UNIVERSIDADE FEDERAL DE UBERLÂNDIA
PROGRAMA DE PÓS-GRADUAÇÃO EM CÊNCIAS DA SAÚDE
FACULDADE DE MEDICINA

ASSOCIAÇÃO DOS HORÁRIOS DAS REFEIÇÕES COM O CONSUMO ALIMENTAR E O GANHO DE PESO DURANTE A GESTAÇÃO: ESTUDO DE COORTE PROSPECTIVO

CRISTIANA ARAÚJO GONTIJO

UBERLÂNDIA
2019

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Tese apresentada ao Programa de Pós-Graduação em Ciências da Saúde da Faculdade de Medicina da Universidade Federal de Uberlândia, como requisito parcial para a obtenção do Título de Doutor em Ciências da Saúde.

Área de concentração: Ciências da Saúde.

Orientadora: Profa. Dra. Yara Cristina de Paiva Maia

Coorientadora: Profa. Dra. Cibele Aparecida Crispim

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ATA DE DEFESA

Programa de Pós-Graduação em:	Ciências da Saúde				
Defesa de:	Defesa de Tese de Doutorado, Nº 014, PPCSA				
Data:	11.07.2019	Hora de início:	13:30	Hora de encerramento:	17:30
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Título do Trabalho:	Impacto dos horários das refeições no consumo alimentar e no ganho de peso durante a gestação.				
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Reuniu-se no anfiteatro do bloco 5OC, Campus Santa Mônica, da Universidade Federal de Uberlândia, a Banca Examinadora, designada pelo Colegiado do Programa de Pós-graduação em Ciências da Saúde, assim composta: Professores Doutores: Sarah Aparecida Vieira Ribeiro (UFV) e Vivian Siqueira Santos Gonçalves (UNB) por videoconferência. Geórgia das Graças Pena (UFU), Luana Padua Soares (UFU) e Yara Cristina de Paiva Maia (UFU) orientador (a) do (a) candidato(a) presentes no recinto.
Iniciando os trabalhos o(a) presidente da mesa, Dr(a). Yara Cristina de Paiva Maia, apresentou a Comissão Examinadora e o candidato (a), agradeceu a presença do público, e concedeu a discente a palavra para a exposição do seu trabalho. A duração da apresentação da discente e o tempo de arguição e resposta foram conforme as normas do Programa.

A seguir o senhor(a) presidente concedeu a palavra, pela ordem sucessivamente, aos(às) examinadores(as), que passaram a arguir o(a) candidato(a). Ultimada a arguição, que se desenvolveu dentro dos termos regimentais, a Banca, em sessão secreta, atribuiu o resultado final, considerando o(a) candidato(a):

Aprovado(a).

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O competente diploma será expedido após cumprimento dos demais requisitos, conforme as normas do Programa, a legislação pertinente e a regulamentação interna da UFU.

Nada mais havendo a tratar foram encerrados os trabalhos. Foi lavrada a presente ata que após lida e achada conforme foi assinada pela Banca Examinadora.

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FOLHA DE APROVAÇÃO

CRISTIANA ARAÚJO GONTIJO

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Presidente da banca: Profa. Dra. Yara Cristina de Paiva Maia

Tese apresentada ao Programa de Pós-Graduação em Ciências da Saúde da Faculdade de Medicina da Universidade Federal de Uberlândia, como requisito parcial para a obtenção do Título de Doutor em Ciências da Saúde.
Área de concentração: Ciências da Saúde.

Banca examinadora

Titular: Profa. Dra. Sarah Aparecida Vieira Ribeiro

Instituição: Universidade Federal de Viçosa - UFV

Titular: Profa. Dra. Vivian Siqueira Santos Gonçalves

Instituição: Universidade de Brasília - UnB

Titular: Profa. Dra. Geórgia das Graças Pena

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Titular: Profa. Dra. Luana Padua Soares

Instituição: Universidade Federal de Uberlândia - UFU

Suplente: Profa. Dra. Maria Carliana Mota

Instituição: SESI-SENAC

Suplente: Profa. Dra. Luciana Saraiva da Silva

Instituição: Universidade Federal de Uberlândia - UFU

DEDICATÓRIA

À Clara, meu mais puro Amor.
Por ter me proporcionado vivenciar a gestação durante a realização deste trabalho.

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A Deus, por sempre guiar meus caminhos e tornar tudo possível.

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“A tarefa não é tanto ver aquilo que ninguém viu, mas pensar o que ninguém ainda pensou sobre aquilo que todo mundo vê.”

(Arthur Schopenhauer)

RESUMO

Introdução: Estudos têm sugerido que não apenas o que e quanto se come, mas também quando se come (variáveis relacionadas aos horários das refeições), contribuem significativamente para o balanço energético, distribuição das calorias ao longo do dia, regulação do peso corporal e controle metabólico. Porém, até o momento, poucos estudos com gestantes foram conduzidos no campo da crononutrição (área da ciência que estuda a relação entre o consumo alimentar e o relógio circadiano). **Objetivo:** Avaliar a associação dos horários das refeições com o consumo alimentar e o ganho de peso durante a gestação. **Material e Métodos:** Trata-se de um estudo de coorte prospectivo realizado com 100 gestantes que foram acompanhadas no atendimento pré-natal de baixo risco em Unidades de Atendimento Integrado (UAIs) do município de Uberlândia ou no serviço de pré-natal do Hospital de Clínicas da Universidade Federal de Uberlândia (HC-UFU). A coleta de dados foi realizada entre os meses de outubro de 2015 e fevereiro de 2017. O consumo alimentar foi avaliado por três recordatórios alimentares de 24 horas em cada trimestre gestacional. A distribuição diária de energia e macronutrientes foi avaliada nas refeições ao longo do dia e a qualidade da dieta foi avaliada pelo Índice de Qualidade da Dieta Revisado (IQD-R). Foram determinados os horários relacionados aos padrões alimentares, isto é, o intervalo entre a primeira e a última refeição (duração da alimentação), o jejum noturno, o horário da primeira e última refeições e o número de refeições por dia. As gestantes foram classificadas em relação ao horário da primeira e da última refeição em “mais cedo” ou “mais tarde”, e também quanto ao “menor” ou “maior” consumo energético no horário das 19:00h às 05:59h. A adequação do ganho de peso foi avaliada com base no valor do ganho de peso em cada trimestre dividido pelo valor do ganho de peso recomendado neste intervalo. O cronotipo foi obtido pelo ponto médio do sono corrigido para o débito de sono. Análises de regressão linear ajustadas para fatores de confusão foram realizadas para associar os horários relacionados aos padrões alimentares e o cronotipo com a qualidade da dieta no primeiro trimestre. Equações de Estimações Generalizadas (GEE) foram utilizadas para avaliar os efeitos do horário da primeira e da última refeição “mais cedo” ou “mais tarde” e o “menor” ou “maior” consumo energético noturno sobre os padrões alimentares, qualidade da dieta e ganho de peso durante a gestação. **Resultados:** Os resultados mostraram que, no primeiro

trimestre gestacional, a maior duração da alimentação, o horário mais cedo da primeira refeição, o maior número de refeições e o cronotipo matutino foram associados à melhor qualidade da dieta - maiores escores do IQD-R total e/ou dos componentes frutas totais e inteiras. Os dados longitudinais mostraram que as gestantes que realizavam a primeira refeição mais cedo consumiam maior percentual de energia e carboidratos nas refeições da manhã e menor nas refeições da noite, e tiveram melhor qualidade de dieta para os componentes frutas totais e inteiras, quando comparadas às gestantes que realizavam a primeira refeição mais tarde. Além disso, as gestantes com maior consumo alimentar à noite tiveram maior ganho de peso excessivo no terceiro trimestre, quando comparado as com "menor" consumo noturno. **Conclusão:** Sugere-se que a realização da primeira refeição mais cedo tem relação com a melhor qualidade da dieta e o menor consumo alimentar nas refeições da noite, e que o menor consumo energético depois das 19h tem relação com o menor ganho de peso no terceiro trimestre. Os horários das refeições devem ser considerados nas orientações nutricionais pré-natais para promover o ganho de peso gestacional adequado e, consequentemente, a saúde materno-fetal.
Palavras-chave: gestação; crononutrição; horários das refeições; padrões alimentares; dieta materna; qualidade da dieta; duração da alimentação; ganho de peso gestacional; distribuição circadiana alimentar; cronotipo.
Apoio: Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG).

ABSTRACT

Introduction: Studies have suggested that not only what and how much you eat, but also when you eat (variables related to meal timing), contribute significantly to energy balance, calorie distribution throughout the day, body weight regulation and metabolic control. However, so far, few studies with pregnant women have been conducted in the field of chrononutrition (an area of science that studies the relationship between food consumption and the circadian clock). **Objective:** The aim of this study was to analyze the associations between meal timing and food intake and weight gain in pregnant women. **Material and Methods:** This is a prospective cohort study conducted with 100 pregnant women who were followed up at low-risk prenatal care at Unidades de Atendimento Integrado (UAIs) in the city of Uberlandia or at the prenatal service at the Hospital de Clinicas of Federal University of Uberlandia (HC-UFU). Data collection was performed between October 2015 and February 2017. Food intake was evaluated by three 24-h food recalls in each gestational trimester. The distribution of energy and macronutrients intake was evaluated at meals throughout the day. Diet quality was assessed using the Brazilian Healthy Eating Index-Revised (BHEI-R). Time-related eating patterns, i.e., the interval between the first and the last meal (eating duration), nightly fasting, time of the first and last meals and number of meals eaten in a day were determined. Pregnant women were classified as “early” or “late” based on the timing of the first and last meals, if the values were below or above the median of the population, respectively. Also, pregnant women were classified as “lower” or “higher” night-time energy intake - amount of energy intake from 19:00 to 05:59h - if these values were below or above the median of the population, respectively. The adequacy of the weight gain in the trimesters was evaluated based on the value of the weight gain in each trimester divided by the value of the recommended weight gain in this interval. Chronotype was derived using the mid-sleep time on free days on weekends (MSF), with a further correction for calculated sleep debt. Linear regression modeling analyses adjusted for confounders were used to investigate the association between time-related eating patterns and chronotype with diet quality in the first trimester. Generalized Estimating Equation models were used to determine the effects of the “early” or “late” meal timing and “lower” or “higher” night-time intake on the eating patterns, diet quality and weight gain during pregnancy. **Results:** The results showed

that in the first gestational trimester a longer eating duration, earlier time of the first meal, higher number of meals and morningness tendency were associated with a better diet quality - higher scores of the total BHEI-R and/or fruit components. Data from the three gestational trimesters showed that the “early” eaters of the first meal consumed a higher percentage of energy and carbohydrates at morning meals and a lower percentage of energy and carbohydrates at evening meals, and had a better diet quality for the total fruit and whole fruit components compared to the “late” eaters of the first meal. In addition, the pregnant women with "higher” night-time intake had greater excessive weight gain in the third trimester when compared to "lower” night-time intake. **Conclusion:** We suggest that having the first meal earlier is related to the better diet quality and the lower food intake in the evening meals, and that the lower energy consumption after 7 pm is related to the lower weight gain in the third trimester. Meal timing should be considered in the nutritional prenatal guidelines to promote adequate gestational weight gain and consequently maternal-fetal health.
Keywords: pregnancy; chrono-nutrition; meal timing; eating patterns; maternal diet; diet quality; eating duration; gestational weight gain; circadian energy distribution; chronotype.

Support: Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG).

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LISTA DE ABREVIATURAS E SIGLAS

FUNDAMENTAÇÃO TEÓRICA

AHEI-P	*Alternative Healthy Eating Index for Pregnancy*
AI	*Adequate Intake*
AMDR	*Acceptable Macronutrient Distribution Range*
BHEI-R	*Brazilian Healthy Eating Index-Revised*
DQI-P	*Diet Quality Index for pregnancy*
EER	*Estimated Energy Requirements*
GPG	Ganho de peso gestacional
HEI	*Healthy Eating Index*
HEI-1995	*Healthy Eating Index* 1995
HEI-2005	*Healthy Eating Index* 2005
HEI-2010	*Healthy Eating Index* 2010
IMC	Índice de massa corporal
IQD	Índice de Qualidade da Dieta
IQD-R	Índice de Qualidade da Dieta Revisado
IOM	*Institute of Medicine*
Kcal	Quilocalorias
Kg	Quilogramas
NA	Não se aplica
RDA	*Recommended Dietary Allowance*
VET	Valor energético total

ARTIGOS

BHEI-R	*Brazilian Healthy Eating Index-Revised*
BMI	*Body mass index*
CNPq	Conselho Nacional de Desenvolvimento Científico e Tecnológico
DIT	*Diet-induced thermogenesis*
FAPEMIG	Fundação de Amparo à Pesquisa do Estado de Minas Gerais
GEE	*Generalized Estimating Equation*
GLzM	*Generalized Linear Models*
Gord-AA	Calorias provenientes de gordura sólida, álcool e açúcar de adição.
MSF	*Mid-sleep time on free days at the weekend*
SD	*Standard deviation*
SE	*Standard error*
SoFAAS	*Calories from Solid Fats, Alcoholic beverages, and Added Sugars*
USDA	*United States Department of Agriculture*
WHO	*World Health Organization*
24HR	*24HR food recalls*
1^{st} T	*First trimester*
2^{nd} T	*Second trimester*
3^{rd} T	*Third trimester*
%EI	*Energy consumed during a period divided by the total daily energy intake.*

SUMÁRIO

1 INTRODUÇÃO

A gestação é caracterizada como o período, em média de 40 semanas, em que o organismo da mulher passa por adaptações fisiológicas e metabólicas (NEWBERN; FREEMARK, 2011). Durante este período também há um aumento das necessidades nutricionais, o que decorre justamente das adaptações maternas e das demandas metabólicas do feto (PLEĆAS; PLESINAC; KONTIĆ VUCINIĆ, 2014). Destacam-se o aumento das necessidades energéticas no segundo e terceiro trimestres e de vários micronutrientes, especialmente ferro e folato, durante todo o período gestacional (IOM, 2009).

A alimentação durante a gestação é considerada como importante fator modificável e que influencia a saúde materno-fetal (RAMAKRISHNAN et al., 2012). A inadequação alimentar durante este período pode ser considerada fator de risco para a ocorrência de desfechos gestacionais desfavoráveis, incluindo ganho de peso excessivo e desenvolvimento de complicações gestacionais, tais como diabetes *mellitus* gestacional, aumento das taxas de prematuridade, restrição do crescimento infantil e morbimortalidade materno-infantil (KING et al., 2003; RIFAS-SHIMAN et al., 2009).

A gestação é normalmente caracterizada por aumento do peso materno que representa o peso do feto, da placenta, do líquido amniótico e de modificações maternas no útero, na glândula mamária, no volume sanguíneo e no tecido adiposo. Os produtos da concepção (placenta, líquido amniótico e feto) abrangem aproximadamente 35% do total de ganho de peso gestacional (IOM, 2009). Apesar do Brasil ainda não possuir recomendações de ganho de peso específicas para sua população, o Ministério da Saúde aconselha a utilização na assistência pré-natal das diretrizes do *Institute of Medicine* (IOM, 2009), que são recomendações de ganho de peso gestacional baseadas no índice de massa corporal pré-gestacional (BRASIL, 2012).

O ganho de peso adequado na gestação é de extrema importância para a saúde materna-fetal (HUNG et al., 2015; SCHACK-NIELSEN et al., 2010), tendo em vista que o ganho de peso excessivo pode predispor a mulher à complicações clínicas durante a gestação, como o diabetes *mellitus* gestacional (HUNG et al., 2015), intolerância a glicose (HERRING et al. 2009), hipertensão gestacional (FORTNER et al. 2009), pré-eclâmpsia (XIA et al. 2017), depressão (BODNAR et al.

2009), parto cesáreo (CHU et al. 2007), além de retenção de peso pós-parto (GILMORE et al., 2015). Ainda, esse ganho de peso excessivo é considerado fator de risco para a ocorrência de resultados adversos neonatais (HUNG et al., 2015) e risco de sobrepeso e obesidade na infância (SCHACK-NIELSEN et al., 2010). Assim, a gestação é considerada uma fase de oportunidade de mudança e adaptação de comportamentos alimentares saudáveis (KOMINIAREK; PEACEMAN, 2017).

As intervenções nutricionais durante a gestação são tradicionalmente direcionadas para a adequação da dieta em qualidade e quantidade (KOMINIAREK; PEACEMAN, 2017; NICODEMUS, 2018; SAMURA et al., 2016). No entanto, estudos recentes sugerem que não apenas o que e quanto se come, mas também quando se come (variáveis relacionadas aos horários das refeições), contribuem significativamente para o balanço energético (de CASTRO, 2004), distribuição das calorias ao longo do dia (GARAULET et al., 2013), regulação do peso corporal (ALJURAIBAN et al., 2015; BARON et al., 2011; BO et al., 2014; MAUKONEN et al., 2019; WANG et al., 2014) e controle metabólico (JAKUBOWICZ et al., 2013; LEUNG; HUGGINS; BONHAM, 2017).

Até o momento, poucos estudos com gestantes foram conduzidos no campo da crononutrição (área da ciência que estuda a relação entre o consumo alimentar e o relógio circadiano), e os estudos publicados mostraram que os horários das refeições durante a gestação foram considerados fatores importantes para determinar os níveis glicêmicos maternos (CHANDLER-LANEY et al., 2016; LOY et al., 2016; LOY et al., 2017a) e o comprimento e a adiposidade do recém-nascido (LOY et al., 2017b). De acordo com o nosso conhecimento, nenhum estudo até o momento examinou o impacto dos horários das refeições, principalmente primeira e última refeição, na distribuição das calorias ao longo do dia, qualidade da dieta e ganho de peso em mulheres durante a gestação.

Espera-se que este estudo longitudinal demonstre a associação entre os horários das refeições com a qualidade da dieta, a distribuição das calorias ao longo do dia e o ganho de peso em mulheres durante a gestação. A presente tese tem como finalidade pesquisar novos fatores de risco modificáveis para o consumo alimentar inadequado e ganho de peso excessivo na gestação, visando repensar as estratégicas atuais de intervenção nutricional gestacional com o intuito de promover a saúde materno-infantil.

1.1 Considerações Iniciais

A formatação desta tese foi realizada de acordo com o modelo alternativo proposto pelo Programa de Pós Graduação em Ciências da Saúde, da Faculdade de Medicina, Universidade Federal de Uberlândia, o qual determina que os resultados do estudo sejam apresentados em formato de artigos científicos.

A Tese foi organizada nas seguintes seções: **Fundamentação Teórica**, a qual está apresentada como forma de revisão da literatura sobre os temas abordados na tese; **Objetivos**, em que são expostos os propósitos do estudo; **Resultados**, que contempla três manuscritos elaborados; **Conclusão**, que discorre sobre a síntese dos principais resultados do estudo; **Perspectivas,** na qual são apresentados expectativas para estudos futuros; **Pós-texto,** na qual estão incluídos referências bibliográficas, anexos e apêndices.

O primeiro manuscrito intitulado **"Time-related eating patterns and chronotype are associated with diet quality in pregnant women"** teve como objetivo associar os horários relacionados aos padrões alimentares e o cronotipo com a qualidade da dieta de mulheres no primeiro trimestre gestacional. Esse artigo foi publicado em setembro de 2018 na revista *Chronobiology International* (*Impact Factor* =2.643).

O segundo manuscrito intitulado **"Effects of timing of food intake on eating patterns, diet quality and weight gain during pregnancy"**, teve como objetivo verificar o efeito dos horários da primeira e última refeição sobre os padrões alimentares, qualidade da dieta e ganho de peso durante a gestação. Esse manuscrito foi submetido à revista *British Journal of Nutrition* (*Impact Factor* =3.657) em 20 de fevereiro de 2019.

O terceiro manuscrito **"A higher energy intake at night-time impacts daily energy distribution and contributes to excessive weight gain during pregnancy"** teve como objetivo associar a ingestão de energia à noite com o ganho de peso e a distribuição circadiana de energia durante a gestação e pretende-se submetê-lo à revista *Nutrition* (*Impact Factor* =3.734).

2 FUNDAMENTAÇÃO TEÓRICA

2.1 Recomendações nutricionais e consumo alimentar na gestação

A alimentação adequada em qualidade e quantidade tem sido reconhecida como importante fator de proteção modificável para uma gestação saudável. Durante esse período as necessidades nutricionais e energéticas aumentam para suprir a maior demanda de energia e nutrientes que favorecem o crescimento e desenvolvimento fetal e as mudanças fisiológicas e metabólicas maternas (PICCIANO, 2003).

O *Institute of Medicine* (IOM) recomenda que a “faixa aceitável de distribuição de macronutrientes” (*Acceptable Macronutrient Distribution Range* - AMDR) - da dieta materna (> 19 anos) deva variar entre 10-35% do valor energético total (VET) para proteína, 20-35% para lipídios e 45-65% para carboidratos, sendo estes valores iguais aos das mulheres não gestantes (>19 anos) (IOM, 2006). Com relação às calorias totais, a necessidade energética está aumentada nos 2º e 3º trimestres, devendo a ingestão não ser inferior a 1.800kcal (IOM, 2009). Para gestantes eutróficas e saudáveis a recomendação é adicionar 180 kcal aos cálculos da “necessidade energética estimada” (*Estimated Energy Requirements* - EER) pré-gestacional, além de 8 kcal por semana gestacional nos 2º e 3º trimestres (IOM, 2006). As recomendações de ingestão para vários nutrientes também estão aumentadas durante a gestação, destacando-se o ferro e o ácido fólico (IOM, 2006) (Tabela 1).

Tabela 1. Valores da Ingestão Dietética de Referência (*Dietary Reference Intakes* - DRIs): Ingestão Dietética Recomendada (*Recommended Dietary Allowance* - RDA) e Ingestão Adequada (*Adequate Intake* - AI) para gestantes e mulheres não gestantes.

RDA ou AI*	Mulheres não gestantes		Gestantes		Alteração dos valores de RDA ou AI na gestação**
	19 a 30 anos	31 a 50 anos	19 a 30 anos	31 a 50 anos	
Carboidratos (g/dia)	130	130	175	175	↑↑↑
Fibras Totais	25*	25*	28*	28*	↑
Ômega 6 (g/dia)	12*	12*	13*	13*	↑
Ômega 3 (g/dia)	1,1*	1,1*	1,4*	1,4*	↑↑↑
Proteína (g/kg/dia)[a]	0,8	0,8	1,1	1,1	↑↑↑↑
Vitamina A (μg/dia)	700	700	770	770	↑
Vitamina C (mg/dia)	75	75	85	85	↑
Vitamina D (μg/dia)	15	15	15	15	=
Vitamina E (mg/dia)	15	15	15	15	=
Vitamina K (μg/dia)	90*	90*	90*	90*	=
Tiamina (mg/dia)	1,1	1,1	1,4	1,4	↑↑↑
Riboflavina (mg/dia)	1,1	1,1	1,4	1,4	↑↑↑
Niacina (mg/dia)	14	14	18	18	↑↑↑
Vitamina B6 (mg/dia)	1,3	1,3	1,9	1,9	↑↑↑↑↑
Folato (μg/dia)	400	400	600	600	↑↑↑↑↑
Vit.B12 (μg/dia)	2,4	2,4	2,6	2,6	↑
Ác.Pantotênico (mg/dia)	5*	5*	6*	6*	↑↑
Biotina (μg/dia)	30*	30*	30*	30*	=
Colina (mg/dia)	425*	425*	450*	450*	↑
Cálcio (mg/dia)	1000	1000	1000	1000	=
Cromo (μg/dia)	25*	25*	30*	30*	↑↑
Cobre (μg/dia)	900	900	1000	1000	↑
Flúor (mg/dia)	3*	3*	3*	3*	=
Iodo (μg/dia)	150	150	220	220	↑↑↑↑↑
Ferro (mg/dia)	18	18	27	27	↑↑↑↑↑
Magnésio (mg/dia)	310	320	350	360	↑
Manganês (mg/dia)	1,8*	1,8*	2,0*	2,0*	↑
Molibdênio (μg/dia)	45	45	50	50	↑
Fósforo (mg/dia)	700	700	700	700	=
Selênio (μg/dia)	55	55	60	60	↑
Zinco (mg/dia)	8	8	11	11	↑↑↑↑
Potássio (mg/dia)	4700*	4700*	4700*	4700*	=
Sódio (mg/dia)	1500*	1500*	1500*	1500*	=
Cloro (mg/dia)	2300*	2300*	2300*	2300*	=
Água Total (L/dia)[b]	2,7*	2,7*	3,0*	3,0*	↑

[a]Gestante utilizar peso pré-gestacional. [b]Água Total: inclui água presente nos alimentos, bebidas e água. *Valores de Adequate Intake – AI. **Refere-se ao aumento dos valores de RDA ou AI para gestantes quando comparada com as recomendações para mulheres não gestantes na mesma faixa etária, ↑: aumento em torno de 10%; ↑↑: aumento em torno de 20%; ↑↑↑: aumento em torno de 30%; ↑↑↑↑: aumento em torno de 40%; ↑↑↑↑↑: aumento em torno de 50%; =: não altera o valor. Fonte: adaptado de IOM, 2006.

Estudos com gestantes brasileiras mostraram que as mulheres podem apresentar dificuldades em atingir as recomendações nutricionais durante este ciclo da vida. Castro; Kac; Sichieri (2006) analisaram o consumo de macronutrientes da dieta de 276 gestantes e verificaram que o percentual de macronutrientes encontrava-se de acordo com faixa aceitável de distribuição de macronutrientes recomendada pelo *Institute of Medicine* (IOM), correspondendo a 11,9%, 65% e 23% para proteína, carboidratos e lipídios, respectivamente. Porém, outro estudo, ao se considerar ingestão excessiva como os valores de consumo energético superior a 20% do recomendado pelo IOM e o percentual de proteínas e lipídios superior, respectivamente, a 15% e 30% do total de energia, encontrou que 88,4% das gestantes avaliadas apresentaram ingestão inadequada no primeiro trimestre gestacional (CASTRO; CASTRO; KAC, 2013).

Por outro lado, dos Santos et al. (2014), em um estudo com 322 gestantes brasileiras, encontraram inadequação da ingestão de ferro em 97% das mulheres avaliadas, cálcio em 82%, folato em 78%, vitamina A em 71%, vitamina B6 em 59%, vitamina C em 40%, zinco em 35% e vitamina B12 em 6% e ingestão excessiva de sódio em 79% das gestantes. Com relação ao estado nutricional e ingestão de nutrientes, Fazio et al. (2011) encontraram que as gestantes com baixo peso apresentaram menor consumo de lipídeos quando comparadas as com eutrofia, o consumo de ferro foi maior nas eutróficas quando comparadas às com excesso de peso e a ingestão de folato foi maior nas eutróficas quando comparadas às com obesidade. Apesar das médias de ingestão de todas as gestantes não atingirem a recomendação para estes micronutrientes.

Na gestação, fatores socioeconômicos e demográficos como renda, escolaridade, cor da pele, estado marital e paridade podem influenciar os padrões alimentares, e com isso, o alcance das recomendações nutricionais (CASTRO et al., 2014). A ingestão alimentar também pode sofrer mudanças devido à intercorrências neste período, como por exemplo, náuseas e vômitos, que são sintomas comuns no primeiro trimestre (LATVA-PUKKILA et al., 2010). Latva-Pukkila et al. (2010) compararam gestantes com (n=134) e sem (n=53) sintomas de náuseas e vômitos. No primeiro trimestre as mulheres com sintomas de náuseas e vômitos apresentaram menor consumo de proteína e maior de carboidratos, e durante toda a gestação, menor ingestão de vitamina B12, magnésio e de zinco, quando comparadas as gestantes sem o sintoma.

Outros fatores também podem influenciar o consumo alimentar na gestação, como o hábito de não realizar o café da manhã. Estudo recente avaliou 97 gestantes saudáveis no segundo trimestre, e encontrou que 38,1% não realizavam o café da manhã duas ou mais vezes por semana, sendo que estas gestantes consumiram menos proteína, menos alimentos dos grupos das carnes e de leite e derivados, e apresentaram menores níveis de ácido eicosapentaenóico e docosahexaenóico plasmáticos, β-caroteno sérico, além de nitrogênio e potássio urinário, quando comparadas as gestantes que realizavam o café da manhã (SHIRAISHI; HARUNA; MATSUZAKI, 2019).

A inadequação alimentar durante a gestação pode ser fator de risco para diabetes *mellitus* gestacional (GAO et al., 2019; MIZGIER; JARZABEK-BIELECKA; MRUCZYK, 2019), pré-eclâmpsia (ACHAMRAH; DITISHEIM, 2018; OLIVEIRA et al., 2016), limitação do crescimento intrauterino (CASTILLO-DURÁN; WEISSTAUB, 2003), baixo peso ao nascer (CLARK et al., 2018; SINGH et al., 2018), bebês pequenos para a idade gestacional (MURPHY et al., 2014), parto prematuro (BLOOMFIELD, 2011). A inadequação alimentar materna também pode ser considerada fator de risco para o desenvolvimento futuro de obesidade infantil (CHEN et al., 2017; ZHU et al., 2017), principalmente em se tratando de alimentação com excesso de carboidratos, especialmente açúcar (CHEN et al., 2017) e grãos refinados (ZHU et al., 2017). Além disso, o consumo energético durante a gestação pode estar associado ao ganho de peso gestacional (TIELEMANS et al., 2016), e o maior consumo de alimentos processados e de gordura saturada durante a gestação parece influenciar a retenção de peso pós-parto (MARTINS; BENICIO, 2011).

Os sabores dos alimentos consumidos pelas gestantes são encontrados no líquido amniótico que é ingerido pelo feto. Desta forma, o ambiente intrauterino pode ter influência futura sobre a melhor aceitação na introdução de alimentos sólidos (MENNELLA; JAGNOW; BEAUCHAMP, 2001), bem como, sobre a preferência de sabor e alimentação saudável na infância, e até mesmo na vida adulta (TROUT; WETZEL-EFFINGER, 2012). Com isso, destaca-se a importância da alimentação saudável e orientação nutricional durante a gestação. Cabe ainda ressaltar que a permanência de hábitos alimentares saudáveis da mãe no futuro também poderá influenciar o comportamento alimentar da criança através do meio ambiente, com a disponibilização de alimentos saudáveis e atuação materna como modelo de comportamento alimentar (SAVAGE; FISHER; BIRCH, 2007).

2.2 Qualidade da dieta na gestação

A avaliação de um único nutriente pode não permitir a análise da interação dos vários nutrientes da alimentação e seus efeitos em conjunto na saúde do indivíduo. Com isso, o estudo da qualidade global da dieta tem sido recomendado como método alternativo para avaliar os resultados da relação dieta e saúde, com o intuito de avaliar a combinação do consumo de vários alimentos (HU, 2002). Os pesquisadores que realizam estudos com gestantes estão cada vez mais interessados em avaliar a qualidade global da dieta materna, em detrimento de somente avaliar as deficiências e excessos nutricionais (MARTIN et al., 2016).

O conhecimento das modificações da qualidade da dieta durante a gestação é importante para que desde o início desse ciclo da vida sejam realizadas intervenções nutricionais adequadas. Nesse sentido, estudos mostraram que a qualidade da dieta pode reduzir durante a gestação (MORAN et al., 2013; SAVARD et al., 2019; TSIGGA et al., 2011). Moran et al. (2013) avaliaram a qualidade da dieta de 301 gestantes na Austrália, com sobrepeso e obesidade, no início do estudo (10ª a 20ª semanas de gestação), nas 28ª e 36ª semanas de gestação e no 4º mês após o parto, e encontraram que a qualidade da dieta diminuiu ao longo da gestação para os componentes leite, carne, gordura saturada, e manteve neste nível reduzido no período pós-parto. Por outro lado, Savard et al. (2019), em um estudo com 79 gestantes canadenses, encontraram redução da qualidade da dieta para os componentes frutas e vegetais, gorduras insaturadas e saturadas ao longo da gestação.

Até o momento não foi encontrado nenhum estudo longitudinal que avaliou a modificação da qualidade da dieta de mulheres brasileiras durante a gestação e seus fatores associados. Porém, um estudo brasileiro, comparando gestantes e mulheres em idade fértil, demonstrou que as gestantes apresentaram menor consumo de refrigerantes. Estas mesmas mulheres consumiram maior quantidade de carnes com excesso de gordura e leite integral quando comparadas com as mulheres não gestantes. Não houve diferenças entre o consumo de frutas e vegetais, sendo que 48,8%, 41,8% e 55,1% das gestantes não consumiram frutas, salada crua, verduras e legumes diariamente, respectivamente (GOMES et al., 2015). Vale ressaltar que o padrão alimentar com maior consumo de frutas e vegetais parece favorecer os desfechos gestacionais (CHEN et al., 2016) e as medidas antropométricas do recém-nascido (LOY et al., 2011).

Na gestação alguns fatores sociodemográficos, nutricionais e clínicos maternos podem estar relacionados com a qualidade global da dieta. Estudos demonstraram que mulheres com menor qualidade da dieta durante a gestação eram mais jovens (BODNAR; SIEGA-RIZ; 2002; EMOND et al., 2018; RIFAS-SHIMAN *et al.*, 2009; RODRÍGUEZ-BERNAL et al., 2010), apresentaram menor escolaridade (BODNAR; SIEGA-RIZ; 2002; EMOND et al., 2018; RIFAS-SHIMAN *et al.*, 2009; RODRÍGUEZ-BERNAL et al., 2010), maior número de filhos (BODNAR; SIEGA-RIZ; 2002; NASH et al., 2013; RIFAS-SHIMAN *et al.*, 2009; RODRÍGUEZ-BERNAL et al., 2010), maiores índices de massa corporal pré-gestacional (EMOND et al., 2018; RIFAS-SHIMAN *et al.*, 2009; RODRÍGUEZ-BERNAL et al., 2010; TSIGGA et al., 2011) e gestacional (TSIGGA et al., 2011), praticavam menos atividade física (NASH et al., 2013; EMOND et al., 2018), eram tabagistas (EMOND et al., 2018; NASH et al., 2013), apresentavam ansiedade e falta de apoio familiar (NASH et al., 2013).

No que se refere às gestantes brasileiras, Crivellenti; Zuccolotto; Sartorelli, (2018) demonstraram, em um estudo com 785 mulheres, que as gestantes com pior qualidade da dieta eram obesas (de acordo com a semana gestacional), apresentavam menor média de idade, praticavam menos atividade física e não faziam uso de suplementos dietéticos (CRIVELLENTI; ZUCCOLOTTO; SARTORELLI, 2018). Estas características maternas devem ser consideradas no atendimento pré-natal, como forma de realizar atendimento nutricional mais efetivo no alcance de uma melhor qualidade da dieta.

Apesar da pior qualidade da dieta possivelmente não influenciar diretamente o ganho de peso durante a gestação (GRANDY et al., 2018; SHIN et al., 2014), esta parece estar associada com desfechos gestacionais desfavoráveis, como o desenvolvimento de diabetes e hipertensão gestacional (GRESHAM et al., 2016; SCHOENAKER et al., 2016). Schoenaker et al. (2016) realizaram uma revisão sistemática com o objetivo de avaliar padrões alimentares relacionados ao diabetes gestacional, e relataram que o padrão alimentar materno com maior consumo de frutas, vegetais, cereais integrais e peixes, e com menor consumo de carne vermelha e/ou processada, grãos refinados e produtos lácteos com alto teor de gordura, foi associado ao menor risco de diabetes gestacional. Gresham et al. (2016) relataram em um estudo longitudinal que as mulheres com melhor qualidade da dieta apresentaram menor chance de desenvolver hipertensão gestacional, e que as mulheres com diagnóstico de hipertensão gestacional, comparadas com àquelas sem, apresentaram pior qualidade da dieta para os componentes vegetais, frutas, cereais e nozes/feijão/soja.

Evidências já demonstraram que a melhor qualidade da dieta durante a gestação parece diminuir a adiposidade neonatal (SHAPIRO et al., 2016), o risco de restrição do crescimento fetal e aumentar o comprimento neonatal (RODRÍGUEZ-BERNAL et al., 2010). Adicionalmente, a melhora da qualidade da dieta durante a gestação parece reduzir o risco do nascimento de bebês pequenos para a idade gestacional (EMOND et al., 2018).

2.2.1 Índices dietéticos na gestação

Os índices dietéticos têm sido utilizados em estudos com gestantes para determinar a qualidade global da dieta e verificar a associação dessa qualidade com a saúde materno-fetal (MARTIN et al., 2016). Esses índices geralmente são utilizados para determinar a qualidade da dieta através dos princípios da proporcionalidade, variedade e moderação (WIRT; COLLINS, 2009), por meio de um ou mais parâmetros, como: adequação da ingestão de nutrientes ou grupos alimentares (os níveis crescentes de ingestão recebem pontuações mais elevadas), moderação da ingestão de nutrientes ou grupos alimentares (os níveis crescentes de ingestão recebem pontuações mais baixas) (GUENTHER et al., 2014) e variedade de gêneros alimentícios presentes na dieta (KENNEDY et al., 1995). Os índices dietéticos mais utilizados em estudos com população gestante são *Healthy Eating Index* (HEI), *Alternative Healthy Eating Index for Pregnancy* (AHEI-P) e *Diet Quality Index for pregnancy* (DQI-P) (MARTIN et al., 2016; SHIN et al., 2014).

No Brasil ainda não foi desenvolvido um índice específico para avaliar a qualidade global da dieta da população no país, e poucos estudos avaliaram a qualidade da dieta de gestantes. Estes estudos com gestantes utilizaram adaptações do *Healthy Eating Index* 1995 (HEI-1995) (GOMES; FERREIRA; GOMES, 2015)*, Alternate Healthy Eating Index for Pregnancy (AHEI-P)* (MELERE et al., 2013) e um estudo propôs novo índice, Índice de Qualidade da Dieta Adaptado para Gestantes, com base no *Healthy Eating Index* 2005 (HEI-2005), AHEI-P e orientações do Ministério da Saúde (CRIVELLENTI; ZUCCOLOTTO; SARTORELLI, 2018).

Ressalta-se que estes estudos brasileiros demonstraram que a qualidade da dieta das gestantes avaliadas merece atenção especial na assistência pré-natal. De acordo com a pontuação máxima de 100 pontos dos índices, Crivellenti; Zuccolotto; Sartorelli (2018) encontraram em gestantes, entre a 24ª e 39ª semanas de gestação, pontuação média ± desvio-padrão de 70,2 ± 11,9, variando entre 31,9 a 98,6 pontos. Por outro lado, Melere et al. (2013) demonstraram valores mais baixos do índice, sendo que as gestantes, entre a 16ª e 36ª semana de gestação, avaliadas tiveram mediana e o intervalo interquartílico de 67,4 [60,0-73,4], respectivamente. Em adição, Gomes; Ferreira; Gomes (2015) observaram, em estudo piloto de delineamento transversal com 25 gestantes a partir da 4ª até a última semana de gestação, que 60% das mulheres possuíam dieta que necessita de modificações (51 e 80 pontos) e 40% dieta inadequada (< 51 pontos).

De acordo com a escolha do melhor índice para avaliar a qualidade da dieta de gestantes, segundo Shin et al. (2014) o HEI-2005 é considerado um índice mais adequado para avaliar a qualidade global de gestantes, quando comparado aos HEI-1995 e AHEI-P, pois representa todos os principais grupos alimentares encontrados nas recomendações do sistema de orientação alimentar norte americano – *MyPyramid* -, além de avaliar os componentes “frutas inteiras”, “vegetais verdes escuro, alaranjados e leguminosas”, “cereais integrais”, “óleos”, “gordura saturada”, e “calorias provenientes de gordura sólida, álcool e açúcar de adição”. Além disso, HEI-2005 também avalia a dieta controlando pela densidade energética (SHIN et al., 2014). Apesar destas considerações, a utilização do *Heathy Eating Index* para gestantes deve ser utilizada com cautela, pois, o índice não diagnostica a necessidade de suplementação de vitaminas e minerais durante a gestação (PICK et al., 2005).

2.2.1.1 Índice de Qualidade da Dieta (IQD) - *Health Eating Index* (HEI)

O HEI aborda as recomendações alimentares propostas pelo governo norte americano, *The Dietary Guidelines for Americans*, que são revisadas a cada cinco anos (GUENTHER; REEDY; KREBS-SMITH, 2008). O HEI original (HEI-1995) foi criado pela *Center for Nutrition Policy and Promotion* em 1995 (USDA, 1995). Em 2005 foram propostas novas recomendações alimentares norte americanas, resultando no *Heathy Eating Index 2005* (HEI-2005) (GUENTHER et al., 2007). Em 2010 foi lançada atualização *The Dietary Guidelines for Americans* 2010, refletindo na versão atual do índice, *Heathy Eating Index 2010* (HEI-2010) (GUENTHER et al., 2013).

O HEI-1995 inicialmente foi caracterizado por um sistema de dez componentes. Os cinco primeiros componentes avaliam a adequação da dieta utilizando os principais grupos de alimentos (Grãos; Leite e derivados; Carne, ovos e leguminosas; Frutas; Vegetais). Os quatro seguintes avaliam nutrientes da dieta que devem ser consumidos com moderação (gordura total, gordura saturada, colesterol e sódio). E o décimo representa a medida da variedade do consumo alimentar (KENNEDY et al., 1995; USDA, 1995).

O HEI 2005 incluiu as recomendações do sistema de orientação alimentar do USDA, "*MyPyramid*", sendo esse sistema caracterizado pelas principais recomendações do "*The Dietary Guidelines for Americans* 2005", que destacaram a importância na qualidade da dieta dos cereais integrais, variedade de vegetais, qualidade da gordura e moderação no consumo de calorias provenientes de gorduras sólidas, bebidas alcoólicas e açúcares de adição (GUENTHER et al., 2007).

O HEI-2005 apresenta 12 componentes, dos quais 9 avaliam adequação da dieta, incluindo: "Frutas Totais"; "Frutas Inteiras (exclui sucos)"; "Vegetais Totais"; "Vegetais Verdes Escuro, Alaranjados e Leguminosas"; "Cereais Totais"; "Cereais Integrais"; "Leite e derivados (inclui leite e derivados, e bebidas a base de soja)"; "Carne, ovos e leguminosas (as leguminosas primeiramente são contabilizadas neste componente, quando alcança o máximo de porções recomendadas, as leguminosas passam a pontuar nos "Vegetais Totais" e "Vegetais Verdes escuro, Alaranjados e Leguminosas)"; "Óleos (óleos vegetais não hidrogenados, óleo de peixe e oleaginosas)". Os três seguintes avaliam nutrientes da dieta que devem ser consumidos com moderação: "Gordura saturada"; "Sódio"; e "*Discretionary Calories* (calorias provenientes de gorduras sólidas, bebidas alcoólicas e açúcares de adição)" (GUENTHER et al., 2007).

O HEI-2010 apresenta 12 componentes, dos quais 9 avaliam adequação da dieta, incluindo: "Frutas totais"; "Frutas Inteiras (exclui sucos)"; "Vegetais totais"; "Vegetais Verdes e leguminosas (Inclui todos os feijões e ervilhas não contabilizados no componente "Alimentos total de proteínas")"; "Cereais integrais"; "Leite e derivados (inclui leite e derivados, e bebidas a base de soja fortificadas)"; "Alimentos total de proteínas" (os feijões e as ervilhas são incluídos neste componente e não em “Vegetais”, enquanto a pontuação total do “Alimentos total de proteínas” não é atingida); “Frutos do mar e proteínas vegetais” (Inclui frutos do mar, nozes, sementes, produtos de soja -exceto bebidas-, bem como feijões e ervilhas contabilizados no componente “Alimentos total de proteínas”); e “Ácidos graxos” (poli-insaturados + monossaturados)/saturados). Os três seguintes avaliam componentes dietéticos que devem ser consumidos com moderação: “Cereais refinados”; “Sódio”; e “Calorias vazias” (calorias provenientes de gorduras sólidas, bebidas alcoólicas e açúcares de adição) (GUENTHER et al., 2013).

De acordo com o HEI-2005 e HEI-2010, o consumo de alimentos e nutrientes é avaliado pela densidade energética, isto é, proporcional ao consumo de energia por 1000 kcal (GUENTHER et al., 2007; GUENTHER et al., 2013). Portanto, avalia a combinação dos alimentos consumidos e reduz de certa forma os efeitos da variabilidade do dia-a-dia da quantidade de alimentos ingeridos, o que melhora a precisão da avaliação da qualidade global da dieta.

No ano de 2004 iniciaram as publicações dos estudos brasileiros utilizando adaptações do HEI-1995 para a avaliação da qualidade global da dieta da população (FISBERG et al., 2004). Em 2011 foi publicado o primeiro estudo utilizando adaptações do HEI-2005 (PREVIDELLI et al., 2011).

Fisberg et al. (2004) adaptaram e validaram o *Healthy Eating Index* 1995 (HEI-1995) (KENNEDY et al., 1995), gerando o Índice de Qualidade da Dieta (IQD), com adaptações seguindo recomendações da Pirâmide Alimentar Adaptada para a população brasileira (PHILIPPI et al., 1999). O IQD é obtido por uma pontuação entre os dez componentes (Tabela 2). Os seis primeiros avaliam a adequação da dieta utilizando os seguintes grupos alimentares: “Cereais”; “Frutas”; “Verduras e Legumes”; “Leite e derivados”; “Carne e ovos”; “Leguminosas”. Os três seguintes avaliam nutrientes da dieta que devem ser consumidos com moderação: “Gordura total”; “Colesterol” e “Sódio”. O décimo representa a medida da “Variedade do consumo alimentar” (FISBERG et al., 2004; FISBERG et al., 2006). Em comparação com o *Healthy Eating Index* 1995 (HEI-1995), no IQD houve adição do grupo das leguminosas aos componentes do índice, com a justificativa do hábito alimentar brasileiro de consumir feijão diariamente, uma vez que, sua inserção no mesmo grupo das carnes e ovos poderia superestimar o consumo desse grupo (FISBERG et al., 2006). Para fazer este acréscimo e continuar pontuando dez elementos, os autores optaram pela exclusão da gordura saturada.

Tabela 2. Componentes e pontuações do Índice de Qualidade da Dieta (IQD).

Componente	Intervalo de Pontuação	Critério para a Pontuação Máxima (10)	Critério para Pontuação Mínima (0)
Cereais Totais[a]	0 a 10	5 a 9 porções	0 porções
Frutas	0 a 10	3 a 5 porções	0 porções
Verduras e Legumes	0 a 10	4 a 5 porções	0 porções
Leite e derivados	0 a 10	3 porções	0 porções
Carne e Ovos	0 a 10	1 a 2 porções	0 porções
Leguminosas	0 a 10	1 porção	0 porções
Gordura Totais	0 a 10	≤ 30% do VET	≥ 45 do VET
Colesterol	0 a 10	≤ 0,3 g	≥0,45 g
Sódio	0 a 10	≤ 2,4 g	≥4,8 g
Variedade	0 a 10	≥ 8,0 tipos de alimentos	≤ 3,0 tipos de alimentos

[a]Cereais Totais: representa o grupo dos Cereais, raízes e tubérculos. VET: valor energético total. *Critério para a pontuação proposto por Fisberg et al. (2004; 2006).

Previdelli et al. (2011) desenvolveram o Índice de Qualidade da Dieta Revisado (IQD-R) para a população brasileira (Tabela 3), baseando-se no *Healthy Eating Index* 2005 (HEI-2005) (GUENTHER et al., 2007), com adaptações seguindo o Guia Alimentar para a População Brasileira, vigente na época do estudo (BRASIL, 2006), e Sociedade Brasileira de Cardiologia (SBC, 2007). O IQD-R determina o número de porções recomendados para 1000 kcal, procurando manter a relação com o preconizado no Guia Alimentar para a população Brasileira (BRASIL, 2006). Com isso, o IQD-R não mensura o consumo energético, e sim, a densidade energética, avaliando a qualidade da alimentação isoladamente da quantidade consumida (PREVIDELLI et al., 2011).

O IQD-R apresenta 12 componentes (Tabela 3). Os nove primeiros seguem as recomendações do Guia Alimentar para a População Brasileira (BRASIL, 2006). Sendo que, alguns componentes como “Frutas Inteiras”, “Vegetais Verdes escuro, Alaranjados e Leguminosas” e “Cereais Integrais” não possuem recomendações específicas no Guia, com isso, esses tiveram seus números de porções computados proporcionalmente aos componentes “Frutas Totais”, “Vegetais Totais” e “Cereais, Raízes e Tubérculos”, respectivamente (PREVIDELLI et al., 2011).

Os demais componentes são sódio, gordura saturada e Gord-AA (valor energético proveniente da ingestão de gordura sólida, saturada e trans, álcool e açúcar de adição). A pontuação máxima de sódio foi baseada na *Adequate Intake* (IOM, 2004) para jovens e adultos que é de 1,5 g e consumo energético de 2.000

kcal, de acordo com o Guia Alimentar para a População Brasileira (BRASIL, 2006) (0,75 g/1.000 kcal). A pontuação intermediária foi calculada a partir do valor máximo estimado pelo Guia Alimentar (BRASIL, 2006) que é de 2,0 g/2.000 kcal, ou seja, 1,0 g/1.000 kcal. Já a pontuação mínima, sendo o dobro do recomendado pelo Guia Alimentar para a População Brasileira (BRASIL, 2006) (percentil 82) (2,0 g/1.000 kcal) (PREVIDELLI et al., 2011). A pontuação máxima de gordura saturada, 7% do Valor Enérgico Total (VET), foi definida de acordo com as diretrizes sobre dislipidemias e prevenção da aterosclerose da Sociedade Brasileira de Cardiologia (SBC, 2007), e a pontuação mínima, 15% do VET, foi determinada pelo percentil 85 da curva de distribuição de seu consumo pela população do estudo (PREVIDELLI et al., 2011). Para o último componente Gord-AA (valor energético proveniente da ingestão de gordura sólida, saturada e trans, álcool e açúcar de adição) não existe recomendação brasileira. Com isso, foi utilizado para a pontuação mínima e máxima o consumo de 35% e 10% do VET, respectivamente. Sendo esses pontos baseados nos percentis 16 e 85 da curva de distribuição da ingestão de Gord-AA da população do estudo (PREVIDELLI et al., 2011).

Andrade et al. (2013) avaliaram a confiabilidade e a validade do IQD-R, de acordo com as propriedades psicométricas. O IQD-R mostrou-se confiável e estruturalmente válido, quando utilizado para avaliar e monitorar a qualidade da dieta de brasileiros.

Tabela 3. Componentes e pontuações do Índice de Qualidade da Dieta Revisado para população brasileira (IQD-R).

Componente	**Intervalo de Pontuação**	**Critério para a Pontuação Máxima (5, 10 ou 20)***	**Critério para Pontuação Intermediária (8)***	**Critério para Pontuação Mínima (0)***
Cereais Totais[a]	0 a 5	2,0 porções / 1000 kcal	NA	0 porções
Cereais Integrais	0 a 5	1,0 porção / 1000 kcal	NA	0 porções
Frutas Totais[b]	0 a 5	1,0 porção / 1000 kcal	NA	0 porções
Frutas Inteiras[c]	0 a 5	0,5 porção / 1000 kcal	NA	0 porções
Vegetais Totais	0 a 5	1,0 porção / 1000 kcal	NA	0 porções
Vegetais Verdes-escuros, Alaranjados e Leguminosas[d]	0 a 5	0,5 porção / 1000 kcal	NA	0 porções
Leite e derivados	0 a 5	1,5 porções / 1000 kcal	NA	0 porções
Carne, Ovos e Leguminosas	0 a 10	1,0 porção / 1000 kcal	NA	0 porções
Óleo[f]	0 a 10	0,5 porção / 1000 kcal	NA	0 porções
Gordura Saturada	0 a 10	≤7% do VET	10% da energia	≥15% do VET
Sódio	0 a 10	≤0,7g/1000 kcal	1,0g/1000 kcal	≥2,0g/1000 kcal
Gord-AA	0 a 20	≤10% do VET	NA	≥35% do VET

[a]Cereais Totais: representa o grupo dos Cereais, raízes e tubérculos; [b]Inclui frutas e sucos de frutas naturais; [c]Exclui frutas de sucos; [d]Inclui leguminosas apenas depois que a pontuação máxima de Carnes, ovos e leguminosas for atingida; [e]Inclui leite e derivados e bebidas à base de soja; [f]Inclui as gorduras mono e poli-insaturadas, óleos das oleaginosas e gordura de peixe. Gord-AA: Calorias provenientes de gordura sólida, álcool e açúcar de adição; VET: valor energético total; NA: para estes itens não se aplica a pontuação intermediária. *Critério para a pontuação proposto por Previdelli et al. (2011).

As adaptações dos HEI-1995 e HEI-2005 para a população brasileira foram realizadas com finalidade de tornar esses índices aplicáveis a realidade dessa população, com o desenvolvimento de adaptações de acordo com as recomendações alimentares específicas para a população brasileira. Até o momento nenhum estudo brasileiro fez adaptação do HEI-2010.

2.3 Ganho de Peso na Gestação

O ganho de peso gestacional (GPG) é um fenômeno biológico único e complexo que se constitui pelos produtos da concepção (placenta, feto, líquido amniótico) e pelas alterações fisiológicas maternas que inclui deposição de proteína, gordura e água no útero, glândula mamária, sangue e tecido adiposo (IOM, 1990). O Ministério da Saúde brasileiro (BRASIL, 2012) recomenda a utilização da proposta do *Institute of Medicine* (IOM, 2009) para a recomendação do ganho de peso total e por trimestre gestacional, de acordo com a classificação do índice de massa corporal (IMC) pré-gestacional. (Tabela 4).

Tabela 4. Recomendações para Ganho de Peso Total durante a gestação e por semana gestacional, de acordo com o IMC pré-gestacional.

IMC pré-gestacional (Kg/m^2)	Ganho de Peso Total (Kg)	Taxas de ganho de peso* 2º e 3º trimestres
	Intervalo em kg	**Média (intervalo) em kg/semana**
< 18,5 (Baixo peso)	12,5 – 18,0	0,51 (0,44 – 0,58)
18,5 – 24,9 (Eutrofia)	11,5 – 16,0	0,42 (0,35 – 0,50)
25,0 – 29,9 (Sobrepeso)	7,0 – 11,5	0,28 (0,23 – 0,33)
≥ 30 (Obesidade)	5,0 – 9,0	0,22 (0,17 – 0,27)

*Os cálculos assumem ganho de peso de 0,5-2 kg no primeiro trimestre (IOM, 2009).

Destaca-se que recentemente foram publicadas recomendações de ganho de peso gestacional a partir de dados do Consórcio Internacional de Crescimento Fetal e Neonatal para o século 21 (INTERGROWTH-21st), o qual avaliou gestantes em uma coorte de base populacional multiétnica e multicêntrica, com participação do Brasil (Pelotas), China, Estados Unidos, Índia, Itália, Omã, Quênia e Reino Unido. Estas novas recomendações são compostas de tabela com a recomendação de ganho de peso de acordo com a semana gestacional, distribuída em percentil, além de uma curva para monitoramento do ganho de peso gestacional de acordo com a semana gestacional, distribuída também em percentil. Porém, estas recomendações foram realizadas somente para gestantes com IMC pré-gestacional eutrófico (ISMAIL et al., 2016), impossibilitando a utilização para gestantes com baixo ou excesso de peso pré-gestacional.

O ganho de peso é considerado um fator de risco modificável para desfechos perinatais adversos. O GPG excessivo pode predispor a mulher a complicações clínicas durante a gestação, como o diabetes gestacional (HUNG et al., 2015), intolerância a glicose (HERRING et al. 2009), hipertensão gestacional (FORTNER et al. 2009), pré-eclâmpsia (XIA et al. 2016), depressão (BODNAR et al. 2009) e parto cesáreo (CHU et al. 2007). Enquanto que para o filho o GPG excessivo materno pode aumentar os riscos de macrossomia fetal (HUNG et al., 2015; SCHACK-NIELSEN et al., 2010), hiperbilirrubinemia e hipoglicemia neonatal (HEDDERSON et al., 2006) e obesidade infantil em longo prazo (SCHACK-NIELSEN et al., 2010). Além disso, o baixo GPG tem sido associado a aumento dos riscos de restrição do crescimento fetal, nascimento prematuro, e dificuldade materna para iniciar a amamentação (IOM, 2009).

O excesso de ganho de peso durante a gestação pode estar associado à inadequação do consumo de energia durante a gestação (TIELEMANS et al., 2016). Além disso, as mulheres com excesso de peso pré-gestacional parecem estar mais propensas a ganhar peso excessivo (OLAFSDOTTIR et al., 2006), e o ganho de peso excessivo durante a gestação é considerado fator de risco para a retenção de peso no pós-parto (GILMORE et al., 2015; KAC et al., 2004). Vale ressaltar que a prevalência de obesidade em mulheres em idade reprodutiva atualmente é considerada questão de saúde pública mundial. No Brasil, dados de pesquisa realizada recentemente em capitais dos estados e no Distrito Federal demonstrou que 51,2% das mulheres com idade acima de 18 anos estavam com excesso de peso (Índice de massa corporal ≥ 25 kg/m^2) (BRASIL, 2018).

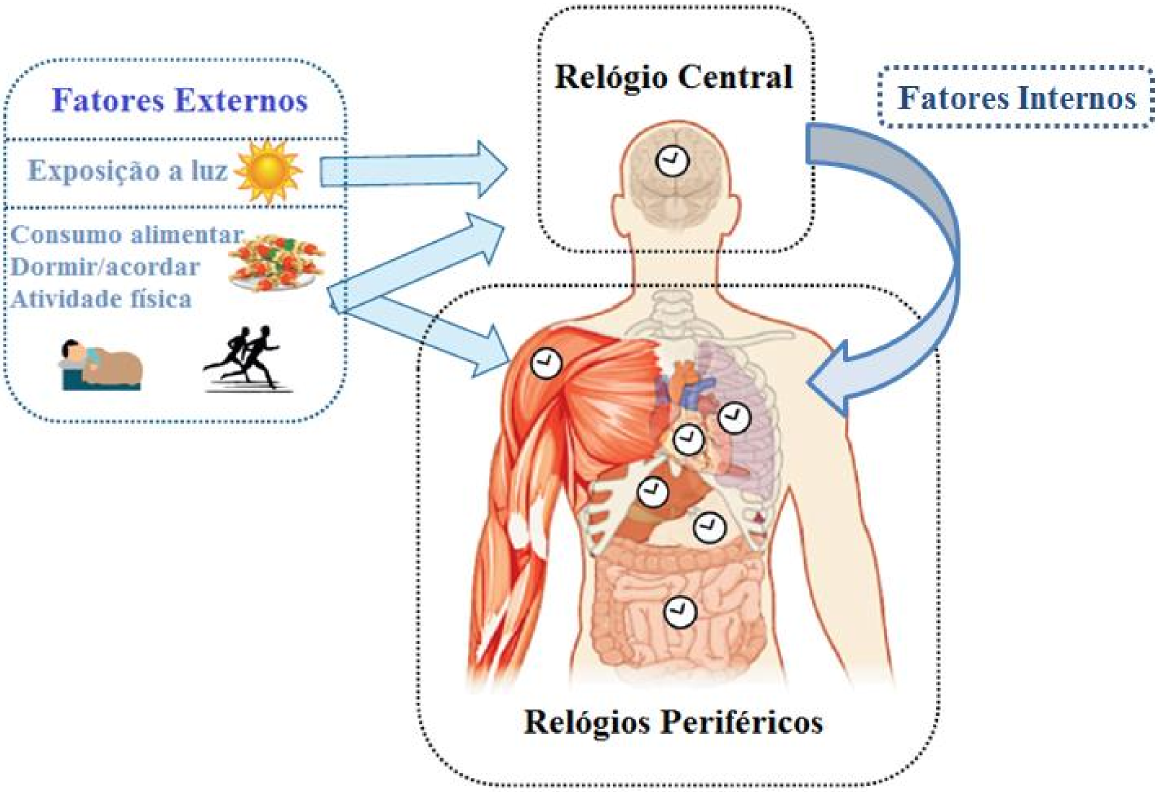
Estudo realizado com 2.244 gestantes brasileiras encontrou que o ganho de peso total foi insuficiente e excessivo em 33,4% e 32,9% das gestantes, respectivamente. Com relação ao ganho de peso nos trimestres, no segundo trimestre o ganho de peso insuficiente e excessivo foram apresentados em 28,1% e 43,4% das mulheres, respectivamente, e no terceiro trimestre 38,9% e 39,1% das gestantes apresentaram ganho de peso insuficiente e excessivo, respectivamente (DREHMER et al., 2013). Estes resultados demonstraram a necessidade de se avaliar os fatores que influenciam o ganho de peso inadequado em gestantes brasileiras, ressaltando a importância de estudos que façam esta avaliação de maneira longitudinal, já que o ganho de peso pode ser diferente de acordo com o trimestre gestacional.

2.4 Crononutrição

Os ritmos circadianos são processos endógenos cíclicos que ocorrem com periodicidade de aproximadamente 24 horas. O sistema circadiano do corpo, que organiza o metabolismo, a fisiologia e o comportamento em um ciclo diário de ritmos circadianos, é composto por um relógio central no núcleo supraquiasmático hipotalâmico, que é regulado principalmente pelos ciclos claro/escuro, a fim de sincronizar o corpo para o ciclo de luz ou dia solar, e também por diferentes relógios nos tecidos periféricos, localizados em outras partes do corpo, como pâncreas, fígado, trato gastrointestinal, músculo esquelético e tecido adiposo (POGGIOGALLE; JAMSHED; PETERSON, 2018).

Os relógios centrais e periféricos atuam juntos e podem ser influenciados pelo horário do consumo alimentar, horário de dormir e acordar e atividade física (POGGIOGALLE; JAMSHED; PETERSON, 2018) (Figura 1). Estudo recente mostrou que o horário tardio das refeições pode desempenhar papel importante na dessincronização dos ritmos circadianos periféricos em humanos, alterando aspectos do metabolismo (WEHRENS et al., 2017).

Figura 1. Fatores externos que influenciam a arquitetura do sistema circadiano.



Fonte: Adaptado e traduzido de Poggiogalle; Jamshed; Peterson (2018).

O termo "crononutrição" tem sido utilizado para denominar a nova área de pesquisa que tem como objetivo estudar a relação entre o consumo alimentar e o relógio circadiano (CRISPIM; MOTA, 2018). Evidências recentes sugerem que o momento de realização das refeições - "quando se come" - por si só pode influenciar o funcionamento do sistema circadiano (POT, 2018), mostrando que a distribuição de energia ao longo do dia (JAKUBOWICZ et al., 2013), os padrões alimentares relacionados aos horários das refeições (GARAULET et al., 2013), bem como o consumo alimentar à noite (BARON et al., 2011; BO et al., 2014; WANG et al., 2014; ALJURAIBAN et al., 2015; MAUKONEN et al., 2019) podem influenciar o metabolismo de nutrientes e a regulação do peso corporal.

2.4.1 Crononutrição e distribuição circadiana de energia

O consumo alimentar e, consequentemente, a ingestão de energia e macronutrientes, são distribuídos em refeições ao longo do dia. O consumo energético maior pela manhã pode resultar em diminuição do consumo total durante o dia, enquanto o consumo energético maior à noite pode resultar em aumento do consumo total, independentemente da subnotificação do consumo alimentar (de CASTRO, 2004). Do mesmo modo, a saciedade produzida pelas refeições pode diminuir ao longo do dia, assim, as refeições da manhã podem produzir maior saciedade, ao passo que as da noite menor saciedade (de CASTRO, 2004).

Berti et al. (2015) encontraram que o melhor controle da saciedade foi obtido a partir do consumo de salada de frutas nos lanches da manhã. Assim, o consumo regular do café da manhã e de frutas nos lanches da manhã podem ser estratégias importantes para a regulação do apetite. Jakubowicz et al. (2012) relataram que a realização de um café da manhã rico em carboidratos e proteínas pode influenciar a melhora da saciedade e redução da fome e desejo alimentar, o que pode auxiliar no controle do ganho de peso.

O consumo do café da manhã parece ser um hábito comum em gestantes brasileiras (GOMES et al., 2015), o que pode ser benéfico para a regulação da quantidade total de calorias consumidas ao longo do dia (de CASTRO, 2004). Porém, um estudo recente realizado com 97 gestantes no segundo trimestre demonstrou que não houve diferença no consumo calórico total entre as gestantes que realizaram ou não o café da manhã, apesar de que as gestantes que não realizavam o café da manhã consumiram menor percentual de proteína (SHIRAISHI; HARUNA; MATSUZAKI, 2019).

O horário de realização das refeições parece também influenciar a regulação do consumo energético total (BARON et al., 2013; REID; BARON; ZEE, 2014). Nesse sentido, estudos sugerem que carboidratos consumidos após as 20h, proteínas e carboidratos 4 horas antes do sono (BARON et al., 2013) e o horário mais tardio da última refeição (REID; BARON; ZEE, 2014) favorecem o maior consumo total de calorias diária. Assim, comer à noite ou antes de dormir e quanto mais tarde é o horário da última refeição, maior poderá ser a janela de oportunidade para consumir alimentos, principalmente escolha por alimentos mais calóricos (BARON et al., 2013; REID; BARON; ZEE, 2014).

Vale ressaltar que o horário da realização da última refeição parece estar relacionado ao horário da primeira e a duração da alimentação – intervalo entre a primeira e última refeição (GILL; PANDA, 2015). Gill; Panda (2015) encontraram que indivíduos adultos que realizaram café da manhã mais cedo também fizeram sua última refeição mais cedo, e que a duração da alimentação correlacionou-se melhor com o horário da última ingestão calórica, do que com o horário da primeira - café da manhã. Neste mesmo estudo os autores realizaram uma intervenção, na qual foi sugerido que os indivíduos com duração de alimentação de 14 horas reduzissem esta para 10 a 12 horas durante 16 semanas. A redução da duração da alimentação proporcionou redução da ingestão calórica total e também do índice de massa corporal dos participantes (GILL; PANDA, 2015), demonstrando que a alteração do horário da primeira e/ou da última refeição parece ser capaz de auxiliar na redução do consumo calórico total e do peso corporal. Destaca-se que fatores genéticos podem estar envolvidos na escolha dos horários das refeições. Nessa linha, o horário do café da manhã foi considerado a refeição mais influenciada por fatores genéticos, quando comparado com o horário do almoço e jantar, o que pode refletir na dificuldade individual em alterá-lo (LOPEZ-MINGUEZ et al., 2018).

Além da influência sobre o consumo energético total, o horário de realização das refeições parece influenciar a distribuição das calorias ao longo do dia (GARAULET et al., 2013). Garaulet et al (2013) realizaram um estudo de intervenção para perda de peso com 420 adultos durante 20 semanas, em que os indivíduos foram categorizados de acordo com o horário cedo ou tarde de realização do café da manhã, almoço e jantar, utilizando os valores da mediana da amostra como ponto de corte. Os indivíduos que realizaram o almoço mais tardiamente consumiram menos calorias no café da manhã, frequentemente não realizavam o café da manhã, além de apresentar maior tendência a vespertinidade e perderam menos peso durante o tratamento. Vale ressaltar que o horário do almoço foi correlacionado positivamente com o horário do jantar, e que o horário do jantar e café da manhã não apresentaram influencia na perda de peso.

A avaliação do horário de realização das refeições e de como o indivíduo distribui o consumo alimentar ao longo do dia é importante para a intervenção nutricional (WITTIG et al., 2017), pois o momento da ingestão de energia é um comportamento modificável que pode influenciar a regulação do consumo energético (de CASTRO, 2004; GILL; PANDA, 2015; REID; BARON; ZEE, 2014) e do peso corporal (GARAULET et al., 2013; JAKUBOWICZ et al., 2013). Apesar destas questões ainda serem pouco estudadas em gestantes, destaca-se que o aumento do consumo energético durante a gestação pode estar associado ao ganho de peso excessivo neste ciclo da vida (TIELEMANS et al., 2016), e que este ganho de peso excessivo representa risco para a saúde materno-fetal (IOM, 2009).

2.4.2 Crononutrição e qualidade da dieta

A distribuição das calorias ao longo do dia e a realização do café da manhã podem influenciar a qualidade global da dieta (PEREIRA et al., 2017; WITTIG et al., 2017). Estudos recentes mostraram que o maior consumo de calorias no período noturno está relacionado à pior qualidade da dieta (WITTIG et al., 2017), e que o consumo frequente do café da manhã influencia positivamente a qualidade da dieta (AZADBAKHT et al., 2013). Além disso, a realização do café da manhã de melhor qualidade pode favorecer o maior consumo total diário de frutas e vegetais e melhor ingestão diária de nutrientes (PEREIRA et al., 2017).

A frequência das refeições parece também ter impacto na qualidade da dieta (ALJURAIBAN et al., 2015; POSCIA et al., 2017). Aljuraiban et al. (2015) realizaram um estudo transversal com 2385 homens e mulheres dos Estados Unidos e Reino Unido, com idade entre 40 e 59 anos, e concluíram que os indivíduos com maior frequência de episódios alimentares e com maior consumo energético no início do dia com relação à noite apresentaram melhor qualidade da dieta, menor consumo energético total, menor consumo de carne vermelha e álcool e maior consumo de frutas e leite e derivados sem ou com baixo teor de gordura. Além disso, estes indivíduos apresentaram menor índice de massa corporal. Poscia et al. (2017), em um estudo com 12000 estudantes universitários, encontraram que a maior frequência de episódios alimentares influencia o maior consumo de frutas e vegetais, o que provavelmente reflete na melhor qualidade da dieta e saúde.

Com isso, espera-se que o maior consumo alimentar pela manhã, a realização do café da manhã, o menor consumo alimentar no período noturno e a maior frequência de episódios alimentares favoreçam a melhor qualidade da dieta (ALJURAIBAN et al., 2015; AZADBAKHT et al., 2013; PEREIRA et al., 2017; POSCIA et al., 2017; WITTIG et al., 2017). Sugere-se que estes fatores devam ser melhor investigados em gestantes, uma vez que o consumo regular das refeições principais (café da manhã, almoço e jantar) pode reduzir o risco de parto prematuro (ENGLUND-OÈ GGE et al., 2017), e que a qualidade da dieta materna pode evitar desfechos materno-fetais desfavoráveis (MARTIN et al., 2016).

2.4.3 Crononutrição e regulação do peso corporal

Estudos em animais têm sugerido uma relação entre o momento da ingestão alimentar durante o dia e a regulação do peso, independente da quantidade calórica consumida (ARBLE et al., 2009; HATORI et al., 2012). Arble et al. (2009) demonstraram que ratos noturnos alimentados por seis semanas com uma dieta rica em gordura em períodos destinados ao repouso ganharam mais peso do que os ratos alimentados durante períodos de atividade, apesar de consumirem quantidade equivalente de energia. Portanto, modificar o horário do consumo alimentar parece afetar o peso corporal em ratos (ARBLE et al., 2009).

Estudos transversais (BARON et al., 2011; WANG et al., 2014; ALJURAIBAN et al., 2015) e longitudinais (BO et al., 2014; MAUKONEN et al., 2019) em humanos encontraram associações entre o consumo energético noturno e maior risco de excesso de peso corporal. Porém, não foi encontrada associação entre o consumo energético noturno e a mudanças de peso em longo prazo (BO et al., 2014; HERMENEGILDO et al., 2016; MAUKONEN et al., 2019) (Quadro 1).

Apesar destes estudos (BARON et al., 2011; BO et al., 2014; WANG et al., 2014; ALJURAIBAN et al., 2015; MAUKONEN et al., 2019) terem encontrado associação entre o índice de massa corporal - variável dependente - e o consumo alimentar à noite - variável independente -, houve diferença de como foi definida a variável independente. A maioria destes estudos, além de avaliar os horários das refeições à noite, considerou o percentual de ingestão calórica diária neste horário como variável que influencia a regulação do peso corporal (Quadro 1).

Quadro 1. Dados de estudos observacionais que relacionaram a regulação do peso corporal com o consumo alimentar à noite.

Autor, (ano)	**Tamanho da amostra e caraterística dos participantes**	**Definição de “consumo alimentar à noite”**	**Resultados**
Baron et al. (2011)	Estudo transversal. n= 52; 48% mulheres; Idade média 31 (DP= 12) anos; IMC média 24,7 (DP= 4,9) kg/m2	Calorias consumidas após às 20h (variável numérica).	Consumo calórico após às 20h foi um preditor independente do índice de massa corporal. Ajuste para idade, duração do sono e tempo de sono.
Wang et al. (2014)	Estudo transversal. n= 239; 65% mulheres; Idade entre 21 a 69 anos.	Calorias consumidas à noite - consumo no horário das 17h às 24h - (variável categórica): < 33% e ≥33% da ingestão diária de energia.	Os indivíduos que consumiram ≥33% da ingestão diária de energia noturna foram duas vezes mais provável terem sobrepeso/obesidade (amostra total), embora essa associação não tenha sido significativa entre os indivíduos que apresentaram relatos verdadeiro de consumo alimentar (n=99 - participantes com ingestão de energia autorreferida dentro de ± 25% do gasto energético total avaliado pelo método da água duplamente marcada). Ajuste para sexo, idade, raça, escolaridade, ingestão de energia total e atividade física.
Aljuraiban et al. (2015)	Estudo transversal. n= 2385; 48% mulheres; Idade entre 40 a 59 anos.	Relação calorias consumidas à noite (das 18h às 23h55) / manhã (das 06h às 11h55) (variável categórica): Quartis da relação entre a ingestão de energia da noite / manhã (1º quartil: <1,0; 2º: ≥ 1,0 a <1,5; 3º: ≥ 1,5 a <2,0; 4º: ≥ 2,0).	Houve associação do IMC com a relação calorias consumidas à noite / de manhã, sendo que a maior ingestão de energia à noite em relação ao consumo energético matinal foi positivamente associada ao IMC. Ajuste para energia total, sexo, idade e amostras da população (8 amostras americanas e 2 amostras do Reino Unido).

(continuação)

Autor, (ano)	Tamanho da amostra e caraterística dos participantes	Definição de "comer noturno"	Resultados
Bo et al. (2014)	Estudo coorte prospectiva. 6 anos de seguimento. n= 1245; Idade entre 45 a 64 anos; Adultos não obesos e não diabéticos.	Calorias consumidas no jantar – refeição no horário das 19h às 22h (variável categórica): Tercil do percentual de ingestão calórica diária no jantar (1º tercil < 33% kcal diárias no jantar; 3º ≥ 48% kcal diária no jantar) (Variável avaliada no início do estudo).	Ao final do seguimento o IMC do 1º tercil foi menor que o 2º e 3º tercil de consumo calórico à noite. Consumo calórico maior no jantar foi associado ao aumento do risco de incidência de obesidade (associação entre 1º e 3º tercil).
Hermenegildo et al. (2016)	Estudo coorte prospectiva. 3,5 anos de seguimento. n= 4243; 50,1% mulheres; Idade ≥ 18 anos.	Calorias consumidas no jantar – refeição no horário das 18h30 às 23h (variável categórica): Quartil do percentual de ingestão calórica diária no jantar (Mulheres: 1º quartil: ≤21,5%; 2º: ≥ 21,6 a ≤27,2; 3º: ≥ 27,3 a ≤ 32,6; 4º: ≥ 32,7; Homens: 1º quartil: ≤22,4%; 2º: ≥ 22,5 a ≤28,1; 3º: ≥ 28,2 a ≤ 34,2; 4º: ≥ 34,3;) (Variável avaliada no início do estudo).	Não foi encontrada associação entre o consumo de calorias no jantar e o ganho de peso (>3 Kg) durante o seguimento. Porém, foi encontrada associação negativa entre calorias do almoço e ganho de peso, sendo esta associação mais forte nas mulheres com sobrepeso ou obesidade.
Maukonen et al. (2019)	Estudo coorte prospectiva. 7 anos de seguimento n= 1097.	Calorias consumidas à noite – consumo no horário das 20h às 02h59). Variável contínua ou Variável categórica: Quartil do percentual de ingestão calórica diária à noite (1º quartil: ≤3,7%; 2º: ≥ 3,8 a ≤11,4; 3º: ≥ 11,5 a ≤19,9; 4º: ≥ 20,0). (Variável avaliada no início do estudo).	Não foi encontrada associação para o aumento de 5% no peso. Porém, foi encontrada associação do consumo à noite com o IMC>30,00 no início e ao final do estudo (associação entre 1º e 4º quartil).

A distribuição das calorias ao longo do dia associada ao menor consumo energético à noite parece influenciar também o sucesso da terapia para a redução do peso. Jakubowicz et al. (2013) realizaram estudo de intervenção por 12 semanas, com 93 mulheres com síndrome metabólica, as quais foram randomizados em grupo “café da manhã” em que as calorias foram distribuídas em 50% no café da manhã e 14% no jantar, e em grupo “jantar” em que as calorias foram distribuídas em 14% no café da manhã e 50% no jantar. As mulheres do grupo “café da manhã” apresentaram maior perda de peso e redução da circunferência da cintura, maior redução nos níveis de glicemia de jejum, insulina e HOMA-IR. Além disso, os níveis diários de grelina e os escores médios de fome foram menores, enquanto que os escores médios de saciedade foram maiores no grupo “café da manhã”, demonstrando que a distribuição das calorias ao longo do dia pode também influenciar o controle do apetite e da saciedade. Com isso, concentrar o consumo energético em horários mais tardios do dia parece diminuir a saciedade e aumentar o apetite por meio da modulação de hormônios relacionados a essa dinâmica (JAKUBOWICZ et al., 2013).

Além disso, os processos metabólicos pós-prandiais mostram variações de acordo com o período do dia, sendo que o período da noite, comparado ao da manhã, apresenta menor efeito térmico dos alimentos - energia gasta em resposta ao consumo alimentar em uma refeição - (ROMON et al. 1993), esvaziamento gástrico mais lento (GOO et al., 1987) e menor tolerância à glicose (LEUNG; HUGGINS; BONHAM, 2017). Estes mecanismos fisiológicos podem estar relacionados ao aumento do peso corporal em resposta ao horário mais tarde da refeição.

Vale destacar a importância da avaliação da preferência diurna ou cronotipo - aspecto fenotípico da ritmicidade circadiana em humanos, referente à classificação relacionada ao horário do dia em que os indivíduos preferem dormir ou realizar atividades diárias (GOEL et al. 2013) -, quando se avalia a relação entre a crononutrição e distribuição circadiana de energia, qualidade da dieta e regulação do peso corporal. Estudos que avaliaram o cronotipo e suas influências gerais em mulheres gestantes ainda são escassos. Merikanto et al., (2017) em um estudo com 1653 gestantes encontraram que as mulheres com tendência a vespertinidade -que preferem realizar suas atividades no final do dia- apresentaram hábitos de vida pouco saudáveis (por exemplo, tabagismo) e mais problemas de sono durante a gestação (por exemplo, problemas de adormecer, má qualidade do sono, cansaço diário). Em população adulta não gestantes, evidências sugerem que indivíduos com tendência vespertinidade tendem a consumir as refeições em horário mais tarde, principalmente o café da manhã (NIMITPHONG et al., 2018), a não realizar o café da manhã (GARAULET et al., 2013; TEIXEIRA; MOTA; CRISPIM, 2018), consumir menos energia e macronutrientes pela manhã e maior quantidade à noite (MAUKONEN et al., 2017) e consumir menos alimentos saudáveis (MUÑOZ et al., 2017), além disso, são indivíduos mais suscetíveis ao excesso de peso (XIAO; GARAULET; SCHEER, 2019), quando comparados a indivíduos com tendência à matutinidade.

2.4.4 Crononutrição e gestação

A crononutrição ainda é um tema pouco estudado em gestantes, porém, estudos recentes com essa população demonstraram que alguns fatores relacionados a esta área de pesquisa podem influenciar o metabolismo materno e medidas antropométricas e composição corporal do recém-nascido. Chandler-Laney et al. (2016) avaliaram 40 gestantes no terceiro trimestre gestacional, eutróficas e obesas de acordo com o IMC pré-gestacional, e encontraram que houve associações entre o consumo de carboidratos nas refeições noturnas (das 20h às 05h59) e as concentrações de glicose e a secreção de insulina nas gestantes obesas. Já três estudos transversais com mulheres entre 26 a 28 semanas de gestação – parte da coorte *Growing Up in Singapore Towards healthy Outcomes* - examinaram as associações entre a predominância do consumo energético à noite (> 50% do consumo total de energia das 19h às 06h59) (LOY et al. , 2016) e frequência de episódios alimentares e jejum noturno (maior intervalo de jejum entre 19h às 06h59) (LOY et al., 2017a) com os níveis glicêmicos maternos durante a gestação; e associações do jejum noturno materno com o tamanho e adiposidade do recém-nascido (LOY et al., 2017b). Esses estudos constataram que: a predominância do consumo alimentar à noite foi associada à maior concentração de glicose em jejum em gestantes eutróficas, mas não com excesso de peso (LOY et al., 2016); maiores intervalos de jejum noturno e frequência de episódios alimentares materno foram associados menor glicemia de jejum e maior glicemia de 2 horas, respectivamente (LOY et al., 2017a); e o maior intervalo de jejum noturno materno foi associado ao aumento da circunferência cefálica e da massa de gordura corporal total em meninas, mas não em meninos (LOY et al. , 2017b). Os dados destes estudos foram analisados transversalmente no terceiro e segundo trimestres gestacionais. No entanto, os padrões alimentares da mulher podem alterar durante este ciclo da vida (SANTANA et al., 2015), sendo importante fazer a avaliação ao longo da gestação, mais especificamente nos três trimestres gestacionais.

No nosso melhor conhecimento, até o momento nenhum estudo com gestantes avaliou a influência do horário de realização das refeições na distribuição circadiana de energia, na qualidade da dieta e no ganho de peso durante a gestação. Considerando a gestação um período único em que o organismo da mãe sofre rápidas transformações, esta avaliação é importante para o melhor direcionamento das intervenções nutricionais durante o pré-natal com o intuito de auxiliar a adequação das recomendações nutricionais e do ganho de peso.

3 OBJETIVOS

3.1 Objetivo Geral

Avaliar a associação dos horários das refeições com o consumo alimentar e o ganho de peso durante a gestação.

3.2 Objetivos Específicos

- Investigar a associação dos horários relacionados aos padrões alimentares e o cronotipo com a qualidade da dieta no primeiro trimestre gestacional (Artigo 1).
- Analisar o efeito dos horários da primeira e última refeição sobre os padrões alimentares, qualidade da dieta e ganho de peso durante a gestação (Artigo 2).
- Verificar a associação da ingestão de energia à noite com o ganho de peso e a distribuição circadiana de energia durante a gestação (Artigo 3).

4 RESULTADOS

Artigo 1. Artigo intitulado "Time-related eating patterns and chronotype are associated with diet quality in pregnant women", publicado na revista *Chronobiology International* (*Impact Factor* =2.643): Chronobiol Int. 2019 Jan; 36(1):75-84. doi: 10.1080/07420528.2018.1518328. Epub 2018 Sep 13.

Time-related eating patterns and chronotype are associated with diet quality in pregnant women

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Abstract

Animal studies strongly suggest that timed feeding can have beneficial physiological effects, including protection against the obesogenic and metabolic consequences of a high-fat diet. However, the relationship between variables related to the timing of eating and diet quality in pregnancy women, which is considered as a period of nutritional vulnerability, is still poorly described in the literature. Therefore, the aim of the present study was to investigate the associations between time-related eating patterns and chronotype with diet quality of pregnant women. This cross-section study was conducted with 100 pregnant women in the first gestational trimester (≤12 week of gestation). The information regarding food intake was obtained by three 24-Hour Dietary Recall (24HR). Time-related eating patterns, i.e., the interval between the first and the last meal (eating duration), nightly fasting, time of the first and last meals, and number of meals eating on a day were determined. Chronotype was derived using the mid-sleep time on free days on weekends (MSF), with a further correction for calculated sleep debt. Diet quality was evaluated using the Brazilian Healthy Eating Index-Revised (BHEI-R), validated for the Brazilian population. Linear regression modeling analyses adjusted for confounders were used to investigate the association between time-related eating patterns and chronotype with diet quality. The BHEI-R total score was negatively associated with time of the first meal (β=-0.355; p=0.002; r^2 adjusted= 0.141), and positively associated with eating duration (β=0.262; p=0.024; r^2 adjusted= 0.086) and number of meals (β=0.273; p=0.019; r^2 adjusted= 0.091). In addition, the score of total fruit component was negatively associated with chronotype (β= -0.236; p= 0.033; r^2 adjusted= 0.078), time of the first meal (β=-0.393; p=0.001; r^2 adjusted= 0.171), and positively associated with eating duration (β=0.259; p=0.022; r^2 adjusted= 0.087) and number of meals (β=0.376; p=0.001; r^2 adjusted= 0.159). The score for whole fruit component was negatively associated with time of the first meal (β=-0.388; p=0.001; r^2 adjusted= 0.152), and positively associated with number of meals (β=0.403; p=0.001; r^2 adjusted= 0.164). A longer eating duration, earlier time of the first meal, higher number of meals and morningness tendency are associated with a better diet quality in the first gestational trimester - higher scores of the total BHEI-R and/or fruit components. We suggest that nutritional guidelines should consider time-related eating patterns and

chronotype to ensure good diet quality of pregnant women since the beginning of gestation, contributing on prevention of metabolic-nutritional complications.

Keywords: diet quality, meal timing, eating duration, chronotype, pregnancy.

Introduction

With the recent advances in molecular circadian biology, the interest in nutritional links has become prominent within the chronobiological field (Johnston, 2014). Studies from this field have shown that the timing of food intake has many physiological (Johnston, 2014) and nutritional (Garaulet et al., 2013; Mattson et al., 2014) consequences. Animal studies strongly suggest that timed feeding can have beneficial physiological effects, including protection against the obesogenic and metabolic consequences of a high-fat diet (Hatori et al., 2012).

Several recent studies have also demonstrated that both meal timing (Arble et al., 2009; Baron et al., 2011; Crispim et al., 2011; Sherman et al., 2012; Garaulet et al., 2013; Jakubowicz et al., 2013; Bandin et al., 2015) and eating duration –the interval between the first and last meal of the day - (Gill and Panda, 2015) -, have an important role in weight gain and obesity.

Some current studies also show that chronotype - the phenotypic aspect of circadian rhythmicity in humans (Goel et al., 2013) - may be associated with dietary quality. In this case, evening-type individuals - who perform their activities later in the day - seem to eat a lower quality diet, with a higher caloric density, high carbohydrate and fat content, lower fruit and vegetable consumption, and higher meat consumption and alcoholic beverages (Sato-Mito et al., 2011; Haghighatdoost et al., 2012; Arora and Taheri, 2015). Moreover, evidence suggests that eating at later times of the day and skipping meals –common habits in the evening people routine (Mota et al., 2016; Silva et al., 2016) - favor weight gain (Wang et al., 2014) and promote lower satiety and higher caloric intake (de Castro, 2004).

Despite the recognized importance of a good diet quality during pregnancy on fetal growth and subsequent developmental health for both mother and child (Abu-Saad and Fraser, 2010), meeting nutritional recommendations in this period is often a challenge (Kominiarek and Rajan, 2016). Based on the above information on the possible relationship between chronobiological and nutritional aspects, it is reasonable to assume that time-related eating patterns and chronotype can influence diet quality, especially when it comes to specific populations such as pregnant women. However, the relationship between these time-related eating patterns and diet quality is still poorly described in the literature.

In this context, we hypothesized that pregnant women with greater eating duration, smaller number of meals, a later time of the first and last meal and with tendency for eveningness would be more likely to have a poor diet quality evaluated using the Brazilian Healthy Eating Index-Revised (BHEI-R). Thus, the aim of this study was to investigate the associations between time-related eating patterns and chronotype with diet quality in pregnant women.

Materials and methods

Subjects and ethics

A cross-sectional study was carried out with women in the first trimester of pregnancy (≤12 week of gestation). The study was conducted at the prenatal service of the Integrated Care Units of Uberlandia and Clinical Hospital of the Federal University of Uberlandia, located in Uberlandia, Minas Gerais, Brazil, between October 2015 and May 2016. Before the invitation, a brief explanation of the research and procedures was made. Data collection conducted by trained personnel with detailed interviews and measurements occurred in the moment that pregnant women were waiting for their medical appointment.

This study was approved by the Human Research Ethics Committee (protocol number 1.199.829/2015) of the Federal University of Uberlandia. Research was conducted according to the guidelines in the Declaration of Helsinki. All participants signed a free and informed consent form.

Eligibility criteria

The study included healthy pregnant women with a single fetus, over 18 years of age and that performed the first prenatal visit within up to the 12^{th} week of gestation. Pregnant women with a positive test for human immunodeficiency virus, syphilis, toxoplasmosis, rubella, cytomegalovirus and varicella were excluded, as well as, those who did not provide all necessary information for the development of the study.

Sample size

The sample size required for this study was determined using the G*Power software version 3.1 (Faul et al., 2007). The sample size calculations were based on t test linear multiple regressions, with effect size of 0.15, an alpha level of 0.05, 95% power, fixed model, single regression coefficient. Given these specifications, a total sample of 74 women was required.

During the time of the study, 121 women in the first trimester of pregnancy were invited to participate. Eleven pregnant women refused to participate and ten pregnant women were excluded because they did not meet the pre-established age criteria, obtaining a final sample of 100 pregnant women participants.

Preliminary questionnaire

A structured questionnaire regarding clinical data and sociodemographic characteristics such as frequency of nausea, sleep habits and age, marital status, schooling were developed by our group.

The frequency of nausea in the last 30 days was evaluated. To determine sleep habits, the participants were asked to report usual bedtime, wake-up time, sleep-onset latency and usual sleep duration on weekdays and weekends during the pregnancy. The questions used in the survey were: "What time have you been going to sleep on weekdays?"; “How many minutes on average do you stay awake in bed before you fall asleep after lights are turned off on weekdays?”, “Did you use wake up with the help of someone or an alarm clock on weekdays?”, "What time have you been waking up on weekdays?"; "What time have you been going to sleep on weekends?", “How many minutes on average do you stay awake in bed before you fall asleep after lights are turned off on the weekends?”, "What time have you been waking up on weekends?" and “Did you use wake up with the help of someone or an alarm clock on weekends?”.

Anthropometric assessment

The pre-gestational weight was self-reported and the current weight was measured with a set of scales, to an accuracy of 0.1 kg. Height was measured with a stadiometer fixed to the wall, with an accuracy of 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by height square (m^2). To determine the pre gestational nutritional status, we used the classifications of the World Health Organization (WHO, 2000) and to ascertain the current nutritional status we used the gestational curves (Atalah et al., 1997).

Chronotype

Chronotype was derived using mid-sleep time on free days at the weekend (MSF), with a further correction for calculated sleep debt – calculated as the difference between average sleep duration on weekends and weekdays (Roenneberg et al., 2007). Individuals were categorized as being morning type (MSFsc ≤ 3:59h), intermediate type (MSFsc = 4-4:59H) or evening type (MSFsc ≥ 5:00h) (Roenneberg et al., 2012).

Dietary assessment

The information regarding food intake was obtained by three 24-Hour Dietary Recall (24HR). The first one was collected in the moment of the interview and the others two were carried out through telephone interviews, according to the technique used in the Vigitel Study (Brasil, 2015). The interviewer encouraged the patients to describe all consumed foods for the day before, from the first to the last meal. The three 24HR recalls were applied on non-consecutive days, including one on the weekend. The average consumption of the three days was used for analysis.

Time-related eating patterns

Time-related eating patterns were evaluated through the number of meals, time of the first and last meal, eating duration and nightly fasting. The number of meals was determined by the number of caloric events ≥50 kcal/day with time intervals between meals of ≥ 15 min (Gibney and Wolever, 1997), reported in the 24HR Recall. The time of the first and last meal was reported at the time of the 24HR Recall. Eating duration was determined by the length between the first and last caloric event in the 24HR Recall (Gill and Panda, 2015). Nightly fasting was determined by calculating the hours between the first and last eating episode for each day and subtracting this time from 24 hours (Marinac et al., 2015). These variables were calculated from the average of the 24HR Recall.

Qualitative dietary assessment

The qualitative dietary assessment was performed using the Brazilian Healthy Eating Index-Revised (BHEI-R) (Previdelli et al., 2011), validated for the Brazilian population (Andrade et al. 2013). O BHEI-R is based on the Healthy Eating Index 2005 (HEI-2005) developed for the American population (Guenther et al. 2008), with some adjustments (Previdelli et al., 2011).

The BHEI-R is composed of twelve components: Total Fruit; Whole Fruit; Total Vegetables; Dark Green and Orange Vegetables and Legumes; Total Grains; Whole

Grains; Milk and Dairy; Meat, Eggs and Legumes; Oils; Saturated Fat; Sodium; and SoFAAS (calories from solid fats, alcohol and added sugars) (Previdelli et al., 2011).

The number of daily servings was adjusted by the energy density (1,000 calories/day). Depending on the component scores can range from zero (minimum) to 5, 10, or 20 (maximum) points. The maximum score is given for intake greater or equal to the portions recommended for the food groups, and zero for no intake. However, the proportion for the components Saturated Fat, Sodium and SoFAAS is inverse - the higher the consumption the lower the score will be. The intermediary scores were calculated in accordance with the quantity consumed. The Total BHEI-R is the sum of the scores of the components and can reach up to 100 points (Previdelli et al., 2011).

The data from the 24HR Recall was converted to units of measurement (grams or milliliters) by Dietpro® software, version 5.7. In order to increase the accuracy and to facilitate the calculation of BHEI-R, all the preparations were detailed, and then the number of servings and total score for each component were calculated by Excel software. Quantification of the components Saturated Fat, Sodium and total energy (kcal) was performed through Dietpro® software, version 5.7, using as a reference, preferably, the Brazilian Table of Food Composition (TACO, 2006). However, for those foods not found in this table, the international reference was used being the table from the United States Department of Agriculture (USDA, 2005).

Statistical analysis

The data was analyzed using SPSS software, version 20.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Initially, normality of the data was tested using the Kolmogorov–Smirnov test. The values are presented as the means and standard deviation for normally distributed data, or as median [interquartile range] for non-normally distributed data.

To associate the time-related eating patterns and chronotype with diet quality in pregnant women, linear regression modeling analyses were carried out. For each one independent variables – Chronotype (MSF), nightly fasting, eating duration, time of the first meal, time of the last meal, and number of meals - a model was performed separately to evaluated the effect of these on each dependent variables - scores of the total BHEI-R and its components. All models were adjusted for age, body mass index, maternal schooling, frequency of nausea in the last 30 days.

Another linear regression modeling was carried out to evaluate the effect of the dependent variable chronotype (MSF) on the independent variables of the previous regression analysis, including the adjustment variables - nightly fasting, eating duration, time of the first meal, time of the last meal, number of meals, age, body mass index, schooling and frequency of nausea in the last 30 days. Statistical tests with $p < 0.05$ were accepted as significant.

Results

Most of the pregnant women were married or lived with their partner (77%), had some level of high school education (74%), BMI with an indication of overweight – overweight and obese (43%), and were morning types (42%) (Table 1).

The median scores of total grains, total fruit, whole fruit, total vegetables, meat, eggs and beans, oils, saturated fat and calories from SoFAAS were more than half of the maximum score, while the scores of whole grains; dark green vegetables, orange vegetables and legumes, and milk and dairy products were closer to the minimum BHEI-R score (Table 2).

The score of the total fruit component was negatively associated with the chronotype score, time of the first meal, and positively associated with eating duration and number of meals. The whole fruit component score was negatively associated with time of the first meal, and positively associated with number of meals. The total grains component score was negatively associated with nightly fasting, eating duration, last meal time, number of meals, and was positively associated with chronotype and time of the first meal. The BHEI-R total score was negatively associated with time of the first meal, and positively associated with eating duration and number of meals (Table 3).

In the linear regression analyses performed with the chronotype (MSF) as a dependent variable and nightly fasting, eating duration, time of the first meal, time of the last meal, number of meals, age, body mass index, schooling and frequency of nausea in the last 30 days as independent variables, we found an association only between chronotype and age (β=-0.211; p=0.041; r^2 adjusted= 0.034) (results not shown in table).

Discussion

The present study investigated the associations between variables related to the chronotype and eating time – such as eating duration, nightly fasting, time of the first and last meals and number of meals – and diet quality in women in the first trimester of pregnancy. The linear regression analysis adjusted for confounders showed that a better quality of diet - obtained by higher total scores of BHEI-R – was associated with longer eating duration, earlier time of the first meal, and greater number of meals. In addition, the total fruit consumption seems to be higher in individuals with a morningness tendency, a longer eating duration, an earlier time of the first meal, and a greater number of meals, and the whole fruit consumption seems to be higher in individuals with an earlier time of the first meal, and a greater number of meals.

Moreover, a longer eating duration - which has been considered as a negative factor for nutritional and metabolic health (Gupta et al., 2017) - was associated with a better quality of diet, which contradicts part of our initial hypothesis. Anyway, most of the results confirm partially our initial hypothesis - that pregnant women with a smaller number of meals, a later first meal time and with a tendency for eveningness are more likely to have poor diet quality. These findings may be considered relevant given that the pregnant poor diet quality seems to impact negatively on pregnancy (Gresham et al., 2016) and newborns (Rodrigues Bernal et al., 2010; Loy et al., 2011). Confirmation of these findings may serve as a basis for nutritional guidelines for pregnant women to consider factors related to timing of eating and chronotype as important variables in the search for a better a better diet quality.

In our study we found that the earlier the time of the first meal, which is usually breakfast, was associated with better diet quality and higher fruit consumption, especially whole fruit. Breakfast has been considered as the most important meal of the day, since it is a central component in the daily nutritional requirements and contributes significantly to energy intake, nutritional quality (Matthys et al., 2006) and optimizing metabolic and endocrine regulation (Astbury et al., 2011; Reutrakul et al., 2014). In this study, we believe that the negative association between time of the first meal and diet quality is evident because breakfast in Brazil tends to be a good opportunity for the consumption of fruit and food with good nutritional value (Pereira et al., 2017). In addition, an early breakfast may be longer and may occur without time pressure, which could lead to the intake of a meal with greater food diversity and hence better quality.

The lack of evidence in this field shows that skipping breakfast by pregnant may lead to a poor environment for fetal health (Mazumder and Seeskin, 2015) and the regular consumption of main meals (breakfast, lunch, dinner) is associated with a lower risk of premature delivery (Englund-Ögge et al., 2017). However, studies regarding the time of breakfast and their impact on variables related to food consumption are scarce, especially among non-pregnant women. Among the few studies in this area, Gill and Panda (2015) analyzed healthy adult males and females and found that breakfast time was weakly positively correlated (r^2= 0.379) with the last caloric intake, so that individuals with earlier breakfast also had their last caloric intake earlier in the evening. In our study we did not assess food intake the day before, and this subject may be the basis for future investigations. Moreover, the lack of studies in the literature on this field and the cross-sectional design of this study prevent us from establishing causality among the variables analyzed.

When it comes to meals in general, studies suggest that eating at earlier times of the day may be a protective factor for excessively gaining weight and better nutritional choices when compared to eating later (Garaulet and Gómez-Abellán, 2014). According to de Castro (2004), the time of day of food intake influences overall intake, mainly that eating a large amount in the morning can reduce the overall intake throughout the day. This author (de Castro, 2009) also analyzed the intake of food at different times of the day and its relation to the total daily intake and macronutrient intake in 388 men and 621 women, and found eating less high-caloric food in the morning and avoiding high-caloric food at night can reduce the total caloric intake. More studies are necessary to evaluate how breakfast consumption can influence the overall diet quality. Anyway, the results found in our study suggest that a nutritional approach related to the time at which meals occur can significantly impact diet quality.

In our study, the BHEI-R total score was negatively associated with the time of the first meal, and positively associated with eating duration. It is interesting to note that a short eating duration has been associated with health benefits (Gill and Panda, 2015). However, in the present study, a longer eating duration seems to be a leading factor to a better quality diet, i.e., the earlier is the time of the first meal, the higher is total scores of BHEI-R and fruit consumption. Moreover, the time of the last meal was not associated with diet quality.

It is important to mention that BHEI-R evaluates the quality of the diet through the presence of food groups throughout the day. In this sense, one of the few studies that related eating duration to food consumption was conducted by Gill and Panda (2015) and it showed that the increased daily eating duration likely contributes to an increased caloric intake. The present study did not this association and possibly the latter is the time of the last meal, the higher is the caloric intake. Thus, given the benefits of a shorter eating duration on health (Gill and Panda, 2015), the findings of the present study allow us to postulate that nutritional education in pregnant women should prioritize a good diet quality and a shorter eating interval, especially make earlier the first and last eating episode.

Our study also found that a greater number of meals was associated with a better diet quality. In addition, the total fruit consumption seems to be higher in individuals who have a higher number of meals. Although this subject has not been studied in pregnant women, studies in other population groups have already shown that the frequency of meals has an impact on the diet quality. Poscia et al. (2017) recently found in 12000 university students that a higher number of eating episodes is significantly associated with a higher frequency of fruit and vegetable intake, which probably reflects the diet quality and good health. Likewise, Aljuraiban et al. (2015) carried out a study with 2,696 men and women aged 40 to 59 from the United States and the United Kingdom, and found that individuals with more frequent eating episodes had higher nutrient density and that a larger number of small meals may be associated with improved diet quality.

The mechanisms that could explain the associations between total energy intake, frequency of eating occasions and diet quality is likely to be multifactorial. The increase in eating occasions per day may have a positive effect on satiety (Smeets and Westerterp-Plantenga, 2008) and appetite control (Speechly and Buffenstein, 1999), because the consumption of smaller multiple meals may possibly be linked to an attenuation in insulin response, gastric stretch and release of gastric hormones (Speechly and Buffenstein, 1999). Additional studies should be performed with representative populations of pregnant women to confirm whether the frequency of meals in pregnant women may constitute a strategy to raise the diet quality of these women.

Current literature has shown that afternoon chronotype is associated with diseases such as type 2 diabetes (Cappuccio et al., 2010) and obesity (Guidolin and Gradisar 2012). Interestingly, these problems are highly prevalent in pregnant women (Boghossian et al., 2014; Yang et al., 2017), but it is not understood if dietary pattern can intermediate the relationship between chronotype and disease. In the present study, the score for total fruit component was negatively associated with the chronotype score. To date, no studies to our knowledge have explored the relationship between chronotype and food consumption in pregnant women, which does not make comparisons with our findings possible.

However, research have been conducted with other population groups. A study conducted by Mota et al. (2016) found that resident physicians with afternoon chronotype had a higher frequency of unhealthy diet than resident physicians with morning chronotype. Kanerva et al. (2012) analysed a random sample of men and women aged 25 to 74, and also showed that individuals who tended to eveningness consumed more chocolate, soft drinks, wine and consumed fewer whole grain, rye, potatoes, vegetables and roots, fruit and fish compared to those prone to morningness. Silva et al. (2016) found that evening type undergraduate students consumed more meat and tended to skip breakfast and had lunch later. However, more studies should analyze how chronotype could influence the consumption of these foods. It is also known that evening individuals usually have meals at later times in the day (Garaulet et al., 2013; Muñoz et al., 2016) and also omit breakfast (Reutrakul et al., 2013; Teixeira et al., 2018). This may be one of the reasons to explain the association between eveningness and the higher prevalence of metabolic and nutritional disorders (Reutrakul et al., 2014). Regarding the possible impact of chronotype on diet quality, it is reasonable to assume that evening type women tend to eat poorly and, consequently, gain more weight and have worse pregnancy outcomes. However, studies are needed to better understand how the chrononutritional aspects in pregnancy could be associated with the diet quality in pregnant women and in gestational outcomes.

Other components of BHEI-R - such as “Meat, Eggs and Legumes”, “Total Vegetables”, “Dark Green and Orange Vegetables and Legumes” – were probably not associated with time-related eating patterns and chronotype because they are food groups that include kinds of food usually consumed during large meals - such as lunch and dinner - by the majority of the Brazilians (de Oliveira Santos et al., 2015).

The consumption of these components of BHEI-R seems to be less affected in this population. In this sense, a nutritional intervention study with Brazilian adults showed that the intake of components “Total Vegetables”, “Dark Green and Orange Vegetables and Legumes” and “Meat, Eggs and Legumes” showed smaller changes after the intervention (Oliveira et al. 2015), confirming that the consumption of these kinds of food does not easily change.

There are some limitations of the present study. This exploratory study was cross-sectional and, although we performed analyzes which removed the effects of possible confounding factors; this experimental design limits its ability to establish causal relationships. Also, most evaluations were performed using questionnaires which, although were previously validated in other studies, are subjective and dependent on the memory and motivation of the participants. In particular, replacing the questionnaires with objective evaluation strategies - like the use of the actigraph - could have provided a more reliable basis for evaluating sleep pattern. Lastly, our results are based on only 100 pregnant women, who had regular consultations in the public health care system, and the generalization of the results for all pregnant women cannot be done.

We conclude that a longer eating duration, an early first meal, a higher number of meals and morningness tendency are associated with better diet quality in the first gestational trimester - higher scores of the total BHEI-R and/or fruit components. We suggest that nutritional guidelines should consider time-related eating patterns and chronotype to ensure good diet quality of pregnant women since the beginning of gestation, contributing on prevention of metabolic-nutritional complications.

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Declaration of interest statement

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

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Table 1. Demographic, anthropometric and chronobiological data of women during first trimester of pregnancy (n = 100).

Variables	Mean ± SD or Median [interquartile range] or n (%)
Age (years)	27.3±5.7
Marital status	
Married or live with a partner	77 (77)
Single	23 (23)
Schooling	
Basic education complete/not complete	4 (4)
High school education complete/not complete	74 (74)
Higher education complete/not complete	22 (22)
Gestacional weeks	9.5 [8.0-11.0]
Pre gestacional BMI (kg/m^2)	24.0±4.4
Current BMI (kg/m^2)	24.7±4.6
Underweight	19 (19)
Normal weight	36 (36)
Overweight	30 (30)
Obesity	13 (13)
Sleep-wake data	
Week sleep time (h:min)	23:00 [22:00 – 23:30]
Week awake time (h:min)	7:00 [6:30 – 8:00]
Week sleep latency (min)	15 [10 – 20]
Mean week sleep duration (h)	8.0 [7.4 – 9.8]
Weekend sleep time (h:min)	24:06 [23:36 – 24:30]
Weekend awake time (h:min)	8:30 [8:00 – 9:30]
Weekend sleep latency (min)	15 [10 – 20]
Mean weekend sleep duration (h)	8.5 [8.0 – 9.3]
Chronotype	
Chronotype (MSF) (h:min)	4:06 [3:42 – 4:54]
Morning: MSFsc ≤ 3:59h	42 (42)
Indifferent: MSFsc = 4:00-4: 59h	36 (36)
Evening : MSFsc ≥ 5:00h	22 (22)
Eating patterns	
Nightly Fasting (h:min)	13:00 [11:00 – 14:00]
Eating Duration (h:min)	11:30 [10:00 – 13:00]
First meal time (h:min)	8:40 [7:41 - 10:00]
Last meal time (h:min)	20:00 [19:13 - 21:00]
Number of meals	4.67 [4 – 5.33]

Note: Values are presented as mean and SD (standard deviation) for normally distributed data or as median [interquartile range] for non-normally distributed data, or n (%). Chronotype (MSF) was derived from time of mid-sleep on free days (weekend), with further correction for calculated sleep debt - the difference between average sleep duration on weekends and weekdays. BMI = body mass index. Eating duration was determined in the length between the first and last caloric event. Nightly Fasting was determined by calculating the hours between the first and last eating episode for each day and subtracting this time from 24 hours.

Table 2. Scores of the total Brazilian Healthy Eating Index-Revised (BHEI-R) and its components during first trimester of pregnancy (n = 100).

Components of the BHEI-R (min.-max. index scores)	Mean ± SD or Median [interquartile range]
Total Grains (0 - 5)[a]	5.0 [4.4- 5.0]
Whole Grains (0 - 5)	0.0 [0.0-0.2]
Total Fruit (0 - 5)[b]	3.0 [1.2-4.9]
Whole Fruit (0 - 5)[c]	3.6 [1.6-5.0]
Total Vegetables (0 - 5)[d]	3.0 [1.9-4.2]
Dark Green and Orange Vegetables and Legumes (0 - 5)[d]	2.1 [0.0-3.9]
Milk and Dairy (0 - 10)[e]	3.4 [1.3-5.4]
Meat, Eggs and Legumes (0 - 10)	8.1 [5.6-9.9]
Oils (0 - 10)[f]	10.0 [10.0-10.0]
Saturated Fat (0 - 10)	8.0 [5.5-9.4]
Sodium (0 - 10)	5.1±2.6
Calories from SoFAAS (0 - 20)	12.2 [6.6-15.7]
Total BHEI-R (0 - 100)	59.8±10.2

Note: Values are presented as mean and SD (standard deviation) for normally distributed data or as median [interquartile range] for non-normally distributed data.
[a]Total grain: cereals, roots, and tubers; [b]All fruit including fruits and fruit juice; [c]All fruit excluding fruit juice; [d]Legumes counted as vegetables only after Meat and Beans standard is met; [e]Includes milk and other dairy products and soy-based beverages; [f]Includes monounsaturated and polyunsaturated fats, oils from oilseeds, and fat in fish. BHEI-R = Brazilian Healthy Eating Index-Revised; SoFAAS=calories from solid fats, alcohol and added sugars.

Table 3. Association of scores of the total BHEI-R and its components with chronotype (MSF), nightly fasting, eating duration, time of the first meal, time of the last meal and number during first trimester of pregnancy (n = 100).

Dependents Variables	Independents Variables											
Components of the BHEI-R	Chronotype (MSF)		Nightly Fasting		Eating duration		Time of the first meal		Time of the last meal		Number of meals	
	β	p	β	p	β	p	β	p	β	p	β	p
Total Grains	**0.169**	**0.008**[a]	**-0.092**	**0.019**[b]	**-0.129**	**0.014**[c]	**0.129**	**0.014**[d]	**-0.051**	**0.023**[e]	**-0.204**	**0.005**[f]
Whole Grains	0.025	0.758	-0.009	0.765	0.112	0.603	-0.156	0.460	0.050	0.732	0.213	0.261
Total Fruit	**-0.236**	**0.033**[g]	0.067	0.197	**0.259**	**0.022**[h]	**-0.393**	**0.001**[i]	0.012	0.225	**0.376**	**0.001**[j]
Whole Fruit	-0.178	0.137	0.080	0.303	0.237	0.062	**-0.388**	**0.001**[k]	-0.017	0.358	**0.403**	**0.001**[l]
Total Vegetables	0.032	0.775	-0.102	0.653	0.060	0.742	-0.140	0.537	-0.055	0.747	0.139	0.538
Dark Green and Orange Vegetables and Legumes	0.087	0.762	-0.022	0.853	0.058	0.819	-0.072	0.797	0.011	0.857	0.053	0.825
Milk and Dairy Products	0.136	0.808	0.074	0.949	0.314	0.098	-0.206	0.513	0.238	0.323	0.311	0.104
Meat, Eggs and Beans	0.084	0.727	0.072	0.754	-0.138	0.574	0.152	0.525	-0.037	0.800	-0.145	0.548
Oils	0.178	0.284	0.064	0.586	0.079	0.558	-0.069	0.578	0.055	0.597	0.139	0.409
Saturated Fat	-0.118	0.586	-0.106	0.624	-0.150	0.486	0.008	0.771	-0.205	0.269	-0.065	0.717
Sodium	-0.201	0.304	0.068	0.728	0.225	0.234	-0.231	0.216	0.138	0.528	0.261	0.136
Calories from SoFAAS	-0.025	0.302	-0.094	0.238	0.076	0.260	-0.115	0.209	0.024	0.302	-0.078	0.258
Total BHEI-R	-0.046	0.232	-0.004	0.247	**0.262**	**0.024**[m]	**-0.355**	**0.002**[n]	0.069	0.213	**0.273**	**0.019**[o]

Note: Linear regression modeling analyses. Adjusted: Age, body mass index, maternal schooling, frequency of nausea in the last 30 days. Significant associations shown in bold. r^2 adjusted= [a]0.112; [b]0.092; [c]0.100; [d]0.100; [e]0.086; [f]0.124; [g]0.078; [h]0.087; [i]0.171; [j]0.159; [k]0.152; [l]0.164; [m]0.086; [n]0.141; [o]0.091. BHEI-R = Brazilian Healthy Eating Index-Revised. Chronotype (MSF) was derived from time of mid-sleep on free days (weekend), with further correction for calculated sleep debt - the difference between average sleep duration on weekends and weekdays. Eating duration was determined in the length between the first and last caloric event. Nightly Fasting was determined by calculating the hours between the first and last eating episode for each day and subtracting this time from 24 hours.

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Effects of timing of food intake on eating patterns, diet quality and weight gain during pregnancy

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Abstract

Studies have suggested that meal timing plays a role in nutritional health, but this subject has not been sufficiently studied in pregnant women. We analysed the effect of timing of food intake on eating patterns, diet quality and weight gain in a prospective cohort study conducted with 100 pregnant women. Data were collected once per trimester: ≥12; 20th to 26th; and 30th to 37th weeks. Food intake was evaluated by three 24-Hour Dietary Recalls, which was used to assess eating patterns and diet quality. Distribution of energy and macronutrient intakes throughout the day was considered eating patterns. Diet quality was assessed using the Brazilian Healthy Eating Index-Revised. Weight gain was evaluated during each trimester. Pregnant women were classified as early or late timing of first and last eating episodes if these values were below or above the median of the population, respectively (first eating episode=8:38h; last eating episode=20:20h). Generalised Estimating Equation models adjusted for confounders were used to determine the effects of timing - early or late - of the first and last eating episodes (independent variable) on eating patterns, diet quality and weight gain (dependent variables). Early eaters of the first eating episode have a higher percentage of energy and carbohydrate intake in morning and a lower at evening meals. They also have a better diet quality for the fruit components when compared to late eaters of the first eating episode. Our results emphasize the importance of considering meal timing in the nutritional antenatal guidelines to promote maternal-foetal health.

Introduction

Maternal feeding during pregnancy is considered an important factor to determine maternal-foetal health[1]. Dietary inadequacy during this period may be a risk factor for excessive weight gain[2], and adverse gestational outcomes[3], in addition to repercussions on foetal nutritional status[4] and the future health of the child[5].

Recent studies have suggested that not only what and how much we eat, but also when we eat has a significant effect on energy balance[6], weight regulation[7-9] and glycaemic control[8,10]. However, the timing of food intake is not well studied among pregnant women, who are considered an at risk group for nutritional health. Only a few studies with pregnant women conducted in this field have shown that meal timing during pregnancy is an important factor in determining maternal glycaemic levels[11-13] and offspring birth size and adiposity[14].

Meal timing seems to influence eating patterns, diet quality[7,15] and weight regulation[7,16]. A study of an adult population showed that higher energy intake in the evening compared to the morning meals seems to influence the increase in body mass index[16]. A longitudinal study performed with obese and overweight non-pregnant Spanish individuals during 20 weeks of weight loss treatment showed that later eaters of the main meal, lunch in this case, had different energy intake distribution throughout the day, with less calorie consumption during breakfast. They also skipped this meal frequently, had worse weight regulation and had an evening tendency to perform activities[7]. In this sense, studies have also shown that the timing of eating episodes has a strong association with chronotype, which is defined as the preference to perform activities during the day[7,17]. A recent study published by our group found that earlier times for the first meal, higher numbers of eating episodes, longer eating duration and a morning chronotype tendency, which has been extensively associated with early eating habits[18], were associated with better diet quality in the first gestational trimester[15].

To date, the influence of the timing of food intake on eating patterns, diet quality and weight gain is still poorly evaluated in the literature; to the best of our knowledge, it has not been evaluated during gestational trimesters. Therefore, the aim of this study was to analyse the effect of timing of food intake on eating patterns, diet quality and weight gain during pregnancy. We hypothesised that pregnant woman with later first and last eating episodes have an inadequate distribution of energy intake throughout the day, i.e. with lower food intake in the morning meals and greater in the evening meals, as well as a poorer diet quality and greater weight gain during pregnancy.

Materials and methods

Design and ethics

A prospective cohort study was carried out with healthy low risk pregnant women. These pregnant women were attending the antenatal clinics of the public health service in the city of Uberlandia, Minas Gerais, Brazil between October 2015 and February 2017. This study was conducted according to the guidelines in the Declaration of Helsinki and ethical approval was obtained from the Human Research Ethics Committee (protocol number 1.199.829/2015) at the Federal University of Uberlandia. Informed written consent was obtained from all women.

Sample

The study included pregnant women, aged 18 years and older, with no shift workers, all carrying a single foetus and who had undergone their first antenatal visit before the 12th week of pregnancy. Pregnant women with foetal malformation or anomalies, or who tested positive for human immunodeficiency virus, syphilis, toxoplasmosis, rubella, cytomegalovirus and varicella were excluded from the study.

The sample size required for this study was determined using the G*Power software version 3.1(19). The sample size calculations were based on repeated measures ANOVA, within-between interaction, with an effect size of 0.25, an alpha level of 0.05, 95% power, 4 groups, 3 measurements, a correlation between repeated measures of 0.5, and a non-sphericity correction ϵ of 1. Given these specifications, a total sample of 60 women was required at the final follow-up. Considering a 20% adjustment for possible losses, a minimum of 72 women was needed at baseline.

During the period of the study, 142 women in the first trimester of pregnancy were invited to participate. Eleven pregnant women refused to participate, 10 were excluded because they did not meet the age criteria and 21 had not completed all of the evaluations. A final sample of 100 pregnant participants was used in the study.

Data collection

The data collection occurred at three time points - once per trimester: First trimester: ≤12 gestational weeks; Second: 20th to 26th weeks; and Third: 30th to 37th weeks. Interviews and measurements were conducted by trained researchers while the pregnant women were waiting for medical appointments in the public service units.

Initial questionnaire

A structured questionnaire enquiring about marital status, educational level, clinical history and physical activity was used. In the first trimester, the women were asked about their marital status (married/living with a partner or single), and education level was recorded by asking women about their highest level of education. In each trimester, we asked whether the pregnant woman had experienced any episodes of nausea in the last 30 days and the frequency of these episodes. Physical activity was assessed using a questionnaire in which women reported if they had performed any physical activity during the last month in each trimester (yes/no) and the type, frequency and duration of this physical activity.

Chronotype

To determine chronotype, the participants were asked to report their usual bedtime, wake-up time, sleep-onset latency and sleep duration on weekdays and weekends during each trimester. Chronotype was derived using mid-sleep time on free days at the weekend (MSF), with a further correction for calculated sleep debt, calculated as the difference between average sleep duration on weekends and weekdays[(20)]. Higher coefficients indicate an evening preference, while lower coefficients indicate morning preference.

Anthropometric measurement and weight gain assessment

Height was measured in the first trimester with a stadiometer fixed to the wall, with an accuracy of 0.1 cm (Welmy®, São Paulo, Brazil). The pre-pregnancy weight was self-reported and the weight at each trimester was measured with a set of scales, to an accuracy of 0.1 kg (Welmy®, São Paulo, Brazil). Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). To determine pre-pregnancy BMI, we used the classifications of the World Health Organization[(21)].

Weight gain was calculated in each gestational trimester using the current measured weight value subtracted from the value of the weight evaluated in the previous trimester, or pre-gestational weight in the case of the first trimester. In each trimester, all pregnant women were not evaluated in the same gestational week; therefore, the value of weight gain was divided by the gestational week of the evaluation to obtain the value of the weight gain per week. The value of the weight gain per week was used to evaluate the weight gain during pregnancy. Pregnant women who lost weight were excluded from the analysis in the gestational trimesters that presented this loss, since the goal was to evaluate the weight gain. Therefore, a total of 9 pregnant women in the first and second trimesters and 6 in the third trimester were excluded.

Dietary assessment

For each trimester, the information regarding dietary intake was assessed by three 24-Hour Dietary Recalls (24HRs) using the 5-stage multiple-pass interviewing technique[(22),] conducted by trained researchers. This required women to report an uninterrupted list of all foods and beverages consumed, answer a forgotten food list, provide details of times, meals and snacks names and a description of foods, including brand names and recipes for home-cooked foods, as well as amounts eaten; the interview ended with a final probe review. Portion sizes were estimated using food pictures of various portion sizes and common household measurements such as cups, glasses, bowls, teaspoons and tablespoons, in addition to individual food items/units.

The first 24HR was collected at the time of the interview and the other two were conducted through telephone interviews[(23)]. The 24HRs were conducted on non-consecutive days, including one on the weekend, and the average consumption of the three days in each trimester was used for analysis. The 24HRs that showed implausible data with energy intakes of less than 500 kcal/day or more than 3500 kcal/day[(14)] were excluded and were not included in the calculations of average consumption. In this case, the plausible data of the other 24HRs of the participant were included in the analysis.

The software Dietpro®, version 5i, was used to calculate the nutrients of food intake and a Brazilian database[(24)] was preferentially used as a reference, followed by nutrient information from food labels and the United States Department of Agriculture (USDA) international nutrient database[25].

Eating patterns

The distribution of energy and macronutrients throughout the day was evaluated by the percentage of total daily energy intake and the percentage of energy intake from protein, fat and carbohydrates segregated in four meal times: Morning (breakfast and mid-morning snacks), Lunch, Afternoon (afternoon snacks), and Evening (dinner and night-time snacks). To classify the types of meals or snacks (breakfast, mid-morning snacks, lunch, afternoon snacks, dinner and night-time snacks), we considered participants' perceptions of the type of meal and/or snacks[26], and also analysed the type of food often consumed by the Brazilian population at every meal[27].

Time-related eating patterns were evaluated by the number of eating episodes, eating duration and night-fasting. The number of eating episodes was determined by the number of caloric events ≥50 kcal/day, with time intervals between food and/or beverage consumptions of ≥15 min[28] reported in the 24HRs. Eating duration was determined by the length between the first and last caloric event in the 24HR[29]. Night-fasting interval was determined by calculating the longest fasting interval between eating episodes from 19:00h to 06:59h[14]. All variables were calculated using the average of the 24HRs in each trimester.

Diet quality

Diet quality was assessed using the Brazilian Healthy Eating Index–Revised (BHEI-R)[30], validated for the Brazilian population[31]. The BHEI-R is similar to the Healthy Eating Index-2005[32] and is composed of 12 components classified as adequate foods: total fruit, whole fruit, total vegetables, dark green and orange vegetables and legumes, total grains, whole grains, milk and dairy, meat, eggs and legumes, and oils; and moderate foods: saturated fat, sodium, and calories from solid fats, alcoholic beverages, and added sugars (SoFAAS)[30]. The number of daily servings was adjusted by the energy density (1000 Kcal/day). Each component received a specific score, ranging from zero to five, zero to ten, or zero to twenty. The maximum score is given for an intake greater than or equal to the portions recommended, and a zero score for no consumption of the components classified as adequate. However, the proportion for the components classified as moderate food is inverse: higher consumption means a lower score. Intermediate values of intake are given proportional scores. The Total BHEI-R is the addition of the scores of the components and can reach up to 100 points, with the higher scores indicating a healthy diet quality[30].

Timing of food intake

In Uberlandia (18° South, 48° West), a city located southeast of Brazil, sunrise and sunset occurred respectively at 06:17 and 18:23 hours on March 20 2016 (autumnal equinox); at 06:45 and 17:44 hours on June 20 2016 (winter solstice); at 06:02 and 18:09 hours on 22 September 2016 (vernal equinox); and at 06:33 and 19:49 hours on 21 December 2016 (summer solstice), considering daylight saving time[34]. Therefore, sunrise in Uberlandia showed little variation throughout the year and occurred at 06:24 on average, while sunset (annual average of 18:31 hours) had a slightly higher variation due to daylight saving time. The timing of sunrise and sunset is an important aspect to consider when studying the timing of food intake, especially in countries with seasonal variations[33]. However, as in the present study, the timing of food intake did not change during pregnancy (Suppl Table 1), and the mean of the values reported in the 24HR for the three trimesters was considered the usual meal time for pregnant women.

The classification of timing of food intake was based on the time of the first concomitant with the last eating episodes: caloric events ≥50 kcal/day with time intervals between food and/or beverages consumptions of ≥15 min. The first eating episode was defined as the first caloric event after waking and the last eating episode was defined as the last caloric event before bedtime. In addition, for women who woke up in the night to eat, this caloric event was considered the last eating episode and computed as a night-time snack. Based on the usual timing of the first and last eating episodes (mean values), pregnant women were classified as early or late if these values were below or above the median of the population, respectively (Median: First eating episode = 8:38h; Last eating episode = 20:20h). Four groups were obtained: Early/Early: early first and last eating episode; Early/Late: early first and late last eating episode; Late/Early: late first and early last eating episode; and Late/Late: late first and last eating episode.

Statistical analyses

Statistical analyses were performed according to the classification of the timing of the first and last eating episodes. The normality of the data was established using Kolmogorov-Smirnov tests. Categorical data were shown as frequencies and percentages, while continuous data were shown as means and standard deviations or median and interquartile ranges. Descriptive analyses of maternal characteristics between the groups were performed using Analysis of Variance or Kruskal-Wallis tests (continuous variables), and Fisher's exact test (categorical variables). Generalised Estimating Equation (GEE) models were used to determine the effects of timing (early or late) of the first and last eating episodes and gestational trimesters (independent variables) on eating patterns (percentage of the total daily energy and macronutrients intakes in the meals, number of eating episodes, eating duration and night-fasting), energy and macronutrients total daily intakes, diet quality (scores of the total BHEI-R and its components), body mass index and weight gain during pregnancy (dependent variables). Gamma distributions were used and multiple comparisons were performed using the Bonferroni post-hoc test when necessary. All models were adjusted for age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days; with an exception for body mass index during pregnancy, the adjustment for pre-gestational body mass index was not used. Statistical analyses were performed using SPSS 20.0 (Chicago, IL, USA), and a p-value of <0.05 was considered statistically significant.

Results

Maternal characteristics

Maternal characteristics according to the groups are presented in Table 1. The pregnant women of the Early/Early group had a higher median age compared to the Late/Early group. There was also a significant difference between the groups in the category of chronotype: the Late/Early and Late/Late groups had a greater evening preference compared to the Early/Early and Early/Late groups. For the other variables analysed, no differences were found between the groups (Table 1).

The time of the meals and the time-related eating patterns did not change during pregnancy (Suppl Table 1). For this reason, the values were presented in the total gestational data values, representing the average of the three trimesters, and the time of the meals and time-related eating patterns differed according to the groups of the timing of food intake (Table 2). The Late/Early and Late/Late groups presented a higher prevalence of skipping breakfast and morning snacks, while the Early/Early and Late/Early groups present a higher prevalence of skipping night-time snacks during pregnancy (Table 2). In addition, the Early/Late group presented higher number of eating episodes compared to the Late/Early and Late/Late groups, and the Early/Late group also presented a higher eating duration than the Early/Early, Late/Early and Late/Late groups. The Early/Early and Late/Late groups presented greater eating duration than the pregnant women in the Late/Early group. Also, the Early/Early and Late/Early groups presented higher values of night-fasting intervals compared to the Early/Late and Late/Late groups (Table 2).

Effect of gestational trimester on eating patterns, diet quality, weight gain and body mass index during pregnancy

The effect of gestational trimester (main effect of time) was evaluated considering the total of pregnant women, without considering the classification groups by timing of food intake. Regarding the effect of gestational trimesters on eating patterns, the pregnant women maintained the number of eating episodes, eating duration, night-fasting interval (Suppl Table 1) and total energy (kcal) and macronutrient (grams) intake during pregnancy (Suppl Table 2). The pregnant women also maintained the distribution of energy and macronutrients in the meals during pregnancy (Suppl Table 2).

In relation to diet quality, the pregnant women showed a decrease from the first to the second trimester in total fruit (mean ± std. error: 3.15 ± 0.17 to 2.57 ± 0.17; p = 0.043) and whole fruit (mean ± std. error: 3.45 ± 0.18 to 2.70 ± 0.20; p = 0.011) components, but did not differ from the third trimester (total fruit: 2.95 ± 0.17; whole fruit: 3.04 ± 0.20) (Suppl Table 3).

As expected for pregnancy, body mass index was increasing over the trimesters (mean ± std. error: Third trimester: 29.01 ± 0.43 kg/m^2 > Second trimester: 26.64 ± 0.44 kg/m^2 > First trimester: 24.76 ± 0.43 kg/m^2; p = 0.001) (Suppl Table 2). There was also an effect of gestational trimesters on weight gain. The weight gain per week was increasing over the trimesters (mean ± std. error: Third trimester: 1.19

± 0.08 kg/week > Second trimester: 0.57 ± 0.04 kg/week > First trimester: 0.24 ± 0.03 kg/week; p = 0.001) (Suppl Table 2).

Effect of timing of food intake with gestational trimester on eating patterns, diet quality, weight gain and body mass index during pregnancy

There was no significant effect of timing of food intake interaction with gestational trimester on diet quality (Suppl Table 4), total energy (kcal) and macronutrient (grams) intakes, weight gain per week and BMI (Table 3). The results showed only an effect of timing of food intake interaction with gestational trimester on percentage of fat intake in the morning eating episodes in the first trimester (mean ± std. error: Early/Early group: 8.20 ± 0.93 % kcal > Late/Late groups: 4.16 ± 0.62 % kcal; p = 0.001) (Suppl Table 5).

Effect of timing of food intake on eating patterns, diet quality, weight gain and body mass index

The effect of timing of food intake was evaluated by considering the total gestational data, representing the average of the three trimesters, alongside the classification groups by timing of food intake. With regard to total energy consumption and macronutrients, the Early/Late group consumed more total energy (kcal), fat (grams) and carbohydrate (grams) than the Early/Early and Late/Early groups, and protein (grams) compared to the Late/Early group (Table 3).

Also, the early eaters of the first eating episode consumed a higher percentage of energy (Early/Late group > Late/Late group) and carbohydrate (Early/Late group > Late/Late group) at morning meals, and a lower percentage of energy (Early/Early group < Late/Early and Late/Late groups; Early/Late group < Late/Late group) and carbohydrate (Early/Early group < Late/Early group; Early/Late group < Late/Early and Late/Late groups) at the evening meals (Figure 1).

The results showed an effect of the timing of first and last eating episodes on diet quality. The early eaters of the first eating episode showed a better diet quality for the total fruit (Early/Late group > Late/Early group) and whole fruit components (Early/Late group > Late/Early and Late/Late groups) (Table 4). Our results did not show any effect of timing of the first and last eating episodes with BMI and weight gain per week (Table 3).

Discussion

To the best of our knowledge, this is the first cohort study to investigate the effect of timing (early or late) of the first and last eating episodes on eating patterns, diet quality and weight gain in pregnant women. The main finding of our study was that early eaters of the first eating episode consumed a higher percentage of energy and carbohydrate in morning meals and a lower percentage of energy and carbohydrate at evening meals, compared to the late eaters of the first eating episode. The early eaters of the first eating episode showed higher scores of total fruit and whole fruit components, obtained by BHEI-R. Our results also showed that the early eaters of the first eating episode skipped breakfast less often and consumed more eating episodes per day. No effect of timing of food intake on weight gain was found.

Among the few studies conducted with non-pregnant individuals(7) and pregnant women(15), the timing of food intake has been associated with eating patterns and diet quality, respectively. A recent study from our group with first-trimester pregnant women found that the timing of the first eating episode had a negative association on diet quality and fruit consumption, but no association was found between the timing of the last eating episode and diet quality(15). The present study found similar results, but have now been evidenced throughout pregnancy, and also showed the effect of timing of food intake on eating patterns.

The results from our cohort highlight the link between first eating occasion and eating patterns and diet quality. Studies with non-pregnant individuals showed that those who consume the first eating episode earlier, supposedly breakfast, may spend more time having this meal without pressure for more adequate quality and quantities(35) and other eating episodes in the morning. This morning dietary pattern can provide the best satiety and hunger control during the day(36,37), favouring lower food consumption at night. The adequate distribution of calories throughout the day, with higher calorie intake in the morning and midday and lower in the evening, seems to be linked with better diet quality(38), as found in the present study. Moreover, the greatest number of eating episodes during the day may be related to the insertion of appropriate snacks between main meals, favouring the best diet quality(16,39), and more specifically, higher numbers of eating episodes may be related to higher fruit intake by pregnant women(15).

The adequate distribution of energy and macronutrients throughout the day, with a larger proportion of total daily energy consumed in the morning and the opposite in the evening,[(8)] and the early time of main meals[(7)] also seems to be better for weight regulation in non-pregnant women. In contrast to these findings, the present study found no effects of timing of food intake on body mass index and weight gain per week during pregnancy. Therefore, the effect of meal timing on weight regulation may differ between pregnant and non-pregnant women, especially considering these studies with non-pregnant women evaluated for meal timing influences on the loss of weight in individuals with overweight and obesity in a weight-loss treatment[(7,8)]; however, in the case of pregnant women, antenatal monitoring should provide adequate weight gain in this period[(40)]. In addition, the weight gain during pregnancy is a result of complex developments in both the mother and foetus and involves components such as foetal weight gain, placental weight change, maternal body fat increases and alterations in extracellular volume[(40)]. However, further studies need to be performed to elucidate the relationship between meal timing and weight gain during pregnancy.

A systematic review of weight gain during pregnancy suggested that higher gestational weight gain is associated with increased energy intake during pregnancy, but did not show a conclusive association with macronutrient intake[(41)]. However, none of the groups evaluated in our study changed their energy and macronutrient consumption during this period. Similar results have been reported in other studies[(42, 43)], which reinforces the tendency of many pregnant women to fail to reach the recommendation of increased energy intake during the second and third trimesters[(44)]. Another possibility is that food intake has been underreported, especially in late pregnancy[(45)], but it is worth mentioning that food consumption results expressed as a percentage of energy intake may have not been altered by the exclusion of under-reporters[(46)], favouring the evaluation of food intake by the distribution of percentage calorie intake throughout the day.

The higher total calorie intake by the Early/Late group, compared to the Early/Early and Late/Early groups, found in the present study could be explained by the time of the last eating episode, since later feeding can provide a longer opportunity to eat[(47)]. Greater eating duration, the interval between the first and last eating episodes of the day[(29)], may result in higher total daily calorie intake[(29, 47)], which has been considered a negative factor for nutritional and metabolic health[(48)].

However, our results suggest that it is important in nutritional interventions to consider not only the total calories consumed, but also the timing of food intake and the distribution of percentage of calories consumed throughout the day.

Despite the differences between groups regarding total energy and macronutrient consumption, no differences were found in the total score and in almost all BHEI-R components, which may be due to the fact that BHEI-R assesses the number of daily servings adjusting by the energy density (1000 Kcal/day). Another consideration is that the BHEI-R is evaluated considering the total of the day, not being evaluated by the meals, making it difficult to compare the data of this index with the difference found in the distribution of calorie intakes in the meals throughout the day.

The main finding of our cohort study needs to be considered in antenatal nutritional counselling, since the early timing of the first eating episode may be related to more adequate eating patterns with higher food intake in the morning and lower in the evening meals and better diet quality for fruit components. A good diet quality(49) and meal timing(11-14) may be also considered a protective factor for maternal outcomes, such as glycaemic control. In this sense, the pregnant women consuming less energy at night(12) and more specifically, the reduction of carbohydrate intake at night(11), may be beneficial for glucose and insulin metabolic in pregnancy(11,12). In addition, pregnancy is a propitious life cycle to improve eating patterns and diet quality for better pregnancy results(2-4) and to encourage healthy lifestyle practices.

There are some limitations in our study that need to be considered. The evaluations were performed using questionnaires which, although previously validated in other studies, are subjective and dependent on the memory and motivation of the participants. To obtain accurate data, however, respondents were trained before participating in the survey and our team has been highly trained(50). Another limitation is that day-length/ nightfall duration (sunrise and sunset) through the year were not controlled during the data collection, and can influence timing of food intake, because individuals should perform some activities, including food intake, during the light portion of the day(51). Further studies with pregnant women are needed to assess sunlight influence on the timing of food intake. In addition, circadian eating could also be influenced by sleep, but this association was not evaluated. Another limitation is that physical activity level, which was used as a confounder, was not assessed by a validated questionnaire. Lastly, our results are based on only 100 pregnant women, who had regular consultations in the public health care system, and the generalisation of results for all pregnant women cannot be made, especially with regard to high-risk pregnant women.

Conclusions

We conclude that the early eaters of the first eating episode have more adequate eating patterns, with a higher percentage of energy and carbohydrates taken in at morning meals and a lower level at evening meals. Early eaters of the first eating episode also have a better diet quality for the total fruit and whole fruit components during pregnancy, when compared to the late eaters of the first eating episode. Our results suggest that the timing of food intake is a new variable to be considered in nutritional guidelines in antenatal care for promoting maternal-foetal health.

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Table 1. Demographic, anthropometric, chronobiological and clinical data of women during pregnancy (n = 100/each trimester).

Variables	Timing of First and Last Eating Episodes								p-value
	Early/Early (n=21)		Early/Late (n=30)		Late/Early (n=25)		Late/Late (n=24)		
	Mean or Median or n	SD or interquartile range or %	Mean or Median or n	SD or interquartile range or %	Mean or Median or n	SD or interquartile range or %	Mean or Median or n	SD or interquartile range or %	
Age (years)	30.17[a]	26.51-35.64	27.87[ab]	22.72-33.71	25.02[b]	21.25-29.36	25.3[ab]	22.62-29.45	**0.013**
Marital status									
Married or live with a partner	16	76.2	24	80	19	76	19	79.2	0.929
Single	5	23.8	5	20	6	24	5	20.8	
Schooling									
Basic education complete/not complete	1	4.8	1	3.3	3	12	0	0	0.770
High school education complete/not complete	14	66.7	22	73.3	14	56	18	75	
Higher education complete/not complete	6	28.5	7	23.4	8	32	6	25	
Chronotype (MSF) (h:min)	3:29[a]	0:45	3:58[a]	0:54	4:40[b]	0:35	4:45[b]	1:05	**0.001**
Pre-gestational BMI									
Kg/m2	24.28	21.54-26.78	24.56	22.04-27.87	23.88	21.91-25.68	22.44	20.98-23.92	0.160
Underweight	0	0	1	3.3	2	8	3	12.5	0.269
Normal weight	12	57.1	15	50	13	52	17	70.8	
Overweight	5	23.8	8	26.7	7	28	4	16.7	
Obesity	4	19.1	6	20	3	12	0	0	
Frequency of nausea in the last 30 days									
First trimester	10.00	2.25-30.00	20.00	4.00-30.00	10.00	8.50-28.50	29.00	20.00-30.00	0.168
Second trimester	0.00	0.00-0.00	0.00	0.00-5.00	0.00	0.00-0.50	0.00	0.00-0.50	0.337
Third trimester	0.00	0.00-0.00	0.00	0.00-0.00	0.00	0.00-0.25	0.00	0.00-0.00	0.675
Physical activity (no)									
First trimester	17	81	25	83.3	20	80	21	87.5	0.923
Second trimester	16	76.2	24	80	19	76	20	83.3	0.926
Third trimester	17	81	23	76.7	19	76	21	87.5	0.758

Note: Early/Early: early first and last eating episodes; Early/Late: early first and late last eating episodes; Late/Early: late first and early last eating episodes; Late/Late: late first and last eating episodes. BMI: body mass index. Analysis of Variance or Kruskal-Wallis, and Fisher's exact test. Values are presented as mean and SD (standard deviation) for normally distributed data or as median [interquartile range] for non-normally distributed data, or n (%). Tukey or Dunn post-hoc test: different letters represent statistical difference in comparisons, p-value < 0.05. Chronotype (MSF) was derived from time of mid-sleep on free days (weekend), with further correction for calculated sleep debt – the difference between average sleep duration at weekends and on weekdays.

Table 2. Effect of timing of first and last eating episodes on meals and snacks-time and time-related eating patterns during pregnancy (Total gestational data's values -represent the average of the three trimesters-, n=100/each trimester).

Dependents variables	Independent variables - Timing of First and Last Eating Episodes								Fisher's exact test	Tests of Model Effects		
	Early/Early (n=21)		Early/Late (n=30)		Late/Early (n=25)		Late/Late (n=24)					
	Mean or n	Std. Error or %	Mean or n	Std. Error or %	Mean or n	Std. Error or %	Mean or n	Std. Error or %	p-value	Wald chi-square	Df	Sig.
Meal and snack times												
Breakfast												
n (%)	62	98.4	88	97.8	64	85.3	63	87.5	**0.001**	---	---	---
h:min	7:52[a]	0:07	7:58[a]	0:04	9:03[b]	0:05	9:02[b]	0:08	---	127.97	3	**0.001**
Mid-morning snacks												
n (%)	38	60.3	63	70	29	38.7	34	47.2	**0.001**	---	---	---
h:min	9:52[a]	0:07	9:58[a]	0:05	10:08[ab]	0:07	10:25[b]	0:07	---	15.20	3	**0.002**
Lunch												
n (%)	62	98.4	88	97.8	73	97.3	68	94.4	0.345	---	---	---
h:min	12:10	0:05	12:22	0:04	12:10	0:04	12:24	0:07	---	6.48	3	0.090
Afternoon snacks												
n (%)	56	88.9	87	96.7	67	89.3	65	90.3	0.143	---	---	---
h:min	16:05[ab]	0:07	16:19[ab]	0:06	15:58[a]	0:07	16:25[b]	0:07	---	10.52	3	**0.015**
Dinner												
n (%)	62	98.4	88	97.8	73	97.3	68	94.4	0.345	---	---	---
h:min	19:40[a]	0:06	20:17[b]	0:07	19:32[a]	0:05	20:22[b]	0:08	---	45.88	3	**0.001**
Night-time snacks												
n (%)	10	15.9	35	38.9	14	18.7	34	47.2	**0.001**	---	---	---
h:min	21:19[a]	0:14	22:13[b]	0:07	21:35[a]	0:13	22:36[b]	0:02	---	20.76	3	**0.001**
Time-related eating patterns												
Number of eating episodes	4.74[ab]	0.18	5.21[a]	0.11	4.37[b]	0.13	4.64[b]	0.13	---	26.55	3	**0.001**
Eating Duration (h:min)	11:39[a]	0:10	12:48[b]	0:09	10:12[c]	0:10	11:37[a]	0:11	---	137.59	3	**0.001**
Night-fasting (h:min)	11:02[a]	0:05	9:59[b]	0:06	11:01[a]	0:04	9:45[b]	0:10	---	112.25	3	**0.001**

Note: Early/Early: early first and last eating episodes; Early/Late: early first and late last eating episodes; Late/Early: late first and early last eating episodes; Late/Late: late first and last eating episodes. Fisher's exact test. Generalised Estimating Equations models, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant associations shown in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05.

Table 3. Effect of timing of first and last eating episodes on total energy and macronutrients intakes, scores of the total Brazilian Healthy Eating Index-Revised (BHEI-R), current body mass index (BMI) and weight gain during the pregnancy (n = 100/each trimester).

Dependents variables	Independent variables - Timing of First and Last Eating Episodes and Timing of First and Last eating episodes with Gestational Trimesters								Tests of Model Effects		
	Early/Early (n=21)		Early/Late (n=30)		Late/Early (n=25)		Late/Late (n=24)		Wald chi-square	Df	Sig.
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error			
Total Energy (kcal)	1578.15	68.13[a]	1857.21	68.73[b]	1452.25	64.13[a]	1661.43	63.77[ab]	19.67	3	**0.001**
First trimester	1577.66	90.55	1835.63	104.36	1344.08	103.22	1712.40	95.25			
Second trimester	1575.76	116.00	1881.79	100.62	1529.95	84.50	1654.23	122.46	2.44	6	0.876
Third trimester	1581.03	93.59	1854.50	90.34	1489.43	91.34	1619.00	70.29			
Protein (g)	65.45	4.18[ab]	75.91	2.64[a]	61.59	3.28[b]	66.73	3.43[ab]	13.09	3	**0.004**
First trimester	62.39	5.34	74.28	4.79	55.82	5.09	65.72	4.86			
Second trimester	63.74	6.37	77.50	4.34	65.32	4.32	72.62	6.74	3.76	6	0.710
Third trimester	70.51	6.34	75.97	4.21	64.06	5.70	62.25	4.05			
Fat (g)	60.64	3.05[a]	72.66	3.27[b]	53.49	2.67[a]	63.91	3.14[ab]	21.43	3	**0.001**
First trimester	58.97	3.76	70.61	4.98	47.01	3.50	65.24	4.61			
Second trimester	62.21	5.65	73.70	4.73	56.55	3.51	63.82	5.26	3.95	6	0.684
Third trimester	60.79	4.08	73.72	4.69	57.57	4.85	62.69	3.95			
Carbohydrate (g)	191.76	8.66[a]	225.16	8.62[b]	180.92	8.76[a]	204.65	7.57[ab]	14.62	3	**0.002**
First trimester	197.23	13.68	225.77	12.53	174.43	14.81	215.60	11.27			
Second trimester	190.22	13.10	227.97	14.21	189.93	13.58	197.35	14.16	1.84	6	0.934
Third trimester	187.97	11.95	221.80	10.63	178.75	10.17	201.43	9.63			
BHEI-R	61.81	1.10	61.61	1.05	59.53	1.20	60.38	0.90	2.75	3	0.432
First trimester	64.40	1.86	61.92	1,72	59.87	1,88	61.80	1,64			
Second trimester	59.46	1.73	60.85	1,47	59.94	1,80	59.45	1,59	3.45	6	0.751
Third trimester	61.66	2.17	62.08	1,46	58.80	1,92	59.92	1,55			
Current BMI (kg/m^2)	27.85	1.03	27.05	0.84	27.27	0.88	24.91	0.64	8.76	3	**0.033**
First trimester	25.59	1.08	25.41	0.86	25.25	0.89	22.89	0.63			
Second trimester	27.97	1.04	26.83	0.88	27.18	0.89	24.71	0.73	7.72	6	0.260
Third trimester	30.20	1.05	29.04	0.85	29.55	0.87	27.33	0.66			
***Weight Gain (kg/week)**	0.58	0.07	0.52	0.06	0.55	0.05	0.54	0.06	0.51	3	0.917
First trimester	0.27	0.07	0.25	0.06	0.26	0.05	0.20	0.06			
Second trimester	0.68	0.11	0.51	0.08	0.57	0.11	0.52	0.06	6.68	6	0.352
Third trimester	1.05	0.16	1.10	0.14	1.14	0.11	1.50	0.26			

Note: Early/Early: early first and last eating episodes; Early/Late: early first and late last eating episodes; Late/Early: late first and early last eating episodes; Late/Late: late first and last eating episodes. BHEI-R: Brazilian Healthy Eating Index-Revised. BMI: Body mass index. Generalised Estimating Equations model, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant Tests of Model Effects showed in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05. ___ Total gestational data's values -represent the average of the three trimesters (n=300; Early/Early: 63; Early/Late: 90; Late/Early: 75; Late/Late: 72). *Weight gain: Pregnant women who lost weight were excluded from the analysis, and Number of pregnant women who were excluded from these analysis - n (%): 1Trimester= Early/Early: 2 (9.5); Early/Late: 4 (13.3); Late/Early: 1 (4); Late/Late: 2 (8.3); 2Trimester= Early/Early: 3 (14.3); Early/Late: 3 (10); Late/Early:0 (0); Late/Late: 3 (12.5); 3Trimester= Early/Early: 2 (9.5); Early/Late: 2 (6.7); Late/Early: 0 (0); Late/Late: 2 (8.3).

Table 4. Effect of timing of first and last eating episodes on scores of the total Brazilian Healthy Eating Index-Revised (BHEI-R) and its components during the pregnancy (Total gestational data's values -represent the average of the three trimesters-, n=100/each trimester).

Dependents variables	**Independent variables - Timing of First and Last Eating Episodes**								**Tests of Model Effects**		
	Early/Early (n=21)		**Early/Late (n=30)**		**Late/Early (n=25)**		**Late/Late (n=24)**				
	Mean	**Std. Error**	**Mean**	**Std. Error**	**Mean**	**Std. Error**	**Mean**	**Std. Error**	**Wald chi-square**	**Df**	**Sig.**
Components of the BHEI-R (min.− max.)											
Total Fruit* (0–5)	3.03[ab]	0.27	3.33[a]	0.18	2.39[b]	0.23	2.85[ab]	0.16	10.39	3	**0.016**
Whole Fruit† (0–5)	3.04[ab]	0.28	3.71[a]	0.16	2.73[b]	0.27	2.79[b]	0.22	8.18	2	**0.017**
Total Vegetables‡ (0–5)	3.12	0.17	3.04	0.15	2.85	0.21	3.27	0.17	2.41	3	0.491
Dark Green and Orange Vegetables and Legumes‡ (0–5)	2.33	0.19	2.21	0.15	2.30	0.21	2.38	0.22	0.51	3	0.917
Total Grains§ (0–5)	4.43	0.09	4.20	0.10	4.49	0.11	4.49	0.10	4.96	3	0.175
Whole Grains (0–5)	0.27	0.10	0.47	0.12	0.26	0.09	0.36	0.10	2.70	3	0.440
Milk and Dairy‖ (0–10)	4.47	0.41	4.87	0.28	3.73	0.40	4.62	0.38	4.79	3	0.188
Meat, Eggs and Legumes (0–10)	7.90	0.36	7.81	0.20	7.43	0.29	7.70	0.33	1.44	3	0.697
Oils¶ (0–10)	9.75	0.16	9.93	0.04	9.61	0.16	9.67	0.16	6.43	3	0.093
Saturated Fat (0–10)	6.18	0.36	6.13	0.26	7.02	0.41	6.43	0.26	3.90	3	0.273
Sodium (0–10)	6.05	0.19	5.70	0.25	5.04	0.34	5.35	0.24	9.30	3	**0.026**
Calories from SoFAAS (0–20)	10.92	0.60	10.11	0.55	11.55	0.70	10.32	0.51	3.29	3	0.349
Total BHEI-R (0–100)	61.81	1.10	61.61	1.05	59.53	1.20	60.38	0.90	2.75	3	0.432

Note: Early/Early: early first and last eating episodes; Early/Late: early first and late last eating episodes; Late/Early: late first and early last eating episodes; Late/Late: late first and last eating episodes. BHEI-R: Brazilian Healthy Eating Index-Revised. SoFAAS: Solid Fats, Alcoholic beverages, and Added Sugars. *All fruit including fruits and fruit juice; †All fruit excluding fruit juice; ‡Legumes counted as vegetables only after Meat, Eggs and Legumes standard is met; §Total grain: cereals, roots, and tubers; ‖Includes milk and other dairy products and soy-based beverages; ¶Includes monounsaturated and polyunsaturated fats, oils from oilseeds, and fat in fish. Generalised Estimating Equations model, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant Tests of Model Effects showed in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05.

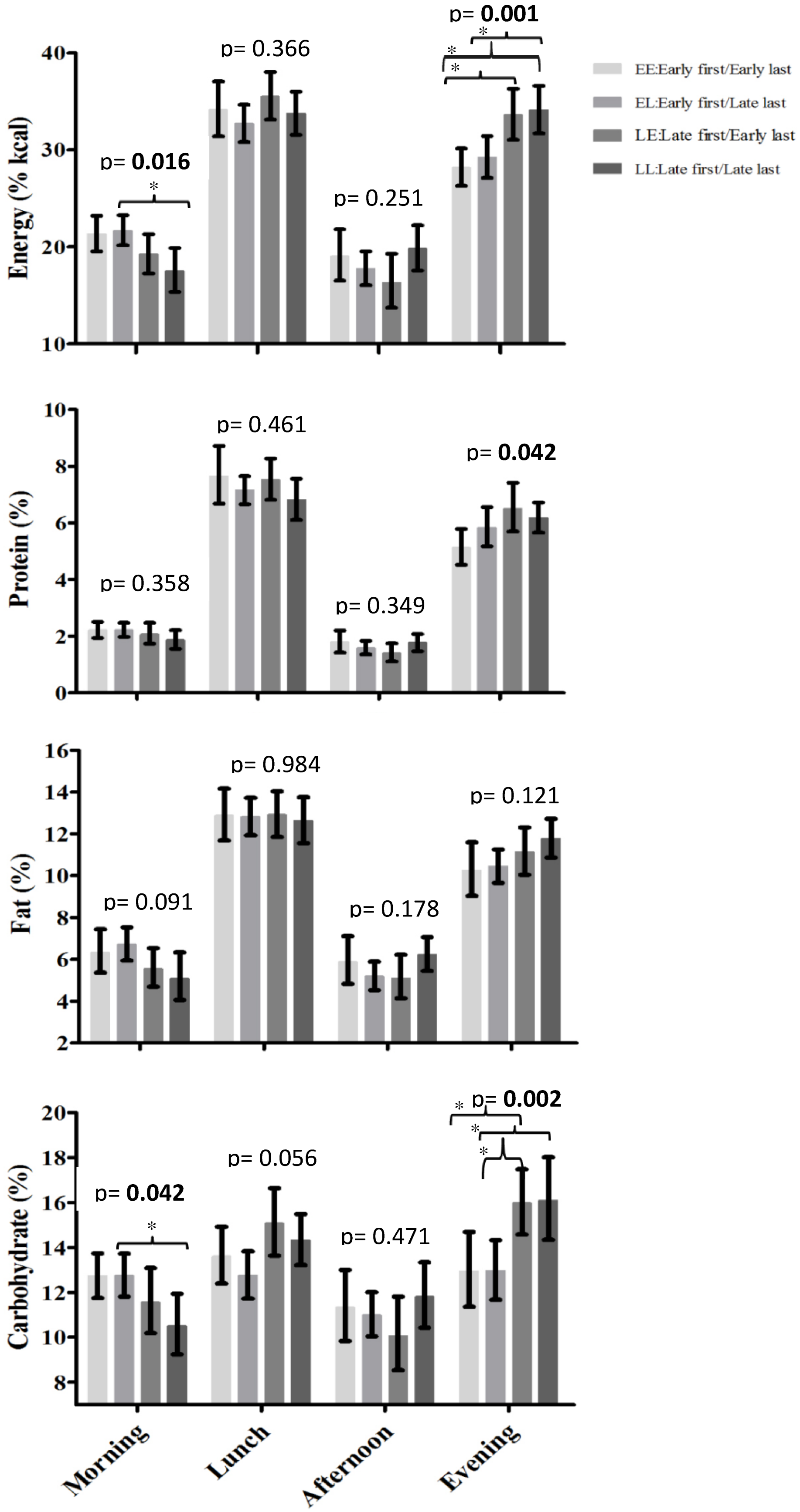

Figure 1. Effect of timing of first and last eating episodes on distribution of energy and macronutrients throughout the day (Total gestational data's values -represent the average of the three trimesters-, n=100/each trimester).

Note: EE: Early/Early, early first and last eating episodes; EL: Early/Late, early first and late last eating episodes; LE: Late/Early, late first and early last eating episodes; LL: Late/Late, late first and last eating episodes. Generalised Estimating Equations model, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant Tests of Model Effects showed in bold. *Bonferroni post-hoc test, pairwise comparisons, p-value < 0.05. Number of pregnant women who had a meal n (%): Morning: EE= 61 (96.83); EL= 84 (96.55); LE= 65 (86.67); LL=67 (89.33); Lunch: EE= 62 (98.41); EL=85 (97.70); LE=73 (97.33); LL= 71 (94.67); Afternoon: EE= 56 (88.89); EL=83 (95.40); LE=67 (89.33); LL= 69 (92); Night: EE=60 (95.24); EL= 84 (96.55); LE=74 (98.67); LL= 74 (98.67).

Suppl Table 1. Effect of gestational trimesters on meal and snack times and time-related eating patterns (n=100/each trimester).

Dependents variables	**Independent variables - Gestational Trimesters**						**Tests of Model Effects**		
	First trimester (n=100)		**Second trimester (n=100)**		**Third trimester (n=100)**				
	Mean	**Std. Error**	**Mean**	**Std. Error**	**Mean**	**Std. Error**	**Wald chi-square**	**Df**	**Sig.**
Meal and snack times (h:min)									
Breakfast	8:22	0:06	8:28	0:06	8:32	0:07	1.30	2	0.521
Mid-morning snacks	10:13	0:05	10:02	0:05	10:01	0:05	4.79	2	0.091
Lunch	12:19	0:04	12:15	0:04	12:17	0:04	0.54	2	0.764
Afternoon snacks	16:08	0:07	16:12	0:04	16:15	0:05	0.64	2	0.727
Dinner	19:58	0:05	19:59	0:05	19:55	0:05	0.66	2	0.719
Night-time snacks	21:55	0:11	21:58	0:11	21:53	0:05	0.23	2	0.892
Time-related eating patterns									
Number of eating episodes	4.75	0.10	4.71	0.10	4.36	0.08	0.10	2	0.950
Eating Duration (h:min)	11:29	0:10	11:35	0:10	11:31	0:10	0.22	2	0.898
Night-fasting (h:min)	10:26	0:06	10:25	0:06	10:26	0:05	0.01	2	0.996

Note: Generalised Estimating Equations models, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Bonferroni post-hoc test.

Suppl Table 2. Effect of gestational trimesters on total energy and macronutrients intakes, distribution of energy and macronutrients throughout the day, current body mass index (BMI) and weight gain (n = 100/each trimester).

Dependents variables	Independent variables - Gestational Trimesters						Tests of Model Effects		
	First trimester (n=100)		Second trimester (n=100)		Third trimester (n=100)				
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Wald chi-square	Df	Sig.
Total Energy (kcal)	1606.78	50.04	1655.14	53.65	1630.64	43.76	0.54	2	0.764
Protein (g)	64.21	2.55	69.58	2.81	67.98	2.60	2.60	2	0.272
Fat (g)	59.78	2.09	63.78	2.42	63.42	2.22	2.36	2	0.307
Carbohydrate (g)	202.29	6.75	200.79	6.90	196.84	5.36	0.53	2	0.769
Energy (% TEI)									
Morning	20.39	1.07	19.87	0.87	19.23	0.68	0.91	2	0.636
Lunch	32.84	1.10	34.53	0.95	34.61	0.99	1.70	2	0.428
Afternoon	19.01	1.25	16.99	0.84	18.48	1.07	2.22	2	0.330
Evening	30.79	1.18	31.83	1.05	30.81	1.08	0.53	2	0.768
Protein (% TEI)									
Morning	2.06	0.16	2.25	0.14	1.93	0.10	3.48	2	0.176
Lunch	7.16	0.38	7.23	0.35	7.39	0.29	0.28	2	0.870
Afternoon	1.72	0.16	1.44	0.09	1.69	0.13	4.73	2	0.094
Evening	5.41	0.28	6.40	0.41	5.85	0.28	3.69	2	0.158
Fat (% TEI)									
Morning	5.61	0.43	6.25	0.41	5.76	0.32	1.57	2	0.456
Lunch	12.22	0.50	13.00	0.48	13.18	0.48	2.00	2	0.368
Afternoon	5.76	0.48	5.16	0.31	5.78	0.46	1.82	2	0.403
Evening	10.69	0.57	11.05	0.49	10.87	0.44	0.20	2	0.903
Carbohydrate (% TEI)									
Morning	12.67	0.71	11.36	0.49	11.52	0.39	2.82	2	0.244
Lunch	13.44	0.49	14.27	0.49	14.00	0.60	1.36	2	0.507
Afternoon	11.53	0.74	10.48	0.56	11.06	0.60	1.32	2	0.517
Evening	14.78	0.72	14.36	0.55	14.04	0.68	0.64	2	0.728
Current BMI (kg/m^2)	24.76^a	0.43	26.64^b	0.44	29.01^c	0.43	386.71	2	**0.001**
***Weight Gain (kg/week)**	0.24^a	0.03	0.57^b	0.04	1.19^c	0.08	146.63	2	**0.001**

Note: BMI: Body mass index. % T EI: percentage of total energy intake. Generalised Estimating Equations model, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant Tests of Model Effects showed in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05. *Weight gain: Pregnant women who lost weight were excluded from the analysis, and Number of pregnant women who were excluded from these analysis - n (%): 1Trimester= Early/Early: 2 (9.5); Early/Late: 4 (13.3); Late/Early: 1 (4); Late/Late: 2 (8.3); 2Trimester= Early/Early: 3 (14.3); Early/Late: 3 (10); Late/Early:0 (0); Late/Late: 3 (12.5); 3Trimester= Early/Early: 2 (9.5); Early/Late: 2 (6.7); Late/Early: 0 (0); Late/Late: 2 (8.3).

Suppl Table 3. Effect of gestational trimesters on scores of the total Brazilian Healthy Eating Index-Revised (BHEI-R) and its components during the pregnancy (n=100/each trimester).

Dependents variables	**Independent variables - Gestational Trimesters**						**Tests of Model Effects**		
	First trimester (n=100)		**Second trimester (n=100)**		**Third trimester (n=100)**				
	Mean	**Std. Error**	**Mean**	**Std. Error**	**Mean**	**Std. Error**	**Wald chi-square**	**Df**	**Sig.**
Components of the BHEI-R									
Total Fruit[*] (0–5)	3.15[a]	0.17	2.57[b]	0.17	2.95[ab]	0.17	6.03	2	**0.049**
Whole Fruit[†] (0–5)	3.45[a]	0.18	2.70[b]	0.20	3.04[ab]	0.20	8.18	2	**0.017**
Total Vegetables[‡] (0–5)	2.99	0.15	2.99	0.14	3.23	0.15	2.06	2	0.358
Dark Green and Orange Vegetables and Legumes[‡] (0–5)	2.34	0.17	2.32	0.17	2.25	0.15	0.28	2	0.871
Total Grains[§] (0–5)	4.43	0.07	4.47	0.07	4.31	0.09	2.39	2	0.303
Whole Grains (0–5)	0.38	0.09	0.28	0.08	0.34	0.08	0.64	2	0.727
Milk and Dairy[||] (0–10)	4.20	0.29	4.65	0.31	4.37	0.29	1.43	2	0.489
Meat, Eggs and Legumes (0–10)	7.27	0.27	7.88	0.25	8.00	0.22	4.69	2	0.096
Oils[¶] (0–10)	9.58	0.17	9.79	0.08	9.86	0.12	1.82	2	0.403
Saturated Fat (0–10)	6.53	0.27	6.17	0.27	6.60	0.27	1.58	2	0.453
Sodium (0–10)	5.66	0.23	5.33	0.20	5.58	0.23	1.49	2	0.476
Calories from SoFAAS (0–20)	11.70	0.54	10.57	0.53	9.94	0.53	5.81	2	0.055
Total BHEI-R (0–100)	61.98	0.89	59.92	0.83	60.60	0.90	3.64	2	0.162

Note: BHEI-R: Brazilian Healthy Eating Index-Revised. SoFAAS: Solid Fats, Alcoholic beverages, and Added Sugars. [*]All fruit including fruits and fruit juice; [†]All fruit excluding fruit juice; [‡]Legumes counted as vegetables only after Meat, Eggs and Legumes standard is met; [§]Total grain: cereals, roots, and tubers; [||]Includes milk and other dairy products and soy-based beverages; [¶]Includes monounsaturated and polyunsaturated fats, oils from oilseeds, and fat in fish. Generalised Estimating Equations model, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant Tests of Model Effects showed in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05.

Suppl Table 4. Effect of timing of first and last eating episodes with gestational trimesters on scores of the total Brazilian Healthy Eating Index-Revised (BHEI-R) and its components (n=100/each trimester).

Dependents variables	Independent variables - Timing of First and Last Eating Episodes with Gestational Trimesters								Tests of Model Effects		
	Early/Early (n=21)		Early/Late (n=30)		Late/Early (n=25)		Late/Late (n=24)				
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Wald chi-square	Df	Sig.
Components of the BHEI-R (min.− max.)											
Total Fruit[*] (0–5)											
First trimester	3.60	0.27	3.62	0.28	2.39	0.38	3.17	0.31			
Second trimester	2.33	0.42	2.87	0.26	2.46	0.32	2.66	0.30	4.90	6	0.557
Third trimester	3.33	0.36	3.55	0.24	2.33	0.35	2.75	0.34			
Whole Fruit[†] (0–5)											
First trimester	3.83	0.27	4.17	0.25	2.50	0.39	3.54	0.36			
Second trimester	2.32	0.44	3.29	0.28	3.02	0.36	2.30	0.38	9.03	6	0.172
Third trimester	3.17	0.42	3.72	0.29	2.70	0.41	2.68	0.39			
Total Vegetables[‡] (0–5)											
First trimester	3.07	0.29	2.99	0.24	2.83	0.37	3.06	0.26			
Second trimester	2.98	0.29	2.99	0.25	2.68	0.31	3.33	0.26	0.81	6	0.992
Third trimester	3.31	0.33	3.15	0.25	3.05	0.32	3.41	0.26			
Dark Green and Orange Vegetables and Legumes[‡] (0–5)											
First trimester	2.38	0.33	2.23	0.28	2.28	0.40	2.50	0.32			
Second trimester	2.15	0.36	2.33	0.25	2.47	0.36	2.34	0.34	1.20	6	0.977
Third trimester	2.47	0.35	2.08	0.25	2.15	0.34	2.31	0.26			
Total Grains[§] (0–5)											
First trimester	4.47	0.11	4.06	0.18	4.69	0.08	4.52	0.15			
Second trimester	4.60	0.13	4.30	0.16	4.43	0.16	4.55	0.13	7.43	6	0.283
Third trimester	4.23	0.21	4.26	0.14	4.36	0.17	4.38	0.14			
Whole Grains (0–5)											
First trimester	0.36	0.20	0.56	0.21	0.25	0.15	0.40	0.16			
Second trimester	0.11	0.08	0.55	0.25	0.23	0.11	0.47	0.22	4.81	6	0.569
Third trimester	0.50	0.22	0.35	0.13	0.31	0.16	0.25	0.11			
Milk and Dairy[||] (0–10)											
First trimester	4.13	0.55	5.56	0.55	3.06	0.52	4.41	0.61			
Second trimester	5.79	0.70	4.47	0.48	4.00	0.64	4.50	0.61	14.22	6	**0.027**
Third trimester	3.74	0.65	4.65	0.47	4.23	0.57	4.96	0.54			
Meat, Eggs and Legumes (0–10)											
First trimester	7.42	0.58	7.41	0.44	7.09	0.59	7.14	0.52	10.22	6	0.116
Second trimester	7.56	0.58	8.04	0.43	7.49	0.50	8.48	0.41			

Third trimester	8.78	0.35	8.00	0.33	7.73	0.57	7.56	0.44			
Oils[¶] (0–10)											
First trimester	9.91	0.07	9.95	0.05	9.12	0.45	9.38	0.45			
Second trimester	9.86	0.10	9.88	0.11	9.76	0.16	9.64	0.20	8.03	6	0.236
Third trimester	9.49	0.46	9.96	0.04	9.98	0.02	9.99	0.01			
Saturated Fat (0–10)											
First trimester	6.58	0.51	5.95	0.55	7.28	0.62	6.40	0.52			
Second trimester	5.58	0.64	5.93	0.44	7.09	0.58	6.20	0.48	2.80	6	0.833
Third trimester	6.43	0.65	6.53	0.44	6.71	0.62	6.72	0.41			
Sodium (0–10)											
First trimester	6.68	0.39	5.38	0.38	5.31	0.52	5.38	0.48			
Second trimester	5.58	0.32	5.57	0.40	4.99	0.44	5.21	0.37	7.11	6	0.311
Third trimester	5.96	0.36	6.17	0.34	4.84	0.54	5.46	0.48			
Calories from SoFAAS (0–20)											
First trimester	11.97	1.05	10.06	1.04	13.07	1.15	11.90	1.09			
Second trimester	10.60	1.18	10.65	0.98	11.31	1.01	9.76	1.07	2.86	6	0.827
Third trimester	10.26	0.95	9.66	0.91	10.41	1.24	9.45	1.15			
Total BHEI-R (0–100)											
First trimester	64.40	1.86	61.92	1.72	59.87	1.88	61.80	1.64			
Second trimester	59.46	1.73	60.85	1.47	59.94	1.80	59.45	1.59	3.45	6	0.751
Third trimester	61.66	2.17	62.08	1.46	58.80	1.92	59.92	1.55			

Note: Early/Early: early first and last eating episodes; Early/Late: early first and late last eating episodes; Late/Early: late first and early last eating episodes; Late/Late: late first and last eating episodes. BHEI-R: Brazilian Healthy Eating Index-Revised. SoFAAS: Solid Fats, Alcoholic beverages, and Added Sugars. [*]All fruit including fruits and fruit juice; [†]All fruit excluding fruit juice; [‡]Legumes counted as vegetables only after Meat, Eggs and Legumes standard is met; [§]Total grain: cereals, roots, and tubers; [||]Includes milk and other dairy products and soy-based beverages; [¶]Includes monounsaturated and polyunsaturated fats, oils from oilseeds, and fat in fish. Generalised Estimating Equations model, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant Tests of Model Effects showed in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05.

Suppl Table 5. Effect of timing of first and last eating episodes with gestational trimesters on distribution of energy and macronutrients throughout the day (n=100/each trimester).

Dependents variables	Independent variables - Timing of First and Last Eating Episodes with Gestational Trimesters								Tests of Model Effects		
	Early/Early (n=21)		Early/Late (n=30)		Late/Early (n=25)		Late/Late (n=24)				
	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Mean	Std. Error	Wald chi-square	Df	Sig.
Energy (% TEI)											
Morning											
First trimester	21.85	1.40	25.03	2.11	19.90	2.90	15.89	1.73			
Second trimester	23.43	2.24	20.34	1.23	17.84	1.52	18.33	1.88	9.56	6	0.145
Third trimester	18.85	1.06	19.94	1.19	19.89	1.52	18.31	1.59			
Lunch											
First trimester	33.62	2.28	30.49	1.81	34.85	2.53	32.55	2.18			
Second trimester	33.91	2.26	32.38	1.78	35.86	1.63	36.09	1.81	5.83	6	0.442
Third trimester	34.81	2.20	35.34	1.50	35.75	2.31	32.63	1.86			
Afternoon											
First trimester	20.96	2.72	19.43	1.51	15.47	2.89	20.72	2.22			
Second trimester	17.41	1.54	15.53	1.54	16.45	1.91	18.74	1.67	1.57	6	0.955
Third trimester	18.75	1.70	18.41	1.71	17.00	2.87	19.88	1.83			
Evening											
First trimester	26.81	2.76	26.84	1.62	36.50	2.50	34.22	2.33			
Second trimester	27.50	1.86	32.86	1.89	32.60	2.07	34.85	2.59	9.64	6	0.141
Third trimester	30.27	1.80	28.21	2.16	31.86	2.53	33.13	2.05			
Protein (% TEI)											
Morning											
First trimester	2.26	0.18	2.70	0.35	2.07	0.48	1.43	0.21			
Second trimester	2.70	0.37	2.16	0.20	2.06	0.22	2.12	0.34	13.67	6	**0.034**
Third trimester	1.75	0.19	1.84	0.14	2.06	0.18	2.08	0.25			
Lunch											
First trimester	7.60	0.88	6.94	0.51	7.29	0.95	6.82	0.65			
Second trimester	7.01	0.78	6.98	0.61	7.80	0.78	7.16	0.64	3.21	6	0.782
Third trimester	8.32	0.73	7.51	0.40	7.42	0.57	6.42	0.61			
Afternoon											
First trimester	2.10	0.36	1.55	0.15	1.42	0.39	1.91	0.24			
Second trimester	1.47	0.18	1.42	0.18	1.34	0.19	1.53	0.19	2.25	6	0.895
Third trimester	1.79	0.22	1.76	0.24	1.41	0.27	1.85	0.28			
Evening											
First trimester	4.27	0.51	5.34	0.47	6.53	0.78	5.74	0.52	7.78	6	0.255

Second trimester	5.14	0.70	6.64	1.03	6.52	0.70	7.56	0.75			
Third trimester	6.09	0.57	5.56	0.52	6.43	0.69	5.39	0.47			
Fat (% TEI)											
Morning											
First trimester	5.72[ab]	0.53	8.20[a]	0.93	5.08[ab]	1.16	4.16[b]	0.62			
Second trimester	7.93[ab]	1.14	6.46[ab]	0.54	5.60[ab]	0.74	5.30[ab]	0.80	17.55	6	**0.007**
Third trimester	5.54[ab]	0.58	5.65[ab]	0.54	5.97[ab]	0.69	5.91[ab]	0.76			
Lunch											
First trimester	12.88	1.17	11.58	0.81	12.24	1.13	12.22	0.88			
Second trimester	12.50	0.98	13.00	0.94	13.04	0.96	13.50	0.97	4.11	6	0.661
Third trimester	13.26	0.97	13.92	0.75	13.45	1.13	12.16	0.94			
Afternoon											
First trimester	7.23	1.24	5.10	0.56	4.65	1.06	6.45	0.85			
Second trimester	5.05	0.68	4.48	0.53	5.20	0.56	6.02	0.69	4.48	6	0.613
Third trimester	5.53	0.69	6.05	0.84	5.42	1.20	6.15	0.86			
Evening											
First trimester	9.56	1.50	9.74	0.68	11.86	0.97	11.80	1.15			
Second trimester	10.07	1.10	11.46	0.85	10.72	1.02	12.06	0.84	4.15	6	0.657
Third trimester	11.13	0.71	10.16	0.88	10.82	1.14	11.41	0.73			
Carbohydrate (% TEI)											
Morning											
First trimester	13.87	1.11	14.14	1.15	12.75	1.78	10.30	1.35			
Second trimester	12.80	0.97	11.72	0.78	10.17	0.91	10.91	1.20	4.53	6	0.606
Third trimester	11.56	0.69	12.45	0.72	11.86	0.93	10.31	0.72			
Lunch											
First trimester	13.19	0.88	11.97	0.92	15.31	1.21	13.50	0.93			
Second trimester	14.40	1.14	12.41	0.68	15.02	1.20	15.43	0.88	4.90	6	0.556
Third trimester	13.22	1.13	13.91	0.95	14.88	1.47	14.05	1.22			
Afternoon											
First trimester	11.62	1.60	12.78	1.05	9.63	1.62	12.36	1.38			
Second trimester	10.89	1.14	9.79	0.95	10.13	1.31	11.19	1.01	2.22	6	0.898
Third trimester	11.43	1.04	10.59	0.83	10.40	1.67	11.88	0.97			
Evening											
First trimester	13.45	1.73	11.75	1.10	18.11	1.43	16.68	1.36			
Second trimester	12.30	0.93	14.76	0.93	15.37	1.01	15.23	1.49	9.01	6	0.173
Third trimester	13.05	1.38	12.48	1.19	14.60	1.37	16.34	1.50			

Note: Early/Early: early first and last eating episodes; Early/Late: early first and late last eating episodes; Late/Early: late first and early last eating episodes; Late/Late: late first and last eating episodes. % TEI: percentage of total energy intake. Generalised Estimating Equations model, adjusted: age, pre-gestational body mass index, schooling, chronotype (MSF), physical activity and frequency of nausea in the last 30 days. Significant Tests of Model Effects showed in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05. Number of pregnant women who had a meal n (%): Morning: EE= 61 (96.83); EL= 84 (96.55); LE= 65 (86.67); LL=67 (89.33); Lunch: EE= 62 (98.41); EL=85 (97.70); LE=73 (97.33); LL= 71 (94.67); Afternoon: EE= 56 (88.89); EL=83 (95.40); LE=67 (89.33); LL= 69 (92); Night: EE=60 (95.24); EL= 84 (96.55); LE=74 (98.67); LL= 74 (98.67).

Artigo 3. Artigo intitulado "A higher energy intake at night-time impacts daily energy distribution and contributes to excessive weight gain during pregnancy", que será submetido à revista *Nutrition* (*Impact Factor* =3.734).

A higher energy intake at night-time impacts daily energy distribution and contributes to excessive weight gain during pregnancy

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Running head: Energy intake at night and gestational weight gain

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Abstract

Objective: The aim of this study was to analyze the effect of night-time energy intake on daily energy distribution and weight gain during pregnancy. **Research Methods & Procedures:** This is a prospective cohort study carried out with 100 pregnant women and the data collection occurred once per trimester. A dietary intake was assessed by three 24-Hour Dietary Recalls and the distribution of energy and macronutrients intake was evaluated at meals throughout the day. Women were classified as “lower” or “higher” percentage energy consumed at night (19:00 to 05:59) if these values were below or above the median. Institute of Medicine recommendation was used to assess the adequacy of weight gain. Generalized Estimating Equation models were used to determine the effects of night-time intake and gestational trimesters on daily energy distribution and weight gain. **Results:** In the overall pregnancy the “higher” group consumed a higher percentage of energy and macronutrients in the evening meals, and less energy, proteins and lipids in the morning meals when compared to the “lower” group. Also women in the "higher" group had greater excessive weight gain in the third trimester when compared to the “lower” group. **Conclusion:** Pregnant women with higher energy intake at night-time had lower percentage of energy and carbohydrates intake in the morning meals during pregnant and worse standard of gestational weight gain in the third trimester.

Keywords: pregnant women; gestational weight gain; pregnancy diet; chrono-nutrition; meal timing; time of energy intake.

Highlights:

This study analyzed longitudinal effect of night-time intake on weight gain.

Higher night-time intake influenced lower energy intake in the morning meals.

Higher night-time intake impacted excessive weight gain in the third trimester.

Introduction

Excessive gestational weight gain is considered an important risk factor for the adverse maternal and neonatal outcomes [1], childhood obesity [2], and women being overweight during reproductive age due to postpartum weight retention [3]. Thereby, as pregnancy is a critical part of the life cycle, it is an opportunity for change and adaptation of healthy behaviors [4].

Nutritional interventions during pregnancy - with the objective of preventing excessive weight gain - are traditionally directed towards diet in terms of quality and quantity, as well as the encouragement to practice physical activity [4,5]. However, recent studies suggest that not only what and how much, but also when we eat plays a role in body weight regulation. These studies have been conducted with healthy adult males and non-pregnant females and emphasized that higher food intake at night-time is associated with greater risk of excessive weight [6,7,8,9,10], which seems to occur due to the worse metabolic response [11,12] and the reduced thermic effect of food [13] at night.

Pregnant women are considered a group with nutritional vulnerability [3], but to the best of our knowledge no studies have discussed its potential association with night-time energy intake and gestational weight gain. The aim of this study was to analyze the effect of night-time energy intake on daily energy distribution and weight gain during pregnancy. We hypothesized that pregnant women with higher caloric intake at night-time have lower food intake in the morning meals and excessive weight gain during pregnancy.

Materials and methods

Study design and ethics

A prospective cohort study carried out with healthy low risk pregnant women with a single fetus (aged 18 years and older). These women were recruited from antenatal clinics in the public health service in the city of Uberlandia, Minas Gerais, Brazil, between October 2015 and February 2017. The exclusion criteria were positive test to human immunodeficiency virus, syphilis, toxoplasmosis, rubella, cytomegalovirus, varicella and pregnant women with foetal malformation or anomalies. This study was approved by the Human Research Ethics Committee (protocol number 1.199.829/2015) at the Federal University of Uberlandia. All the procedures conformed to the principles of the Helsinki Declaration and all women provided their written informed consent.

The sample size required for this study analysis was determined using the G*Power software version 3.1 [14]. The sample size calculations were based on ANOVA -repeated measures, within-between interaction- with an effect size of 0.25, an alpha level of 0.05, 95% power, 2 groups, 3 measurements, a correlation between repeated measures of 0.5 and non-sphericity correction ϵ of 1. Given these specifications, a total sample of 44 women was required at the final follow-up for statistical analysis.

During the period of the study, 142 women in the first trimester of pregnancy were invited to participate. Eleven pregnant women refused to participate, 10 were excluded because they did not meet the age criteria and 21 had not completed all of the evaluations. A final sample of 100 pregnant participants was used in the study.

Assessment in gestational trimesters

The data collection occurred once per trimester: First trimester: ≤ 12 gestational weeks; Second: 20th to 26th weeks; and Third: 30th to 37th weeks. Through face-to-face interviews, an initial questionnaire was used to collect data including maternal age, marital status, educational level, clinical history, physical activity and chronotype. Chronotype was derived using mid-sleep time on free days on the weekend (MSF), with a further correction for calculated sleep debt – calculated as the difference between average sleep duration on weekends and weekdays [15]. Data on dietary intake, meal time and weight gain was collected at interview in each trimester and is described in the following topics.

Dietary intake and meal time assessment

A dietary intake was assessed by three 24-Hour Dietary Recalls (24HRs) in each trimester using the 5-stage multiple-pass interviewing technique [16] by trained researchers. The first 24HR was collected by a face-to-face interview and the other two were conducted through telephone interviews [17]. The 24HRs were conducted on non-consecutive days, including one on the weekend.

All of the following variables were calculated using the average of the 24HRs in each trimester. The 24HRs that showed implausible data with energy intakes of less than 500 kcal/day or more than 3500 kcal/day [18] were excluded and were not included in the calculations of average consumption. In this case, the plausible data of the other 24HRs of the participant were included in the analysis.

The intake of energy and nutrients was calculated using the software Dietpro®, version 5i, with Brazilian database [19] as a reference, followed by nutrient information from food labels and the international nutrient database [20]. Nutrient supplementation was not considered in the evaluation of dietary intake composition.

The number of eating episodes was determined by the number of caloric events ≥50 kcal/day, with time intervals between food and/or beverage consumptions of ≥15 min [21], and the meal and snacks clock time were reported for each eating episodes in the 24HR. To classify the types of meals or snacks (breakfast, mid-morning snacks, lunch, afternoon snacks, dinner and night-time snacks), we considered participants' perceptions of the type of meal and/or snacks [22], and also analysed the type of food often consumed by the Brazilian population at every meal [23].

Daily energy and macronutrient distribution was segregated in four meal times: Morning (breakfast and mid-morning snacks), Lunch, Afternoon (afternoon snacks), and Evening (dinner and night-time snacks). The energy, protein, fat and carbohydrates intakes for each meal times were calculated as a percentage of total energy intake.

Food intake at night was evaluated by calculating the energy consumed at night-time (19:00 to 05:59) as a percentage of total energy intake. Based on this value, pregnant women were classified as “lower” or “higher” night-time intake if these values were below or above the median of the population for at least two trimesters (First trimester = 29.96%; Second = 29.83%; Third = 30.64%).

Adequacy of weight gain assessment

Maternal height was measured at first trimester evaluation. The pre-pregnancy weight was self-reported and pregnancy weight was measured in each trimester. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). The World Health Organization cut-off points [24] were used to determine the classifications of pre-pregnancy BMI. The Institute of Medicine recommendation was used to assess weight gain during pregnancy [25]: In the first trimester the adequate weight gain range of 0.5 to 2 kg and mean 0.51; 0.42; 0.28 and 0.22 kg per week in the 2[nd] and 3[rd] trimester, for women who had pre-gestational BMI classified as underweight, normal weight, overweight and obese, respectively.

The adequacy of the weight gain was evaluated in each trimester by the following described steps: first, the recommended weight gain [25] in each trimester was calculated considering the number of gestational weeks corresponding to the interval between evaluations, except for the first trimester in which the recommended weight gain was considered in the range of 0.5 to 2 kg. Second, the weight gain in each trimester was evaluated using the current measured weight value subtracted from the value of the weight in the previous trimester, or pre-gestational weight in the case of the first trimester. Third, to evaluate the adequacy of the weight gain in the trimesters, the value of the weight gain in each trimester was divided by the value of the recommended weight gain. Values equal to 1 represent a weight gain equal to the recommended weight gain (Adequate), values greater than 1 represent a weight gain above the recommended amount (Excessive), and values lower than 1 represent a weight gain below the recommended amount (Insufficient).

Statistical analyses

The descriptive analyses of maternal characteristics between the groups was performed using Generalized Linear Models (GLzM) for continuous variables and Fisher's exact test for categorical variables. Categorical data was presented as frequencies and percentages, while continuous data was presented as means and standard error. Generalized Estimating Equation (GEE) models using gamma distributions were used to determine the effects of night-time intake -“lower” or “higher” night-time intake groups - and gestational trimesters (independent variables) on energy, macronutrient and micronutrient total daily intakes, meal time, number of eating episodes, daily energy and macronutrient distribution and adequacy of weight gain during pregnancy (dependent variables). Multiple comparisons were performed using Bonferroni post-hoc test when necessary. All models were adjusted for age, pre-gestational BMI, level of education, chronotype, physical activity and frequency of nausea. Statistical analyses were performed using SPSS 20.0 (Chicago, IL, USA), and a p-value of <0.05 was considered statistically significant.

Results

The sociodemographic, anthropometric, chronobiological and personal characteristics are shown in Table 1. The pregnant women in the "higher" night-time intake group had a greater tendency for eveningness during pregnancy, lower physical activity in the second trimester, and skipped more breakfasts in the third trimester when compared to the “lower” group (Table 1).

Table 1. Sociodemographic, anthropometric, chronobiological and personal characteristics of women during pregnancy (n = 100/each trimester).

Variables	All womem (n=100)	Night-time energy intake		p-value
		Lower (n=55)	Higher (n=45)	
	Mean±SE or n (%)	Mean±SE or n (%)	Mean±SE or n (%)	
Age (years)	27.72±0.56	28.02±0.76	27.37±0.82	0.562
Marital status				
Married or live with a partner	79 (79)	45 (81.8)	34 (75.6)	0.440
Single	21 (21)	10 (18.2)	11 (24.4)	
Level of education				
Basic education	5 (5)	2 (3.6)	3 (6.7)	0.349
High school education	68 (68)	34 (61.8)	34 (75.6)	
Higher education	27 (27)	19 (34.5)	8 (17.8)	
Chronotype (MSF)				
(h:min)	4.26±1.26	4.04±0.15	4.52±0.11	**0.010**
Pre-gestacional BMI				
kg/m^2	24.25±0.43	24.10±0.56	24.43±0.62	0.688
Underweight	6 (6)	3 (5.5)	3 (6.7)	0.247
Normal weight	57 (57)	35 (63.6)	22 (48.9)	
Overweight	24 (24)	10 (18.2)	14 (31.1)	
Obese	13 (13)	7 (12.7)	6 (13.3)	
Physical activity (no)				
1st trimester	83 (83)	43 (78.2)	40 (88.9)	0.188
2nd trimester	79 (79)	38 (69.1)	41 (91.1)	**0.012**
3rd trimester	80 (80)	42 (76.4)	38 (84.4)	0.452
Skipping breakfast				
1st trimester	6 (6)	1 (1.8)	5 (11.1)	0.080
2nd trimester	6 (6)	1 (1.8)	5 (11.1)	0.080
3rd trimester	7 (7)	1 (1.8)	6 (13.3)	**0.043**
Meals after-dinner				
1st trimester	33 (33)	21 (38.2)	12 (26.7)	0.315
2nd trimester	36 (36)	19 (34.5)	17 (37.8)	0.900
3rd trimester	38 (38)	11 (18.2)	17 (37.8)	0.073

Note: Generalized Linear Models (GLzM) and Fisher’s exact test. Values are presented as mean and SE (standard error) or n (%).Chronotype (MSF) was derived from time of mid-sleep on free days (weekend), with further correction for calculated sleep debt – the difference between average sleep duration at weekends and on weekdays. BMI= body mass index. Physical activity (no): shows pregnant women who did not perform physical activity.

No effect of gestational trimesters was found on food intake, daily of energy distribution, meal times and number of eating episodes (data not shown in tables). Thus, total energy intake (Kcal), macronutrients (grams and % energy intake in the meals), nutrients/1000 kcal, meal time and number of eating episodes did not change during gestational trimesters ($p > 0.05$).

Table 2 shows an effect of the night-time intake in the overall pregnancy on food intake, meal times and number of eating episodes. The pregnant women in the “lower” night-time intake group had higher intakes of energy (Kcal), lipids (g), carbohydrates (g), calcium (mg/1000Kcal), iron (mg/1000Kcal) and riboflavin (mg/1000 Kcal) (Table 2). When food consumption was evaluated after 19:00, the “higher” group showed greater intakes of energy (% and Kcal), proteins (g) and carbohydrates (g) (Table 2). Table 2 also shows that the pregnant women in the group "higher” had later breakfast times and also more number of eating episodes, compared to the "lower” group.

Table 2. Effect of night-time energy intake in the overall pregnancy and in the gestational trimesters on food intake, meal times and number of eating episodes during pregnancy (n = 100/each trimester).

Dependents variables	**Independents variables - Night-time energy intake**									
	Lower	**Higher**		**Lower**			**Higher**			
	Overall (n=165)	**Overall (n=135)**	p-	**1st T (n=55)**	**2nd T (n=55)**	**3rd T (n=55)**	**1st T (n=45)**	**2nd T (n=45)**	**3rd T (n=45)**	p-
	Mean±SE	Mean±SE	value	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	Mean±SE	value
Daily total calories and macronutrients										
Energy (kcal)	1732.17±54.76^{a}	1552.90±42.50^{b}	**0.009**	1706.55±72.61	1743.94±78.49	1746.31±66.94	1542.26±77.60	1586.29±72.45	1530.70±57.03	0.864
Protein (g)	70.38±2.50^{a}	65.05±2.32^{b}	0.117	68.82±3.62	69.66±3.49	72.73±3.46	60.87±3.62	71.26±4.37	63.45±3.73	0.226
Fat (g)	67.17±2.50^{a}	58.56±2.04^{b}	**0.007**	63.76±3.11	68.42±3.53	69.47±3.34	57.94±3.63	59.73±3.28	58.03±2.98	0.705
Carbohydrate (g)	211.29±6.66^{a}	191.29±5.72^{b}	**0.022**	213.54±9.79	212.84±10.19	207.54±7.70	194.32±9.27	190.92±9.64	188.66±7.79	0.982
Calories and macronutrients after 7 p.m.										
% EI	26.85±0.57^{a}	35.81±0.81^{b}	**0.001**	27.37±1.59	28.26±1.14	25.03±1.05	33.22±1.79	37.22±1.75	37.15±1.66	0.148
Energy (kcal)	478.87±16.46^{a}	566.04±23.20^{b}	**0.002**	488.50±38.89	508.32±33.58	442.25±25.99	526.13±39.24	607.25±51.13	567.64±36.15	0.516
Protein (g)	23.27±1.06^{a}	27.20±1.42^{b}	**0.024**	22.72±2.32	24.24±2.20	22.89±1.67	23.41±1.89	32.79±3.98	26.20±2.52	0.450
Fat (g)	19.31±0.75	21.67±1.07	0.066	19.31±1.58	20.71±1.51	18.00±1.35	20.20±1.91	22.67±2.12	22.24±1.69	0.586
Carbohydrate (g)	52.95±2.18^{a}	65.42±3.13^{b}	**0.001**	55.96±4.99	56.23±3.98	47.18±2.88	62.67±5.23	68.03±5.83	65.68±4.69	0.330
Daily total Nutrients/1000 kcal										
Calcium (mg)	302.65±12.30^{a}	260.31±13.31^{b}	**0.021**	308.20±20.62	299.67±19.28	300.15±20.11	254.14±21.82	268.27±25.72	258.71±20.22	0.868
Cholesterol (mg)	137.25±6.73	126.93±4.88	0.210	141.71±16.72	128.82±6.64	141.63±6.84	117.70±5.84	143.55±10.56	121.03±8.20	0.731
Iron (mg)	4.09±0.09^{a}	3.79±0.10^{b}	**0.024**	4.27±0.18	3.90±0.13	4.11±0.12	3.79±0.15	3.89±0.15	3.70±0.19	0.252
Fiber (g)	9.54±0.34	10.23±0.34	0.151	10.16±0.75	9.34±0.35	9.15±0.43	10.83±0.60	9.30±0.48	10.63±0.54	0.211
Phosphorus (mg)	512.32±9.55	507.13±10.28	0.712	509.99±18.92	502.25±13.56	524.99±14.39	497.56±17.23	535.09±18.69	489.89±16.57	0.076
Riboflavin (mg)	0.55±0.03^{a}	0.45±0.03^{b}	**0.011**	0.62±0.08	0.53±0.03	0.50±0.03	0.43±0.04	0.47±0.04	0.45±0.04	0.397
Sodium (mg)	1284.95±23.58	1337.82±34.71	0.205	1247.41±45.44	1300.49±33.20	1307.79±40.41	1316.59±56.21	1380.27±55.26	1317.57±57.47	0.742
Thiamine (mg)	0.53±0.02	0.60±0.03	0.086	0.52±0.04	0.51±0.03	0.56±0.05	0.66±0.06	0.55±0.05	0.60±0.05	0.547
Vitamin B6 (mg)	0.35±0.01	0.35±0.02	0.852	0.35±0.03	0.36±0.02	0.33±0.02	0.33±0.03	0.40±0.04	0.34±0.03	0.669
Vitamin C (mg)	76.41±13.09	80.11±13.34	0.843	83.62±14.89	74.68±26.44	71.44±21.34	64.59±10.06	101.77±38.36	78.23±18.57	0.415
Zinc (mg)	5.63±0.17	5.41±0.21	0.416	5.66±0.29	5.58±0.29	5.66±0.30	4.83±0.28	6.17±0.42	5.31±0.34	0.084
Meal and snack times (h:min)										
Breakfast	8:18±0:06^{a}	8:37±0:07^{b}	**0.042**	8:21±0:10^{ab}	8:09±0:10^{a}	8:24±0:10^{ab}	8:17±0:11^{ab}	8:52±0:11^{b}	8:41±0:10^{ab}	**0.044**
Morning snacks	9:58±0:04	10:10±0:05	0.092	10:07±0:07	9:49±0:08	9:58±0:06	10:13±0:09	10:12±0:08	10:04±0:07	0.386
Lunch	12:16±0:04	12:19±0:04	0.684	12:12±0:05	12:17±0:04	12:20±0:05	12:29±0:07	12:13±0:06	12:13±0:05	**0.049**
Afternoon	16:17±0:05	16:01±0:04	0.095	16:13±0:09	16:19±0:06	16:20±0:07	16:08±0:09	16:02±0:05	16:08±0:07	0.757
Dinner	20:06±0:07	19:58±0:05	0.706	19:58±0:09	20:02±0:08	20:02±0:07	20:04±0:08	19:59±0:06	19:50±0:07	0.433
Night-time Snack	22:00±0:12	22:24±0:10	0.126	22:02±0:18	21:50±0:11	22:09±0:19	22:21±0:20	22:29±0:15	22:22±0:10	0.642
Number of eating episodes										
	4.91±0.11^{a}	4.60±0.10^{b}	**0.027**	4.93±0.15	5.00±0.13	4.81±0.14	4.67±0.16	4.45±0.17	4.66±0.13	0.294

Note: Generalized Estimating Equations model, adjusted: age, pre-gestational body mass index, level of education, chronotype, physical activity and frequency of nausea. Overall Pregnancy = Total gestational data's values -represent the average of the three trimesters (n=300). Significant Tests of Model Effects shown in bold. Bonferroni post-hoc test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05. %EI = Energy consumed during this period divided by the total daily energy intake. SE = standard error. T = trimester.

As expected, the pregnant women in the “higher” night-time intake group showed in the overall pregnancy a higher percentage of energy intake in the evening meals, as well as a higher percentage of protein, lipid and carbohydrate intake during these meals, compared to the “lower” group. Still, the "higher” group showed lower percentages of energy, protein and lipid intake in the morning meals, compared to the “lower” group (Figure 1).

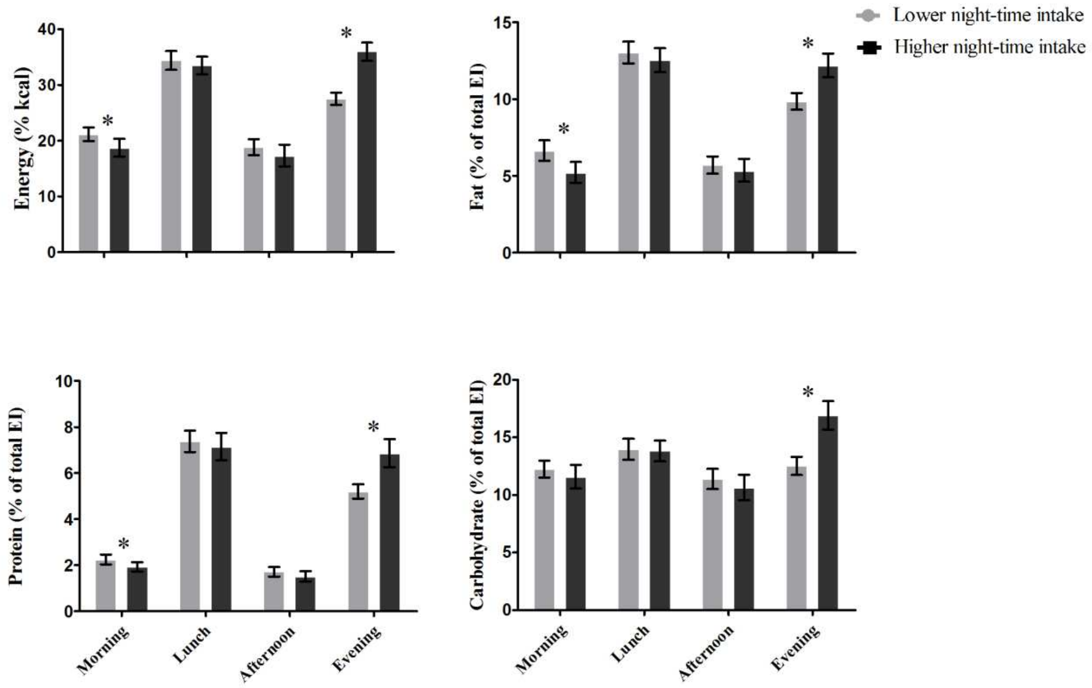

Figure 1. Effect of night-time energy intake in the overall pregnancy on daily energy and macronutrients distribution (Total gestational data’s values -represent the average of the three trimesters-, n=300).

Note: Generalized Estimating Equations model, adjusted: age, pre-gestational body mass index, level of education, chronotype, physical activity and frequency of nausea. Bonferroni post-hoc test: * represent statistical difference in pairwise comparisons, p-value < 0.05. % of total EI = Energy consumed during each period was divided by the total daily energy intake.

Figure 2 shows the effect of night-time energy intake on daily energy distribution in the meals of each gestational trimester separately. It can be noted that in the analysis within groups, the "lower" group showed energy intake in the evening meals similar to morning and lunch meals and higher than the afternoon meals in the first and second trimesters. But in the third trimester, this group showed energy intake in the evening meals similar to morning and afternoon meals and smaller than lunch meals (Figure 2). The “higher” group, on the other hand, showed energy intake in the evening meals higher than morning and afternoon meals and similar to lunch meal in all trimesters (Figure 2). When comparing the energy intake between groups, the groups differed in the energy intake of the evening meals in the second and third trimesters, and the "higher" group showed greater consumption during this meal, compared to the "lower” group (Figure 2).

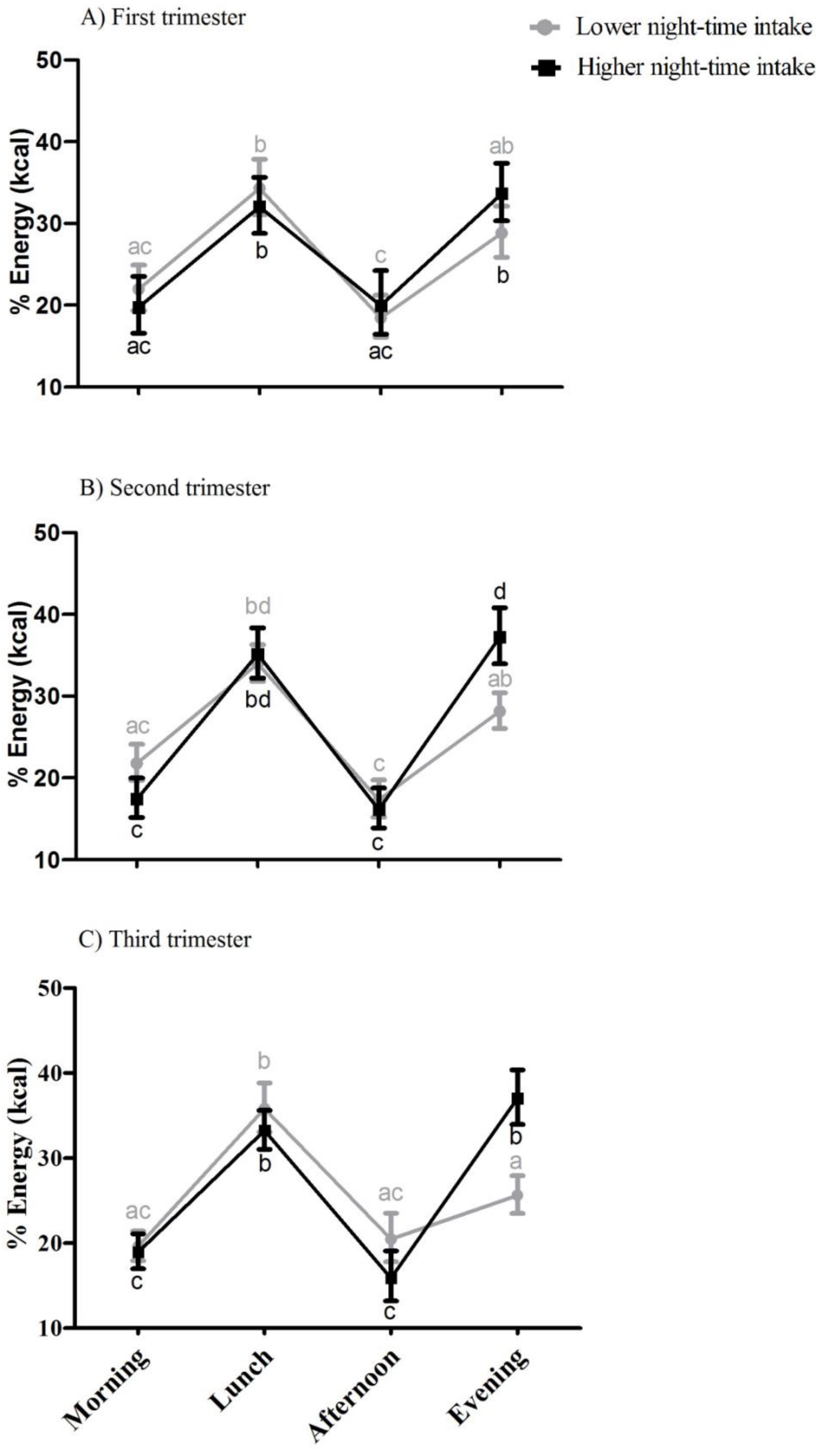

Figure 2. Effect of night-time energy intake on daily energy distribution in each gestational trimester (n = 100/each trimester).

Note: Generalized Estimating Equations model, adjusted: age, pre-gestational body mass index, level of education, chronotype, physical activity and frequency of nausea. Bonferroni test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05. % Energy = Energy consumed during each period was divided by the total daily energy intake.

Figure 3 shows that there was no change in the adequacy of weight gain of the women within the "lower" group during pregnancy (mean±SE: 1T= 1.42±0.17, 2T= 1.42±0.15, 3T= 1.48±0.10). On the other hand, the "higher" group showed a difference in the adequacy of weight gain from the first to the third trimester, increasing excessive weight gain (p-value = 0.007; mean difference= 0.93±0.27) (mean±SE: 1T= 1.35±0.15; 2T= 1.57±0.19; 3T= 2.29±0.21).

The effect of night-time intake on adequacy of weight gain was found between groups in the third trimester with a greater excessive weight gain in the "higher" group (mean±SE: 3T= 2.29±0.21), when compared to the "lower" group (mean±SE: 3T= 1.48±0.10) (p-value= 0.009; mean difference= 0.81±0.24) (Figure 3).

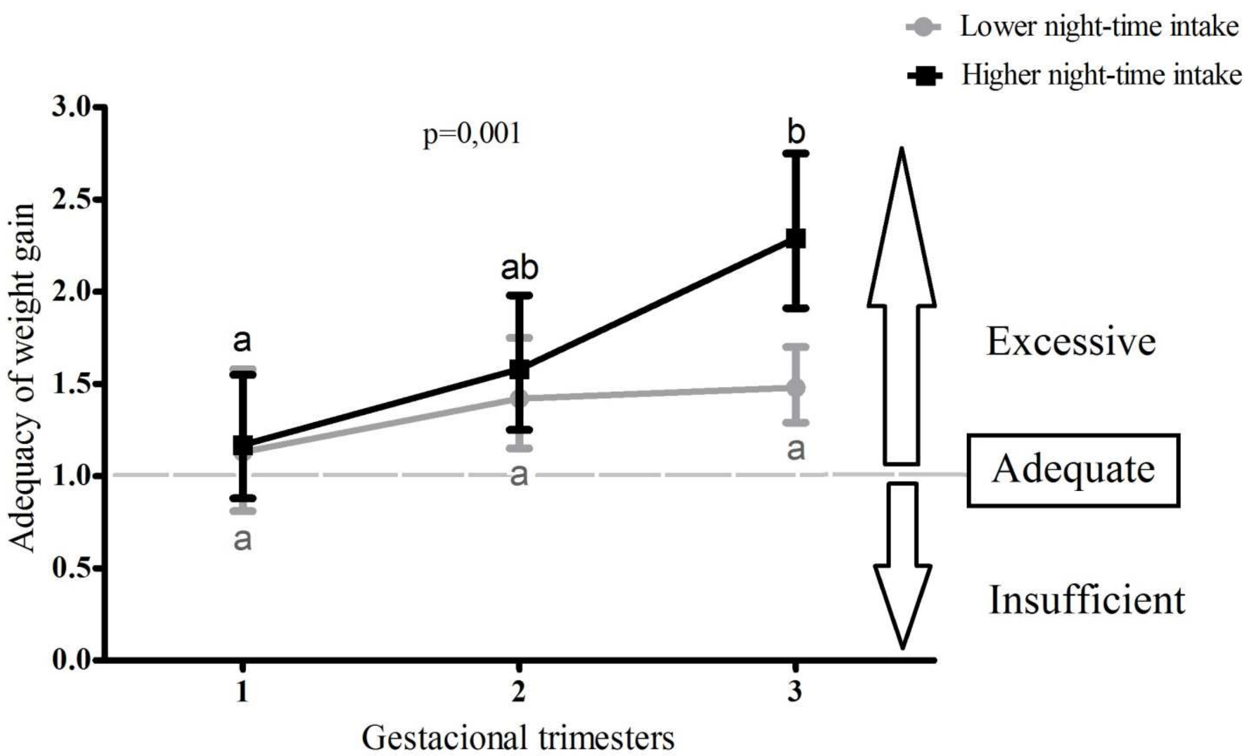

Figure 3. Effect of night-time energy intake in the gestational trimesters on adequacy of weight gain during pregnancy (n = 100/each trimester).

Note: Generalized Estimating Equations model, adjusted: age, pre-gestational body mass index, level of education, chronotype, physical activity and frequency of nausea. Bonferroni test: different letters represent statistical difference in pairwise comparisons, p-value < 0.05.

Discussion

As far as we are aware, this is the first cohort with pregnant women that investigated the effect of higher energy intake at night-time on weight gain and daily energy distribution throughout pregnancy. Our study showed that the pregnant women with a higher intake at night had greater excessive weight gain in the third trimester when compared to the women with lower intake at night. It is important to point out that there was no difference in energy intake and macronutrients in the third trimester between groups of “higher” and “lower” night-time intake. Another relevant result found in our study was that in the overall pregnancy the women who had a higher energy intake at night consumed a higher percentage of energy and macronutrients in the evening meals, and less energy, proteins and lipids in the morning meals when compared to the women who had a lower intake at night-time.

These results are consistent with other studies conducted with adult males and non-pregnant females [6,7,8,10] reporting the link between energy intake at night-time and weight regulation. In general, this evidence has shown that the higher food intake at night-time was associated with greater risk of excessive weight - evaluated by body mass index (BMI) - [6,7,8,10]. Other studies have also showed that the higher evening intake relative to morning intake was positively associated with BMI [9], and the distribution energy throughout the day with a larger proportion of total daily energy consumed in the morning and smaller in the evening was favorable for weight loss in individuals undergoing treatment for weight loss [26]. This topic should be better investigated in pregnant women and, if the findings of this study are confirmed, meal timing and daily energy distribution should be one of the strategies to be addressed in the nutritional counseling of pregnant women.

A potential mechanism for excessive gestational weight gain in response to higher energy intake at night-time may be related to the morning/evening difference in the diet-induced thermogenesis (DIT), being that DIT is lower in the evening than in the morning [13], thereby potentially promoting weight gain. It is worth mentioning that DIT does not appear to change during pregnancy and there is no difference between normal weight and overweight women [27]. Another possibility that may justify the relationship of weight gain and intake at night are probably related to the influence that food intake at night has on the increase of glucose and insulin concentrations [11], the reduction of fat oxidation [12], metabolic changes that could favor weight gain.

In addition, a mechanism that could explain the relationship between night-time intake and daily energy distribution is related to the fact that a better energy distribution throughout the day with higher energy intake in the morning and midday can provide the best satiety and hunger control during the day [28,29], favoring lower food consumption at night-time. Furthermore, higher habitual food intake at night-time can favor the perpetuation of this energy distribution pattern, since after a large evening meal the individual may not be in a totally post-absorptive state the following morning [30], resulting in reduced breakfast intake and a subsequent increased food intake in the evening meal [31]. Moreover, it is worth noting that a better caloric distribution has been shown to have an important effect on the healthy nutritional status of non-pregnant adults [9]. In this sense, studies with pregnant women showed that less energy intake at night-time [32], more specifically the reduction of carbohydrate intake at night-time [33], was beneficial for glucose and insulin metabolism [32,33].

However, it is important to mention that our study verified that the majority of pregnant women gained weight excessively in all gestational trimesters. Excessive gestational weight gain may predispose women to clinical complications such as gestational hypertension [34], pre-eclampsia, and cesarean delivery [1], as well as a greater retention of postpartum weight [3]. In addition, the pregnant women in our study did not change their energy intake during pregnancy in both groups of “higher” and “lower” night-time intake.

The present study also found that the pregnant women in the group of “higher” night-time intake showed lower intakes of nutrients such as calcium, iron and riboflavin in the overall pregnancy, later eating times for breakfast and less number of eating episodes when compared to the women who had a lower intake at night-time. Previously, our research group showed that the earlier the time of the first meal - supposedly breakfast - and a higher number of eating episodes were associated with a better diet quality for fruit components in women in the first gestational trimester [35]. Other studies with adult population have shown that low ratio of evening/morning energy intake and more eating episodes may be related to better diet quality and also lower body mass index [9].

Some limitations should be considered as the possibility that some women may have underreported their intake [36], especially in the group "higher" night-time intake. However, it is worth mentioning that food intake results expressed as a percentage of energy intake may have not been altered by the exclusion of under-reporters [37]. Another limitation in our study that needs to be considered is that our analysis was performed with only 100 pregnant women who had regular appointments in the public health system, and the generalization of the results for all pregnant women cannot be done, especially in high-risk pregnant women.

In conclusion, pregnant women with higher energy intake at night-time had lower percentage of energy and carbohydrates intake in the morning meals during pregnant and worse standard of gestational weight gain in the third trimester. These results may help improve the effectiveness of weight-control interventions in the prenatal care by emphasizing the importance of adequate daily energy distribution with the lowest food intake at night.

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5 CONCLUSÕES

A partir das análises transversais (Artigo 1) foi possível concluir que a maior duração da alimentação, o horário mais cedo da primeira refeição, o maior número de refeições e o cronotipo matutino foram associados à melhor qualidade da dieta no primeiro trimestre gestacional. Com relação às análises longitudinais (Artigos 2 e 3), foi possível concluir que as gestantes que realizavam a primeira refeição mais cedo consumiram maior percentual de energia e carboidratos nas refeições da manhã e menor nas refeições da noite durante a gestação, apresentaram melhor qualidade da dieta, realizaram com maior frequência o café da manhã e consumiram maior número de refeições por dia, quando comparadas às gestantes que realizavam a primeira refeição mais tarde (Artigo 2). Além disso, as gestantes que tinham maior consumo calórico à noite apresentaram menor consumo de energia, proteínas e lipídios nas refeições da manhã durante a gestação e maior ganho de peso no terceiro trimestre, quando comparados com as gestantes que consumiram menos energia à noite (Artigo 3).

Estes resultados, se forem confirmados em estudos futuros, poderão melhorar a eficácia das intervenções nutricionais no pré-natal, enfatizando a importância do menor consumo alimentar depois das 19h com o intuito de favorecer o ganho de peso adequado. Além disso, o horário de realização da primeira refeição mais cedo poderá colaborar para melhor qualidade da dieta das gestantes desde o início da gestação e favorecer o menor consumo alimentar à noite, contribuindo assim para a prevenção de complicações metabólicas e nutricionais materno-fetais.

6 PERSPECTIVAS

Como perspectiva, pretende-se realizar análises adicionais e elaborar artigos os seguintes objetivos:

- Verificar a associação entre cronotipo e as variáveis relacionadas ao consumo alimentar, tendo em visto que o cronotipo foi avaliado como variável independente somente no primeiro artigo e nos demais foi considerado como variável de ajuste.
- Avaliar a associação do intervalo entre o horário de acordar e a primeira ingestão calórica e entre o horário de dormir e a última ingestão calórica com a distribuição circadiana de energia e o ganho de peso durante a gestação.
- Avaliar a associação do ponto médio da ingestão calórica com a qualidade da dieta e o ganho de peso durante a gestação.

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ANEXO

ANEXO A - Comprovante de aprovação do projeto de pesquisa pelo Comitê de Ética em Pesquisa (CEP).

UFU Comitê de Ética em Pesquisa

UNIVERSIDADE FEDERAL DE UBERLÂNDIA/MG

Plataforma Brasil

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: INFLUÊNCIA DO TRABALHO EM TURNOS E DA QUALIDADE DA DIETA NO PERÍODO GESTACIONAL SOBRE OS DESFECHOS GRAVÍDICOS

Pesquisador: Yara Cristina de Paiva Maia

Área Temática:

Versão: 2

CAAE: 43473015.4.0000.5152

Instituição Proponente: Faculdade de Medicina

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 1.199.829

Situação do Parecer:
Aprovado

Endereço: Av. João Naves de Ávila 2121- Bloco "1A", sala 224 - Campus Sta. Mônica
Bairro: Santa Mônica **CEP:** 38.408-144
UF: MG **Município:** UBERLANDIA
Telefone: (34)3239-4131 **Fax:** (34)3239-4335 **E-mail:** cep@propp.ufu.br

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APÊNDICES

APÊNDICE A – Termo de consentimento livre e esclarecido.

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO

Você está sendo convidado (a) para participar da pesquisa intitulada **“Influência do trabalho em turnos e da qualidade da dieta no período gestacional sobre os desfechos gravídicos”**, sob a responsabilidade dos pesquisadores: Yara Cristina de Paiva Maia, Cristiana Araújo Gontijo e Laura Cristina Tibiletti Balieiro. Nesta pesquisa nós pretendemos descreve a influência do trabalho em turnos e da qualidade da dieta no período gestacional sobre os desfechos gravídicos em gestantes atendidas na rede pública de saúde da cidade de Uberlândia, MG. O Termo de Consentimento Livre e Esclarecido será obtido pela pesquisadora Cristiana Araújo Gontijo, Laura Cristina Tibiletti Balieiro e Bruna Borges Macedo no momento da apresentação do estudo que será realizado no momento da consulta pré-natal, no primeiro, segundo e terceiro trimestre gestacional.

Na sua participação você fornecerá informações sobre: Condição socioeconômica; Trabalho em Turno; Identificação do Cronotipo; Avaliação Antropométrica (peso, estatura, índice de massa corporal, ganho de peso); Recordatório Alimentar de 24 horas; Questionário de Frequência Alimentar; Nível de atividade física habitual; Intercorrências Durante a Gestação; Avaliação Clínica durante a Gestação; Escala de Sonolência de Epworth; Índice de Qualidade do Sono de Pittsburgh; e dados do prontuário médico, como: cistite, presença de doenças crônicas, hipotireoidismo gestacional, prematuridade, restrição de crescimento intrauterino, abortamento, sangramentos, descolamento prematuro de placenta, alteração do líquido amniótico, edema gestacional, idade gestacional da ocorrência do parto, tipo de parto, exames bioquímicos (dosagem de hemoglobina e hematócrito, glicemia em jejum, teste de tolerância oral de glicose) e pressão arterial. Além das seguintes informações sobre os bebês: peso e comprimento ao nascer, Apgar, má-formações e aleitamento materno na alta hospitalar.

Em nenhum momento você será identificado. Os resultados da pesquisa serão publicados e ainda assim a sua identidade será preservada. Você não terá nenhum gasto e ganho financeiro por participar na pesquisa. Os riscos consistem em constrangimento (“vergonha”) para medição de peso e estatura e responder aos questionários, mas serão tomados todos os cuidados para se evitar qualquer ocorrência deste tipo. Existindo ainda, a possibilidade remota de sua identificação, porém todos os procedimentos serão tomados para preservar seu anonimato, sendo os nomes substituídos por códigos. Além disso, por necessitar de uma disponibilidade do tempo do indivíduo, pode causar desconforto. O benefício será a descrição da influência do trabalho em turnos e da qualidade da dieta no período gestacional sobre os desfechos gravídicos em gestantes atendidas na rede pública de saúde da cidade de Uberlândia, MG.

Você é livre para deixar de participar da pesquisa a qualquer momento sem nenhum prejuízo ou coação. Uma cópia deste Termo de Consentimento Livre e Esclarecido ficará com você. Qualquer dúvida a respeito da pesquisa, você poderá entrar em contato com:

Yara Cristina de Paiva Maia. Professor Adjunto I, Curso de Nutrição, Faculdade de Medicina, Universidade Federal de Uberlândia. Endereço: Avenida Pará, 1720- Bloco 2U, Sala 20, *Campus* Umuarama. Fones: 3218-2084./ Cristiana Araújo Gontijo. Curso de Nutrição, Faculdade de Medicina, Universidade Federal de Uberlândia/ Laura Cristina Tibiletti Balieiro. Curso de Nutrição, Faculdade de Medicina, Universidade Federal de Uberlândia.

Poderá também entrar em contato com o Comitê de Ética na Pesquisa com Seres-Humanos – Universidade Federal de Uberlândia: Av. João Naves de Ávila, nº 2121, bloco 1A, sala 224, Campus Santa Mônica – Uberlândia –MG, CEP: 38408-100; fone: 34-32394131.

Uberlândia,_____de___________________de 201__.

____

Prof. Dr(a) Yara Cristina de Paiva Maia
Coordenadora

____

Cristiana Araújo Gontijo
Nutricionista/ Doutoranda

____

Laura C. Tibiletti Balieiro
Nutricionista/Mestranda

Eu aceito participar do projeto citado acima, voluntariamente, após ter sido devidamente esclarecido.

____

Participante da pesquisa

APÊNDICE B – Instrumento de coleta de dados, Questionário de avaliação.

Preenchimento da equipe executora	Data: ____ / ____ / ___	Código da voluntária:

Questionário de Avaliação

Data nascimento: ___/___/___ Idade: _______________________
Idade da menarca:________ Apresenta ciclos menstruais regulares:_______________
DUM: ___/___/___ DPP: ___/___/___
IG DUM: ____________ IG 1ª USG: _________

Gestações anteriores: (   ) Não   (   ) Sim, quantas: ___________
Intercorrências obstétricas ou gestacionais anteriores:
____
Intercorrências gestacionais atuais:
____

Antecedentes pessoais:
Você tem ou teve alguma destas doenças citadas abaixo:

DOENÇA	SIM	Tempo	
Diabetes (Tipo)			
Dislipidemias			
Hipertensão arterial			
Doença Cardiovascular			
Câncer			
Doença da Tireóide - Especificar:			
Outras			

Condição socioeconômica
Estado civil: Você é:
___Casada___Mora com companheiro ___ Solteira ___ Viúva
___Separada/divorciada
Escolaridade: Até que ano da escola você completou? ________________________
Núcleo familiar: Quantas pessoas moram na sua casa, incluindo você?
Quantos são crianças, menores de 5 anos? _________________________________
Das pessoas que moram em casa, quantas trabalham? ________________________

Estilo de Vida

Você fuma ou já fumou?

____Sim (ler as alternativas) ____Não, nunca fumou (Pular para questão x)

Situação da fumante:

___Você fumava antes da gestação e continua fumando. Quantos cigarro(s) por dia?___

___Você fumava antes da gestação e parou. Quantos cigarro(s) por dia?____

___Você não fumava antes da gestação e passou a fumar na gestação. Quantos cigarro(s) por dia? ____

Você consume ou consumia bebida alcoólica:

____Sim (ler as alternativas) ____Não, nunca bebeu (Pular para próxima questão)

Situação do consumo:

___Você bebia antes da gestação e continua bebendo.

___Você bebia antes da gestação e parou.

___Você não bebia antes da gestação e passou a beber na gestação.

Quantidade, frequência e qual bebida:

Você teve algum desses sintomas nesta gestação?

Azia __sim __não. Se sim, quantas vezes você apresentou azia no último mês?-______

Enjoo/Náusea __sim __não. Se sim, quantas vezes você apresentou náusea no último mês?______

Vômito __sim __não. Se sim, quantas vezes você apresentou vômito no último mês?_______

Desejo de alimento especial __sim __não. Se sim, quantas vezes ocorreu no último mês?______

Desejo de comer coisas que não são alimentos, como giz, terra,...? ___sim ___não

Se sim, quantas vezes você ocorreu no último mês?_____

Uso de suplementos:

Você está fazendo uso de suplementos:( ) Não ( ) Sim:

Se sim, qual:_____________________________Dosagem: ________Frequência:

Uso de medicamentos:

Você está fazendo uso de medicamento:( ) Não ( ) Sim:

Se sim, qual:_____________________________Dosagem: ________Frequência:

Atividade:
Atividade Profissional: ______________________________ Horário de Trabalho: ______________
Trabalho em turno: ( )Sim ( )Não
Turno que trabalha: _____________________ Há quanto tempo?_______________
Já trabalhou em turnos: ( )Sim ( )Não Horários:___________ Há quanto tempo?_____________

Presença de esforço físico intenso, exposição a ruídos, agentes químicos e físicos potencialmente nocivos, estresse, postura predominante no trabalho atual?
____

Atividade Física
Pratica atividade física: ( )Sim ( )Não
Qual: _________________________ Há quanto tempo? ___________
Frequência: ____________________Duração: ______________

Avaliação Antropométrica
Peso pré-gestacional : _____________ Altura: ______________________
IMC pré-gestacional: ____________________________

Medida	1º trimestre	2º trimestre	3º trimestre
Altura			
Semana gestacional			
Peso atual			
IMC atual			

Hábitos de sono
A que horas normalmente você vai dormir durante a semana? ______:_____horas
Quanto tempo você leva para dormir a noite durante a semana? ______ minutos.
A que horas normalmente você acorda durante a semana? _______:_____horas
Você acorda com auxílio de um despertador ou de alguém durante a semana? ( ) sim ( ) não

---

A que horas normalmente você vai dormir nos dias livres (fins de semana ou folga)? ______:______horas

Quanto tempo você leva para dormir a noite nos dias livres (fins de semana ou folga)? ______ minutos.

A que horas normalmente você acorda nos dias livres (fins de semana ou folga)? ______:_____horas

Você acorda com auxílio de um despertador ou de alguém nos dias livres (fins de semana/ folga)? ( ) sim ( ) não

---

Quanto tempo você gostaria de dormir a noite? _______ horas ________ minutos.

Como você considera a qualidade do seu sono de 0 a 10?

0 1 2 3 4 5 6 7 8 9 10

Muito ruim____.____Muito Boa

Uso de medicamento para dormir ou antidepressivos? ( ) Sim ( ) Não

Quais:

1)______________________________ Freq: ______x D S M Consome há _____ A M Dose: ______ g mg

2)______________________________ Freq: ______x D S M Consome há _____ A M Dose: ______ g mg

3)______________________________ Freq: ______x D S M Consome há _____ A M Dose: ______ g mg

4)______________________________ Freq: ______x D S M Consome há _____ A M Dose: ______ g mg

5)______________________________ Freq: ______x D S M Consome há _____ A M Dose: ______ g mg

D: Diária; S: Semanal; M: Mensal.

A: Anos. M: Meses.

APÊNDICE C – Formulário para aplicação de Recordatório Alimentar 24 horas.

Recordatório Alimentar 24 Horas

Código: **______________________**Data Avaliação: **___/___/___** ***REC:__***

Refeição	**Alimentos/Preparações**	**Medida Caseira**
Horário:		
Horário:		
Horário:		
Horário:		
Horário:		
Horário:		