as intervenções direcionadas às mães de maneira individual são promissoras. Por outro lado, são métodos limitados por dificuldades logísticas nas rotinas de atenção à saúde. Assim, VITOLO e cols., 2014 conduziram uma intervenção baseada nos “Dez Passos” direcionada aos profissionais de saúde. Foram randomizadas vinte Unidades de Saúde (US) de Porto Alegre em intervenção e controle. As US do grupo intervenção receberam orientações quanto às diretrizes alimentares para lactentes do Ministério da Saúde. Gestantes no terceiro trimestre foram cadastradas e os desfechos foram avaliados em seus filhos. Estudo publicado com dados das dietéticos das crianças aos seis meses de vida (n = 619) demonstrou que a prevalência de aleitamento materno

exclusivo no primeiro (72,3 *versus* 59,4%; RR = 1,21; IC95% 1,08 – 1,38), segundo (62,6 *versus* 48,2%; RR = 1,29; IC95% 1,10 – 1,53) e terceiro mês de vida (44,0 *versus* 34,6; RR = 1,27; IC95% 1,04 – 1,56) foi maior no grupo intervenção em relação ao controle. Além disso, as crianças do grupo intervenção também foram aquelas que consumiram carne quatro ou mais vezes na semana em relação àquelas do grupo controle (36,8 *versus* 22,6%; RR = 1,62; IC95% 1,30 – 2,03). Em relação aos alimentos não recomendados para menores de dois anos, a prevalência do consumo de refrigerantes (34,9 *versus* 52,5%; RR = 0,66; IC95% 0,54 – 0,80), chocolate (24,5 *versus* 36,7%; RR = 0,66; IC95% 0,53 – 0,83), *petit suisse* (68,9 *versus* 79,7%; IC95% 0,75 – 0,98) e café (10,4 *versus* 20,1%; RR = 0,51; IC95% 0,31 – 0,85) foi menor no grupo intervenção.

Desta forma, diferentes intervenções apresentam resultados satisfatórios nas práticas alimentares de crianças nos primeiros anos de vida, entretanto, esses achados são limitados em aspectos culturais, comportamentais, escolaridade, nível socioeconômico e acompanhamento (ICKES; HURST; FLAX, 2015; HENDBERG, 2013). É necessário que estudos considerem estas barreiras como estratégias de intervenção para que maiores resultados possam ser alcançados.

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2 OBJETIVOS

2.1 Objetivo geral

Avaliar o impacto de um programa de atualização em alimentação infantil para profissionais de saúde em desfechos dietéticos, antropométricos e de saúde entre crianças de baixa condição socioeconômica.

3.2 Objetivos específicos

- Avaliar o impacto de um programa de atualização em alimentação infantil para profissionais de saúde na prevalência de constipação entre crianças aos seis anos de idade.
- Verificar o impacto de um programa de atualização em alimentação infantil para profissionais de saúde no consumo de energia e adiposidade nas idades de seis meses, doze meses, três anos e seis anos de idade.
- Identificar o período critíco de ganho de peso excessivo entre crianças de até seis anos de idade e verificar a associação entre este momento e padrões dietéticos precedentes.

3 ARTIGO 1

Infant feeding practices and the effect in reducing functional constipation 6 years later: a randomised field trial

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Infant Feeding Practices and the Effect in Reducing Functional Constipation Six Years Later: A Randomised Field Trial.

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Abstract

OBJECTIVE:

To assess the impact of health worker training on infant feeding practices on the prevalence of functional constipation among children at six years of age.

METHODS:

Cluster randomised field trial conducted in Porto Alegre, Brazil. Health centers were randomly allocated into intervention (n=9) or control (n=11) groups. In intervention sites, health workers joined training sessions on the "Ten Steps for Healthy Feeding for Children from Birth to Two Years of age". Pregnant women in the last trimester of both groups were identified, invited to participate and enrolled in the study as the potential mothers to receive the dietary counseling provided by the health workers. At six years of age, the prevalence of functional constipation was evaluated based on Rome III, defined by two or more of the following: infrequent defecation, fecal incontinence, history of retentive posturing or/and history of painful defecation.

RESULTS:

Among 387 mother-child pairs (206 intervention, 181 control) evaluated at six years of age, the prevalence of functional constipation was lower in the intervention group compared to the control group (15.0% vs 23.9%, respectively). The probability of being constipated was 38% lower in the intervention group (PR=0.62; 95% CI 0.44-0.87; P<0.01).

CONCLUSION:

The health workers training to promote the 'Ten Steps' was an effective way to reduce the prevalence of constipation among children at six years of age.

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INTRODUCTION

Functional constipation (FC) in childhood represents a public health issue (1-3), with a worldwide prevalence ranging from 0.7 to 29% (4). Nowadays, the disease poses a healthcare burden on the budgets of many countries regarding to patient care, expenditure for investigations and prescriptions (5). Besides, FC is related to low quality of life (6-9) and poor school performance (5, 10), and may persist through young adulthood (6-8).

The most widely accepted diagnostic criteria for FC is Rome III (11). Also, the National Institute for Health and Clinical Excellence guideline (12) has recommended a detailed exploration of common signs that suggest organic causes of constipation ('red flags'). Currently, studies focus on treatment that includes educating the child and family, improving diet quality and organizing toilet habits, by administering laxatives for the regulation of bowel movements (13). Despite the etiology remains unclear (14), studies have been suggested that FC begins early in life, many even in the first year (15-18). Thus, early dietary factors (15, 19, 20) may play a role in the pathophysiology of the disorder and that is the reason to believe that adequate feeding practices early in life may be a protection against constipation.

We conducted a cluster randomized field trial with health care centers staff to promote the “Ten Steps for Healthy Feeding for Children from Birth to Two Years of age”. Previous studies showed that the intervention was effective to improve breastfeeding rates and complementary feeding practices (21, 22). Therefore, the question of this current study was to verify the impact of the early intervention on the FC later in childhood, when the children were six years of age.

METHODS

Study design and participants

This study was a cluster randomised field trial conducted in Porto Alegre, Brazil. The trial included health centers that provide primary care services predominantly to low-income families. Of 52 municipal health centers, 31 met eligibility criteria for the trial (Figure 1). Exclusion criteria were: ≤ 100 infant patient visits per year, staff-sharing between clinics, or participation in other community-based dietary programs.

The initial sample size for the trial aimed to detect the impact of the intervention on exclusive breastfeeding duration. Six hundred mother-child pairs would be needed to detect a 40% exclusive frequency of exclusive breast-feeding up to 4 months of age in the intervention group (23) and a 25% frequency in the control group (90% power and α of 0.5) and a design effect of 1.5. Seven hundred and twenty pregnant women were enrolled to obtain required study power, accounting for an anticipated loss of 20%.

Following staff training at the intervention sites, interviewers visited both groups' health centers (intervention and control), from April to December 2008, to identify and enroll pregnant women who were in the last trimester of pregnancy. The study was explained to them and who agreed to participate answered a questionnaire about their socioeconomic status and expected due date. Addresses and telephone numbers were obtained in order to schedule subsequent home visits. Births occurred from May 2008 to February 2009. Women reporting a positive HIV test were excluded because of concerns on virus transmission through breastfeeding.

Ethics

The study was approved by the Ethics Committee of the *Universidade Federal de Ciências da Saúde de Porto Alegre*, and was registered on the ClinicalTrials.gov website under the identification number NCT00635453. Mothers provided informed consent on behalf of their children.

Randomisation and masking

The randomisation process took place in the university research office. Of the 31 eligible health centers, 16 were initially selected via a witnessed drawing, by the main investigator, of labeled markers from an opaque container, so that 2 health centers from each of the city's 8 geo-administrative districts would be included. Following a stratified randomisation scheme, health centers were block-randomised by district, with one health center per district allocated to the intervention and another to the control group. In order to increase statistical power, 4 additional centers were randomly drawn. Health center size differed to maintain a balanced number of births by intervention group, the additional 4 health centers were block-randomised at a 1:3 ratio. This yielded 9 intervention and 11 control group centers. The 20 health centers were invited to participate without disclosure of allocation status, and all consented.

Intervention

Physicians, nurses and administrative staff in the treatment group health centers participated in a training, in January 2008, based on the "Ten Steps for Healthy Feeding for Children from Birth to Two Years of age" guideline (24)**.** In summary, the recommendations provide: (1) exclusive breastfeeding until six months of age; (2) continue breastfeeding until two years of age with the gradual introduction of complementary food; (3) start complementary feeding at six months of age while continuing breastfeeding; (4) provide meals at regular intervals, adjusted to the child's internal hunger cues; (5) new food should be gradually made thicker until the child is able to eat a normal family meal; (6) offer of a variety of healthy food every day; (7) present daily intake of different fruits and vegetables; (8) avoid sugar, sweets, soft drinks, salty snacks and processed/fried food; (9) use good hygiene practices for food preparation; and (10) afford appropriate, responsive feeding when the child is ill.

A standardized training session, conducted by an experienced nutritionist, for the health care team to outline the "Ten Steps" recommendations and strategies and to incorporate these into follow up consultations. Health staff members received a pocket guide for use during the appointments and waiting room sessions. The research team did not involve in the consultations at any time in the study.

The health workers received two printed materials, developed by the principal researcher, which would be delivered to mothers during the follow-up consultations. Both flyers included illustrative pictures to facilitate explanation by the health workers. The first one mentioned the “Steps”, suggesting to mothers that she should get more information about it with the health workers. The second one included detailed messages about the guideline. In addition, we provided two colorful posters for display in the waiting rooms of health care centers with (1) information about introducing complementary food, the number of meals and food scheme; and (2) colorful pictures of foods that should not be offered to children under two years of age. The two posters remained in the clinics after the intervention.

Control group

Healthcare centers randomised to non-intervention groups continued their routine of assistance without the research team interference. No material was provided to them.

Data collection

Trained field workers, who were not involved in the intervention and who were unaware of group allocation, conducted maternal interviews in pregnancy and later for follow-up home-visits at six months and six years of child age. At six months, data on sex, date of birth, weight and length at birth were collected from the maternity records during home visits. The field workers received theoretical and practical eight-hour training and were supervised by the main investigator. At six years of age (2014), the interviews were conducted at the University, in an appropriate location. A single interviewer, unaware of group allocation, performed the questionnaire based on Rome III (11), related to the functioning of the gastrointestinal. After the data collection, the information was confirmed through telephone calls made to 5% of the mothers surveyed, who were randomly selected.

Definition of Constipation

The FC diagnosis was defined based on Rome III, considering positive by two or more of the following: (1) two or less bowel movements in the toilet per week - positive answer; (2) one or more episodes of fecal incontinence per week - positive

answer equivalent to “yes, at least once a week"; (3) history of retentive posturing or excessive volitional stool retention - positive answer equivalent to “yes, at least once a week" or "frequently holds the stools until lose the necessity to evacuate"; (4) history of painful or hard bowel movements - positive answer equivalent to "intense pain" or "very intense pain"; (5) history of large diameter stools that may obstruct the toilet - positive answer equivalent to yes. All the answers were considered positive when the period was confirmed - at least two months. The presence of a large fecal mass in the rectum was not examined.

Statistical analyses

The database was built using Statistical Package for the Social Science, version 16.0 (SPSS Inc.), and all statistical analyses were performed using the same software. The Kolmogorov–Smirnov test was used to assess distribution normality. Characteristics of children and their household were compared between groups using the $\chi 2$ test and Student’s t test, or the Mann–Whitney U test, as deemed appropriate. Statistical significance was set at $P<0{\cdot}05$.

The analysis was conducted on the basis of an intention-to-treat approach. The intervention effect on the prevalence of constipation and each characteristic of the disorder was evaluated by using the Generalized Estimation Equation (GEE) model adjusted for clustering. Data were expressed using percentage, risk ratio (RR) and 95% confidence interval (95% CI).

RESULTS

Among the 715 mothers initially registered, 633 mother-child pairs (322 intervention; 311 control) were indeed in the study at six months of age and 387 children (206 intervention; 181 control) remained in the follow-up at six years of age **(Figure 1**). For the purpose of this study, children with genetic diseases (n=5), autism spectrum disorder (n=1), irritable bowel syndrome (n=6) and incomplete data (n=66) were excluded from the analyses. Thus, 309 children (167 intervention; 142 control) underwent FC assessment at six years of age. No adverse events were reported during the intervention.

No differences were found between children who were lost to follow-up and those who remained at age six in terms of race, sex (P=0.73), weight at birth (P=0.74), length at birth (P=0.87), maternal age at child's birth (P=0.58), maternal education level (P=0.26) and family per capita income (P=0.52). Characteristics of children and their household were similar for both groups (**Table 1**). Overall, 20.4% (n=79) of the mothers were under age 20 at the child's birth, 29.2% (n=113) had eight years of schooling or less, 99.2% (n=614) *were able* to *read* and *write*, and 66.7% (n=258) did not have paid employment. Family per capita income was low for most families - 77.3% (n=290) had a monthly per capita income below the national minimum wage (approximately US$ 188.63/month).

The prevalence of FC was lower in the intervention group compared to the control group (15% (n=25) versus 23.9% (n=34), respectively). Furthermore, the number of children who presented infrequent defecation (two or less bowel movements in the toilet per week) and history of retentive posturing differed between the intervention and control groups (PR= 0.54; 95%CI: 0.30-0.97; P<0.05, and PR= 0.34; 95%CI: 0.22-0.54 P<0.01, respectively) **(Table 2)**. The probability of being constipated was 38% lower in the intervention group (PR=0.62; 95% CI 0.44-0.87; P <0.01).

DISCUSSION

To our knowledge, this is the first randomised field trial to investigate the effects of a primary care intervention aimed at improving infant feeding practices on the prevalence of FC later in life. The lower prevalence of constipation in the intervention group may be explained by the improvement in breastfeeding and complementary feeding practices observed among these children during the first year of life. First, we found that the prevalence of exclusive breastfeeding in the intervention group was higher than in the control group in the first (72.3% versus 59.4%; RR = 1.21; 95% CI 1.08 – 1.38), second (62.6% versus 48.2%; RR = 1.29; 95% CI 1.10 – 1.53), and third months of life (44.0% versus 34.6%; RR = 1.27; 95% CI 1.04 – 1.56) (18). Exclusive breastfeeding is known to be a protective factor for FC because it promotes more frequent bowel movements when compared to formula-fed infants (25, 26). The high digestibility of human milk and the presence of oligosaccharides can affect stool consistency and frequency (27). Other studies have found that exclusive breastfeeding for three or four months results in a normal evacuation pattern and softer consistency of stools compared to other feeding practices (28, 29). We also found that the intervention was effective during the first years of life in increasing meat consumption (36.8% versus 22.6%; RR = 1.62; 95% CI 1.32 – 2.03) and reducing the consumption of non-recommended foods, such as soft drinks (34.9% versus 52.5%; RR = 0.66; 95% CI 0.54 – 0.80) (21). Although there is no evidence that healthier complementary feeding is associated with FC, we suppose that a better dietary pattern was tracked by the children in the intervention group and that, as a consequence, higher fiber intake was achieved by this group in the subsequent years. Nevertheless, fiber intake plays a role in FC among school-aged children (20). Some evidence was found linking junk food consumption (30) and lower meat consumption with a higher prevalence of constipation among children aged two to seven (20). These dietary differences found between groups can explain our results, since there is evidence that constipation starts in the first year of life for 17% to 40% of children (15-18, 31).

The strategy implemented at the health centers was effective in reducing the prevalence of constipation in children at age six by 38%. This result underscores the impact of the gastrointestinal disorder treatment, since children with constipation

require high medical attention, at a cost of $3.9 billion per year (2). FC treatment is complex and has a poor prognosis, as only 50% of children will recover and not require laxatives after six to twelve months of age (32). The present study was not designed specifically to prevent FC. However, this outcome was evaluated at age six years due to the evidence that exists impacts of dietary practices in first years of life on health later in life (33-35). A recent review confirmed the importance of the first 1000 days of life as a critical period for nutritional interventions to reduce potential future health risks (36).

In our results, the prevalence of infrequent defecation and retentive posturing was lower in the intervention group than in the control group. Although the prevalence of painful defecation did not differ between the groups, the high prevalence of retentive posturing among constipated children may reflect a vicious circle. A child may hold in a stool because he/she is afraid to feel pain while defecating. This condition, in turn, leads to greater water reabsorption through the rectal mucosa and a hardening of the stool, thus making the next bowel movement more painful (37, 38).

Some potential limitations should be discussed. First, the number of participants lost to follow-up from birth to six years of age. Our losses are similar to those of other studies involving the follow-up of people living in low-income urban areas (39). Besides, selection bias is unlikely to be a major problem, considering the similarity in characteristics between those who were lost and those who were not. Second, we included only children from low-income families. In response, we note that this target population is of specific interest for the introduction and evaluation of large-scale dietary interventions to improve population health in regional or national health programmes. Third, the self-report questionnaire could be biased in diagnosing FC due to possible answers subjectivity. However, Roma III was repeatedly tested and validated for the FC diagnosis (1, 11). Another limitation was the impossibility to know the health workers accomplishment to the dietary counseling and who were the mothers receiving such counseling. The study was designed to implement an action in the primary care that would apply to all families assisted in the health services and not only to the children enrolled in the study. Our hypothesis is that the training led the health workers to bring this matter during the

care, promoting healthier dietary practices to the children. Furthermore, we did not assess FC in earlier ages, preventing us from knowing when this dysfunction started.

FC is an emerging public health problem with serious implications for the lives of children and their families (5) and our results highlight that training health workers who promote the “Ten Steps” is an effective way to reduce the prevalence of FC among children at six years of age.

Conflict of Interest: None.

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Autorship:

Caroline Nicola Sangalli: Ms. Sangalli contributed to the data analyses, interpretation of the results, drafting, and critical revision of the article. The author approved the final version to be published and agree in to be accountable for all aspects of the work.

Paula dos Santos Leffa: Ms. Leffa contributed to the data analyses, interpretation of the results and critical revision of the article. The author approved the final version to be published and agree in to be accountable for all aspects of the work.

Mauro Batista de Morais: Dr. Morais contributed to the to the research proposal, interpretation of the results and critical revision of the article. The author approved the final version to be published and agree in to be accountable for all aspects of the work.

Márcia Regina Vitolo: Dr. Vitolo contributed to the research proposal, data analyses, interpretation of the results, drafting of the manuscript, student supervision, and critical revision of the article. The author approved the final version to be published and agree in to be accountable for all aspects of the work.

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Table 1. Characteristics of children and their household according to the group at age six months* (Numbers and percentages; mean values and standard deviations).

		Intervention		Control		
Characteristics	**n***	**n**	**%**	**n**	**%**	**P†**
Child						
Boys	619	168	52.8	157	52.2	0.86
Households at baseline						
Maternal pre-pregnant BMI	608	309		299		0.61
Mean ±SD			*24.4±4.6*		*24.61±4.8*	
Maternal weight gain (kg)	607	311		298		0.73
Mean ±SD			*11.14±6.1*		*11. 31±6.4*	
Gestational age (weeks)	561	285		276		0.77
Mean ±SD			*39.17±1.6*		*39.13±1.6*	
Delivery by caesarean section	616	103	32.4	94	31.5	0.82
Maternal age at child's birth < 20 years	619	62	19.5	69	22.9	0.29
Marital status (living with partner)	619	254	79.9	228	75.7	0.21
Mother's education ≤ 8 years	619	151	47.5	141	46.8	0.87
Father's education ≤ 8 years	590	142	47.0	145	50.3	0.41
Mother's unemployment	619	207	65.1	214	71.1	0.11
Father's unemployment	596	29	9.5	36	12.3	0.27
Annual household income <US$ 3000	601	261	85.0	236	80.3	0.32
Monthly income per capita <US$ 188.6	601	231	75.2	232	78.9	0.28

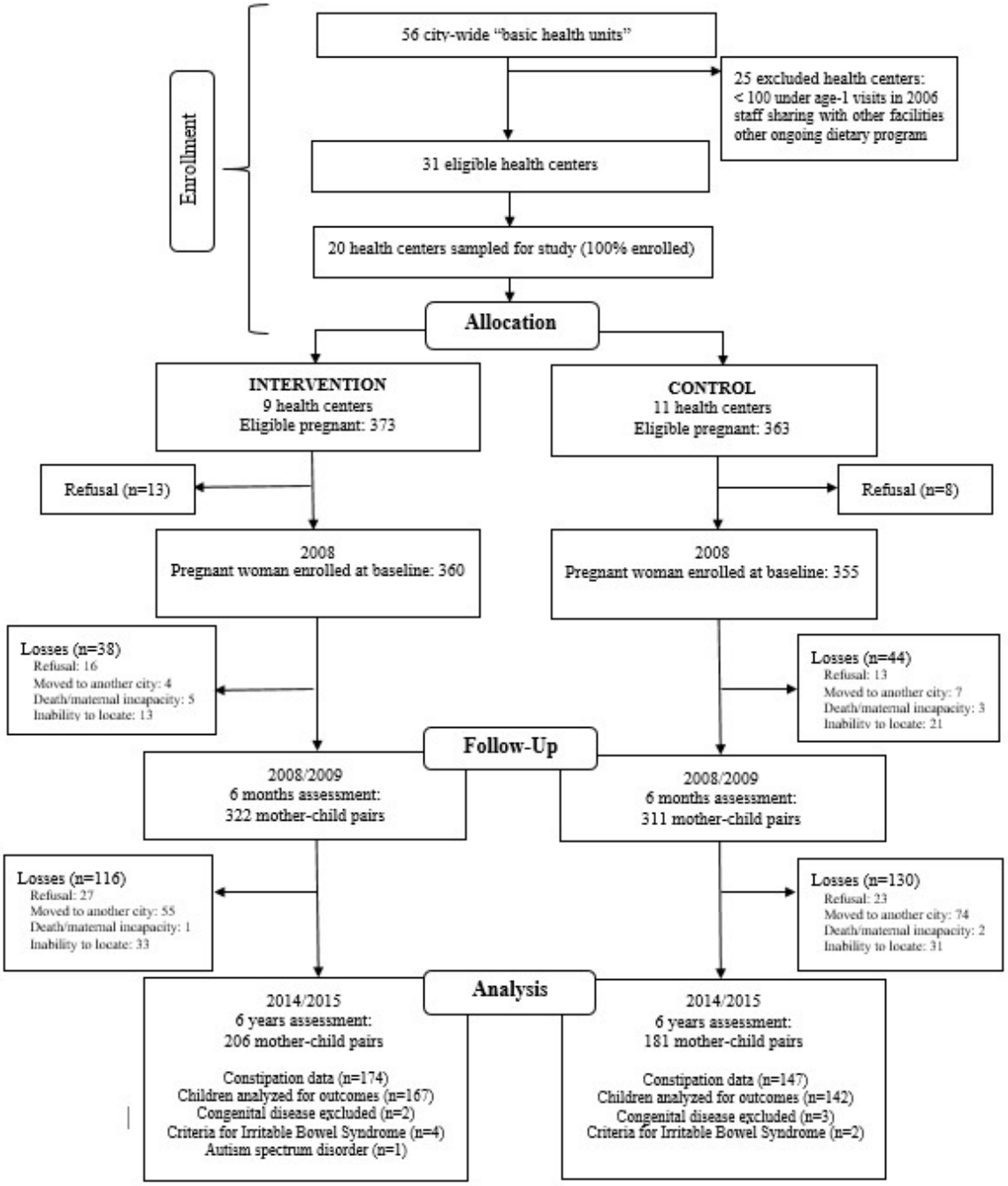
*n Indicates the number of responses recorded for each characteristic.
†Student's t test or $\chi 2$ was used (depending on categorical or continuous variables).

Table 2. The prevalence of functional constipation and each symptoms of the disorder among children at six years of age (n=309).

Variables	**Intervention %(n)**	**Control %(n)**	**PR (95% CI)**
Infrequent defecation	9.6(16)	17.6(25)	0.54 (0.30-0.97)*
Fecal incontinence	10.2 (17)	10.6(15)	0.96(0.50-1.83)
Retentive posturing	6.6(11)	19(27)	0.34(0.22-0.54)**
Painful defecation	28.7(48)	30.3(43)	0.94 (0.71-1.26)
Large diameter stools	9.9(14)	10.2(17)	1.03(0.58-1.82)
Two or more of the symptoms	15.0 (25)	23.9(34)	0.62 (0.44-0,87)**

*P<0.05
**P<0.01

Figure 1. Flow diagram of the study.



4 ARTIGO 2

The long-term impact of a primary care intervention to promote healthy infant feeding practices on children adiposity up to six years of age in Brazil: a cluster randomised controlled trial

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Conflict of Interest: None.

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ABSTRACT

Background

Early interventions could improve infant and child nutrition and health through life. We assessed the long-term impact of a primary care intervention to stimulate better infant feeding in early life on dietary intake and adiposity into childhood.

Methods

A cluster randomised controlled trial (ClinicalTrials.gov NCT00635453) was carried out in community health care centers in Porto Alegre, Brazil. Centers were randomly allocated to intervention (n=9) or control (n=11) groups. In intervention sites, health workers joined training sessions to advise future mothers on the "Ten Steps for Healthy Feeding for Children from Birth to Two Years of age". Pregnant women at all sites were invited to participate in the study before giving birth. After delivery, field workers blinded to treatment allocation collected dietary data through 24-h recalls and anthropometric measures in infants between six months and six years of age.

Findings

633 infants underwent nutritional assessments at six months of age, 545 at 12 months, 476 at three years and 387 at six years. At age three, children in the intervention group had a lower caloric intake (Difference -92kcal/day; 95% CI -154·3 to -30·8; P=0·03) compared to those in the control group. After six years, children in the intervention group had lower values of waist circumference (Difference -1·3cm; 95% CI -2·7 to -0·0; P=0·04), triceps skinfold thickness (Difference -1·3mm; 95% CI -2·5 to -0·0; P=0·04) and subscapular skinfold thickness (Difference -1·3mm; 95% CI -2·6 to -0·0; P=0·04).

Interpretation

Health workers training to promote better infant feeding was effective in reducing adiposity indicators at six years of age. Future interventions to prevent childhood obesity should focus on reducing energy intake as early as the first year of life.

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INTRODUCTION

Healthy feeding practices during the first two years of life are considered the window of opportunity for promoting optimal growth, health and development during childhood and later in life.[1,2] This period is also associated with the development of food preferences and appetite regulation laying the foundation of lifelong food habits.[3,4] Nonetheless, current dietary patterns of infants and toddlers in Latin American countries and the United States are characterised by the low consumption of fruit and vegetables and high consumption of ultra-processed foods that are high in sugar, saturated fat and sodium, and low in fibre.[5,6,7]

There is some evidence that dietary counselling interventions with educational components may be effective in promoting breastfeeding, healthy complementary feeding and preventing excessive weight gain in the first two years of life.[8,9] Effective interventions are still needed however as the obesity pandemic has continued to develop worldwide, with more than 40 million children under the of age five in 2011 classified as obese or overweight.[10] We identified two systematic reviews of interventions to prevent obesity in infancy or in childhood.[11,12] These reviews document some improvement in early feeding practices, but show no convincing evidence of obesity prevention. No obesity measures were reported beyond two years of age for any of the children studied.

In 2001, our team started a randomised trial of a home intervention to improve infant feeding practices based on the Brazilian nutrition policy "Ten Steps for Healthy Feeding from Birth to Two Years of Age"[13] and World Health Organization's guidelines.[14] The intervention improved infant feeding practices[15, 16] and diet quality at pre-school age.[17] Encouraged by these findings, we in 2008 started the current cluster randomised trial in a primary care clinic setting, educating and updating the clinic staff on the national dietary guidelines. In previous reports on this trial, we have shown that the intervention was effective in improving breastfeeding and complementary feeding practices in the first year of life.[18,19] We now examine the impact of the clinic interventions on the energy intake, BMI z-score, skinfold measurements and waist circumference among children followed from six months to six years of age.

METHODS

Study design and participants

We conducted a cluster randomized controlled trial targeting selected primary health care centers in Porto Alegre, South of Brazil, a city of 1.4 million inhabitants. The trial included health centers that provide primary care services predominantly to low-income families. Of the 52 municipal health centers, 31 met eligibility criteria for the trial. Exclusion criteria were: ≤ 100 infant patient visits in 2006, staff-sharing between clinics, or participation in other contemporaneous, community-based dietary programs.

The initial sample size for the trial was based on detecting the impact of educating health professionals on the duration of exclusive breastfeeding. Six hundred mother-child pairs would be needed to detect a statistical difference between a 40% prevalence of exclusive breast-feeding up to four months of age in the intervention group[15] and a 25% prevalence in the control group, with 90% power, α of 0.5, and a design effect of 1.5. We therefore recruited 715 pregnant women to obtain the required study power, taking into account an anticipated loss to follow-up of 20%.

Following staff training at the intervention sites, interviewers visited the intervention and control health centers from April to December 2008 to identify and enroll pregnant women who were in the last trimester of pregnancy. 98% of eligible pregnant women agreed to participate and answered a questionnaire about their socioeconomic status and expected due date. Addresses and telephone numbers were obtained in order to schedule subsequent home visits. Births from May 2008 to February 2009 were included for study. Women reporting a positive HIV test were excluded because of concerns of HIV transmission through breastfeeding.

The study was approved by the Ethics Committee of the *Universidade Federal de Ciências da Saúde de Porto Alegre.* This study was registered on the ClinicalTrials.gov website under the identification number NCT00635453. Mothers provided informed consent on behalf of their children.

Randomization and masking

The randomization process took place in the university research office. Of the 31 eligible health centers, 16 were initially selected via a witnessed drawing, by the principal investigator, of labeled markers from an opaque container, such that two health centers would be included from each of the city's eight geo-administrative districts. Following a stratified randomization scheme, the health centers were block-randomized by district, with one health center per district allocated to the intervention group and another to the control group. To increase statistical power, four additional health centers from the original 31 were randomly drawn. To maintain a balanced number of births by intervention group, the additional four health centers were block-randomized at a 1:3 ratio. This yielded nine intervention and 11 control group health centers. The 20 health centers were invited to participate without disclosure of allocation status, and all consented.

Intervention

Physicians, nurses and administrative staff of all intervention health centers participated in a training in January 2008 based on the "Ten Steps for Healthy Feeding for Brazilian Children from Birth to Two Years of Age" guideline.[13] An experienced nutritionist conducted a standardized session for the health care team to outline the "Ten Steps" recommendations and strategies and to provide suggestions how best to incorporate these into the consultations. Printed materials were provided to the Health Care Centers for use by these professionals and

for access to the Brazilian Ministry of Healthy Nutrition Department´s website. Health staff members received a pocket guide for use during the appointments and waiting room sessions.

The "Ten Steps" recommend: (1) providing exclusive breastfeeding until six months of age; (2) continued breastfeeding until two years of age with the gradual introduction of complementary foods; (3) starting complementary feeding (grains, meat, fruits) at six months of age three times daily while continuing breastfeeding; (4) providing meals at regular intervals, adjusted to the child's internal hunger cues; (5) making new foods gradually thicker until the child is able to eat a normal family meal, but foods should never be liquefied; (6) providing a variety of healthy foods every day; (7) providing a daily intake of different fruits and vegetables; (8) avoiding sugar, sweets, soft drinks, salty snacks and processed/fried foods; (9) using good hygiene practices for food preparation and handling; and (10) providing appropriate, responsive feeding when the child is ill.

The health workers also handed a flyer to the mothers with the "Ten Steps", encouraging them to ask more information from the health worker if needed. In addition, two colorful posters were provided by us for display in the waiting rooms of health care centers with (1) information about introducing complementary food, the number of meals and food scheme; and (2) pictures of foods that should not be offered to children under two years of age (i.e. cookies, coffee, jelly, salty foods, candy, soft drinks and snacks). The posters remained in the clinics throughout the intervention period.

Control group

Healthcare centers randomized to the non-intervention group continued their routine medical assistance without any involvement of the research team. No materials were provided to these clinics.

Data collection

Maternal interviews using structured questionnaires were conducted at baseline (during pregnancy) and at follow-up home-visits at mean child ages six months, 12 months, three years and six years by six pairs of field workers who were not involved in the intervention and who were unaware of the group allocations.

Mothers were advised to seek advice at the health care centers if during the interviews any questions or doubts were raised concerning an infant's nutrition, diet or any health problems. Data collection by the interviewers was verified through telephone call backs to a 5% random sample of interviewed mothers. All field workers received theoretical and practical 8 hours training on data collection.

At all waves of the study, tracing and re-enrollment was attempted of children who were lost to follow-up at previous examinations.

Dietary Data

Daily energy intake of all children was estimated by administering a multiple-pass 24-hour dietary recall. One dietary recall was collected at six months of age. Two recalls were collected on non-consecutive days at ages 12 months, three years and six years. Mothers provided information about all foods and beverages consumed by their children during the previous day. Details about food types, amounts and preparation methods were recorded. Common household measures (e.g. teaspoons, tablespoons, cups and serving sizes) were used to help mothers report the amounts of food given to their children and to standardize portion sizes.

Data on the consumption of rice, pasta, roots, tubers, vegetables, meat, eggs and beans, fruits, fruit juice, cow milk, bread (french bread and mass-produced packaged breads and buns), processed meat and sauces (mayonnaise, dressing and sauces, margarine, ready-to-eat

sauces), cookies (crackers, chips, salty snacks, sweet cookies), sweets (candy, chocolate and ice cream), sweet beverage (soda, sweetened juice), sugary milk beverages, chocolate powder, baby cereal, added sugar and others(instant noodle and dehydrated soup, fried foods such french fries, fried chicken, nuggets, onion rings, etc., cheese, honey, canned vegetables and infant formula at six months of age)were collected to assess the children's food consumption. Energy intake estimates were obtained using the Dietwin® software program (version 2008 professional; Dietwin®), based on US Department of Agriculture chemical composition tables. (USDA, Agricultural Research Service, 1998) Manufacturers' information on industrial products and national chemical composition tables were added to the program where available.

To estimate breast milk intake, information on the frequency of feeding was combined with the estimated volume of breast milk per feed as taken from Dewey et al. (1984)[20] If the child received breast milk six times a day or more, the assigned volume was 130 ml/feed; with three to five feeds a day, the assigned volume was 89 ml/feed; and with less than three feeds a day, the volume assigned was 53 ml/feed. The caloric density of breast milk was taken to be 67kcal/100ml.

Anthropometric measurements

At ages six months, 12 months and three years, children were weighed without clothing on a portable digital scale (Techline, São Paulo, Brazil), and length was measured using an infant stadiometer (SECA, Hamburg, Germany). At six years of age, children were weighed barefoot wearing light clothes on a digital scale (Líder, São Paulo, Brazil) to the nearest 0·1 kg, and standing height was measured on a stadiometer (AlturaExata, São Paulo, Brazil) to the nearest 0 ·1 cm. At six years of age, one nutritionist measured all anthropometric data.

BMI-for age z scores (BMIz's) were estimated based on the World Health Organization standards.[21] Overweight was defined as BMIz >2SD for all ages. Triceps and subscapular skinfold thickness was measured in duplicate to the nearest 0·5 mm with a caliper at the right side of the body (Lange Skinfold Caliper, BETA Tech, Inc., Cambridge, MD). The sum of the skinfolds was compared to the 90th percentile as an indicator of excess adiposity. Waist circumference (WC) was measured to the closest 0.1 cm at the minimum circumference between the iliac crest and the rib cage using a non-stretchable tape.

Data Analysis

Dietary energy intake at ages twelve months, three years and six years was estimated by the Multiple Source Method (MSM) https://msm.dife.de/.[22] The MSM calculates dietary intake for individuals and then constructs the population distribution based on these data. This method was used to adjust dietary intake data for intra- and inter-personal variability. Estimated Energy Requirements (EER) were calculated for each child according to the Institute of Medicine reference.[23] The equations are age-specific, requiring for infants (6 months and 12 months) only their current weight (kg). However for children at the ages of three and six it was necessary weight, height and the physical activity level which was estimated based on the daily and weekly children activities.

Statistical analyses were performed using Statistical Package for the Social Science, version 16·0 (SPSS Inc., Chicago, IL, USA). All data were double entered independently by different staff members for subsequent validation in EPI-INFO, version 6·4(CDC) and later resolution of any discrepancies. Outliers of all outcomes were examined and three skinfold measures with poor fold definition were excluded from further analysis. No cases were

excluded based on estimated energy intake. The Kolmogorov–Smirnov test was used to assess distributions of normality where applicable.

To estimate p-values and 95% confidence intervals while accounting for non-independence within clusters, we used Poisson (binary outcomes) or linear (continuous outcomes) regressions, with allocation status as the independent variable and robust variance estimates from the clustered sandwich estimator. Statistical tests were two-sided (alpha=0·05) and based on cluster-adjusted variance estimates. The same approach was taken to compare baseline characteristics of the analytic sample and those lost to follow-up.

RESULTS

From 715 pregnant women enrolled at baseline, 633 infants underwent nutritional assessments at six months of age, 545 at 12 months, 476 at three years and 387 at six years. We excluded from further study premature births (17 intervention; 21 control) and children with genetic and congenital diseases (4 intervention; 10 control) including sickle cell anaemia, Down syndrome, thalassemia, congenital heart disease, deficiency of glucose 6 phosphate dehydrogenase, congenital adrenal hyperplasia and cleft lip and/or palate. (**Figure 1**)

Among infants who were lost to follow-up between six and 12 months of age, 35 were recovered at three years and seven at six years of age. Of those lost between 12 months and three years, 33 were recovered at six years of age. Two children in the control group lost after baseline allocation were traced again at six years. Complete dietary data were available for 561 children at age six months, 486 at 12 months, 421 at three years and 329 at six years. Complete anthropometric data were available for 578 children at age six months, 493 at 12 months, 429 at three years and 293 at six years. No adverse events were reported during the intervention. No differences were found between intervention and control groups for maternal age at child's birth, marital status, maternal level of education and other selected baseline characteristics (**Table 1**). In addition we did not find any differences in the pattern of losses between intervention and control groups between six months and six years of follow-up (**Suppl. Table**).

Energy intake at all ages was lower in the intervention group, and a statistically significant difference was observed at the age of three years (Difference -92·5kcal/day; 95% CI -154·3 to -30·8; P=0·03) (**Table 2**). Energy intake exceeded estimated energy requirements (EER) however both in the intervention group and in the control group across all data collection points: six months, 12 months, three years and six years of age. The excess energy intake varied between 23-48% in the intervention group and between 30-51% in the control group. It appeared to be highest at age 12 months (**Figure 2**).

Children's dietary intake from selected food groups by age and intervention status is presented in **Table 3**. At six months of age, children from the intervention group consumed less calories from cow milk and sugary milk beverages than the control group (Difference -41·2kcal/day; 95% CI -72·3 to -10·1 and Difference -4·5kcal/day; 95% CI -8·2 to -0·8; respectively). We also found a lower energy intake from cookies (Difference -22.2kcal/day; 95% CI -40·6 to -3·7; P=0·02) and chocolate powder (Difference -17·5kcal/day; 95% CI -30·2 to -4·8; P<0.01) for children in the intervention group at three years of age and again at six years of age (Difference -22·2kcal/day; 95% CI -40·6 to -3·7 and Difference -13·0kcal/day; 95% CI -22·6 to 3·3; P<0·05, respectively).

There were no systematic differences in body size measures at six months, 12 months, or three years of age comparing the intervention and control groups. At age six years however, the specific measures of body fat were significantly lower in the intervention compared to the control group. We found a smaller waist circumferences and triceps and subscapular skinfolds in the intervention than in controls (Differences -1·3cm 95% CI -2·7 to -0·0; Difference -1·3mm 95% CI -2·5 to -0·0 and Difference -1·3mm 95% CI -2·6 to -0·0; P

<0·05, respectively). At age six, the less specific BMI measure of body fat was also lower in the intervention compared to the control group (BMI 16·6 vs.17·1) but this difference did not reach a statistical significance. (**Table 4**).

The sum of triceps and subscapular skinfold measurements in all ages are present in **Figure 3**. At six years of age, the sum of skinfolds was significantly smaller in the intervention than the control group (Difference -2·7mm 95% CI -5·3 to -0·2; P <0·05). **(Table 4)** Children from the intervention group had 34% less likely of having excess of adiposity (sum of skinfolds >P90) (Prevalence ratio=0·66; 95% CI 0·50-0·87; p<0·05).

DISCUSSION

We examined the six year impact of a dietary intervention in the first years of life on energy intake and obesity measures. We observed an overall pattern of lower energy and less adiposity in the intervention group which reached statistical significance for energy intake at age three years and specific measures of body fat at age six years.

We show a decrease in waist circumference, triceps, and subscapular skinfolds six years after dietary intervention. This is important as the waist and skinfold adiposity measures are the best external indicators of the fat compartments related to metabolic and cardiovascular complications,[24] and especially children with central adiposity are at higher risk of chronic metabolic disease development.[25] A reduction of 1·3 cm in waist circumference at age six as seen in the intervention group might therefore have long-lasting benefits. This will need further follow-up of our study groups.

In spite of the positive impact of the intervention on body fat measures, their values in in absolute terms greatly exceed WHO standards, not only in the control group but also in the intervention group. As an example, the sum of subscapular and triceps skinfolds in our children at age six exceeds WHO references standards by 37% in the intervention group and 57% in the control group. This excess shows the large and immediate impact of infant food practices on adiposity development in childhood.

We see a clear relation between energy intake at age three and adiposity measures at age six years. Our observations are in agreement with the findings in a large cohort of American children from birth to five years (TEDDY study) that larger energy intakes at previous ages are associated with an increased overweight risk at age five.[26] The children in the intervention group were also more exclusively breastfed and had better complementary feeding practices.[18,19] These factors may have had an additional positive impact on lowering overweight and adiposity rates later in life.[27]

The reduction in BMI by 0·5 units in the intervention group at age six did not reach statistical significance, contrary to what was seen for waist circumference and skinfold measures. This could be for three reasons. First, BMI at the individual level is a highly specific but a less sensitive measure of adiposity.[28] Second, the absence of a significant reduction at age six could be due to the biological BMI rebound around that age that raises BMI as a normal pattern in growth[29] by an increase in fat-free mass rather than fat mass[30]. Researchers should therefore not only rely on BMI, but also examine waist circumference and/or skinfold changes in intervention studies addressing childhood obesity.[31] The reduction in BMIz scores is consistent with the observed reduction in BMI.

This study has some potential limitations. It was carried out in a low income group of children which may limit applicability of the study findings to more privileged populations. The less privileged socioeconomic groups in Brazil are larger in number however, more socially vulnerable and require better health care. Another potential limitation is the number of children lost to follow-up between birth to six years of age. Follow-up was achieved for

85% of children at age 12 months, 74% at age three years, and 51% at age six years, largely due to the family moving to an unknown address. Although our follow-up results compare favourably to other household-based studies we were concerned that differential losses to follow-up could have biased our study findings. We therefore examined selected baseline characteristics of individuals lost to follow-up at every time point and found no differences between the study groups. **(Suppl Table)** Finally, the 24-hour recall may be the best method for collecting food intake information but it is a complex and expensive undertaking, especially in a large sample of individuals. We could only perform a limited number of 24-hour recalls for each child and these might not fully reflect the child's usual intake because of day-to-day variations. To minimize this concern, dietary records in this study were therefore analysed gathering all the recalls in one treatment group for comparison with the other. In addition, the dietary intake data have been corrected for inter- and intra-individual variability using the MSM method for all ages, except at six months.[22]

The original aim of our intervention study was to improve exclusive breastfeeding and healthy feeding practices, as the first two years of life are known as a window of opportunity to accomplish optimal growth, health and development through better feeding.[1,2] By the further follow-up of our study group we were able to examine longer term effects of an early intervention on energy intake, weight gain, and adiposity in infants, toddlers, and children. There are only few comparable studies of this question. Some found small improvements in weight status,[32,33,34] but none followed the children beyond the age of 24 months. A non-randomised intervention study in a primary care setting showed no improvements in anthropometric outcomes during the first year of life[35] and one reported lower rates of overweight or obesity at the age of two years.[36] Except for our study, we know of no other randomised controlled trials that examine the impact of promoting healthy feeding practices in the first two years of life on childhood obesity at age six.

Based on our results, the dietary counselling of mothers about better infant feeding practices in a primary care setting appears to be a promising and feasible intervention strategy in a National Health System. It can reduce to a measurable extent the excessive energy intake and adiposity in young children aged six years old. These findings are hopeful, but future interventions should focus intensively on the avoidance of energy-dense foods in the first year of life as an important strategy to help preventing childhood obesity worldwide.

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Figure 1. Flow diagram of the study.

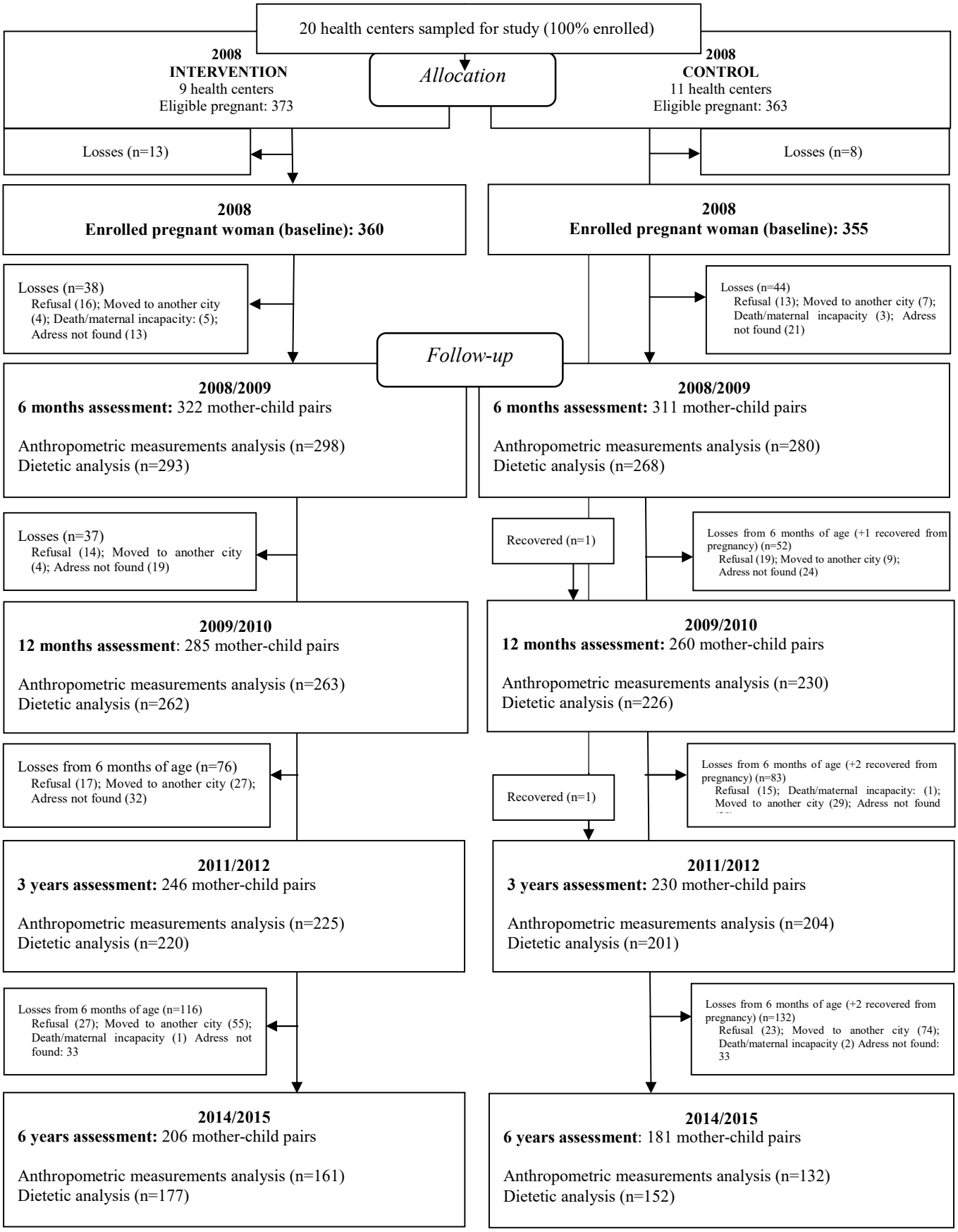
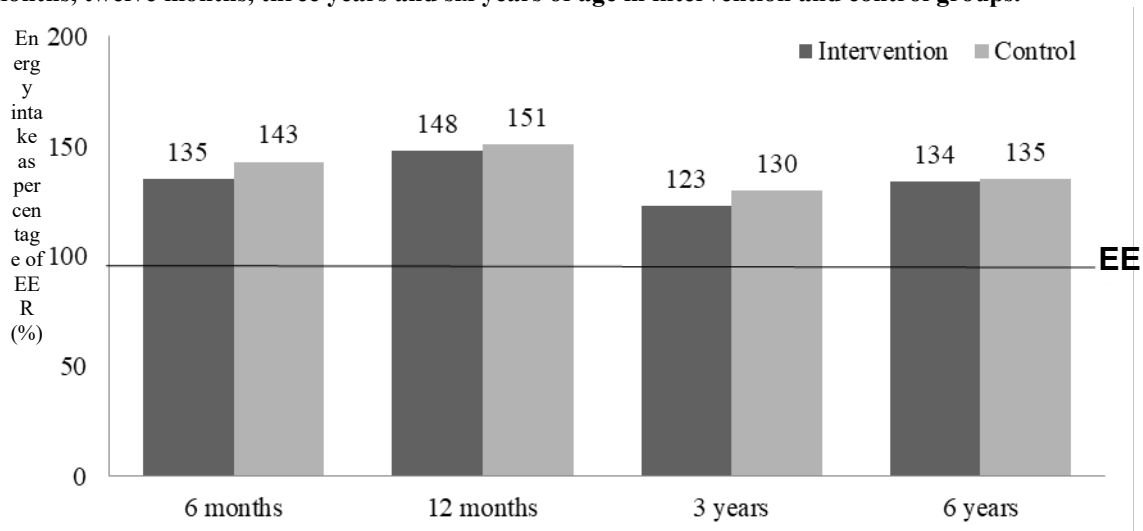


Figure 2. Energy intake as percentage of Estimated Energy Requirements (EER) among children at six months, twelve months, three years and six years of age in intervention and control groups.



EER values according to ages and allocation status: 6 months 670±8.0kcal intervention and 663.5±4.5kcal control; at 12 months 823.7±6.9Kcal intervention and 828.2±4.9kcal control; at 3 years 1176.8±6.7kcal and 1185.4±7.5kcal; at 6 years1367.7±8.7kcal intervention and 1385.5±13.3kcal control. Energy intake as percentage of EER: energy intake/EER x 100%.

Figure 3. Sum of triceps and subscapular skinfold measurements in children at six months, twelve months, three years and six years of age in intervention and control groups.

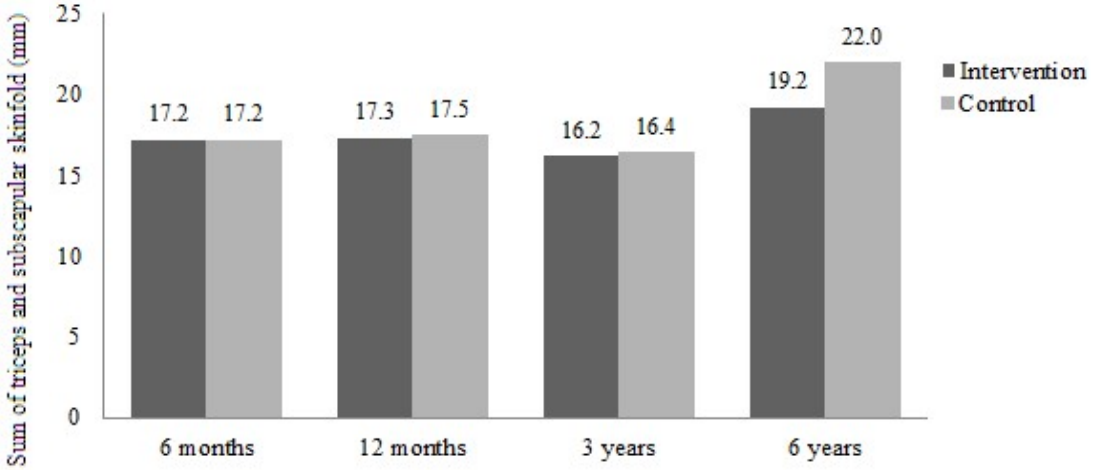


Table 1. Characteristics of households at baseline in intervention and control groups.

	Intervention % (n=360)	**Control** % (n=355)
Households at baseline		
Maternal pre-pregnant BMI ≥25kg/m²	36.2(114)	37.2(115)
Delivery by caesarean section	32.4(103)	31.5(94)
Maternal age at child's birth < 20 years	20.0(72)	21.4(76)
Maternal Skin Color (white)	59.6(214)	51.0(181)
Marital status (living with partner)	79.4(286)	76.1(270)
Mother's education < 8 years	27.8(100)	33.8(120)
Father's education < 8 years,	27.0(92)	29.5(100)
Mother's unemployment	65.0(234)	68.7(244)
Father's unemployment	9.9(34)	11.8(41)
Annual household income <US$ 3000	15.0(46)	19.7(58)

Table 2. Estimated Energy Requirements (EER), daily energy intake, energy intake above the requirement, calories per weight in children at six months, twelve months, three years and six years of age in intervention and control groups.

	6 months			12 months			3 years			6 years		
	Intervention (n=293)	**Control (n=268)**		**Intervention (n=262)**	**Control (n=226)**		**Intervention (n=220)**	**Control (n=201)**		**Intervention (n=177)**	**Control (n=152)**	
Variables	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**
EER[a]	670.3±102.7	662.9±88.1	7.3 (-5,0;19.7)	823.7±119.9	828.2±119.0	-4.5 (-18.5;9.4)	1176.8±105.8	1185.4±120.2	-8.5 (-27.8;10.6)	1367.7±116.5	1385.5±162.0	-17.7 (-49.7;14.2)
Daily energyintake (kcal)	904.6±344.9	950.7±369.7	-46.0 (-109.2;17.1)	1222.8±344.7	1256.2±369.7	-33.4 (-21.6;88.4)	1454.1±276.8	1546.6±357.8	-92.5 (-153.5;-31.5)†	1838.8±312.6	1872.9±303.0	-34.0 (-36.0;104.1)
Energy intake as percentage of EER (%)	134.9±55.6	143.4±61.2	-8.5 (-0.4;17.4)	148.4±45.6	151.6±50.2	-3.2 (-12.7;4.5)	123.5±24.7	130.4±33.5	-6.9 (-13.0;-1.6)†	134.4±26.4	135.1±25.1	-0.7 (-7.5;4.8)
Calories per weight (kg)	113.9±45.7	120.6±49.5	-6.6 (-14.0;0.6)	122.3±36.4	125.6±40.1	-3.3 (-9.0;2.38)	93.8±22.0	99.6±28.1	-5.7 (-10.2;-1.3)†	80.4±20.0	80.0±20.8	0.4 (-5.8;6.8)

† P < 0.05; SD, Standard Deviation; CI, Confidence Interval; Energy intake as percentage of EER: energy intake/EER x 100%; Complete dietary data were available for 561 children at age 6 months, 486 at 12 months, 421 at 3 years and 329 at 6 years.

Table 3. Energy from breast milk and from selected food groups in children at six months, twelve months, three years and six years of age in intervention and control groups.

	6 months			12 months			3 years			6 years		
	Intervention (n=293)	Control (n=268)		Intervention (n=262)	Control (n=226)		Intervention (n=220)	Control (n=201)		Intervention (n=177)	Control (n=152)	
Source ofcalories	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**
Estimated breast milk	298.5±281.4	276.9±283.4	21.6 (-20.4;63.8)	209.2±278.1	205.4±281.0	3.8 (-38.7;46.4)	-	-	-	-	-	-
Rice, pasta, roots, tubers	43.5±53.4	45.9±57.1	-2.4 (-13.8;8.9)	77.4±36.9	75.8±35.8	1.5 (-4.3;7.4)	97.6±42.9	99.5±39.4	-1.9 (-7.5;3.7)	140.9±53.2	131.6±47.3	-9.2 (-20.1;1.6)
Vegetables	15.4±30.8	12.8±31.7	-2.5 (-6.8;1.6)	10.2±9.5	8.3±7.2	1.8 (0.4;3.3)†	6.1±6.0	5.1±6.4	1.00 (0.1;1.8)†	8.9±12.5	8.8±8.9	0.1 (-1.5;1.8)
Meat, eggs and beans	34.2±53.2	33.9±46.8	0.2 (-6.6;7.2)	99.4±56.4	93.9±55.0	5.5 (-0.4;11.5)	173.0±64.2	180.6±67.1	-7.6 (-18.0;2.8)	231.5±85.4	230.3±94.2	1.1 (-13.1;15.3)
Fruits	44.6±52.8	39.6±50.6	5.0 (-0.4;10.5)	51.1±36.7	50.3±42.4	0.8 (-8.6;10.2)	65.5±51.1	59.0±48.0	6.5 (-1.2;14.4)	56.0±38.1	58.6±36.9	-2.6 (-10.4;5.1)
Cow milk	180.0±230.0	221.2±263.7	-41.2 (-72.3;-10.1)†	381.6±294.4	395.1±303.1	-13.5 (-87.1;60.0)	279.2±171.9	292.9±152.8	-13.6 (-54.6;27.4)	159.7±95.7	174.1±99.4	-14.4 (-32.1;3.4)
Fruit juice	15.3±31.6	10.8±26.2	4.5 (-1.0;10.1)	11.2±26.9	15.7±29.9	-4.4 (-9.4;0.4)	8.3±24.0	8.2±30.1	-0.1 (-6.6;6.4)	7.3±17.4	13.4±28.4	-6.1 (-11.9;-0.1)
Bread[a]	9.8±36.5	10.4±28.7	-0.5 (-6.9;5.8)	37.4±30.3	40.3±33.3	-2.8 (-6.8;1.2)	95.0±56.8	105.8±64.3	-10.7 (-28.4;6.8)	160.9±75.0	171.5±68.0	-10.6 (-23.3;2.1)
Processed meat,sauces[b]	2.5±13.4	1.8±9.2	0.7 (-1.4;2.8)	12.3±18.7	13.1±19.2	-0.8 (-2.7;1.0)	53.5±50.4	53.3±52.5	0.2 (-11.9;12.3)	68.4±50.1	69.9±51.3	1.5 (-11.6;13.7)
Cookies[c]	25.1±55.6	22.8±48.5	2.2 (-6.7;11.1)	72.1±60.6	79.5±64.3	-7.4 (25.8;10.9)	130.1±105.8	158.5±124.6	-28.3 (-52.1;-4.5)†	188.6±130.5	210.8±132.6	-22.2 (-40.6;-3.7)†
Sweets[d]	6.1±36.6	3.7±16.5	2.4 (-5.3;1.9)	53.7±62.1	56.5±59.8	-2.7 (-11.7;6.1)	130.9±106.5	133.4±110.5	-2.5 (-30.3;25.3)	171.0±130.0	158.9±188.4	12.1 (-6.6;30.7)
Sweet beverages[e]	40.7±46.6	30.6±25.7	10.1 (-3.6;23.8)	28.3±24.7	29.4±25.8	-1.1 (-5.4;3.1)	72.8±25.0	75.6±27.6	-2.8 (-11.4;5.8)	151.8±81.7	149.1±76.0	2.7 (-17.2;22.7)
Sugary milk beverages	3.2±17.9	7.7±30.1	-4.5 (-8.2;-0.8)†	37.0±42.9	39.6±42.9	-2.6 (-9.4;4.2)	56.6±66.4	63.3±78.8	-6.6 (-23.4;10.1)	45.6±44.7	44.3±44.7	1.3 (-6.0;8.7)
Chocolate powder	2.8±23.5	0.9±6.2	1.9 (-1.0;4.9)	13.3±31.5	13.0±29.2	0.2 (-5.5;6.1)	54.5±58.5	72.1±79.3	-17.5 (-30.2;-4.8)†	51.3±45.8	64.3±48.9	-13.0 (-22.6;3.3)†
Baby cereal	72.0±135.5	87.0±157.5	-15.0 (-37.4;7.4)	72.8±102.0	78.6±113.7	-5.7 (-22.6;11.0)	30.9±77.0	22.9±55.8	8.0 (-2.2;15.5)	52.4±77.8	44.4±65.9	8.0 (-1.2;17.3)
Added sugar	25.4±58.2	29.2±57.1	-3.7 (-17.1;9.5)	32.6±50.4	40.8±57.4	-8.2 (-23.6;7.2)	30.1±41.6	29.5±42.0	0.6 (-4.1;5.3)	22.3±24.4	24.5±26.2	-2.2 (-4.8;0.6)
Others[f]	85.5±93.7	115.5±102.5	-30.0 (-42.6;3.4)	23.2±18.1	20.9±15.2	-2.2 (-39.0;34.5)	170.5±102.8	186.7±107.4	-16.2 (-63.9;27.1)	322.2±180.6	318.4±181.8	3.8 (-19.0;58.3)
Total daily energy intake (kcal)	904.6±344.9	950.7±369.7	-46.0 (-109.2;17.1)	1222.8±344.7	1256.2±369.7	-33.4 (-21.6;88.4)	1454.1±276.8	1546.6±357.8	-92.5 (-153.5;-31.5)†	1838.8±312.6	1872.9±303.0	-34.0 (-36.0;104.1)

CI, confidence interval; † P < 0.05;[a] French bread , mass-produced packaged breads and buns; [b]Mayonnaisedressing, margarine, ready-to-eat sauces; [c]Crackers, chips, salty snacks, sweet cookies; [d]Candy, chocolate, homemade desserts, gelatin dessert and ice cream; [e]Soda, sweetened juice; [f]Others: Instant noodle and dehydrated soup, fried foods such frenchfries,fried chicken, nuggets, onion rings, etc. , cheese, honey, canned vegetables, infant formula (at 6 months of age). Complete dietary data were available for 561 children at age 6 months, 486 at 12 months, 421 at 3 years and 329 at 6 years.

Table 4. Anthropometric measures in children at six months, twelve months, three years and six years of age in intervention and control groups.

	6 months			12 months			3 years			6 years		
	Intervention (n=298)	**Control (n=280)**		**Intervention (n=263)**	**Control (n=230)**		**Intervention (n=225)**	**Control (n=204)**		**Intervention (n=161)**	**Control (n=132)**	
Variables	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**	**Mean±SD**	**Mean±SD**	**Difference (95% CI)**
Weight (kg)	8.0±1.1	8.0±0.9	0.0 (-0.0;0.2)	10.1±1.3	10.1±1.3	-0.0 (-0.2;0.1)	15.7±2.4	15.8±2.6	-0.1 (-0.5;0.3)	23.7±5.6	24.6±5.7	-0.8 (-2.2;0.4)
Length or Height(cm)	67.2±2.7	67.1±2.6	0.0 (-0.2;0.3)	74.8±2.9	74.9±2.9	-0.08 (-0.3;0.2)	96.5±4.3	96.9±4.4	-0.4 (-1.2;0.4)	118.7±5.5	119.4±5.6	-0.7 (-1.8;0.4)
BMI	17.8±1.9	17.7±1.8	0.1 (-0.1;0.3)	18.1±1.7	18.0±1.8	-0.0 (-0.2;0.1)	16.8±1.9	16.8±2.2	0.0 (-0.1;0.2)	16.6±2.8	17.1±3.0	-0.4 (-1.1;0.3)
BMIz	0.3±1.2	0.3±1.2	0.0 (-0.1;0.2)	0.9±1.1	0.9±1.1	- 0.0 (-0.1;0.1)	0.9±1.2	0.9±1.4	0.0 (-0.1;0.1)	0.6±1.4	0.8±1.5	-0.1 (-0.5;0.1)
WC (cm)	-	-	-	-	-	-	52.2±4.3	52.3±5.4	-0.1 (-0.9;0.6)	55.2±5.7	56.5±5.9	-1.3 (-2.7;-0.0)†
TSF (mm)	9.4±2.0	9.3±2.0	0.0 (-0.3;0.3)	9.7±2.4	9.6±2.7	0.0 (-0.2;0.3)	9.5±2.8	9.6±3.0	-0.1 (-0.4;0.2)	11.5±5.2	12.8±5.8	-1.3 (-2.5;-0.0)†
SSF (mm)	7.8±1.8	7.8±1.9	-0.0 (-0.3;0.2)	7.7±2.0	7.8±2.2	-0.0 (-0.5;0.3)	6.8±2.6	6.7±2.7	0.0 (-0.2;0.4)	7.7±4.9	9.1±6.2	-1.3 (-2.6;-0.0)†
TSF + SSF (mm)	17.2±3.5	17.2±3.5	-0.0 (-0.6;0.5)	17.3±4.0	17.5±4.4	-0.14 (-0.5;0.2)	16.2±5.0	16.4±5.4	-0.2 (-0.7;0.3)	19.2±9.6	22.0±11.8	-2.7 (-5.3;-0.2)†

† P < 0.05; SD, Standard Deviation; CI, Confidence Interval; BMI, Body-mass index; WC, Waist Circumference; TSF, Triceps Skin-fold; SSF, Subscapular Skin-fold. Complete anthropometric data were available for 578 children at age 6 months, 493 at twelve months, 429 at three years and 293 at 6 years.

Supplementary Table. Characteristics of drop out children and their households at baseline in intervention and control groups from six months to six years of age (Numbers and percentages; mean values and standard deviations).

Characteristics	Intervention Losses (n=116)	Control Losses (n=132)	Relative Risk or Mean Difference (95% CI)	p-value
Monthly household income <3 minimum wage ($227)*, %(n)	70.8(80)	78.9(101)	0.90 (0.76 to1.06)	0.20
Schooling <8 years, %(n)	29.3(34)	36.4(48)	0.81 (0.44 to 1.49)	0.49
Mother's Age <20 years, %(n)	23.3(27)	19.7(26)	1.18 (0.79 to 1.77)	0.42
Mother's Pre-gestation Body Mass Index (kg/m^2)**, (mean±SD)	24.48±4.72	24.23±4.42	0.25 (-0.91 to 1.41)	0.67
Primiparous, %(n)	50.0(58)	41.7(55)	1.2 (0.95 to 1.44)	0.15

*Household income not reported for 3 women in intervention group and four in control group. **Mother's BMI not known for two women in intervention group and three women in control group.

5 ARTIGO 3

The early origin of childhood obesity: dietary patterns and excessive weight gain

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ABSTRACT

Objective: To identify the critical period of excessive weight gain in children up to six years of age and to verify the association between the moment of greater weight gain and previous dietary patterns. **Methods:** Follow-up of a randomized controlled trial with children from low-income families, Porto Alegre, Brazil. Excessive weight gain were analyzed as BMI-for-age z-score variation >0.67, considering four age groups: from birth to 6 months (n=565); from 6 months to 12 months (n=490); from 12 months to 3 years (n=392); and from 3 to 6 years (n=270). Dietary data were assessed using a 24-h recall. The energy provided by high energy dense foods, added sugar and baby cereal, table foods, cow milk, formula and breast milk according to the milk feeding type were verified as a percentage of total energy. Dietary patterns were identified using factor analysis. Data were analyzed using analysis of variance and Poisson regression. **Results:** The highest prevalence of excessive weight gain occurred in the second semester of life. At this age, breastfed infants were 34% less likely to have excessive weight gain (PR= 0.66; 95%CI: 0.56-0.78 P<0.01). Energy provided by added sugar and baby cereal, and high-energy dense foods was significantly higher in the cow milk-fed infants (p<0.01) compared to breastmilk and mixed feeding group. The 'bottle feeding', 'natural juice and petit suisse' and "sweet beverages" patterns were associated with greater risk of children having excessive weight gain from six to twelve months of age. **Conclusions:** Unhealthy dietary patterns play a role in the excessive weight gain in the first year of life.This findings reiforce that there is an urgent demand to improve the complementary feeding as a stategy in childhood obesity prevention.

INTRODUCTION

World Health Organization (WHO) estimates that roughly 41 million children, younger than five years of age, present overweight or obesity, most of them living in developing countries [1] In fact, the rising prevalence of childhood excess weight has been described as one of the most concerning worldwide public health issues [1,2], since it is related with an increased risk for chronic diseases and psychosocial complications [3–5]. This relation appears not only during youth, but also later in life [6–8].

The first thousand days of life (from conception to age two years) is considered a critical period for the development [9,10] and, consequently, a key moment to prevent childhood obesity [11,12]. Many complex interactions are involved in the obesity etiology, but excessive weight gain during infancy is a strong predictor and it is related to later obesity and adiposity [12]. Growing evidence suggests that, since the beginning of life, the choice to feed the infant with breast milk [13] or formula [14,15] play a role in the development of food preferences and dietary intake later in childhood. After the first semester of life, a variety of dietary patterns begin to emerge from this period [16,17].

Given these concerns, the contribution of excessive weight gain during childhood has sparked much scientific attention, specially related to subsequent obesity [18–20] e comorbidities years later [21]. Thus, an understanding of dietary patterns associated with the critical period of weight gain may provide insights to appropriate interventions to reduce the risk of excessive weight during childhood. Therefore, we decided to (1) identify the critical period of excessive weight gain in children up to six years of age and (2) verify the association between the moment of greater weight gain and previous dietary patterns.

METHODS

Study design and participants

This study used data from children who participated in a randomized trial in the primary care setting to promote the "Ten Steps for Healthy Feeding for Brazilian Children From Birth to Two Years of Age" guideline [22], in Porto Alegre, South of Brazil, a city of 1.4 million inhabitants. The randomization units were health centers that provide primary medical services predominantly to low-income residents. The outcomes were assessed for mothers and children who received treatment at these centers. From April to December 2008, all pregnant women at the participating healthcare centers were invited to sign up for outcome tracking by fieldworkers who were blinded to the allocation status of the participants. Births from May 2008 to February 2009 were indeed for study. Women reporting a positive HIV test were excluded because of concerns of HIV transmission through breastfeeding.

The initial sample size for the trial was based on the aim of detecting the impact of the intervention on the duration of exclusive breastfeeding. Six hundred mother-child pairs would be needed to detect a statistical difference between a 40% prevalence of exclusive breast-feeding up to 4 months of age in the intervention group [23] and a 25% prevalence in the control group, with 90% power, α of 0.5, and a design effect of 1.5. Therefore, seven hundred and twenty pregnant women were enrolled in recruitment to obtain required study power, to take into account an anticipated loss of 20%.

The study was approved by the Ethics Committee of the *Universidade Federal de Ciências da Saúde de Porto Alegre*. Mothers provided informed consent on behalf of their children.

Data collection

Six pairs of field workers who were not involved in the intervention and who were unaware of group allocation conducted maternal interviews following questionnaires at baseline (in pregnancy) and at follow-up home-visits at mean child ages six months, twelve months, three years and six years. During the interviews, if questions and doubts were raised concerning the nutrition, diet or health problems of the infants, mothers were advised to look for assistance at the health care centers. After the data collection, the information was confirmed through telephone call backs made to 5% of the mothers surveyed, randomly selected. All field workers received theoretical and practical 8 hours training on data collection.

Anthropometric measurements

At ages six months, twelve months and three years, children were weighed without clothing on a portable digital scale (Techline, São Paulo, Brazil), and length was measured using an infant stadiometer (SECA, Hamburg, Germany). At six years of age, children were weighed barefoot wearing light clothes on a digital scale (Líder, São Paulo, Brazil) to the nearest 0.1 kg, and standing height was measured on a stadiometer (AlturaExata, São Paulo, Brazil) to the nearest 0.1 cm. At six years of age, one nutritionist measured all anthropometric data.

Age- and sex-specific BMI z-scores and cutoffs were determined by using the WHO Child Growth Standards (2006) by using WHO Anthro software (www.who.int/childgrowth/ software/en/). Changes in weight gain measurements from birth to six years of age were analyzed as BMI-for-age z-score variation, considering four periods: from birth to six months, from six months to twelve months, from twelve

months to three years and from three to six years of age. The excessive weight gain was considered as a change in BMI-for-age z-scores >0.67 from one age to another.

Dietary Data

Daily energy intake at six months of age was estimated by administering one multiple-pass 24-hour dietary recall. Mothers provided information about all foods and beverages consumed by their children during the previous day. Details about food types, amounts and preparation methods were recorded. Common household measures (e.g. teaspoons, tablespoons, cups and serving sizes) were used to help mothers report the amounts of food given to their children and to standardize portion sizes.

Data on the consumption (in grams and calories) of all foods and beverages were obtained to understand the infant's dietary and to identify the dietary patterns. Each food or beverage item was then assigned to one of the groups based on type of food or similarities in nutrient content: high energy dense foods (biscuits, sweets, soft drinks, sugary milk beverages, powdered chocolate and fried foods), added sugar and baby cereal, table foods (pasta, vegetables, roots and tubers, meat, eggs and beans, fruits), cow milk, formula and breast milk. To illustrate the energy provided by food groups according to the type of milk, infants were then assigned into one of the three milk-feed types as recorded in the dietary recalls: breast-fed, cow milk-fed, and mixed fed (breast milk or infant formula and cow milk).

Dietary Patterns

For dietary pattern analysis, quantities of consumed foods reported in the 24-h recalls were converted to grams. Then, we assigned all food and beverage items into 15 food groups based on their similarity in nutrient content or culinary usage. Infant

formula was excluded from the dietary pattern analyses due to the low prevalence of consumption (5.2%). To determine the dietary pattern we used principal components analysis. The obtained factors were linear combinations of the included variables, explaining as much of the variation in the original variables as possible. Five distinct dietary patterns were identified, and factor scores were obtained for each participant. Then, individuals were categorized based upon their factor scores into four groups with quartiles. The subjects in the highest quartile of a pattern were more likely to have that dietary pattern.

Data Analysis

Statistical analyses were performed using Statistical Package for the Social Science, version 21.0 (SPSS Inc., Chicago, IL, USA). All data were double entered independently by different people for subsequent validation in EPI-INFO, version 6.4 (CDC). The presence of outliers was investigated for all outcomes. The Kolmogorov–Smirnov test was used to assess distribution normality. Baseline characteristics were compared between groups using the $\chi 2$ test and Student's t test, or the Mann–Whitney U test, as deemed appropriate. Statistical significance was set at $P<0.05$.

Mean and standard deviation for the contribution of each food group to the total energy intake were then calculated (as a percentage of total energy) for children strata corresponding to the milk feeding type. One-way ANOVA with Bonferroni post-test was used to compare the percentage of energy provided by food groups and also weight gain trajectories from six to twelve months of age according to the milk feeding type. Poisson regression analysis was used to assess the effect of the consumption of breast milk at six months and excessive weight gain from six to twelve months.

Principal component analysis was used to derive dietary patterns. We identified five dietary patterns using 15 food groups' intake data collected at six months of age. The number of dietary patterns were identified by assessing the break point in the screenplot, eigenvalues >1.5, and proportion of variance explained by a factor. Then we ran the analysis using the five-factor solution. The orthogonal (Varimax) rotation was applied to achieve the highest interpretability.

Poisson regression analysis was used to assess the effect of the each diet pattern in quartiles and excessive weight gain. The model was adjusted for child's group status (intervention or control), dietary patterns, exclusive breastfeeding until 4 months, birth weight (in grams), gestational weight gain, smoking on pregnancy. Data were expressed using percentage, risk ratio (RR) and 95% confidence interval (95% CI).

RESULTS

Among the 715 pregnant women initially enrolled at baseline, 633 children underwent the assessment at six months of age, 545 at twelve months, 476 at three years and 387 at six years. For the purposes of this study, premature births and children with genetic and congenital diseases were excluded from the analyses (**Figure 1**). Anthropometric data were available for 568 infants at birth (data collected from the children's records during home visits), 578 at age six months, 493 at twelve months, 429 at three years and 293 at six years. Excessive weight gain trajectories were analyzed at four age groups: from birth to 6 months (n=565); from 6 months to 12 months (n=490); from 12 months to 3 years (n=392); and from 3 to 6 years (n=270).

Regarding maternal and family characteristics, no differences were found for maternal age at child's birth, maternal education level, and maternal employment between the children who were lost to follow-up and those who remained at six years of age (P>0.05; **data not show**). Overall, 20.7% (n=148) of the mothers were under 20 years of age at the child's birth, 30.8% (n=220) had less than 8 years of schooling and 66.9% (n=478) did not have paid employment. Family income was low for most families - 70.3% (n=485) had a monthly income less than three times the national minimum wage (approximately US$ 565.00/month). More than half of the children were male (52.6%, n=326) and 36.5% (n=225) were non-white.

The anthropometric data from each wave are presented in **Table 1**. The prevalence of excessive weight gain (>0.67 BMI-for-age z score) were 34.3% (n=194) from birth to six months, 46.5% (n=228) from six to twelve months, 27.0% (n=106) from twelve months to three years, 18.5% (n=50) from three to six years of age. The

higher prevalence of weight gain >0.67 BMI-for-age z score occurred in the second semester of life (from six to twelve months of age) ($p<0.01$).

In order to better understand the excessive weight gain from six to twelve months of age, dietary data at six months were evaluated. Exclusively breastfed infants (n=18) and those who were sick (n=2) were excluded because the food consumption was unusual. Thus, complete dietetic data were available for 561 children. According to the milk feeding type, 33.3% of infants (n=187) received breast milk, 30.7% (n=172) cow milk, and 30.7% (n=172) received mixed (breast milk or infant formula + cow milk). The prevalence of infant formula-fed infants was 5.2% (n=29), and only one (0.2%) child did not receive any kind of milk. Energy contribution of food groups was evaluated according to the milk feeding type (**Figure 2**). Energy provided by added sugar, baby cereal, and high-energy dense foods was significantly higher in the cow milk group ($p<0.01$) compared to breast milk and mixed feeding group.

Weight gain trajectories from six to twelve months of age according to the milk feeding type at six months are presented in **Figure 3**. Infants who received cow milk ($p=0.01$) or mixed feeding ($p<0.01$) had higher weight gain compared to the breastfed infants. Breastfed infants were 34% less likely to have excessive weight gain (PR= 0.66; 95%CI: 0.56-0.78 $P<0.01$) (**data not shown**).

Five major dietary patterns were identified by factor analysis in infants at six months of age in order to identify which pattern would increase the risk for excessive weight gain. The factor loadings were presented in **Table 2**. The first one was characterized by high consumption of cow milk, sugar and baby cereal, through the bottles. The second one was characterized by high consumption of roots, tubers, meat, eggs, fruits, and vegetables. The third component loaded represented the highest loading of rice and pasta, and considerable high loading of beans, bread, and baby

biscuits. The fourth factor was characterized by high consumption of sweet beverages. Finally, the last pattern represented the highest loading of natural juice and *petit suisse*.

The Poisson regression analysis evaluated the associations between excessive weight gain from six months to twelve months of age and quartiles of dietary patterns scores (**Table 3**). In multivariate analysis, infants in the third and fourth quartile of bottle feeding pattern were more likely to have excessive weight gain. These findings persisted after adjustment for other dietary patterns, exclusive breastfeeding until 4 months, birth weight (in grams), gestational weight gain, and smoking on pregnancy. Regarding this pattern, 64.7% (n=363) infants were bottle fed at six months of age. Of those, 79.7% (n=290) of the bottles had sugar or/and baby cereal. The mean calories per bottle were 158.9±85.6Kcal, and the consumption varied from 1 to 9 bottles per day. Besides the 'bottle feeding' pattern, infants in the second quartile of *'natural juice and petit suisse'* pattern were more likely to have excessive weight gain, even after adjustments. Higher adherence to the 'sweet beverages' dietary pattern was associated with excessive weight gain. After adjustment, the second quartile was associated.

DISCUSSION

Understanding weight gain trajectories during childhood and the role of eating patterns in the most critical period of excessive weight gain may allow for targeted intervention efforts to promote healthy diets and prevent overweight and obesity. Our findings showed that the highest prevalence of excessive weight gain occurred in the second semester of life. At six months of age, receiving no breast milk as a source of milk feeding type and unhealthy dietary patterns were associated with an increased risk of excessive weight gain at twelve months of age.

Our findings demonstrated that the second semester of life was a critical period of excessive weight gain during childhood. These results are alarming, since a recent systematic review suggested that children who presented excessive weight gain during the first two years of life had 3.66 times (95% CI: 2.59– 5.17) greater odds of being overweight or obesity later in life than those who did not present [12]. In Brazil, a cohort study did not find a critical window for rapid weight gain in different age periods, however the authors did not evaluate from six to twelve months of age [18]. Similarly, emerging studies have attempted to evaluate the critical periods of excessive weight gain during childhood. However, most investigations are limited to a time interval, do not investigated the first year of life in detail and aimed to predict late obesity [18–20].

Epidemiological findings point out to early modifiable risk factors to prevent excessive weight gain [11], including what, when, and how much an infant is fed [24,25]. Our study showed that weight gain trajectories differed according to infant's milk feeding type status. Breastfed infants were 34% less likely having excessive weight gain than those cow milk-fed or mix-fed. Publication from the Avon Longitudinal Study of Parents and Children, that examined the effects of different feeding types of milk at

eight months of age on childhood growth, showed that the high volumes of cow milk consumption in infancy is associated with faster weight and height gain than breastfed infants [26]. Besides, our findings demonstrated a high contribution of sugar and baby cereal among cow milk-fed and mix-fed infants, it may be explained to the widespread addition of these foods into the bottle. This finding is highlight, given that 75% of Brazilian children under twelve months of age consume cow's milk [27].

Following this line of statement, our findings suggested that the dietary patterns 'bottle feeding', 'natural juice and *petit suisse*' and 'sweet beverages' were associated with excessive weight gain from six months to twelve months of age. These associations are alarming due to high energy provided by these foods and also due to sugar into the composition. In United States, a study with 2442 children, between two and eight years of age, from NHANES, showed that the dietary energy density was positively associated with body weight status. Obese children had a higher dietary energy density than lean children. Also, the energy density was associated with high added sugar intake, more energy from fat and significantly lower intake of fruits and vegetables [28]. Regarding the high sugar intake in our sample, the sweetness of sugar has a capacity to lay a strong foundation for food preferences that often extend over a lifetime [29]. Aside from providing 4g/kcal of energy, sugar is non-nutritive, and the inappropriate introduction of solids and beverages that are sweet, raises the infant's risk for later obesity and may discourage the acceptance of other bitter or sour foods, like fruits and vegetables [29,30].

Besides the immediate association with excessive weight gain, dietary patterns are established in the first two years of age and track into mid-childhood [25,31]. Recent study that assessed patterns of dietary exposures at nine months and the association with child diet and weight at six years of age, from the IFPS II and Year 6 Follow-Up Study

(Y6FU), showed that infants in the MXHED pattern (infant formula and breastmilk as milk source) class were fed with diets higher in energy density and lower in nutrient density at nine months of age, and these children continued to eat diets higher in energy-dense foods including fries, regular soda and sweet dessert foods at six years of age [25].

This study has some limitations. Although we experienced losses to follow-up, we found no differences between the baseline characteristics of children who remained in the study and those who were lost to follow-up. Second, cautious generalization of our results is required, since most of our sample is of low income families. In response, we note that this target population is of specific interest for the introduction and evaluation of large-scale dietary interventions to improve population health in regional or national health programmes. Third, a single 24-h recall might be limited in capturing usual intake of participants and might affect interpretation of the higher or lower tracking observed for specific dietary patterns, especially if the components of the dietary patterns are consumed episodically. However, compared to food frequency questionnaire, the commonly used method in other studies, this method does not depend on long-term memory and has the advantage of being more flexible and open-ended to collect more detailed food consumption data [32].

Based on our results, the period from six to twelve months of age was critical for excessive weight gain during the first six years of children's life. Three dietary patterns explained this outcome, bottle feeding, sweet beverages and natural juice and/or *petit suisse*. Therefore, there is an urgent demand to improve the feeding practices during the first year of life as a main strategy to prevent the childhood obesity.

Figure 1. Flow diagram of the study.

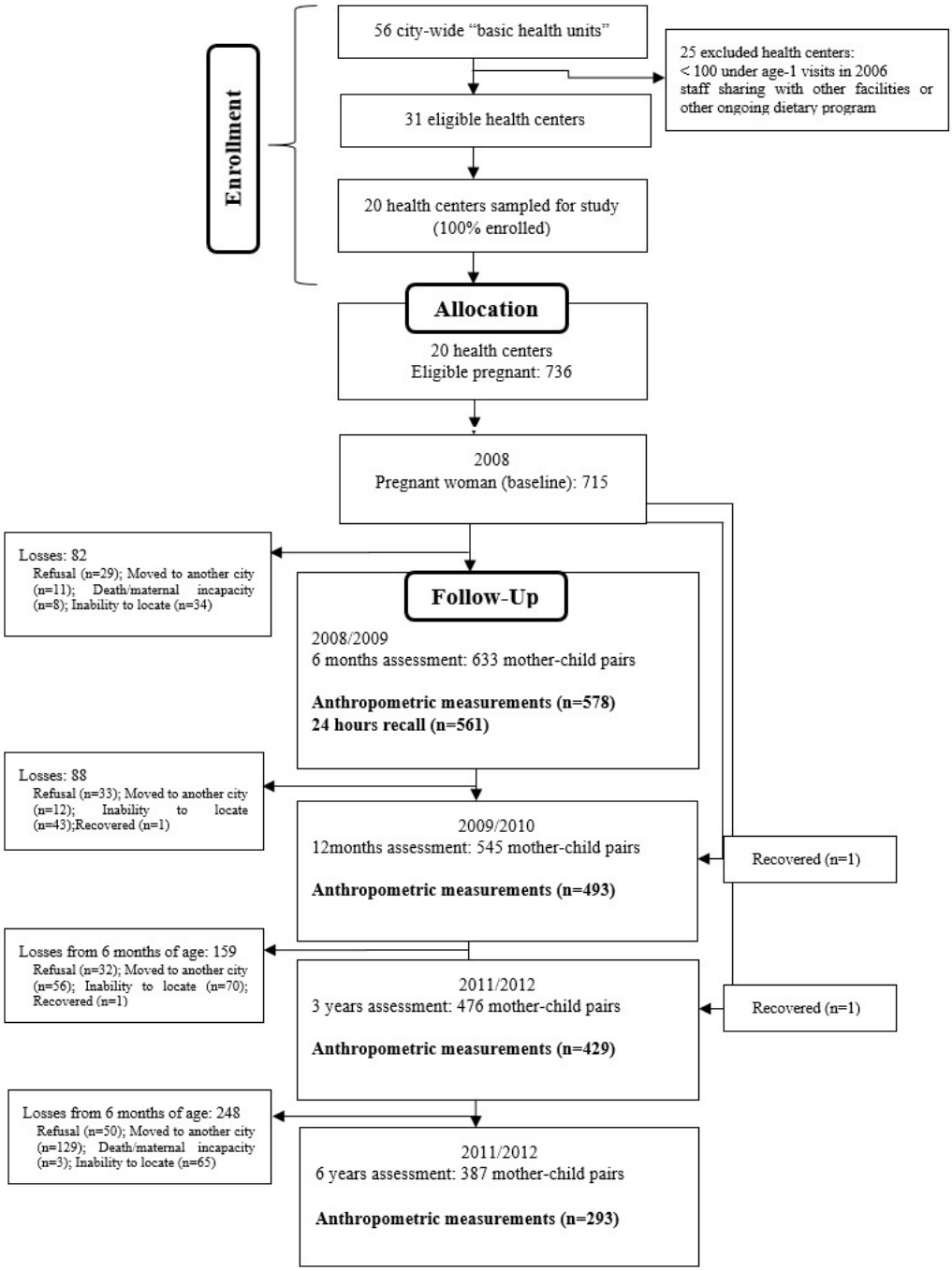
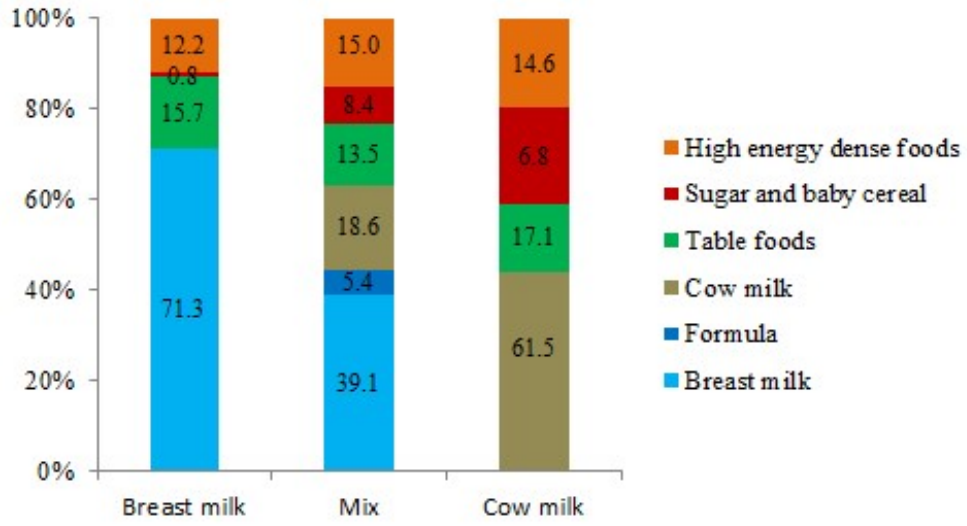


Table 1. Anthropometric assessment in children at ages six months, twelve months, three years and six years.

	Birth[a](n=568)	**6 months (n=578)**	**12 months (n=493)**	**3 years (n=429)**	**6 years (n=293)**
Weight (kg), *mean±SD*	3.3±0.4	8.0±1.0	10.1±1.3	15.8±2.5	24.1±5.6
Length/ Height(cm), *mean±SD*	49.2±2.2	67.1±2.6	74.8±2.9	96.74.3	119.0±5.6
BMI z-score, *mean±SD*	0.1±1.0	0.3±1.2	0.9±1.1	0.9±1.3	0.7±1.4
BMI z-score >1SD, n (%)	20.6(117)	29.2(169)	47.9(236)	43.8(187)	33.4(99)
BMI z-score >2SD, n (%)	2.6(15)	8.3(48)	17.4(86)	18.5(79)	18.2(54)
BMI z-score >3SD, n (%)	0.2(1)	2.4(14)	3.9(19)	4.7(20)	7.8(23)

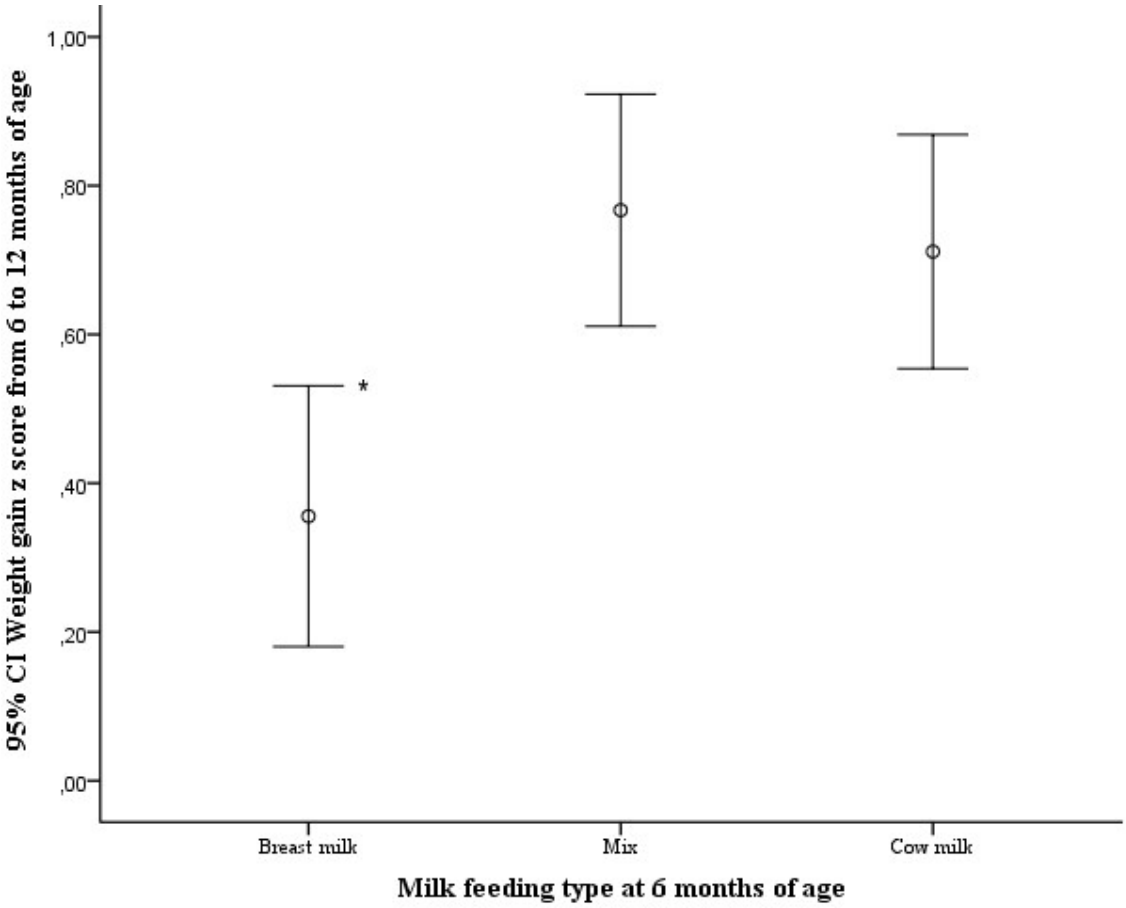
SD, Standard Deviation; BMI, Body Mass Index; [a] Data collected from the children's records during home visits at six months of age.

Figure 2. Contribution of food groups to the energy intake according to the milk feeding type at age six months (n=561).



Mix: Breast milk or Infant Formula + Cow milk; High energy dense foods: biscuits, sweets, soft drinks, sugary milk beverages, powdered chocolate and fried foods; Table foods - pasta, vegetables, roots and tubers, meat, eggs and beans, fruits.

Figure 3. Mean and standard deviation of weight gain from six months to twelve months of age according to the milk feeding type at six months of age.



*: p<0.01 vs. mix and cow milk

Table 2. Factor loadings after rotation for the food groups on five dietary patterns extracted by principal component analysis among children at six months of age (n=561).

	Dietary Patterns				
	Bottle	Roots and tubers, meat and eggs, fruits and vegetables	Rice and pasta, beans, bread, baby biscuits	Sweet Beverages	Natural juice and *petit suisse*
Breast milk	-0.756	-0.131	-0.123	0.026	-0.202
Cow milk	**0.842**	-0.017	0.086	0.049	-0.016
Rice and pasta	0.008	0.087	**0.698**	0.224	0.194
Roots and tubers	0.157	**0.565**	0.107	0.107	-0.392
Meat and eggs	-0.044	**0.608**	0.098	0.406	0.316
Beans	0.079	-0.113	**0.735**	-0.062	0.074
Fruits	-0.051	**0.517**	0.059	-0.089	0.023
Vegetables	0.018	**0.728**	-0.126	-0.024	0.056
Natural juice	0.032	0.304	0.017	-0.483	**0.491**
Bread[a]	-0.047	-0.306	**0.376**	0.334	0.177
Baby biscuits[b]	0.124	0.227	**0.574**	-0.154	-0.297
Sweet beverages[c]	0.099	0.077	0.013	**0.743**	0.021
Petit suisse	0.148	0.005	0.113	0.075	**0.607**
Sugar	**0.641**	0.008	-0.012	0.051	0.070
Baby cereal	**0.768**	-0.078	0.001	0.007	-0.079

[a]Mass-produced packaged bread and buns; french bread, salt biscuits and crackers; [b]Baby biscuits and cookies; ‘Soda, sweetened juice.

Table 3. Prevalence ratio (95% CI) for excessive weight gain[a] from six to twelve months of age according to the quartiles (Q) of dietary pattern scores among children at 6 months of age (n=561)[b].

		Univariate model†		Multivariate model‡			
				Model 1		Model 2	
	Q	PR (95% CI)	P	PR(95% CI)	P	PR (95% CI)	P
Bottle							
	Q1	1		1		1	
	Q2	0.88(0.70-1.10)	0.289	0.90(0.73-1.11)	0.363	0.90(0.73-1.11)	0.347
	Q3	1.30(1.05-1.62)*	0.015	1.37(1.13-1.67)*	≤ 0.01	1.43(1.15-1.79)*	≤ 0.01
	Q4	1.34(1.10-1.63)*	0.003	1.43(1.16-1.77)*	≤ 0.01	1.59(1.28-1.97)*	≤ 0.01
Roots and tubers, meat and eggs, fruits and vegetables							
	Q1	1		1		1	
	Q2	0.97(0.73-1.29)	0.869	0.98(0.73-1.32)	0.926	0.99(0.74-1.32)	0.970
	Q3	0.79(0.58-1.08)	0.143	0.85(0.62-1.17)	0.331	0.82(0.59-1.13)	0.234
	Q4	1.00(0.84-1.19)	0.925	1.08(0.91-1.28)	0.362	0.99(0.74-1.32)	0.970
Rice and pasta, beans, bread, baby biscuits							
	Q1	1		1		1	
	Q2	0.97(0.80-1.17)	0.787	1.12(0.88-1.42)	0.331	1.07(0.89-1.29)	0.430
	Q3	1.05(0.83-1.33)	0.667	1.16(0.93-1.46)	0.184	1.18(0.93-1.49)	0.155
	Q4	0.90(0.76-1.06)	0.213	0.97(0.81-1.16)	0.775	1.15(0.90-1.46)	0.249
Sweet Beverages							
	Q1	1		1		1	
	Q2	1.16(0.99-1.37)	0.064	1.20(1.04-1.38)*	≤ 0.01	1.19(1.02-1.38)*	0.024
	Q3	1.04(0.93-1.15)	0.438	1.07(0.91-1.26)	0.396	1.06(0.88-1.27)	0.534
	Q4	1.30(1.05-1.61)*	0.016	1.29(0.99-1.69)	0.052	1.31(0.98-1.74)	0.060
Natural juice and *petit suisse*							
	Q1	1		1		1	
	Q2	1.34(1.05-1.70)*	0.016	1.33(1.05-1.69)*	≤ 0.01	1.39(1.08-1.33)*	0.008
	Q3	1.18(0.97-1.44)	0.097	1.14(0.92-1.40)	0.208	1.19(0.92-1.53)	0.178
	Q4	1.15(0.96-1.39)	0.114	1.06(0.87-1.29)	0.534	1.05(0.83-1.33)	0.652

*p≤0.05; [a]ΔBMI Z-score >0.67; [b]Generalized estimating equations; CI, confidence interval; PR, prevalence ratio.† Univariable model: â-coefficients for a separate model for each listed variable.‡ Multivariate model 1: adjusted for child's group status (intervention or control) and dietary patterns.‡ Multivariate model 2: adjusted for child's group status (intervention or control), dietary patterns, exclusive breastfeeding until 4 months, birth weight (in grams), gestational weight gain, smoking on pregnancy.

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6 CONCLUSÕES E CONSIDERAÇÕES FINAIS

Os resultados reforçam que a atualização, baseada na diretriz nacional *“Dez Passos da Alimentação Saudável para Crianças Menores de Dois Anos”,* para profissionais de saúde dos serviços de atenção primária, pode ser uma estratégia para melhorar a saúde de crianças de baixa condição socioeconômica, reduzindo a prevalência de constipação aos 6 anos. Além disso, as crianças pertencentes ao grupo intervenção consumiram menos calorias aos 3 anos e apresentaram menor adiposidade aos 6 anos de idade.

Por outro lado, nossos achados evidenciam o consumo energético acima das recomendações em todas as idades avaliadas. Ao observar este comportamento, seguido das altas prevalências de excesso de peso, avaliamos o período de maior ganho de peso excessivo e padrões dietéticos associados. Nesta perspectiva, nossos achados demonstraram associação entre ganho de peso excessivo e padrões alimentares não saudáveis aos 6 meses de idade das crianças. Considerando que as preferências alimentares são formadas nos primeiros anos de vida, estes padrões contribuem para manutenção de hábitos inadequados em idades posteriores. Desta forma, urge a necessidade de planejamento e viabilização de políticas capazes de promover e apoiar padrões alimentares saudáveis, além de monitorar a velocidade de ganho de peso na infância.

7 ANEXOS

ANEXO A – Aceite do Comitê de ética – Primeira fase

MINISTÉRIO DA EDUCAÇÃO
FUNDAÇÃO FACULDADE FEDERAL DE CIÊNCIAS MÉDIC
COMITÊ DE ÉTICA EM PESQUISA
APROVADO PELA CARTA Nº 880/2004-CONEP/CNS/
RUA SARMENTO LEITE, 245 – FONE: (51) 3224.88
CEP 90050-170 – PORTO ALEGRE – RS - cep@fffcmp

Of. 532/07-CEP

Porto Ale

Ilma. Sra.
Profa. Márcia Regina Vitolo
Nesta Faculdade

Senhora Professora

Informamos que seu projeto intitulado "Imple
Alimentação Saudável para Crianças Menores de Dois An
Saúde.", Processo nº 226/07, foi aprovado por este Comitê, na
conforme parecer consubstanciado nº 471-07.

Atenciosamente,

ANEXO B – Parecer do Comitê de ética em pesquisa – Segunda fase

UFCSPA

COMISSÃO CIENTÍFICA E COMISSÃO DE PESQUISA E ÉTICA EM SAÚDE

COMITÊ DE ÉTICA EM PESQUISA - CEP
UFCSPA

O Comitê de Ética em Pesquisa da UFCSPA, registrado na Comissão Nacional de Ética em Pesquisa (CONEP) sob o nº 075/05 em 23/07/04, analisou o Projeto:

Projeto: 11-748 **Versão do Projeto:** **Versão do TCLE:**

Pesquisadores:
MÁRCIA REGINA VITOLO
CARLOS ALBERTO FELDENS

Título: IMPACTO DE INTERVENÇÃO NA ATENÇÃO PRIMÁRIA À SAÚDE NAS CONDIÇÕES NUTRICIONAIS DE CRIANÇAS EM IDADE PRÉ-ESCOLAR:SEGUNDA FASE DE AVALIAÇÃO DE ENSAIO DE CAMPO RANDOMIZADO POR CONGLOMERADOS

Esse projeto foi aprovado em seus aspectos éticos e metodológicos conforme as Resoluções 196/09 e demais Resoluções complementares. Toda e qualquer alteração do projeto, assim como eventos adversos graves, deverão ser comunicados a este CEP. Os TCLE, quando necessários, somente poderão ser utilizados após prévia e explicita aprovação (carimbo) de sua redação por este CEP".

Porto Alegre, 06 de maio de 2011.

José Geraldo Vernet Taborda
Coordenador do CEP/UFCSPA

ANEXO C - Parecer do Comitê de Ética em Pesquisa – Terceira fase

UNIVERSIDADE FEDERAL DE CIÊNCIAS DA SAÚDE DE PORTO ALEGRE

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Impacto nas condições nutricionais e de saúde de crianças na idade de 6 e 7 anos que participaram de um ensaio de campo randomizado por conglomerados no primeiro ano de vida

Pesquisador: Marcia Regina Vitolo

Área Temática:

Versão: 1

CAAE: 30741714.7.0000.5345

Instituição Proponente: Universidade Federal de Ciências da Saúde de Porto Alegre

Patrocinador Principal: Conselho Nacional de Desenvolvimento Científico e Tecnológico

DADOS DO PARECER

Número do Parecer: 689.596

Data da Relatoria: 12/06/2014

Apresentação do Projeto:

O presente estudo é continuidade de um projeto (471-07 e nº 748/11 Comitê de Ética e Pesquisa da UFCSPA) desenvolvido para avaliar o impacto de atualização de profissionais da atenção primária à saúde em relação ao guia alimentar "Dez passos para uma alimentação saudável para crianças brasileiras menores de dois anos" nas condições nutricionais e de saúde de crianças assistidas por unidades de saúde da cidade de Porto Alegre.

O mesmo visa estudar se existe impacto da atualização para profissionais da atenção primária em relação às práticas alimentares no primeiro ano de vida (realizado no estudo anterior) nas condições de nutrição e saúde de crianças na idade escolar e os fatores de risco para obesidade, anemia, dislipidemias e alterações metabólicas.

Para isso, crianças na idade de 6-7 anos receberão visitas domiciliares. Os dados antropométricos e dietéticos serão coletados por estudantes de graduação e pós-graduação da Universidade Federal de Ciências da Saúde de Porto Alegre (UFCSPA) por meio de questionário abordando fatores familiares, antropométricos e dietéticos. Os entrevistadores não terão conhecimento do grupo no qual as crianças pertenceram (intervenção ou controle) e serão previamente treinados para coleta de dados. Será realizada confirmação dos dados coletados em 5% da amostra por telefone. Será realizado analise de amostras de sangue na Universidade Federal de Ciências da

Endereço: Rua Sarmento Leite ,245
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Saúde de Porto Alegre (UFCSPA). O deslocamento das mães e crianças, em grupos, será realizado por meio de serviço terceirizado de transporte.

Objetivo da Pesquisa:

Avaliar o impacto de uma atualização para profissionais da atenção primária em relação às práticas alimentares no primeiro ano de vida nas condições de nutrição e saúde de crianças na idade escolar e os fatores de risco para obesidade, anemia, dislipidemias e alterações metabólicas.

Avaliação dos Riscos e Benefícios:

A nível individual, as crianças terão os resultados de todos os exames e serão encaminhadas ao posto de saúde se necessário. Os resultados dessa pesquisa poderão subsidiar políticas públicas de alimentação e nutrição, sobretudo da população infantil de baixa renda.

Os riscos são pequenos e envolvem a realização de punção venosa na fossa cúbita. Os autores não descrevem os potenciais riscos de equimoses, dor local etc.

Comentários e Considerações sobre a Pesquisa:

É um estudo relevante que poderá auxiliar em políticas públicas de alimentação e nutrição na população infantil. O mesmo apresenta objetivos e metodologia claros. O mesmo foi contemplado com o Edital do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPQ) Nº 14/2013-47731/2013-8.

Considerações sobre os Termos de apresentação obrigatória:

As mudanças solicitadas no termo de consentimento livre e esclarecido foram atendidas.

Os pesquisadores justificaram a falta de anuência da Secretaria Municipal de Saúde uma vez que o projeto não será realizado nas Unidades Básicas de Saúde e sim por visitas domiciliares.

Recomendações:

As sugestões foram atendidas.

Conclusões ou Pendências e Lista de Inadequações:

Parecer favorável a aprovação.

Situação do Parecer:

Aprovado

Necessita Apreciação da CONEP:

Não

UNIVERSIDADE FEDERAL DE CIÊNCIAS DA SAÚDE DE PORTO ALEGRE

Considerações Finais a critério do CEP:

Término do projeto 05/2015.

De acordo com o parecer do Relator.

PORTO ALEGRE, 17 de Junho de 2014

Assinado por:
José Geraldo Vernet Taborda
(Coordenador)

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ANEXO D – Normas das revistas (endereços eletrônicos)

Artigos	Revista	Normas
Infant feeding practices and the effect in reducing functional constipation 6 years later: a randomised field trial	*Journal of Pediatric Gastroenterology & Nutrition*	http://edmgr.ovid.com/jpgn/accounts/ifauth.htm
The long term impact of a primary care intervention to promote healthy infant feeding practices on children adiposity at six years old in Brazil: a cluster randomised controlled trial	*The Lancet*	http://www.thelancet.com/pb/assets/raw/Lancet/authors/lancet-information-for-authors.pdf
The early origin of childhood obesity: dietary patterns and excessive weight gain	*Pediatrics*	http://www.aappublications.org/content/pediatrics-author-guidelines#formatting_requirements