

**The relationship between pregnancy intentions and diet or physical activity behaviours
in the preconception and antenatal periods: A systematic review and meta-analysis**

Isaac NKRUMAH^{1,2}, MSc, RN, Madelon NORTH³, GDipPsych, Emily KOTHE³, PhD, Tze
Lin CHAI⁴, BSc (Hons), Stephanie PIROTTA⁴, MDiet, Siew LIM⁴, PhD, Briony HILL^{4*},
PhD

¹ University Hospital, Kwame Nkrumah University of Science and Technology, PMB,
Kumasi, Ghana

² Garden City University College, PO BOX KS 12775, Kumasi, Ghana

³ School of Psychology, Deakin University, Faculty of Health, Locked Bag 20000, Geelong
3220, Australia

⁴ Monash Centre for Health Research and Implementation, School of Public Health and
Preventive Medicine, Monash University, Level 1, 43-51 Kanooka Grove, Clayton,
Melbourne 3168, Australia

**Corresponding author*

Dr Briony Hill

Monash Centre for Health Research and Implementation

School of Public Health and Preventive Medicine, Monash University

Level 1, 43-51 Kanooka Grove, Clayton, VIC 3168, Australia

E-mail addresses: briony.hill@monash.edu; Phone: (+613) 8572 2380

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Abstract

Introduction: Healthy preconception and antenatal diet and physical activity behaviours are crucial to prevent adverse maternal and offspring outcomes. These behaviours are thought to be linked to pregnancy intentions. The aim of this study was to conduct a systematic review and meta-analysis to determine the association between women's pregnancy intentions and diet or physical activity behaviours in the preconception and antenatal periods.

Methods: Medline Complete, PsycINFO, CINAHL Complete, Global Health, Embase, and INFORMIT: Health Subset were searched in September 2018 for studies that evaluated relationships between pregnancy intentions and dietary and physical activity behaviours. Risk of bias was assessed and random effects meta-analyses were conducted for dietary (food groups; energy and macronutrients; diet quality; and caffeine, iodine and folate intake) and physical activity outcomes.

Results: Of 2623 screened records, 19 eligible studies were identified. Overall risk of bias was moderate to high. Twelve studies measured diet/physical activity behaviours during preconception, 5 during pregnancy, and 2 across both periods. Eleven studies measured pregnancy intention retrospectively, and 8 prospectively measured pregnancy intention. The number of studies available for meta-analyses of individual dietary and physical activity outcomes ranged from 2 to 5. Pregnancy intentions were not associated with preconception fruit, vegetable, or caffeine intake or physical activity. Antenatally, women with intended pregnancies were more likely to report healthier diets, lower caffeine intake and higher physical activity. Insufficient studies were available to conduct subgroup comparisons for prospective/retrospective assessment.

Discussion: Pregnancy intentions were not associated with preconception diet or physical activity behaviours. In contrast, antenatally, women with intended pregnancies demonstrated better diet and physical activity behaviours. Given the small number of studies available for meta-analyses, further research is needed to consolidate our findings. Meanwhile, health professionals can assess women's pregnancy intentions during preconception and pregnancy and encourage a healthy lifestyle.

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Key words

Pregnancy intentions, 'pregnancy, unplanned', preconception, pregnancy, diet, physical activity

Précis

Women's pregnancy intention status is associated with diet and physical activity behaviours during pregnancy but not in the preconception period.

Quick Points

- Women intending to become pregnant do not report different preconception dietary or physical activity behaviours compared with women without pregnancy intentions.
- Women with planned pregnancies report healthier diets, lower caffeine consumption and higher physical activity levels during pregnancy than women with unintended pregnancies.
- These findings highlight that attention is needed to address barriers that hamper women's attempts to improve their dietary and physical activity behaviours during preconception and for pregnant for women with unintended pregnancies.

Introduction

The first 1000 days from conception through to a child's second birthday, are arguably the most critical period to promote good nutrition and healthy growth in children.¹ Given that key embryonic development occurs immediately after conception, often prior to realisation of pregnancy, the maternal preconception period is also a crucial phase impacting offspring development.² Lifestyle factors such as diet and physical activity are two readily modifiable factors that impact short-and long-term maternal and offspring health during this time. For example, inadequate antenatal intake of folic acid, particularly early in the first trimester, is associated with the development of neural tube defects.³ Inadequate iodine intake during pregnancy is associated with adverse reproductive outcomes, including fetal growth retardation, stillbirth, abortion and increased neonatal mortality, as well as neurological damage and intellectual impairment in offspring.⁴ High caffeine exposure (>300 mg) during pregnancy has been linked with increased risk of pregnancy loss and low-birth-weight neonates.⁵

Poor dietary habits and inadequate physical activity are also major individual-level lifestyle factors contributing to obesity.⁶ About half of all women enter pregnancy with above-optimal body weight,⁷ which is associated with a range of adverse maternal and perinatal outcomes such as infertility, pregnancy and delivery complications, congenital anomalies, stillbirth, low birth weight, and breastfeeding problems (lower initiation rates and early breastfeeding cessation).⁸⁻¹⁰ During pregnancy, excessive intake of energy dense, poor nutrient foods, as well as lack of physical activity, have been linked with excessive gestational weight gain, increasing the risk of gestational diabetes, caesarean section, infant macrosomia, and higher long-term weight status for both mother and infant.^{11, 12} Therefore, optimising diet and physical activity behaviours during preconception and pregnancy are essential for promoting positive maternal and infant health outcomes.

Understanding pregnancy planning and intentions is important when exploring motivations for positive lifestyle behaviours before and during pregnancy.¹³ Globally, 44% of all pregnancies are unintended,¹⁴ with similar rates reported in Britain¹⁵ and the US.¹⁶ While definitions in the literature vary,¹⁷ an intended pregnancy generally refers to a pregnancy in which a woman reports that at or just before the time of conception, she wanted to become pregnant.¹⁸ Pregnancy planning is a related construct and may include concepts such as contraceptive use, readiness and intentions for pregnancy, and preparations for future pregnancies.¹⁹ Unintended pregnancies are associated with delayed initiation of antenatal care, fewer antenatal care visits, increased risk of adverse birth outcomes, developmental delay in offspring,^{17, 20} and maternal depression and parenting stress.^{21, 22} Several studies have sought to determine whether pregnancy intentions may be associated with nutrition or physical activity behaviours before or during pregnancy.²³⁻²⁹ However, findings appear to be inconsistent, with some studies highlighting that women who plan to be pregnant or become pregnant appear to have improved eating habits.^{24, 26, 29} In contrast, others have revealed no association²⁷ or poorer diet quality.^{23, 25} Findings are similarly inconsistent for physical activity.^{2, 23, 30, 31} A recent mapping review of 303 studies that explored the relationship between pregnancy intentions and a range of lifestyle behaviour and psychological variables identified an urgent need for meta-analyses to comprehensively synthesise studies in this area, and called for focus on lifestyle behaviours targeting diet and physical activity.¹³ Therefore, the aim of this study was to conduct a systematic review and meta-analysis to determine the association between women's pregnancy intentions and diet and physical activity behaviours in the preconception and antenatal periods. The findings of this review may inform the design of targeted interventions to promote healthy eating habits and improved physical activity for women throughout the reproductive years.

Methods

Information Sources and Search Strategy

The systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines³² and was registered on PROSPERO (registration number CRD42018107854). The search strategy was developed in consultation with a university librarian and was conducted using six databases: Medline Complete, PsycINFO, CINAHL Complete, Global Health, Embase, and INFORMIT: Health Subset. The search strategy combined terms for pregnancy intentions and terms for diet, nutrition, food intake, physical activity, sedentary lifestyle, and sitting. Pregnancy intentions (and synonyms) were then combined with diet or physical activity behaviours before or during pregnancy (and synonyms). The full search strategy for the Medline database is presented in Supplementary Information Appendix S1. The search was conducted in September 2018. No date limits were applied. Forward and backward citation searching of included studies was conducted.

Inclusion and Exclusion Criteria

Eligibility criteria are presented in Table 1. Articles or studies that compared preconception, pregnant or postpartum women's diet or physical activity behaviours by pregnancy intention/planning status were eligible for inclusion. Women of any age or parity were included. With the exception of qualitative studies, all primary research studies including preconception, pregnant or postpartum women were eligible, including studies that tracked women from preconception into pregnancy as long as the study reported analyses that explored the association between diet/physical activity and pregnancy intentions. Studies focusing exclusively on diet or physical (in)activity outcomes in the postpartum period that did not include an inter-pregnancy perspective were excluded. Studies on animals, women seeking abortion, unpublished/grey literature, and conference abstracts were also excluded.

We were unable to translate non-English articles, therefore only papers published in English were included.

Study Selection and Screening

After removal of duplicates, titles and abstracts were screened in duplicate (by MN and TLC) with discrepancies resolved by discussion. Remaining full text papers were read in full and screened by two authors (BH and MN). In both cases, a third author (EK) was consulted when consensus could not be reached.

Risk of Bias

Using the method described by Shah et al.,³³ risk of bias was assessed by one author (TLC), with a sub-sample of 20% assessed by a second author (BH) for consistency. Assessment was made on the basis of the presence of six key methodological domains: participant selection, exposure assessment, outcome assessment, confounding factors, analytical strategy, and attrition.³³ Studies were classified as no bias, low risk, moderate risk, and high risk of bias, with overall bias ascertained based on the highest bias reported in any of the categories.

Data Extraction and Synthesis of Results

Data were extracted in duplicate (by BH, EK, or SL) and then assessed by a third author (MN) to check for discrepancies. Any discrepancies were evaluated and resolved with direct reference to the paper. Information regarding study aims; sample size; participant age, ethnicity, and pregnancy intentions; dietary behaviour; physical activity; study design and method; and findings regarding pregnancy intentions and dietary or physical activity behaviours before or during pregnancy were extracted. Study authors were contacted to request details on outcomes of interest that were not available in the paper. Narrative synthesis was conducted on all included studies and meta-analyses conducted when appropriate. Dietary behaviours were arranged into conceptually similar groups to allow

comparison across studies. Of note, vegetable intake and green salad intake were kept separate because effect sizes could not be combined due to being measured in the same study.

Analytic Decisions for Meta-Analysis

Papers were considered for inclusion in the meta-analysis when there was sufficient homogeneity in both measurement of pregnancy intention and measurement of behaviour; a minimum of two studies were required for each specific meta-analysis. Where studies reported findings separately among categories of pregnancy intentions (e.g., mistimed was presented separately from unintended), then only the unintended/unplanned findings were used. Diet and physical activity behaviours were collapsed into homogenous categories (e.g., fruit consumption, energy intake). Analyses were conducted separately for preconception and pregnancy behaviours.

A random effects meta-analysis was conducted using the meta package for R³⁴ using RStudio Cloud. The restricted maximum likelihood estimator was used, and the Hartung-Knapp modification for random effects meta-analysis was implemented in cases where tau squared was greater than zero, according to the approach described by Jackson et al.³⁵ In one instance (preconception healthy eating), the Hartung-Knapp adjustment produced implausibly large confidence intervals; here, the standard method (i.e., random effects meta-analysis without the Hartung-Knapp adjustment) was retained. The effect size of interest in categorical outcomes was odds ratio and for continuous measures the outcome of interest was the standard mean difference (Hedge's g), albeit no meta-analyses were conducted on continuous measures due to only one study reporting their findings in this fashion. As funnel plots are not reliable in instances where there are fewer than ten included studies,³⁶ funnel plots are not presented as there were no analyses with ten or more studies. Cochran's Q , I^2 statistic and prediction intervals were the planned measures of statistical heterogeneity³⁷;

however, in small sample sizes, I^2 is imprecise and has not been reported here.³⁸ Ninety-five percent prediction intervals are reported only for meta-analyses including three or more estimates. Sensitivity analyses were planned excluding studies that combined mistimed pregnancies with unintended pregnancies and for variations of timing of assessment of pregnancy intentions (i.e., prospective vs. retrospective); again, these were not conducted due to the small number of studies in each meta-analysis.³⁹ Significance was set at $p < .05$.

Results

Study Selection

Figure 1 presents the flow of studies in the review. The search retrieved 2140 records for screening and 1282 articles were identified through other sources (namely forward and backward citation searching). After removal of duplicates, 2623 titles and abstracts were screened, and 113 full-text articles assessed for eligibility. Papers excluded at the full text stage and their reasons are presented in Supplementary Information Appendix S2. In total, 20 studies were eligible for inclusion in the review, however, at data extraction stage, discrepancies between data reported within one study became apparent.⁴⁰ After attempting to contact the authors with no response, this study was excluded from analyses, resulting in 19 included studies; 11 studies were included in the meta-analyses. Two papers reported on one study, and so the paper by Chuang et al. 2010²³ was excluded from the meta-analyses to avoid duplication.

<< Insert Figure 1. Flow of included studies >>

Risk of Bias

Risk of bias at the study level is shown in Figure 2. Overall risk of bias was moderate⁴¹⁻⁴⁸ to high,^{23, 25, 30, 47, 49-53} with nine studies each achieving these ratings. The main

contributors to sub-optimal overall risk of bias scores were the domains of exposure and outcome assessment, which scored poorly mainly due to the use of non-validated scales or poor reporting of outcome measures. Studies also performed inadequately on the confounding factors domain, primarily due to lack of adjustment of confounding factors in analyses. Risk of bias at the outcome level is shown in Figure 3. Risk of bias for dietary iodine ($k = 1$) and folate intake ($k = 1$) was low. Studies measuring caffeine consumption ranged from low to moderate risk of bias. Risk of bias for diet and physical activity measures ranged from low to high.

<< Insert Figure 2. Risk of Bias at the study level>>

<< Insert Figure 3. Risk of bias at the outcome level>>

Study Characteristics

Characteristics of included studies are presented in Table 2. Eight studies were conducted in the US,^{23, 43, 45, 47, 50, 51, 54, 55} three in Australia,^{42, 46, 48} two each in Brazil^{30, 41} and New Zealand^{52, 53}, and one each in Singapore,⁴⁴ Turkey,⁴⁹ Sweden,⁵⁶ and The Netherlands.²⁵ Eleven studies employed a cross-sectional design.^{25, 30, 41, 42, 45, 46, 49, 50, 52, 53, 55} Five were cohort studies,^{23, 44, 47, 48, 51} two were case-control studies,^{43, 54} and one employed an observational design.⁵⁶

Of the 19 studies, 11 measured pregnancy intentions retrospectively^{30, 41-45, 49, 51-54} and 8 prospectively.^{23, 25, 46-48, 50, 55, 56} Regarding assessment of pregnancy intentions, 10 studies reported specifically on pregnancy intentions,^{23, 43, 45-49, 51, 54, 55} and of these, 2 asked participants whether they were trying to conceive.^{46, 55} The remaining 9 studies reported on pregnancy planning^{25, 30, 42, 44, 50, 52, 53, 56} and only 1⁴¹ of these studies measured this via the

validated London Measure of Unplanned Pregnancy, which is considered the gold standard measure for pregnancy planning.¹⁹

Ten studies reviewed women's dietary and physical activity behaviours during the preconception period,^{23, 25, 41, 42, 46, 47, 50, 51, 54, 55} five reported on behaviours during pregnancy^{30, 48, 49, 53, 56} and four examined the behaviours both in the preconception and pregnancy period.^{43-45, 52} Dietary behaviours were arranged into the following conceptually similar groups: 'food groups', including fruit, vegetable, green salad, soda/soft drink, fast food, dairy, fish, grains, nut/bean/soya, and meat intake; 'energy and macronutrients', including energy intake, carbohydrates (including sugars), fat (including saturated fat), and protein; 'diet quality'; and 'caffeine, iodine and folate'. Caffeine, iodine and folate were only included if intake was measured via whole food consumption (i.e., not supplements). A matrix indicating which outcomes were reported in each study is presented in Table 3.

Relationship between Pregnancy Intentions and Preconception Behaviours

Given only 11 studies were able to be included in meta-analyses, a narrative synthesis of the literature was also conducted.

Food groups. All four studies reporting preconception food groups measured pregnancy intentions prospectively.^{23, 46, 47, 55} Broadly, relationships between food groups and pregnancy intentions were not significant. Hure et al. reported no difference in vegetable, fruit, grain, dairy, nut/bean/soya, or fish intake in women currently trying to conceive compared with other women.⁴⁶ Berenson et al. reported similar findings for fruit, vegetable, salad, soda and fast food consumption.⁵⁵ Whilst Parrott et al. reported no relationship for fruit, they found that women not considering future pregnancy were more likely to meet weekly vegetable, salad and fish consumption targets.⁴⁷ In this same study, Chuang et al. reported that positive longitudinal behaviours for fruit and vegetable intake were similar among women with and without pregnancy intentions.²³

Energy and macronutrients. Only two studies reported energy or macronutrient intakes, and findings were generally null.^{25, 46} One study reported on energy, carbohydrate and protein intake; this study reported prospective pregnancy intentions and found that the proportion of women meeting the recommended dietary allowance (RDA) for energy and protein did not differ between women planning pregnancy and controls.²⁵ The proportion of women meeting RDA for carbohydrates and mono-/disaccharides (sugars) was higher in the planning group. The two studies reporting on fat intake both found no difference between women with and without pregnancy intentions.^{25, 46}

Diet quality. Two studies with conflicting findings reported on preconception diet quality,^{41, 46} of which one assessed pregnancy intentions prospectively.⁴⁶ Hure et al. calculated the Australian Recommended Food Score from the Dietary Questionnaire for Epidemiological Studies (version 2) food frequency questionnaire.⁴⁶ Diet score did not differ between women trying to conceive and other women. In contrast, Borges et al. presented self-reported data for the variable “started eating healthier”; more women with planned compared with ambivalent pregnancies reported eating healthier.⁴¹

Caffeine, iodine, and folate. Three studies, all measuring pregnancy intentions retrospectively, reported on dietary caffeine intake with mixed results.^{43, 45, 54} Hellerstedt et al. reported that preconception caffeine intake was lower in women with intended pregnancies compared to unintended pregnancies.⁴⁵ Similarly, Chen et al. found that women who wanted to be pregnant at that time were more likely to report lower caffeine intake.⁴³ However, Dott et al. reported no difference in the proportion of women exceeding 300 mg caffeine intake per day for intended versus ambivalent, mistimed or unwanted pregnancies. The only study reporting preconception iodine intake also measured pregnancy intentions retrospectively and found that iodine intake from fortified bread was higher in unplanned compared with planned pregnancies.⁵² The only study reporting preconception folic acid intake from fortified foods

measured pregnancy intentions retrospectively and found that women who planned their pregnancy for at least two months were more likely to have a higher intake of folate from foods.⁴²

Physical activity. Associations between pregnancy intentions and preconception physical activity or inactivity were evaluated in seven studies,^{23, 44, 46, 47, 50, 51, 55} of which two assessed pregnancy intentions retrospectively.^{44, 51} The majority of these studies reported no associations between pregnancy intention and preconception physical activity.^{23, 43, 47, 50, 55} However, Hure et al. reported that the proportion of women with inactive/low physical activity level was greater for women trying to conceive than other women.⁴⁶ In contrast, Kingsley et al. reported that women with unintended pregnancies were more likely to be physically inactive.⁵¹

Relationship between Pregnancy Intentions and Antenatal Behaviours

Food groups. No studies reported on associations between pregnancy intentions and intake of food groups during pregnancy.

Energy and macronutrients. No study was found to have investigated the relationship between pregnancy intentions and energy or macronutrient intake during pregnancy.

Diet quality. Two studies with similar findings reported on preconception diet quality, of which both assessed pregnancy intentions retrospectively.^{49, 53} Okesene-Gafa et al. found that women with unplanned pregnancies were more likely to report infrequent healthy eating. In the study by Arslan Ozkan and Mete, more women with unplanned pregnancies perceived their nutritional status as low.⁴⁹

Caffeine, iodine, and folate. Four studies reported on associations between pregnancy intentions and antenatal caffeine intake.^{43, 45, 48, 49} Only the study by Peacock et al. prospectively assessed pregnancy intentions,⁴⁸ however all four studies reported similar

findings. Peacock et al. found that a greater proportion of women who planned their pregnancy reported low caffeine consumption.⁴⁸ Similarly, Chen et al. reported that women with unplanned pregnancies were more likely to increase their coffee/tea consumption during pregnancy than women with planned pregnancies⁴³ and Arslan Ozkan and Mete reported that women with planned pregnancies were more likely to decrease their caffeine intake compared to before pregnancy.⁴⁹ Hellerstedt et al. found that women with unintended pregnancy were more likely to drink caffeine daily.⁴⁵ The study by Mallard et al. was the only one to report pregnancy iodine intake, where women with unplanned pregnancies were more likely to have higher intake of iodine through fortified bread than women with planned pregnancies in both early and late pregnancy.⁵² No studies reported on the association between pregnancy intentions and folate intake during pregnancy.

Physical activity. Three studies explored the relationship between pregnancy intentions and antenatal physical activity^{30, 44, 56}; two were conducted retrospectively^{30, 44} and the remaining one prospectively.⁵⁶ Two studies found that planned pregnancies were associated with exercising in pregnancy,^{30, 56} while the other study reported no association.⁴⁴

Meta-Analysis

Only eight preconception^{43-45, 47, 50, 51, 54, 55} and six pregnancy^{30, 43-45, 48, 49} studies included data that could be incorporated into the meta-analysis, with few studies reporting on the same behaviours. Consequently, results are presented below only for behaviours with two or more estimates available.

Preconception behaviours. Fruit intake. Two estimates of the relationship between preconception fruit intake and pregnancy intention were available and are presented in the forest plot in Figure 4A. Fruit intake was not associated with pregnancy intentions (OR = 0.83, 95%CI = 0.67 to 1.02; $p = .070$; Cochrane's $Q = 0.27$, $p = .600$).

Vegetable intake. Two estimates of the relationship between preconception vegetable intake and pregnancy intention were available and are presented in the forest plot in Figure 4B. Vegetable intake was not associated with pregnancy intentions (OR = 0.84, 95%CI = 0.11 to 6.53, $p = .485$; Cochrane's $Q = 1.89$, $p = .169$).

Green salad intake. Two estimates of the relationship between preconception green salad intake and pregnancy intention were available and are presented in the forest plot in Figure 4C. Green salad intake was associated with unintended pregnancy (OR = 0.61, 95%CI 0.45 to 0.83; $p = 0.001$; Cochrane's $Q = 0.09$, $p = .766$).

Caffeine intake. Three estimates of the relationship between preconception caffeine intake and pregnancy intention were available and are presented in the forest plot in Figure 4D. Preconception caffeine intake was not associated with pregnancy intentions (OR = 1.01, 95%CI = 0.47 to 2.21, $p = .924$, 95% prediction interval = 0.01 to 80.46; Cochrane's $Q = 16.59$, $p < .001$).

Physical activity. Five estimates of the relationship between preconception physical activity and pregnancy intention were available and are presented in the forest plot in Figure 4E. Preconception physical activity was not associated with pregnancy intentions (OR = 1.06, 95%CI = 0.86 to 1.31, $p = .484$, 95% prediction interval = 0.65 to 1.73; Cochrane's $Q = 6.47$, $p = .166$).

Pregnancy behaviours. Diet quality. Two estimates of the relationship between healthy eating in pregnancy and pregnancy intentions were available and are presented in the forest plot in Figure 5A. Women with pregnancy intentions were more likely to report healthy eating (OR = 2.96, 95%CI = 1.20 to 7.33, $p = .019$; Cochranes's $Q = 11.17$, $p < .001$).

Caffeine intake. Four estimates of the relationship between caffeine intake in pregnancy and pregnancy intention were available and are presented in the forest plot in Figure 5B. Women with pregnancy intentions were more likely to report lower caffeine

intake (OR = 1.90, 95%CI = 1.09 to 3.19, $p = .372$, 95% prediction interval = 0.59 to 5.94; Cochrane's $Q = 7.78$, $p = .051$).

Physical activity. Two estimates of the relationship between antenatal physical activity and pregnancy intention were available and are presented in the forest plot in Figure 5C. Antenatal physical activity was higher in women with intended pregnancies (OR = 1.38, 95%CI = 1.06 to 1.80, $p = 0.016$; Cochrane's $Q = 0.04$, $p = .833$).

<< Insert Figure 4. Forest plots showing estimates of the relationships between pregnancy intention and preconception (A) fruit intake, (B) vegetable intake, (C) green salad intake, (D) caffeine intake, and (E) physical activity>>

<<Insert Figure 5. Forest plots showing estimates of the relationships between pregnancy intention and pregnancy (A) diet quality, (B) caffeine intake, and (C) physical activity>>

Discussion

This study explored the association between women's pregnancy intentions and their preconception or antenatal diet and physical activity behaviours. To our knowledge, this is the first systematic review and meta-analysis on this topic. We were able to report novel findings highlighting that, overall, preconception diet and physical activity behaviours did not differ between women with intended and unintended pregnancies. In contrast, antenatal diet and physical activity behaviours were better in women with intended pregnancies compared with women experiencing unintended pregnancies.

During the preconception period, both narrative review and meta-analytic findings indicated that dietary behaviours or physical activity were, overall, not associated with pregnancy intention, albeit green salad intake was lower in women intending pregnancy.

However, the green salad finding should be interpreted cautiously. It is possible that preconception women are avoiding salad due to the known risk of *Listeria* pathogen in ready-to-eat salads.⁵⁷ Taken in the context of all our preconception findings, women intending pregnancy are not engaging in potentially essential diet and physical activity behaviours. This is despite the strong evidence indicating the importance of a healthy diet and regular physical activity behaviours before pregnancy.² This finding is concerning given that 59% of women in the general population do not meet physical activity recommendations⁵⁸ and less than 2% of women meet the recommended daily serves of vegetables.⁵⁹ It is well documented that women of reproductive age face several barriers to achieving successful health behaviour change, such as poor knowledge regarding the importance of specific behaviours, lack of time, low self-efficacy, perceived difficulty in accessing reputable preconception health information, and poor availability of resources.^{60, 61} Furthermore, reduced risk perception and low prioritisation of comprehensive preconception healthcare limit uptake of preconception care.⁶² Indeed, many individuals do not perceive themselves to be “preconception” and therefore do not seek out advice or make changes for an impending pregnancy.⁶³ However, with up to 50% of pregnancies being unplanned, work is needed to ensure individuals understand the importance of preconception wellbeing regardless of current pregnancy intention.⁶⁴

As with preconception, the importance of healthful diet and physical activity behaviours during pregnancy is irrefutable.^{28, 44, 65} Our analyses revealed that, during pregnancy, women with intended pregnancies reported healthier eating/diet quality, lower caffeine intake, and higher levels of physical activity than women with unintended pregnancies. Findings for dietary iodine were inconclusive and no studies reported on dietary folate, highlighting a need for additional research relating to these nutrients. While it is a positive finding that pregnant women with intended pregnancies reported improved diet and

physical activity behaviours, the flip side is that women with unintended pregnancies have sub-optimal behaviours, with potential implications for the health of the fetus.^{11, 12} Women with unintended pregnancies are more likely to experience antenatal depression.²⁰ Given that lifestyle behaviours are inextricably linked with mental health concerns,⁶⁶ it is possible that women with unintended pregnancies who experience low mood and other psychological disturbances do not have the capacity to initiate or maintain positive diet and physical activity behaviours during this time. Other possible reasons as to why women with unintended pregnancies report sub-optimal diet and physical activity behaviours compared to women with intended pregnancies may be due to the lack of motivation or awareness relating to maternal behaviour and its impact on offspring outcomes.⁵⁴ Unintended pregnancies are associated with later pregnancy recognition and poor behavioural patterns of women with unintended pregnancies persist after pregnancy recognition.⁵⁴ In order to help women with unintended pregnancies improve their diet and physical activity behaviours, barriers must be overcome.^{60, 61, 67} Hure et al. reported that individual factors such as pre-pregnancy lifestyle behaviour and prior success with weight control may possibly influence women's antenatal dietary and physical activity behaviours.⁶⁸ This study also found that women reported inadequate knowledge and limited supportive behaviour change strategies/advice.⁶⁸ This reflects other research that highlights the importance of self-efficacy and motivation (which can be impacted by constructs such as knowledge and previous success) play in pregnant women's health behaviours.^{60, 61, 67}

Overall, our findings indicate that there is clearly a need to equip women with evidence-based behaviour change strategies to allow them to take control of their lifestyle behaviours during the preconception and antenatal periods. This may require different approaches for different women. For example, in a 2018 *Lancet* series on preconception care, Stephenson et al.² posited that from an individual perspective, the decision to have a baby

constitutes the beginning of the preconception period, while from a public health perspective, the preconception period could relate to any sensitive period in the lifecourse where lifestyle behaviours become established. Pregnancy is also a distinct life phase where women are more likely to make positive lifestyle changes for the health of their baby.⁶⁹ However, the data included in this meta-analysis indicate that these changes are likely to be unequally distributed according to pregnancy intention. As such, identifying women with unintended pregnancies may be an important step in screening for individuals requiring additional support for behaviour change. Tailoring interventions to each of these key periods or to women with different characteristics may facilitate behaviour change before and throughout the reproductive years.^{66, 70}

Limitations

Findings from our review should be interpreted cautiously owing to several limitations. First, although 19 studies were eligible for inclusion, heterogeneity across these studies was apparent regarding measurement of dietary or physical activity outcomes and prospective and retrospective assessment. Hence, not all outcomes included in the narrative synthesis were able to be included in the meta-analyses, with only 11 studies providing data for the meta-analyses and only 2 to 5 studies in each meta-analysis of the different diet and physical activity behaviours. Second, many of the included studies measured pregnancy intentions and lifestyle behaviours retrospectively. As such, participant recall bias may impact the findings. There is also the possibility that women may change their feelings regarding the desire for a pregnancy after pregnancy recognition.² Third, all variations of intended pregnancies, including planning and trying to conceive, were grouped together, which may have masked nuances in the relationships between these concepts and the behaviours investigated. Unfortunately, given the small number of studies available, analyses teasing out differential effects based on measurement of pregnancy intentions were not

possible. Fourth, all included studies had moderate to high risk of bias; this must be considered when reflecting on the findings. Lastly, almost all studies reviewed (17 out of 19) were from high income countries, limiting the generalisability of our findings to other settings.

Conclusion

Our findings indicate that pregnancy intentions were not associated with improved dietary or physical activity behaviours during preconception, but that pregnant women with intended pregnancies reported healthier diets, lower caffeine intake, and higher physical activity levels. Given the heterogeneity of included studies, further research is needed to evaluate the relationships between diet and physical activity behaviours and pregnancy intentions. Regardless, it is clear that focus is needed to address the individual and environmental barriers that hamper women's attempts to improve their dietary and physical activity behaviours both during preconception and pregnancy. Preconception women and pregnant women with unintended pregnancies are populations requiring specific attention. Targeted individual and system-wide interventions designed to promote healthy eating and improved physical activity for women throughout their reproductive years are imperative to improving the health of mothers and their children.

Table 1. PICO eligibility criteria

Participants	Preconception, pregnant or postpartum women of any age or parity.
Exposure	Pregnancy intention (including wantedness, planning, trying to conceive)
Comparator	Women with unintended pregnancies or not intending to get pregnant
Outcome	Any diet or physical activity behaviour that is associated with lifestyle. The individual behaviours were not pre-specified and depended on the outcomes presented in the literature but included diet quality, energy intake, intake of food groups such as fruit, vegetables, or takeaway foods, caffeine intake in the diet, participation in physical activity, or measurement of sedentary behaviour.

Abbreviation: PICO - Participants, Intervention/Exposure, Comparator, Outcome

Table 2. Characteristics of included studies

Author (year) Country	Aim	Participant characteristics	Study design	Measurement of pregnancy intention	Measurement of diet or physical activity	Key relevant findings
Ayoola et al. (2016) USA	To examine women's perceived health status and behaviours such as drinking, smoking, exercise and folic acid/multivitamin use within the context of the pregnancy planning status of low-income, mostly ethnic minority non-pregnant women living in urban medically underserved neighbourhoods.	N=123 Mean age: 30.6±7.3 years Age range: 18-51 years Ethnicity: <ul style="list-style-type: none"> • Hispanic: 63% • African American: 45% • Caucasian: 15% 	Cross-sectional. Baseline survey completed by a convenience sample of women who took part in a larger ongoing Women's Health Promotion study, recruited through flyers in neighbourhoods.	Prospective Women were asked "To what extent do you plan to get pregnant in the next 6 months?"	Behavioural Risk Factor Surveillance System Pregnancy Risk Assessment Monitoring Survey. <u>Physical activity</u> During the past month, other than your regular job, did you participate in any physical activities or exercise such as running, calisthenics, golf, gardening or walking for exercise? What type of physical activity or exercise did you spend the most time doing	82.93% were not trying to get pregnant at the time of the survey. 41.46% reported their last pregnancy was unplanned. 35.3% were planning on getting pregnant in the next 6 months. <u>Preconception physical activity</u> 82% of women planning to get pregnant in the next 6 months exercised in the past month versus 74% of women definitely not planning, albeit this difference was not significant ($p = .802$)

					during the past month?	
Berenson (2014) USA	To explore the dietary and lifestyle habits and weight loss practices of low-income women trying to conceive compared to women not trying to conceive.	<p>N=1711</p> <p>Mean age: 26.2 years</p> <p>Age range: N/A</p> <p>Ethnicity:</p> <ul style="list-style-type: none"> • Non-Hispanic White <ul style="list-style-type: none"> ○ Trying to conceive: 20.5% ○ Not trying: 25.7% • Non-Hispanic Black: <ul style="list-style-type: none"> ○ Trying to conceive: 52.9% ○ Not trying - 39.9% • Hispanic: <ul style="list-style-type: none"> ○ Trying to conceive: 26.5% ○ Not trying: 34.5% 	<p>Cross-sectional</p> <p>Women of reproductive age recruited through reproductive health clinics completed a self-administered questionnaire.</p>	<p>Prospective</p> <p>Women were asked: "Are you trying or hoping to get pregnant right now?" - Yes or No</p>	<p><u>Diet</u></p> <p>Frequency of intake of fruit, vegetables and green salad and consumption of fast foods and soft drinks (not including diet drinks) in the past week.</p> <p><u>Physical activity</u></p> <p>Frequency of exercise in the past week.</p>	<p>8.9% of the women were currently trying to get pregnant.</p> <p><u>Preconception diet</u></p> <p>There was no difference in the proportion of women trying/not trying to conceive for fruit, vegetable, salad and soda consumption, in bivariate or multivariable analyses. Fast food intake was lower in women trying to conceive on univariable analyses; this relationship did not remain on multivariable analyses.</p> <p><u>Preconception physical activity</u></p> <p>There was no difference in the proportion of women</p>

						trying/not trying to conceive for exercise for 30mins on 3 or more days in the past week.
Borges (2016) Brazil	To measure the proportion of women who performed preconception health behaviours, to describe the measures adopted by women during the preconception period, and to explore the effect of pregnancy planning status and other sociodemographic characteristics on the adoption of preconception health behaviours.	N=649 Mean age: N/A Age range: <ul style="list-style-type: none"> 13-19 years: 28.4% 20-25 years: 26.5% 26-30 years: 19.7% 31 years and over: 25.4% Ethnicity: <ul style="list-style-type: none"> White: 66.1% Non-white: 33.9% 	Cross-sectional Women attending hospitals for prenatal care or abortion in Sao Paulo, Brazil	Retrospective London Measure of Unplanned Pregnancy (LMUP). 10-12 points = planned, 4-9 points = ambivalent about the planning of pregnancy, 0-3 points = unplanned.	<u>Diet</u> Preconception health behaviours were assessed using the LMUP which included "started eating healthier".	66.3% of pregnancies were ambivalent and 33.7% planned (unplanned pregnancies were excluded). <u>Preconception diet</u> Greater proportions of women with planned compared with ambivalent pregnancies reported eating healthier.
Bower (2005) Australia	To evaluate health promotion of folate and its intake in Western Australia.	N=578 Mean age: N/A Age categories: <ul style="list-style-type: none"> <25 years: 16% 	Cross-sectional Participants with a live born baby in Western Australia	Retrospective Detail on measure not reported. Classification as:	<u>Diet</u> Data on the folic acid content of fortified foods were obtained from the manufacturer.	Proportion of planned and unplanned (N = 487): Yes, planned for ≥ 2 months: 43% (n = 208). Yes, planned for

		<ul style="list-style-type: none"> • 25-39 years: 37% • 30-34 years: 32% • ≥35 years: 15% <p>Ethnicity: N/A</p>		<p>Yes, planned for ≥ 2 months; Yes, planned for ≤ 1 month; No, not planned</p>	<p>Total folate intake in the 6 months was estimated by summing all fortified food sources and categorised as none, <100 micrograms of folate daily, and 100 or more micrograms daily.</p>	<p>≤ 1 month: 17 % (n=82). No, Not planned: 40% (n=197).</p> <p><u>Preconception diet</u> Women who did not plan their pregnancy were less likely to take folate from foods than those who had planned for ≥2 months (OR = 0.93, 95%CI 0.47,1.84). Women who planned their pregnancy for ≤1 month were 0.98 times less likely to consumer folate in their foods compared to those who planned their pregnancy for ≥2months (OR = 0.98, 95%CI 0.4, 2.38).</p>
Chen (2014) USA	To describe patterns of caffeine consumption before and after pregnancy	<p>N=8488</p> <p>Mean age: N/A Maternal age ranges at conception:</p> <ul style="list-style-type: none"> • ≤19 years 	<p>Case- Control study</p> <p>Women in the National Birth Defects</p>	<p>Retrospective</p> <p>Intent (wanted to be pregnant, wanted to wait until later, did</p>	<p><u>Diet</u> A shortened version of the Willett food frequency questionnaire.</p>	<p>60.4% of participants reported a current pregnancy intention.</p> <p><u>Preconception diet</u></p>

	recognition among pregnant women over the previous decade.	<ul style="list-style-type: none"> • 20-34 years • ≥35 years • <p>Ethnicity:</p> <ul style="list-style-type: none"> • Non-Hispanic white: 58% • Non-Hispanic black: 11% • Hispanic: 24% • Other: 7% 	Prevention Study who gave birth between October 1 1997 to December 31 2007, sampled from each of the study sites across USA. Controls were selected from either birth certificates or hospital birth records.	not want to be pregnant at all or did not care).	<p>Caffeine consumption:</p> <ul style="list-style-type: none"> • 1 cup coffee=100mg • 1 cup tea=37mg <p>Caffeine content of specific brands of soda were based on the caffeine content per 12 ounce serving obtained from the soda manufacturers when available. An average of 37mg caffeine was assigned to soda when caffeine content was unable to be determined. 10mg caffeine/ounce for chocolate.</p>	<p>Of women with low caffeine intake (0 to <10 mg/d), 65% wanted to be pregnant. Of women with very high caffeine intake (300+ mg/d), 56% of women wanted to be pregnant then.</p> <p><u>Pregnancy diet</u> Mothers with unplanned pregnancies were more likely to increase coffee/tea consumption than those with planned pregnancies.</p>
Cheng (2016) Singapore	To investigate behaviours before and during pregnancy alongside	<p>N=861</p> <p>Mean age: N/A Age is only stated as ≥18 years.</p>	<p>Cohort Study</p> <p>Attendance at hospital antenatal clinic.</p>	Retrospective Women were asked whether their pregnancy	<u>Physical activity</u> Physical activity levels before and during pregnancy via the	56% participants had a planned pregnancy (n = 481), 39% had a mistimed pregnancy (n = 334) and 5% had

	<p>pregnancy outcomes, by pregnancy planning status and to test whether there was an association between pregnancy planning status and birth outcomes.</p>	<p>Ethnicity: N/A</p>		<p>was planned. If they answered yes, they were classified as having a planned pregnancy. If they replied in the negative, they were asked how enthusiastic they felt about being pregnant on a 5-point Likert scale. Women who had not planned to become pregnant but were enthusiastic were classified as 'mistimed', and women who had not planned to become pregnant and were not enthusiastic were classified as 'unintended'.</p>	<p>International Physical Activity Questionnaire (IPAQ). The duration (in minutes) and frequency (number of days per week) of physical activity were used to calculate the total score of physical activity in metabolic equivalents (MET-minutes/week) and a highly active level of physical activity was defined as MET-minutes/week ≥ 3000.</p>	<p>an unintended pregnancy (n = 46).</p> <p><u>Preconception physical activity</u> There was no difference in the proportion of mothers with a highly active preconception physical activity level for planned versus mistimed (OR = 0.8, 95%CI: 0.6, 1.1) or unintended (OR = 0.8, 95%CI 0.4, 1.7) pregnancies.</p> <p><u>Pregnancy physical activity</u> There was no difference in the proportion of mothers with a highly active antenatal physical activity level for planned versus mistimed (OR = 0.9, 95%CI 0.6, 1.2) or unintended (OR =</p>
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						0.7, 95%CI 0.3, 1.6) pregnancies.
Chuang (2010) USA	To examine whether pregnancy intention predicted maintenance of healthy behaviours or improved health behaviours over a 2-year follow-up of women of reproductive age.	<p>N=847</p> <p>Mean age: N/A</p> <p>Age categories:</p> <ul style="list-style-type: none"> • 18-24 years: 17.0% • 25-34 years: 40.0% • 35-45 years: 43.0% <p>Ethnicity:</p> <ul style="list-style-type: none"> • White non-Hispanic: 93.0% • Other: 7.0% 	Cohort Study Women residing in Central Pennsylvania.	Prospective Women were asked: "Are you considering become pregnant within the next year, at some other time in the future, or not at all?"	<p><u>Diet and physical activity</u></p> <p>Preconception behaviours of nutrition (fruit and vegetable consumption) and physical activity were assessed. Behaviours were evaluated and defined as positive longitudinal behaviour between baseline and follow-up (sustained healthy behaviours, improved from unhealthy to healthy, or remained unhealthy but improved) or negative longitudinal behaviour (worsened from healthy to unhealthy levels,</p>	<p>9% of women were considering pregnancy in the next year, 37% were considering pregnancy at some other time in the future, and 53% were not considering future pregnancy.</p> <p><u>Preconception diet</u> Women considering pregnancy within the next year were no more likely to report positive longitudinal behaviours relating to diet (i.e., fruit or vegetable intake) than women not considering pregnancy (fruit: OR = 1.2, 95%CI 0.8, 2.0); vegetable: OR = 1.2, 95%CI 0.8, 2.0).</p> <p><u>Preconception physical activity</u></p>

					or remained unhealthy without improvement).	Women considering pregnancy within the next year were no more likely to report positive longitudinal behaviours relating to physical activity than women not considering pregnancy (OR = 0.8, 95%CI 0.5, 1.3).
de Weerd (2003) The Netherlands	To evaluate the nutritional intakes and lifestyle factors of women currently planning pregnancy and a control group, and to explore whether women planning a pregnancy also adjust their nutritional intake and lifestyle, as well as personal views and knowledge of health practices.	N=69 Mean age: <ul style="list-style-type: none"> Planner: 31.5 years Controls: 28.0 years Age range: <ul style="list-style-type: none"> Planner: 19-45 years Controls: 18-43 years Ethnicity: N/A	Cross-sectional Women residing in Nijmegen and surrounding regions (The Netherlands).	Prospective Women planning a pregnancy vs. control women (no information on how pregnancy planning status was determined is provided)	<u>Diet</u> Preconception diet quality was assessed via a food frequency questionnaire. Macronutrient intakes were computed and compared to the recommended dietary allowance (RDA; energy, fat, saturated fat, protein, carbohydrates, mono-/disaccharides)	66.7% of women were planning a pregnancy and 33.3% were control women. <u>Preconception diet</u> The proportion of women meeting RDA for energy, fat and protein did not differ between women planning pregnancy and controls. The proportion of women meeting RDA for saturated fat, carbohydrates, and mono-/disaccharides was higher in the planning group.

Dott (2010) USA	To 1) determine the extent to which women with unintended pregnancies were more likely than women with intended pregnancies to engage in certain behaviours, and 2) determine the extent to which pregnancy intention status was associated with pregnancy behaviour change after a woman recognised her pregnancy.	<p>N=4094</p> <p>Mean age: N/A</p> <p>Age ranges:</p> <ul style="list-style-type: none"> • <20 years: 14.35% • 20-34 years: 73.9% • ≥35 years: 11.55% <p>Ethnicity:</p> <ul style="list-style-type: none"> • White, non-Hispanic: 60% • Black non-Hispanic: 12% • Hispanic: 22.7% • Other: 5.0% 	<p>Case- Control Study -the National Birth Defects Prevention Study</p> <p>Infants randomly selected from hospitals and birth certificates.</p>	<p>Retrospective</p> <p>If a woman reported no use of contraception, that she did not know if she was using contraception or that she got pregnant during an interruption in use of contraception she was asked if she wanted to be pregnant then, later or did not want to become pregnant.</p>	<p><u>Diet</u></p> <p>Drinking >300mg of caffeine daily during the year before pregnancy, measured during interview. Caffeine exposure was estimated by asking women who many cups of caffeinated or regular tea and caffeinated or regular coffee and how many bottles, cans or glasses of soda they had drunk a day during the year before the pregnancy.</p>	<p>40% of pregnancies were unintended.</p> <p><u>Preconception diet</u></p> <p>There was no difference in the proportion of women exceeding 300mg caffeine intake per day for intended versus ambivalent, mistimed or unwanted pregnancies (Chi-square $p = .25$)</p>
Hellerstedt (1998) USA	To examine whether pregnancy intention was associated with alcohol drinking and consumption of caffeinated drinks prior to pregnancy and in early pregnancy.	<p>N=7174</p> <p>Mean age: N/A</p> <p>Age range: 18-48 years</p> <ul style="list-style-type: none"> • 18-19 years: 3% • 20-29 years: 44% • >29 years: 53% <p>Ethnicity: N/A</p>	<p>Cross-Sectional Study</p> <p>Women selected from appointment logs for first scheduled visits to antenatal clinics, within 20 weeks of pregnancy.</p>	<p>Retrospective</p> <p>Characterised by responses to the following questions: 'Thinking back to just before your pregnancy, how did you feel about becoming</p>	<p><u>Diet</u></p> <p>Caffeine beverage consumption (not at all, once a week or less, a few times a week, once a day or a few times a day or more during preconception and pregnancy).</p>	<p>74% of pregnancies were reported as intended, 23% mistimed and 4% unwanted.</p> <p><u>Preconception diet</u></p> <p>The frequency of preconception caffeine intake was higher for women</p>

				pregnant? Would you say you wanted to be pregnant sooner than you were (i.e. intended), wanted to be pregnant but at a later time (i.e. mistimed) or did not want to be pregnant now or in the future (i.e. unwanted)?'		with unintended pregnancies when compared to intended pregnancies (OR = 1.15, 95%CI 1.01, 1.30). <u>Pregnancy diet</u> Women with unintended pregnancies were more likely to report daily antenatal caffeine use (OR = 1.17, 95%CI 1.03, 1.32)
Hure (2009) Australia	To investigate and report the diet quality of young Australian women by pregnancy status.	N=9076 Mean age: 27.2±1.5 years Age range: 20-35 years Ethnicity: N/A	Cross- sectional Study Australian Longitudinal Study on Women's Health Survey 3.	Prospective i) Pregnant; ii) trying to conceive; iii) had a baby in the last 12 months; iv) other	<u>Diet</u> Dietary Questionnaire for Epidemiological Studies (DQES) version 2 was used to calculate the Australian Recommended Food Score (ARFS) of each woman, with scores for each food group (vegetables, fruit, grain, dairy,	8% of participants were currently pregnancy, 6% trying to conceive, 11% gave birth in the last 12 months and 75% of women reported other status. <u>Preconception diet</u> Vegetable, fruit, grain, dairy, nut/bean/soya, fish, or fat intake, or total diet score were not significantly different

					<p>nut/bean/soya, meat, fish, fat) and a total score.</p> <p><u>Physical activity</u> Frequency and intensity.</p>	<p>between women trying to conceive and other women. Meat intake was higher in women trying to conceive than other women (mean score 2.5 (SD 1.2) vs. 2.2 (SD 1.3).</p> <p><u>Preconception physical activity</u> The proportion of women with inactive/low physical activity level was greater for women trying to conceive than other women (45.6% vs. 40.9%, p<.05)</p>
Kingsley et al. (2012) USA	To evaluate the health behaviours (alcohol use, smoking, physical inactivity, multivitamin use) of preconception women who had intended and unintended pregnancies using	<p>N=15386</p> <p>Mean age: N/A Age range: 13-47 years</p> <p>Ethnicity:</p> <ul style="list-style-type: none"> Caucasian: 35.2%; 	Cohort Study All women who gave birth in Texas	Retrospective Unintended pregnancy was defined as not wanting to be pregnant then or anytime in the future, or wanting to	<p><u>Physical activity</u> Preconception physical inactivity - PRAMS survey asked women about their behaviours in the 3 months before pregnancy. Inactivity was defined as less</p>	<p>Overall, 46% of women (n = 7323) reported that their current pregnancy was unintended, while 54% (n = 7821) reported that it was intended.</p> <p><u>Preconception physical inactivity</u></p>

	Pregnancy Risk Assessment Monitoring System (PRAMS) data.	<ul style="list-style-type: none"> African American: 27.4% Hispanic: 37.4% 		become pregnant later.	than one day per week of 30+ minutes of exercise.	Women with unintended pregnancies were more likely to be physically inactive than women with intended pregnancies (prevalence ratio = 1.1, 95% CI 1.0, 1.2)
Mallard (2014) New Zealand	To evaluate the impact of a mandatory bread fortification programme on estimated iodine intakes of childbearing women and to describe the extent to which uptake of a maternal iodine supplement recommendation is associated with sociodemographic characteristics.	<p>N= 723</p> <p>Mean age: N/A</p> <p>Age categories:</p> <ul style="list-style-type: none"> <25 years: 15.2% 25-34 years: 57.6 ≥35 years: 26.7% <p>Ethnicity:</p> <ul style="list-style-type: none"> NZ European: 63.2% Maori: 13.7% Pacific: 5.2% Asian: 8.3% Other: 8.4% 	Cross- Sectional	Retrospective	<u>Diet</u> Iodine intake from fortified bread in perinatal period - self-administered questionnaire. Values were obtained for the month before conception, months 1-3 of pregnancy and months 4-9 of pregnancy.	<p>44% of the pregnancies were unplanned.</p> <p><u>Preconception diet</u> Preconception iodine intake through fortified bread was greater in unplanned than planned pregnancies (M= 44ug/d, 95%CI 39-49 vs. M = 38 ug/d, 95%CI 28, 36, $p = .043$)</p> <p><u>Pregnancy diet</u> Women with unplanned pregnancies were more likely to obtain a higher intake of iodine through</p>

						fortified bread than women with planned pregnancies at both 1-3 (M = 47 ug/d, 95%CI 39, 52 vs. M = 36 ug/d, 95%CI 29, 42, $p = .026$) and 4-9 (M = 49 ug/d, 95%CI 34, 56, vs. M = 38 ug/d, 95%CI 30, 45, $p = .008$) months gestation.
Nascimento (2015) Brazil	To assess the physical activity levels of pregnant women and to examine the characteristics associated with the practice of exercise and the activities of daily living during pregnancy	N= 1279 Mean age: 27.1±6.4 years Ethnicity: <ul style="list-style-type: none"> • White: 47.5% • Non-white: 52.5% 	Cross- Sectional Women invited to participate whilst within maternity wards 12-72 hours post-partum on pre-specified days.	Retrospective How pregnancy planning was measured was not reported in the method	<u>Physical activity</u> Physical activity during pregnancy based on their last 3 months or third trimester of pregnancy: 1) a specific questionnaire was adapted from the Borg Scale; 2) Pregnancy Physical Activity Questionnaire (PPAQ) - Each woman classified according to intensity in Metabolic Task (MET) -	49.96% of women had a planned pregnancy and 50% reported unplanned pregnancy. <u>Pregnancy physical activity</u> Planned pregnancy increased the odds of exercising during pregnancy (OR: 1.3, 95%CI 1.0, 1.8). Among women who planned the pregnancy, 56.2% were active and 48% were sedentary during pregnancy.

					sedentary, low, moderate, vigorous intensity. Overall women classified as active or sedentary.	Among women with an unplanned pregnancy, 43.8% were active during the pregnancy.
Okesene-Gafa (2016) New Zealand	To explore knowledge of nutrition during pregnancy, factors influencing eating habits and the willingness to participate in a nutritional intervention.	N=422 Mean age: 28.9±5.8 years Ethnicity: <ul style="list-style-type: none"> • Maori: 24.2% • Pacific: 40.5% • Asian: 12.8% • European/other: 21.8% 	Cross- Sectional Pregnant women booked to give birth in a South Auckland birthing facility (September and December 2013).	Retrospective Pregnancy planning measured as part of the questionnaire asking "Were you planning to be pregnant at this time?", classified as Yes/No	<u>Diet</u> Healthy eating during pregnancy - classified as frequent healthy eating (very frequently or frequently) vs. infrequent healthy eating (occasionally, rarely or never).	49.7% of women reported planned pregnancies and 49.8% reported unplanned pregnancies. <u>Pregnancy diet</u> Women with an unplanned pregnancy were at increased risk of infrequent healthy eating (OR 4.76, 95% CI 3.10, 7.30; adjusted OR 1.95, 95% CI 1.18, 3.22).
Ozkan and Mete (2010) Turkey	To determine the relationship between pregnancy planning and antenatal behaviours.	N=1355 Mean age: 26.5±5.2 years Age range: 17-45 years Ethnicity: N/A	Cross- Sectional Participants attending public hospital who gave birth during a 2-month period.	Retrospective Mothers asked: Think about when you become pregnant. What were your thoughts about	<u>Diet</u> Caffeine (tea, coffee and cola consumption), nutrition (women's perception of their own nutritional intake) y during pregnancy - all	71.3% of women reported planned pregnancies and 17% reported unplanned pregnancies. <u>Pregnancy diet</u> 51.9% of women with planned pregnancy consumed

				getting pregnant then?	measured using a 28-item questionnaire developed by the researchers after reviewing the literature. Questionnaire was administered through a 15-minute interview.	less caffeine than before pregnancy compared to 32% and 19.6% for unplanned and unwanted pregnancies respectively (p<0.01). 17.2% of mothers with planned and 28% unplanned pregnancies perceived their nutritional status as low.
Parrott (2009) USA	To identify the positive habits associated with folic acid supplementation among women of reproductive age who are able to become pregnant.	N=1258 Age range: 18-45 years <ul style="list-style-type: none"> • 18-34: 61% • 35-45: 39% Ethnicity: <ul style="list-style-type: none"> • White, non-Hispanic: 89% • Black, non-Hispanic/Other: 11% 	Cohort Study Phase 1 of the Central Pennsylvania women's Health Study.	Prospective In the survey women were asked if they 'considered a future pregnancy.'	Phase 1 of longitudinal survey: Central Pennsylvania Women's Health Study. <u>Diet</u> Preconception behaviours of nutrition (daily fruit, vegetable, green salad, fish consumption). <u>Physical activity</u>	49% of women considered future pregnancy whilst 51% were not considering a future pregnancy. <u>Preconception diet</u> Significantly more women not considering future pregnancy were meeting daily vegetable consumption (39 vs. 46%, p=0.01), daily green salad

					Assessed whether meeting physical activity guidelines (at least 30 minutes of moderate to strenuous activity if not all, on most days of the week).	consumption (10 vs. 15%, p=0.01) and any fish consumption typical in a week (57 vs. 674%, p=0.01). No difference in daily fruit consumption was observed among women according to pregnancy intention. <i>Preconception physical activity</i> No difference in physical activity consumption was observed among women according to pregnancy intention.
Peacock (2018) Australia	To identify i) the proportion of women exceeding the caffeine intake guideline (>200mg/d) during each trimester accounting for the points of pregnancy awareness and ii)	N=1634 Mean age: N/A Ethnicity: N/A	Cohort Study Women attended a hospital antenatal clinic between 2009-2013 across several hospitals in NSW and WA	Prospective During the first interview participants were asked how they felt about falling pregnant as by the following responses: 'I wanted to become	<i>Diet</i> Maternal caffeine use: according to each trimester women were asked to specify the type and quantity of caffeinated beverages consumed in terms of typical and	78% of women planned their pregnancy. <i>Pregnancy diet</i> A greater proportion of women who planned their pregnancy were 'low consumers' of caffeine (84% vs. 17%), were within

	guideline adherence trajectories across pregnancy.			pregnant', 'I did not want to become pregnant', I hadn't thought about becoming pregnant' and 'other.'	maximal intake and frequency (everyday, 5-6 times per week, 3-4 times per week, 1-2 times per week, 2-3 times a month, once a month or once or twice during the period).	the caffeine consumption guidelines outlined as less than or equal to 200mg/d of caffeine (77% vs. 23%) and decreased heavy use post pregnancy awareness (70% vs. 30%).
Rodriguez (2000) Sweden	To combine psychosocial factors in conjunction with contextual factors (e.g., pregnancy planning) into a model to predict health-damaging behaviour, smoking, and one health-promoting behaviour, exercise, during mid- and late pregnancy.	N=350 Mean age: 27±4.0 years Ethnicity: 100% Swedish	Observational Study Women attending antenatal care from five prenatal healthcare centres in Uppsala County, Sweden.	Prospective At week 10 of gestation participants rated (5-point scale) to what extent the pregnancy was planned. This scale was later dichotomised into 'definitely yes' vs all other answers.	<u>Physical activity</u> Preconception exercise assessed at week 10 and mid-late pregnancy exercise were assessed at weeks 20 and 32 respectively. Exercise frequency was measured on a 1-5 scale (anchored never, to 5-7 times per week) and duration ranged from 10 minutes, to more than an hour. A composite score for exercise	56.9% had 'definitely planned' their pregnancies, while 11.7% rated their pregnancies as 'definitely not planned'. <u>Pregnancy physical activity</u> In a path model, pregnancy planning was associated with exercise at week 20.

					was generated by multiplying frequency by duration of exercise to reflect the entire amount of time participants spent exercising per week.	
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Abbreviation: N/A; not available

Table 3. Reported preconception and pregnancy diet and physical activity outcomes in included studies.

Author (year)/ Outcome	Food groups										Energy & macronutrients				Diet quality	Caffeine, iodine & folate			Physical activity	
	Fruit	Vegetables	Green Salad	Soda/soft drink	Fast Food	Dairy	Fish	Grains	Nut/bean/soya	Meat	Energy	Carbohydrates (incl. sugar)	Fat (incl. saturated)	Protein		Caffeine	Iodine	Folate	Physical activity	Physical inactivity
Ayoola et al. (2016)																			PC	
Berenson (2014)	PC	PC	PC	PC	PC														PC	
Borges (2016)															PC					
Bower (2005)																		PC		
Chen (2014)																	PC/ Preg			
Cheng (2016)																			PC/ Preg	
Chuang (2010)*	PC	PC																	PC	
de Weerd (2003)											PC	PC	PC	PC						
Dott (2010)																	PC			
Hellerstedt (1998)																	PC/ Preg			
Hure (2008)^	PC	PC				PC	PC	PC	PC	PC			PC		PC				PC	

Kingsley et al. (2012)																				PC
Mallard (2014)																	PC/ Preg			
Nascimento (2015)																			Preg	
Okesene-Gafa (2016)															Preg					
Arslan Ozkan & Mete (2010)															Preg	Preg				
Parrott (2009)	PC	PC	PC				PC												PC	
Peacock (2018)																	Preg			
Rodriguez (2000)^																			Preg	
<i>Total n Preconception</i>	4	4	2	1	1	1	2	1	1	1	1	1	1	1	2	3	1	1	6	1
<i>Total n Pregnancy</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	1	0	3	0

Abbreviations: Incl, Including; PC, Preconception; Preg, pregnancy.

Shaded cells indicate the outcome was reported in a study.

Bold indicate outcomes that were included in meta-analyses.

*Chuang et al. (2010) reported data duplicating that in Parrot et al. (2009) and was not included in meta-analyses.

^Hure et al. (2008) and Rodriguez et al. (2000) presented data in continuous format and hence could not be combined with other studies in meta-analyses.

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