Review Article

Appropriate Interventions for Pregnant Women with Indicators of Metabolic Syndrome on Pregnancy Outcomes: A Systematic Review

Abstract

Metabolic syndrome (MetS), a series of symptoms, including abdominal obesity, impaired glucose tolerance and insulin metabolism, hypertension, and dyslipidemia, is considered as the risk of developing cardiovascular disease and diabetes that can predispose a pregnant women to serious health problem, women in the developed as well as the developing countries. This study was aimed to investigate the effects of appropriate interventions on pregnant women with indicators of MetS to further improve the outcome of pregnancy. This systematic review was performed to extract articles of randomized controlled trials (RCT) on pregnant women with indicators of (MetS) and focusing on physical activity, dietary or lifestyle interventions on maternal health or perinatal outcomes, with searching in the Web of Science, PubMed, CDSR, Scopus, and Google Scholar were investigated. Two researchers independently evaluated the quality of the studies, being presented in all the articles and ranked the studies as high/low quality; the level of evidence was based on the number of high-quality studies and the coordination of the obtained results. Then, 17 articles, which met the inclusion criteria, were selected; among these, 7 articles studied the physical activity, 3 articles reviewed diets, 6 probed the lifestyle interventions, and 1 article was on counseling. In general, evidence suggested how the physical activity and proper diet impacts on proper weight gain during pregnancy, prevents maternal complications, and improves the outcome of pregnancy. According to the results of this systematic review, proper interventions during pregnancy can have a positive effect on maternal weight gain and the general health condition of pregnant women with indicators of MetS.

Keywords: *Interventions, metabolic syndrome, pregnancy outcomes, pregnant women*

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Introduction

Being first identified by Reaven as a syndrome in 1988,[1] metabolic syndrome (MetS) is a series of metabolic disorders, including abdominal obesity, impaired glucose tolerance and insulin metabolism, hypertension, and dyslipidemia.[2-4] The most important health problems of the 21st century, this complicated and epidemic disorder, today, growingly effects the health of a large number of people in the developed and developing countries as well.[5]

According to the predictions of World Health Organization (WHO), by 2020, chronic noncontagious diseases will have accounted for three quarters of deaths in developing countries, and MetS, which begins in childhood and is symptomatic in adulthood, will have been the risk factor for cardiovascular diseases and diabetes. Changes in dietary patterns, low physical activity, and smoking, so-called new world syndrome or lifestyle, are the main causes of the epidemic of noncontagious diseases in recent and future years.[6,7] Reports indicate an upward trend for MetS in the population, especially women.[8] According to statistics, about 25% of the US population – equivalent to 50 million individuals – is suffering from this syndrome.[9] The first national study conducted on the prevalence of MetS in Iran in 2009 estimated the prevalence of this syndrome 34.7%, which is clearly higher than the average in the United States.[10]

The prevalence of MetS in pregnant women varied from 3% to 42% in different studies based on the presence of preexisting syndrome components, age, and region.[11]

Prepregnancy metabolic changes are not only the determinant of complications during pregnancy, after pregnancy, during postpartum life, but the reasons

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for inappropriate perinatal outcomes. Overweight women before pregnancy increases the risk of pregnancy complications; obesity turns out to be an independent risk factor for macrosomia cesarean section pregnancy-induced hypertension, preterm delivery intrauterine growth restriction, congenital malformation, intrauterine fetal death, etc.[12,13] Pregnancy also creates an environment similar to MetS, including insulin resistance, increased blood sugar, triglycerides, and blood pressure; it is also considered as a potential accelerator for the risk of cardiovascular disease and diabetes. The emergence of MetS characteristics during pregnancy may also harm the fetus.[14]

Diagnosis of MetS during pregnancy identifies women at high risk for cardiovascular and metabolic complications in later life and pregnant mothers potentially prone to pregnancy-related complications (preeclampsia, eclampsia, gestational diabetes mellitus [GDM], and coma). This characteristic makes it an appropriate opportunity to evaluate these adverse effects in perinatal period.[15,16] MetS is a risk factor for preterm delivery[17] and preeclampsia, leading to future cardiovascular disease in mothers.[18-21] This becomes even more important once we consider that women with MetS are at higher risk for GDM, and they are 30% more likely to have type 2 diabetes in the future.[22]

Pregnant women are presented with risk factors for MetS at high risk of adverse maternal and neonatal outcomes such as abortion, preterm delivery, preeclampsia, gestational diabetes, gestational hypertension, preeclampsia postpartum hemorrhage, childbirth trauma, fetal abnormalities, low birth weight, intra uterine growth retardation, macrosomia stillbirth, and mortality.

Regarding perinatal complications in mother with MetS, infants have an increased probability of developing a MetS in late lactation period. An increase in these effects may not be limited to the first generation of the offspring, and in subsequent generations, metabolic problems may continue to persist.[13,17,22-27]

There are various strategies' measures to take to prevent obesity and MetS during nonpregnancy period, including increased physical activity, proper dietary habits, frequent and regular physician visits, and helping maintain the safe levels of blood pressure, cholesterol, and blood glucose. The feasible treatment of syndrome would be to change the wrong lifestyle, via increasing physical activity, casting excess weight, reducing daily stress, quitting smoking, and medication treatment before pregnancy, to name a few. The beneficial effects in reducing the risk factors of MetS such as blood pressure, lipid, and lipoprotein have been observed in individuals.[28,29] Although some interventions such as fostering proper diet and physical activity have a positive effect on preventing weight gain during pregnancy, there are currently limited information on effective interventions that can be used to improve maternal, fetal, and neonatal health outcomes.

Therefore, this study aimed to conduct a systematic review using high-quality interventional studies in order to identify appropriate interventions in pregnant women with indicators of MetS during pregnancy and use these interventions to improve the pregnancy outcomes. Reducing maternal complications such as gestational diabetes, preeclampsia, etc., promoting the health of fetuses and newborns includes the Apgar score, the weight, and so on.

Methods

This systematic review was in accordance with the criteria presented by the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement.[30]

Data sources

Data collection was performed by searching in articles using four main electronic databases of Cochrane Library (search CDSR), Web of Science, PubMed, Scopus, and Google Scholar.

Searching strategy

Using the Mesh terms, following relevant keywords and combination of words were used in systematic searches: metabolic syndrome; indicators of metabolic syndrome; obesity or overweight; lipids; triglycerides; high-density cholesterol; low-density cholesterol; diabetes; fasting blood glucose; waist circumference; blood pressure; maternal outcomes; pregnancy complications; gestational hypertension; gestational diabetes; maternal weight gain; preeclampsia; cesarean section; postpartum hemorrhage; induction of labor; neonatal outcomes; macrosomia; birth weight; gestational age; hyperbilirubinemia; hypoglycemia; Apgar score; gestational age; preterm delivery; intervention; physical activity; exercise; exercise therapy; lifestyle; early intervention (training); health education; patient education; health promotion; counseling; nutrition; diet; carbohydrate limitation; Mediterranean diet; fat limitation; weight loss; diet therapy; clinical trial. The searches were performed with no time limitations; they were confined to human studies and clinical trials published until August 2017. Systematic searches were performed on the main databases and targeted searches were performed on other databases. All sources were evaluated for increased sensitivity. The search results were categorized and evaluated using Endnote software.

Criteria inclusion and exclusion for studies

All studies in English or Persian with on time limitations, encompassing randomized controlled trials that evaluated and measured the effects of different interventions in pregnant women with indicators of MetS and the outcome of pregnancy were included. Systematic reviews, before-and-after-pregnancy intervention studies, and observational studies were excluded. In this study, the population, intervention, comparison, outcome, study design system was designed which is expanded as follows: *P* = pregnant women with risk factors for MetS,

I = intervention involving physical activity, lifestyle, counseling, and diet, C = pregnant women with metabolic risk factors with standard health care, O = outcome of pregnancy, S = interventional studies and randomized clinical trial.

Study selection

Two researchers separately carried out electronic searching, picked up a study, and applied proper methodology for evaluation, separately selected relevant studies according to entry criteria. Screening was performed after narrowing the search strategy and duplication removal. Inappropriate articles were identified during the review of titles, abstracts, and full text.

Data collection process

The two researchers independently extracted the data. In the first step, the title and the abstract of each article was carefully scrutinized. In the next step, studies were evaluated in terms of methodology quality and appropriate entry criteria by two researchers independently without considering the results [Tables 1 and 2].

Quality evaluation of studies

The methodology quality of studies was evaluated by two researchers on the basis of how they minimized bias and error in their work. Studies were classified based on the PRISMA,[30,31] Jadad, and Cochrane Library[32] guidelines as high or low quality. For example, objectives, the comparison of the control and intervention group, the population studied, and information about the results were reported in high-quality studies. The quality validation and evaluation of the studies included random method, concealment and random allocation, blindness, incomplete results, selective result reporting, and complete follow-up. The selection of the results was agreed upon by both researchers based on an assessment of the scales in Table 3. In this assessment, the scores ≥3 were considered as high quality and scores ≤2 as poor quality.[33,34] Further coordination, later, helped resolve the controversies between the authors.

Data items

The extracted data for each study included the primary outcome of weight gain during pregnancy and secondary outcomes such as maternal and neonatal complications, gestational diabetes, preeclampsia, gestational hypertension, preterm delivery, cesarean delivery, neonatal macrosomia (>4000 g); birth weight; intrauterine growth retardation; and low birth weight ≤2500 g, and their Apgar scores are summarized in Tables 4 and 5.

Ethics statement

The study was approved by the Ethics Committee of the Shahroud University of Medical Sciences No. IR.SHMU.REC.1395.123**.** The permission to use articles from all authors was not applicable.

Results

The evaluation process is shown in Figure 1, and the selected articles and the results of review are summarized in Tables 3 and 4. A total number of 1043 studies were evaluated by searching in electronic sources. About 1027 studies were excluded by endnote in the first phase after the duplication review. Out of 210 studies, 193 studies were excluded due to lack of inclusion criteria and 17 papers' randomized clinical trials (on 5475 pregnant women) were matched and evaluated; among these, 7 articles studied the physical activity (1499), 3 articles reviewed diets (3089), 6 probed the lifestyle interventions (1125), and 1 article was on counseling (122). In general, evidence suggested how the physical activity and proper diet impacts on proper weight-gain during pregnancy, prevents maternal complications, and improves the outcome of pregnancy.

The main reasons for the exclusion were participants with normal/healthy BMI, nonpregnant women, women who needed extraweight in pregnancy, irrelevant results, irrelevant goals, irrelevant interventions, unreliable full article, irrelevant design, nonclinical trials, and articles published in languages other than English or Persian. Characteristics of the studies are described in Table 2. All of these studies were designed as a clinical trial.[35-51] All the final 17 studies were conducted in developed countries: 5 in Spain, 2 in the United States, 2 in Belgium and 2 in United Kingdom, 1 in Brazil, 1 in Canada, 1 in Turkey, 1 in Denmark, 1 in Australia, and 1 in Norway. They were all inclusive of seven physical activities ranging from 30 to 90–120 min/session;[36,37,45-47,50,51] six cases of lifestyle,[35,38,39,41-43] three cases of diets,[40,44,49] and one case of consultation[35] [Figure 1]. In all studies, prepregnancy interventions were preferably done in the first trimester of pregnancy. Dietary interventions included a balanced diet such as carbohydrates, protein, and fat, and routine interventions based on physical activity, including light intensity exercises, weight bearing exercises, and moderate walking for 30 min. Combined interventions included counseling sessions, training on the potential benefits of a good diet and physical activity, and feedback on weight gain in pregnancy. Combined interventions were used as behavioral modification techniques to improve women's insight on their emotional control of eating and preventing their eating habits. The number of physical activity or exercise sessions was between 2 and 3 times/week and the duration of exercise per session varied from 30 to 120 min. The total number of program sessions was 24–85 weeks. The sample size in the collected clinical trials featured 5475 participants; each study had 60–1555 participants. In the studies of intervention and control groups, the maternal age and BMI were matched. The main goal of most studies was primarily to reduce and control overweight and to enhance the pregnancy outcome. Seventeen clinical trials were evaluated in terms of quality according to Table 5. For all cited trials, the control group received no

Table 1: A summary randomized trials on pregnant women with risk factors for metabolic syndrome

ID	Reference	Country	Aim	Gestational age at recruitment	Study population	Intervention	Study groups	
							Intervention	Controls
1	Guelinckx *et al*.[35]	Belgium	Whether a lifestyle intervention based on a brochure or on active education can improve dietary habits, increase PA, and reduce GWG in obese pregnant women	<15 weeks	*n*=195 white obese pregnant women	Counseling	(a) Passive group: *n*=37 (b) Active group: *n*=42	*n*=43
2	de Oliveria Melo *et al*.[36]	Brazil	To estimate the effect of supervised physical exercise on maternal physical fitness, fetoplacental blood flow, and fetal growth	Initiated at 13 weeks (group A) Initiated at 20 weeks (group B)	*n*=187 pregnant	Physical exercise	(a) Group A: *n*=62 (b) Group B: *n*=63	*n*=62
3	Barakat *et al*.[37]	Spanish	The effects of a structured, moderate-intensity exercise program during the entire length of pregnancy on a woman's method of delivery	6-9 weeks	*n*=290 pregnant	Exercise	*n*=138	*n*=152
4	Adamo *et al*.[38]	Canada	To determine if a structured prenatal PA and nutrition intervention provided to pregnant women during their 2nd and 3rd trimester will reduce offspring obesity risk	Between 12 and 20 weeks	*n*=60 pregnant obese	Lifestyle	*n*=30	*n*=30
5	Bogaerts *et al*.[39]	Belgium	Examine whether a lifestyle program for obese pregnant women reduces GWG	<15 weeks	*n*=197 pregnant obese	Lifestyle	(a) Brochure: *n*=58 (b) Lifestyle: *n*=76	*n*=63
6	Deveer *et al*.[40]	Turkey	The aim of the study was to examine the effect of diet on birth weight, number of LGA (birth weight >90th percentile) babies, total maternal weight gain, gestational age, and route of delivery among patients with positive 50 g glucose challenge test	Between 24 and 28 weeks	*n*=100 pregnant with abnormal glucose	Diet	*n*=50	*n*=50
7	Hawkins *et al*.[41]	Hispanic	The aims of the intervention were to reduce excess gestational weight gain, increase postpartum weight loss, and improve maternal metabolic status in this population	<18 weeks	*n*=68 pregnant overweight and obese	Lifestyle	*n*=33	*n*=35
8	Vinter *et al*.[42]	Denmark	The objective of this clinical trial was to investigate whether lifestyle intervention during pregnancy could improve the metabolic status and subsequently improve pregnancy outcomes in obese women	10-14 weeks	*n*=304 obese pregnant	Lifestyle	*n*=150	*n*=154
9	Kimberly *et al*.[43]	USA	Whether the weight management model often used in no pregnant adults, i.e., a weekly, group-based weight management intervention focused on diet and behavior change, would be effective among obese women for limiting GWG and reducing the proportion of LGA infants	7-21 weeks	*n*=114 obese women	Dietary	*n*=56	*n*=58

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Table 1: Contd...

ID	Reference	Country	Aim	Gestational age at recruitment	Study population	Intervention	Study groups	
							Intervention	Controls
10	Poston *et al*.[44]	UK	Whether a complex intervention addressing diet and PA could reduce the incidence of gestational diabetes and LGA infants	15-18 weeks	*n*=1555, obese pregnant women	Behavioral	*n*=783	*n*=772
11	Haakstad *et al*.[45]	Norwegian	The aims of the present study were to evaluate the effect of regular exercise on arterial systolic and diastolic BP at rest and during uphill treadmill walking, in healthy former inactive pregnant women	12 weeks	*n*=61 pregnant women	Regular exercise	*n*=35	*n*=26
12	Ruben *et al*.[46]	Spain	The aim of the present study was to examine the impact of a program of supervised exercise throughout pregnancy on the incidence of pregnancy-induced hypertension	9-11 weeks	*n*=765 pregnant women	Exercise	*n*=382	*n*=383
13	Aparicio *et al*.[47]	Spain	The main objective was to assess the effects of a novel supervised exercise intervention developed in overweight and grade I obese pregnant on maternal and fetal health	17 weeks	*n*=60 overweight and obese pregnant women	Supervised aerobic and strength training	*n*=30	*n*=30
14	McCarthy *et al*.[48]	Australian	To determine the effect of serial weighing and dietary advice compared with standard antenatal care on obstetric outcomes	<20 weeks	*n*=371 overweight and obese pregnant women	Dietary	*n*=187	*n*=184
15	Al Wattar *et al*.[49]	England	The aim was to evaluate the effectiveness of a simple, targeted intervention modeled on Mediterranean diet in preventing maternal and fetal complications in pregnant women with metabolic risk factors	<18 weeks	*n*=984 pregnant women with metabolic risk factors	Diet	*n*=492	*n*=492
16	Tinius *et al*.[50]	USA	The purpose of the study was to determine the influence of self-reported PA levels on obstetric outcomes in pregnant obese women	8-9 weeks	*n*=96 obese pregnant women	PA	*n*=48	*n*=48
17	Barakat *et al*.[51]	Spain	The aim of the present RCT was to examine the effect of regular moderate-intensity exercise on the incidence of GDM (primary outcome)	10-12 weeks	*n*=102 pregnant women with gestational diabetes mellitus	Exercise	*n*=41	*n*=61

RCT=Randomized controlled trials, PA=Physical activity, LGA=Large-for-gestational age, GDM=Gestational diabetes mellitus, GWG=Gestational weight gain

intervention and only received standard care for pregnancy. The evaluated results included birth weight, infant birth, Apgar score, gestational diabetes, type of delivery, maternal overweight, labor duration, gestational hypertension, and preeclampsia. Considering the significant differences in the provided interventions and the type of risk factors, it was not appropriate to combine the results for meta-analysis. In 17 clinical trials, the effect of interventions on increasing maternal weight was compared in mothers with metabolic risk factors and women in control group. The lowest overweight was observed in the intervention group ranging from 4.1 ± 5.0 kg weight gains in the intervention group to 14.5 ± 3.9 kg in control group, which was statistically significant ($P \leq 0.001$). Interventions had no negative effect on birth weight. The birth weight in the intervention group ranged from the lowest level of 3.203 ± 464 g to the highest

Table 2: A summary of the features of the interventions used in the reviewed studies

ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
1	Nutritionist	Intervention sessions	Dietary recommendations (9-11% of the energy should come from proteins, 30-35% from fat, and 50-55% from carbohydrates)	3 1-h sessions	At 15, 20, and 32 weeks of pregnancy	The sessions provided subjects with recommendations on a balanced, healthy diet, based on the official National Dietary Recommendations The dietary intervention aimed at limiting the intake of energy-dense foods (e.g., fast food and sweets) by substituting them with healthier alternatives (e.g., fruit), increasing low-fat dairy products, increasing whole-wheat grains, and reducing saturated fatty acids. Moreover, more general topics such as energy balance, body composition, nutrition fact labels, and how to increase PA were discussed	Nutritional habits were evaluated every trimester through 7-day food records. PA was evaluated with the Baecke questionnaire	Dietary habits, physical activity, and GWG
2	Physical educators	Intervention sessions	The supervised intervention was performed 3 times weekly. The initial duration of walking was 15 min, gradually increasing over the study period in accordance with the woman's previous physical fitness level. Before beginning the exercise, the women performed warming-up and stretching exercises	3 50-75 min sessions	3 sessions/week	The exercise program was developed by physical educators in accordance with the recommendations of the ACOG	Habitual pattern of PA at (during week 13) and 32 weeks of gestation A version of the pregnancy PA questionnaire validated for women in Brazil	Uteroplacental, fetal blood flow, physical fitness, and fetal growth

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ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
3	A qualified fitness specialist with an obstetrician's assistance	Intervention sessions	Each session included a 25-min core portion that was preceded and followed by a gradual warm-up and cool-down period, both of 7-8 min in duration and consisting of walking and light, static stretching (to avoid any muscle pains) of most muscle groups (upper and lower limbs, neck, and trunk muscles)	40-45 min sessions	3 sessions/week	The exercise program accordance with the recommendations of Guidelines of the ACOG for exercise during pregnancy and the postpartum period		Rate of cesarean and instrumental deliveries
4	The CSEP in partnership with the SOGC	Intervention sessions	These women receive the MOM trial - A Healthy Pregnancy Handbook© which is a 100 page workbook for healthy gestation providing background regarding the risks of maternal obesity and excessive gestational weight gain, pregnancy weight gain guidelines, and helpful suggestions on ways in which to incorporate healthful options into their lifestyle (i.e., goal setting, obstacles, stress management, relapse prevention, dietary options, label reading, healthy restaurant choices, myths and facts, getting active, strong and lean muscle, etc.)	60 min sessions	Group exercise 2 times each week and group-nutrition education classes are scheduled 3 times (7 in total)	We have developed a set of safe and pregnancy specific exercise classes that incorporate the evidence-based SOGC/CSEP Canadian National Guidelines for Exercise during pregnancy and postpartum	Nutritional assessment, counseling sessions with a registered dietitian and group nutrition modules [food record (7 days), actical (7 days), and PA recall (7 days)] questionnaire	Measure compliance to the trial expectations, which we define as completing 75% of their required activities; class attendance (for intervention), completion of dietary records, accelerometer measures, and questionnaires and attendance at follow-up assessments

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ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
			Knowing that frequent visits and reminders foster good compliance rates which are a predictor of success in weight management					
5	Midwife trained	Intervention sessions	Recommendations for a healthy and balanced diet were based on the official National Dietary Recommendations and consisted 50-55% carbohydrate intake, 30-35% fat intake, and 9-11% protein energy intake	90-120 min sessions	4 1.5-2 h session	Institute of Medicine and National Research Council Guidelines for Obese Women	Nutritional habits were evaluated every trimester through 7-day food records. PA was evaluated based on the Baecke questionnaire	Gestational weight gain, mental health
6	Qualified dietitian	Intervention sessions	Carbohydrate intake was restricted to 45% of calories, with the remainder divided between protein (about 20%) and fat (about 35%)	10 session		The diet was tailored for women of different BMI by recommending a norm caloric intake in the range of 1800-2500 cal/day. Approximately for BMI of 20-25 kg/m^2, 30 kcal/kg/day; for BMI of 25-30 kg/m^2, 25 kcal/kg/day; for BMI of 30 kg/m^2 and more, 15-20 kcal/kg/day were given. Calories were divided over three meals and three snacks	Group, patients were followed weekly for the first month after diagnosis and in every 2 weeks until delivery	Pregnancy outcomes
7	The health educators	Counseling sessions	The dietary component was to decrease intake of foods high in saturated fat and increase dietary fiber as recommended by the American Dietetic Association	≥30 min of moderate-intensity activity on most days of the week	6 monthly in-person behavioral counseling sessions and five telephone-delivered booster sessions delivered	The ACOG guidelines for physical activity during pregnancy through increasing walking and developing a more active lifestyle; the dietary instructions by the American Dietetic Association	Physical activity was measured via the pregnancy physical activity questionnaire Diet was assessed by two unannounced 24-h dietary recalls at each of the three assessment time points	The primary goals were to encourage women to achieve the recommended guidelines for physical activity during pregnancy and to decrease intake of saturated fat and increase dietary fiber

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ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
8	Obstetricians and gynecologists	Diet counseling and physical activities	The Official National Dietary Recommendations and consisted of 50-55% carbohydrate intake, 30-35% fat intake, and 9-11% protein energy intake	2 h/week	Four separate diet counseling sessions and an exercise program of weekly aerobic classes	The ACOG guidelines for physical activity during pregnancy through increasing walking and developing a more active lifestyle; the dietary instructions by the American Dietetic Association	Daily physical activities during work or leisure time was based on the validated SGPALS and a short fitness test (the Danish step test)	Lifestyle intervention during pregnancy could improve the metabolic status
9	The study dietician	Intervention sessions combination of dietary and exercise	The study dietician used this formula for personalizing daily calorie goals: Initial caloric needs = [(prepregnant weight in kg) (30 kcal/kg/day) (0.70)] + [(10 kcal) (gestational age in weeks)] 30 min of moderate physical activity per day	16 Each 90-min group session	Two individual counseling sessions, the first immediately after randomization and the second 1 week later then per week	Diet based on DASH dietary pattern physical activity and the recommendations of the ACOG	They asked women to keep food and physical activity diaries and to monitor their progress weekly by charting their weight	Limiting gestational weight gain
*10	Health trainer	Intervention sessions	Women assigned to the intervention received advice on self-monitoring, identification, and problem-solving of barriers to behavior change; enlisting social support; and providing opportunities for social comparison. We encouraged participants to attend all sessions and provided them with a handbook in which information was included about the intervention and the theory behind it, with recommended foods and recipes and suggestions	8 1-h sessions	1 Individual interview and/or individual sessions of 1 h duration once a week for 8 weeks	The study according to the UK NICE guidelines for diabetes in pregnancy. The intervention, which was informed by control theory and elements of social cognitive theory	Food frequency questionnaire to assess the diet of participants and the IPAQ to assess the physical activity of participants	Whether a complex intervention addressing diet and physical activity could reduce the incidence of gestational diabetes and large-for-gestational-age infants

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ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
			for physical activity. We also gave the women a DVD of an exercise regimen that was safe for pregnancy, a pedometer, and a log book for recording their weekly SMART goals					
11	Highly qualified aerobics instructors	Intervention sessions	5-min warm-up Standing on the floor Flexibility exercises Breathing exercises 35-min aerobic dance Low-impact aerobic on the floor or Step aerobic No running or jumping Borg Scale: 12-14 (somewhat hard) 15-min muscular strength exercises Upper/Lower extremities Back Pelvic floor Deep abdominals 12-15 repetitions with three sets 5-min cool-down Stretching Relaxation Body awareness	24 60 min sessions	2 times/week for a minimum of 12 weeks	The aerobic exercise program was designed to follow the ACOG recommendations and consisted of aerobic dance sessions	Measured by ratings of perceived exertion at 12-14 (somewhat hard) on the 6-20 Borg's rating scale	To evaluate the effect of regular exercise on maternal arterial blood pressure
12	A qualified fitness specialist carefully supervised every training session with the assistance of an obstetrician	Intervention sessions	Each exercise session by a gradual warm-up and cool-down period (both 10-12 min duration) and consisted of walking and light static stretching of most muscle groups	85 (50-55 min session	3 days/week training sessions involved aerobic exercise, muscular strength, and flexibility	The intervention involved aerobic exercise, aerobic dance, muscular strength, and flexibility, and met the standards of the American Congress of Obstetricians and Gynecologists	IPAQ to assess the physical activity of the participants	The primary outcome was the number (percentage/ incidence) of women who developed hypertension during pregnancy

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ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
			The main exercise session (25-30 min) included moderate resistance exercise performed through the full range of motion and engaged major muscle groups (pectoral, back, shoulder, upper and lower limb muscles)					
13	By qualified exercise professionals with experience in working with pregnant women	Intervention sessions face-to-face interview	Warm-up: 10 min Conditioning: 40 min Cool-down: 10 min Combined aerobic and strength training and pelvic floor exercises	67 55-60 min/ session	3 days/week	The recommendations of the ACOG in 2002	Questions from the PARmed-X for pregnancy health checklist by the CSEP	To assess the effects of a novel supervised exercise intervention developed in overweight and grade I obese pregnant on maternal and fetal health
14	Midwife	Intervention sessions	Advising on their target gestational weight gain based on IOM GWG guidelines	30 min	18 weeks, 14-18, 20, 24, 28, 32, 36	The reverse side listed seven general points of weight management advice, based on The Australian Guide to Healthy Eating	GWG was calculated as the difference between this weight and self-reported prepregnancy or early pregnancy weight. Participants also completed written questionnaires recalling frequency of weighing at home and during antenatal consultations and quality of life (WHOQOL-BREF)	The primary outcome was a reduction in a composite of obstetric complications
15	The study dietician or a trained allied health professional	Intervention group sessions and telephone follow-ups	The ESTEEM dietary intervention is based on Mediterranean diet, with	7 sessions	Before 18 weeks, 20, 28, 24, 32, 36 of delivery	Mediterranean dietary pattern	At the first visit, the dietician or a trained allied health professional will assess the	

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ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
			education to modify lifestyle choices. The key components of the diet include high intake of fruit and vegetables; nonrefined grains; legumes; moderate-to-high consumption of fish; small-to-moderate intake of poultry and dairy products such as yoghurt and cheese; low consumption of red meat and processed meat; and avoidance of sugary drinks, fast food, and food rich in animal fat				participant's dietary habits using 24 h food recall followed by focused questions to estimate their basal dietary intake and identify elements for change towards a Mediterranean diet, baseline information, as well as ESTEEM Q, IPAQ, and EQ5D questionnaires	The ESTEEM trial is designed to provide a definitive estimate of the effects of Mediterranean dietary pattern in pregnancy on maternal and fetal outcomes
16	Obstetrician	Intervention sessions	Suggest 150 min of moderate physical activity per week, 18, 19, 150 min/week of structured/ planned physical activity was used as the criteria for selecting physical activity for the study	85 50 min	3 sessions/week	The federal physical activity guidelines suggest 150 minutes of moderate physical activity per week. According to Physical Activity Guidelines Advisory Committee report, 2008 AND Global Recommendations on Physical Activity for Health. Geneva: 2010	Therefore, the purpose of the study was to examine obstetric outcomes in pregnant obese women who self-reported being physically active during pregnancy versus pregnant obese women who did not	Maternal physical activity during pregnancy would reduce occurrence rate of cesarean sections in pregnant obese women
17	A qualified fitness specialist and obstetrician	Intervention sessions	The main part of the session lasted 25-30 min and included the following moderate-intensity resistance exercises: toning and joint mobilization exercises, that is,	85 50-55 min/ session	3 days/week from weeks 10-12 up to weeks 38-39	Aerobic exercises, muscle strength and flexibility and met the standards of the ACOG	The standards of the ACOG	The effect of regular exercise on the incidence of GDM (primary outcome)

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Table 2: Contd...

ID	Person delivering intervention	Method of intervention delivery	Intervention recommendations	No. of sessions/ visits	Intervention intervals	Intervention guidance	Intervention assessment	Primary outcomes assessed
			shoulder shrugs and rotations, arm elevations, leg lateral elevations, pelvic tilts, and rocks					

CSEP=Canadian Society for Exercise Physiology, SOGC=Society of Obstetricians and Gynecologists of Canada, BMI=body mass index, SGPALS=Saltin-Grimby Physical Activity Level Scale, DASH=Dietary Approaches to Stop Hypertension, ACOG=American College of Obstetricians and Gynecologists, NICE=National Institute for Health and Care Excellence, IPAQ=International Physical Activity Questionnaire, PARmed-X=Physical Activity Readiness Medical Examination, GDM=gestational diabetes mellitus, GWG = Gestational weight gain, SMART = Specific, Measurable, Assignable, Realistic, Time-related, IOM = Institute of Medicine; WHOQOL-BREF = World Health Organization Quality of Life-BREF, ESTEEM = Effect of simple, targeted diet in pregnant women with metabolic risk factors on maternal and fetal outcomes

Table 3: Quality evaluation of clinical trial studies based on scale

Items	Score standard			Study ID															
	0	1	2	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Randomization	Not randomized or inappropriate method of randomization	The study was described as randomized	The method of randomization was described appropriately	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Double blinding	No blind or inappropriate method of blinding	The study was described as double blinded	The method of double blinding was described appropriately	0	1	1	1	0	0	0	0	0	1	2	2	2	0	2	0	2
Withdrawals and dropouts	Do not describe the follow-up	A description of withdrawals and dropouts		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Score summaries				3	4	4	4	3	3	3	3	3	4	5	5	5	3	5	3	5

According to systematic review done, the most appropriate intervention for pregnant women with MetS indicators is the combination of physical activity and diet that is provided by an obstetrician's with nutritionist assistance. According to the American College of Obstetricians and Gynecologists, guidelines for physical activity during pregnancy through increasing walking and developing a more active lifestyle and the dietary by the American Dietetic Association are summarized in Table 6.

Discussion

The main objective of this study was to collect and present articles on the interventions related to pregnant women with indicators of MetS on the pregnancy outcome. The results of this systematic review showed that there is currently limited information available on clinical recommendations for effective interventions for counseling in terms of physical activity, diet, and lifestyle for pregnant women with MetS; that's why there are comprehensive articles defining the possible, thus far unresolved, complications associated with indicators of MetS during pregnancy and childbirth, also there is limited information available related to effective interventions that may be implemented to improve maternal, fetal, and infant health outcomes. Exercise in pregnancy affects health outcomes for the woman through improved cardiovascular function and restriction of weight gain,[23] with a documented reduction in the risk of preterm birth,[47] and favorable effects on labor and birth.[23] This is an important consideration because excessive gestational weight gain is associated with higher postpartum weight retention, which in turn increases the risk of cardiovascular disease and other chronic conditions later in life.[35] Excessive gestational weight gain also raises the risk of developing other obstetric complications such as gestational diabetes or hypertension,[35,41,45] which are considered cardiovascular disease risk factors in the course of pregnancy, during delivery and in the postpartum period.[39,43]

The current study with a high sample size (5475 pregnant women with a metabolic syndrome index) of the Articles clinical trial was conducted. Based on the results of the present study, dietary and lifestyle interventions are effective in reducing overweight during pregnancy without any complication. Compared to physical activity and combined approach, dietary interventions had the highest weight loss results during pregnancy. Interventions also led to a significant reduction in maternal complications (preeclampsia, gestational diabetes, preterm delivery, pregnancy overweight, gestational hypertension) and improved pregnancy outcomes. The results were not, however, statistically significant.[40] In addition, there was

Table 4: Summary of the maternal outcomes in there viewed studies

ID and intervention	Maternal outcomes									
	GWG (kg)	Pregnancy-induced hypertension [*n* (%)]	Chronic hypertension [*n* (%)]	Preeclampsia [*n* (%)]	Induction of labor [*n* (%)]	Cesarean section [*n* (%)]	Vacuum/ Forceps	Postpartum hemorrhage	GDM	Total time in labor (h)
(1) Counseling	*P*=0.749 Passive group: 39.5, 6, 1.1 Active group: 39.2, 6, 1.1 Control group: 39.0, 6, 1.3	*P*=0.392 Passive group: 6 (16.7) Active group: 18 (43.9) Control group: 14 (34.1)	*P*=0.392 Passive group: 9 (25.0) Active group: 5 (12.2) Control group: 8 (19.5)	*P*=0.463 Passive group: 0 (0) Active group: 2 (4.8) Control group: 1 (2.3)	*P*=0.268 Passive group: 15 (40.5) Active group: 24 (57.1) Control group: 21 (48.8)	*P*=0.208 Passive group: 9 (24.3) Active group: 11 (26.2) Control group: 7 (16.3)				
(2, 3, 11, 12, 13, 16, 17) Physical exercise	*P*=0.0001 Exercise: 11.9 (3.7) Controls: 13.7 (4.1) *P*=0.02 Intervention group: 12.9±4.8 Control: 14.5±3.9 *P*=0.01 Intervention group: 12.1±3.7 Control: 12.9±4.5 *P*=0.37 Intervention group: 10.0±6.4 Control: 11.5±9.1 *P*=0.536 Intervention group: 11.2±4.1 Control: 13.3±3.7		*P*=0.81 Exercise: diastolic: 69.6±9.6 Systolic: 113.8±15.1 Controls: Diastolic: 70.8±8.5 Systolic: 69.6±9.6 *P*=0.009 Intervention group: 8/2.1 Control: 22/5.7	*P*=0.52 Initiated exercise at 13 weeks: 3/54, 0.63 (0.16-2.52) Initiated exercise at 20 weeks: 6/60, 1.14 (0.37-3.53) Control group: 5/57 (1.0) *P*=0.03 Intervention group: 2/0.5 Control: 9/2.3 *P*=0.19 Intervention group: 19 (39.6%) Control: 13 (27.1%)	*P*=0.46 Intervention group: 27 (56.2%) Control: 21 (43.8%)	RR=0.47 (0.26, 0.82) Exercise: 22/15.9 Controls: 35/23 *P*=0.38 Intervention group: 73/19.1 Control: 83/21.7 *P*=0.49 Intervention group: 12 (25.0%) Control: 15 (31.2%) *P*=0.934 Intervention group: 9 (22) Control: 17 (27.9)	*P*=0.13 Intervention group: 49/12.8 Control: 64/16.7 *P*=0.65 Intervention group: 3 (6.3.0%) Control: 2 (4.2%)		*P*=0.21 Exercise: 6/4.3 Controls: 12/7.9 *P*=0.03 Intervention group: 9/2.4 Control: 21/5.5 *P*=1.00 Intervention group: 3 (6.3%) Control: 3 (6.3%)	*P*=0.048 Intervention group: 19.2±15.6 Control: 19.2±15.6
(4, 5, 7, 8, 10) Lifestyle	*P*=0.007 Lifestyle intervention group: 10.6 (7) Brochure group: 9.5 (6.8)	*P*=0.22 Lifestyle intervention group: 39.3 (1.7) Brochure group: 39 (2.3)		*P*=0.09 Lifestyle intervention group: 2 (2.7) Brochure group: 7 (12.3)	*P*=0.73 Lifestyle intervention group: 14 (18.7) Brochure group: 12 (20.7)	*P*=0.77 Lifestyle intervention group: 20 (11.9) Brochure group: 14 (15.5)	*P*=0.77 Lifestyle intervention group: 8 (10.5) Brochure group: 14 (15.5)	≥1000 *P*=0.20 Intervention group: 109/755 (14%) Control: 91/747 (12%)	*P*=0.98 Lifestyle intervention group: 9 (11.8) Brochure group: 7 (12.1)	

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Table 4: Contd...

ID and intervention	Maternal outcomes									
	GWG (kg)	Pregnancy-induced hypertension [*n* (%)]	Chronic hypertension [*n* (%)]	Preeclampsia [*n* (%)]	Induction of labor [*n* (%)]	Cesarean section [*n* (%)]	Vacuum/ Forceps	Postpartum hemorrhage	GDM	Total time in labor (h)
	Controls: 13.5 (7.3) *P*=0.89 Intervention group: 17.73 (1.0) Controls: 17.87 (0.59) *P*=0.014 Intervention group: 7.4-4.6, 144 Control: 8.6-4.4, 148 *P*=0.041 Intervention group: 7.19 (4.6), n=526 Control: 7.76 (4.6), *n*=567 *P*=0.001 Intervention group: 12.62±3.85 Controls: 16.10±4.09 *P*<0.001 Intervention group: 5.0±4.1 Control: 8.4±4.7 *P*≥0.05 [0.9 kg (95% CI: 2.0, 0.25)]	Controls: 39.5 (1.8)		Controls: 4 (6.3) *P*>0.99 Intervention group: 27/753 (4%) Control: 27/752 (4%)	Controls: 15 (24.2) *P*=0.15 Intervention group: 251/765 (33%) Control: 275/757 (36%)	Controls: 19 (12.7) *P*=0.75 Intervention group: 271/765 (35%) Control: 274/757 (36%)	Controls: 7 (11.1)	≥2000 *P*=0.075 Intervention group: 20/755 (3%) Control: 10/747 (1%)	Controls: 7 (11.1) *P*=0.68 Intervention group: 160/629 (25%) Control: 172/651 (26%)	
(6, 9, 14, 15) Diet			*P*≥0.05 Intervention group: 17/124 Control: 19/124	*P*=0.269 Intervention group: 2 (4) Controls: 0 (0) Odds ratio: 0.85 95% CI for odds ratio: [0.24, 2.96] Effect size: 0.02 Intervention group: 5 (9%) Control: 6 (10%)	*P*=0.405 Intervention group: 16 (32) Controls: 20 (40) Odds ratio: 95% CI for odds ratio: Effect size: Intervention group: 21 (38%) Control: 26 (45%) *P*≤0.05 Intervention group: 28/124 Control: 37/124	*P*≥0.05 Intervention group: 24/124 Control: 21/124	*P*≥0.05 Intervention group: 68/124 Control: 64/124	Odds ratio: 0.87 95% CI for odds ratio: [0.28, 2.78] Effect size: 0.02 Intervention group: 6 (11%) Control: 7 (12%) *P*≥0.05 Intervention group: 37/124 Control: 35/124	

GDM=Gestational diabetes mellitus, GWG = Gestational weight gain

in the control group 3678 ± 583 g. The two groups did not have any significant difference in this regard ($P \geq 0.05$). Other neonatal outcomes in two groups were different, though this difference was not statistically significant.

Table 5: Summary of neonatal outcomes in reviewed studies

ID	Neonatal outcomes												
	Birth weight (kg)	**Birth weight ≥4000 g [*n* (%)]**	**Gestational age (weeks)**	**Infant length (cm)**	**Preterm delivery mean (SD) or *n*/%**	**LGA**	**SGA**	**Apgar score 1 min**	**Apgar score 5 min**	**VO_{2max} week 28**	**NICU admission *n* (%)**	**Hyperbil irubinemia *n* (%)**	**Birth trauma *n* (%)**	**Hypoglycemia *n* (%)**
(1) Counseling	*P*=0.106 Passive group: 3.585±0.398 Active group: 3.492±0.468 Control group: 3.419±0.425	*P*=0.312 Passive group: 5 (13.5) Active group: 5 (11.9) Control group: 3 (7.0)	*P*=0.112 Passive group: 10.9±5.6 Active group: 9.8±7.6 Control group: 10.6±6.9	*P*=0.182 Passive group: 51.0±2.1 Active group: 50.6±2.0 Control group: 50.0±1.8										
(2, 3, 11, 12, 13, 16, 17) Physical exercise	*P*=0.53 Initiated exercise at 13 weeks: 3,279±453.1 Initiated exercise at 20 weeks: 3285±477.3 Control group: 3378±593.2 *P*=0.56 Exercise: 3203 (461) Controls: 3232 (448) *P*=0.29 Intervention group: 3252±438 Controls: 3218±453 *P*=0.92 Intervention group: 3548±507 Control: 3558±464 *P*=0.025 Intervention group: 3204±470 Control: 3429±427	*P*=0.61 Initiated exercise at 13 weeks: 9/46, 0.82 (0.38-1.79) Initiated exercise at 20 weeks: 6/48, 0.52 (0.21-1.30) Control group: 11/46 (1.0) *P*=0.03 Intervention group: 7/1.8 Controls 18/4.7	*P*=0.81 Exercise: 278.3 (9.9) Controls: 278.0 (10.3) *P*=0.11 Intervention group: 39.3±1.6 Controls: 39.6±1.7 *P*=0.76 Intervention group: 39.5±1.1 Control: 39.5±1.0 *P*=0.137 Intervention group: 41 Control: 41	*P*=0.98 Exercise: 49.7 (2.06) Controls: 49.5 (2.07) *P*=0.11 Intervention group: 50.0±2.2 Controls: 49.8±2.1 *P*=0.85 Interventional group: 51.8±2.2 Control: 51.7±2.3	*P*=0.98 Exercise: 9/6.5 Controls: 10/6.6 *P*=0.31 Intervention group: 29/7.6 Controls: 37/9.7	*P*=0.21 Initiated exercise at 13 weeks: 3/54, 0.45 (0.12-1.66) Initiated exercise at 20 weeks: 4/60, 0.57 (0.17-1.82) Control group: 7/57 (1.0)	*P*=0.94 Initiated exercise at 13 weeks: 4/54, 1.06 (0.28-4.01) Initiated exercise at 20 weeks: 4/60, 0.98 (0.26-3.74) Control group: 4/57 (1.0)	*P*=0.34 Exercise: 49.7 (2.06) Controls: 49.5 (2.07) ≥7, *n*/% *P*=0.19 Intervention group: 366/95.8 Controls: 359/93.7 *P*=0.66 Interventional group: 7.5±1.6 Control: 7.4±2.0 *P*=0.347 Interventional group: 8.8±1.3 Control: 8.9±1.2	*P*=0.22 Exercise: 9.7 (0.6) Controls: 9.8 (0.8) ≥7, *n*/% *P*=0.31 Intervention group: 381/99.7 Controls: 380/99.2 *P*=0.33 Interventional group: 8.8±0.8 Control: 8.6±1.4 *P*=0.10 Interventional group: 9.8±0.7 Control: 10±1.2	*P*=0.03 Initiated exercise at 13 weeks: 27.3±4.3 Initiated exercise at 20 weeks: 28±3.3 Control group: 25.5±3.8				

Contd...

Table 5: Contd...

ID	Neonatal outcomes													
	Birth weight (kg)	**Birth weight ≥4000 g [*n* (%)]**	**Gestational age (weeks)**	**Infant length (cm)**	**Preterm delivery mean (SD) or *n*/%**	**LGA**	**SGA**	**Apgar score 1 min**	**Apgar score 5 min**	**VO_{2max} week 28**	**NICU admission *n* (%)**	**Hyperbil irubinemia *n* (%)**	**Birth trauma *n* (%)**	**Hypoglycemia *n* (%)**
(4, 5, 7, 8, 10) Lifestyle	*P*=0.54 Lifestyle intervention group: 3.444 (0.503) Brochure group: 3.386 (0.682) Controls: 3.504 (0.583) *P*=0.64 Intervention group: 3338.8±640.7 Controls: 3429.8 ± (532.6) *P*=0.37 Intervention group: 3420 (580), *n*=761 Controls: 3450 (580), *n*=751	*P*=0.93 Intervention group: 105/761 (14%) Controls: 105/751 (14%)	*P*=0.58 Lifestyle intervention group: 39.3 (1.7) Brochure group: 39 (2.3) Controls: 39.5 (1.8) *P*=0.36 Intervention group: 39.1 (2.1) Controls: 39.1 (2.4) *P*=0.89 Intervention group: 39.5 (2.0), *n*=761 Controls: 39.5 (2.4), *n*=751		*P*=0.70 Intervention group: 45/761 (7%) Controls: 48/751 (6%)	*P*=0.43 Intervention group: 39/761 (5%) Controls: 32/751 (4%)	*P*=0.39 Intervention group: 36/761 (5%) Controls: 43/751 (6%)	*P*=0.50 Lifestyle intervention group: 8.3 (1.5) Brochure group: 8.5 (1.4) Controls: 8.6 (0.7)	*P*=0.64 Lifestyle intervention group: 9.4 (1) Brochure group: 9.4 (0.9) Controls: 9.5 (0.5)	*P*=0.049 Intervention group: 23±5.90 Controls: 22±4.76	*P*=0.49 Intervention group: 65/761 (9%) Controls: 57/751 (8%)			*P*=0.020 Intervention group: 27/760 (4%) Controls: 12/751 (2%)
(6, 9, 14, 15) Diet	*P*=0.001 Intervention group: 3310±342.36 Controls: 3587±460.20 Mean difference: −194 95% CI for difference: [−411, 22]	*P*=0.004 Intervention group: 1 (2) Controls: 10 (20) Odds ratio: 0.42 95% CI for odds ratio [0.15, 1.18]	*P*=0.269 Intervention group: 38.91±1.02 Controls: 38.69±1.14		*P*=0.363 Intervention group: 1 (2) Controls: 4 (8) Odds ratio: 0.28 95% CI for odds ratio: [0.09, 0.84]	*P*=0.007 Intervention group: 2 (4) Controls: 11 (22) Odds ratio: 0.28 95% CI for odds ratio: [0.09, 0.84]	*P*=0.461 Intervention group: 5 (10) Controls: 3 (6) Odds ratio: 0.76 95% CI for odds ratio [0.11, 4.76]				*P*=0.061 Intervention group: 8 (16) Controls: 16 (32) Odds ratio: 0.91 95% CI for odds ratio: [0.29, 2.91]	Odds ratio: 1.08 95% CI for odds ratio: [0.03, 2.00] Effect size: 0.01 Intervention group: 2 (4%)	Odds ratio: 1.08 95% CI for odds ratio [0.08, 15.38] Effect size: 0.13 Intervention group: 1 (2%)	Odds ratio: 0.33 95% CI for odds ratio: [0.03, 2.00] Effect size: 0.01 Intervention group: 2 (4%) Control: 6 (11%)

Contd...

Table 5: Contd...

ID	Neonatal outcomes													
	Birth weight (kg)	**Birth weight ≥4000 g [*n* (%)]**	**Gestational age (weeks)**	**Infant length (cm)**	**Preterm delivery mean (SD) or *n*/%**	**LGA**	**SGA**	**Apgar score 1 min**	**Apgar score 5 min**	**VO_{2max} week 28**	**NICU admission *n* (%)**	**Hyperbil irubinemia *n* (%)**	**Birth trauma *n* (%)**	**Hypoglycemia *n* (%)**
	Effect size: 0.33 Intervention group: 3484±583 Controls: 3678±583	Effect size: 0.16 Intervention group: 6 (11%) Control: 13 (22%)			Effect size: 0.22 Intervention group: 5 (9%) Control: 15 (26%)	Effect size: 0.22 Intervention group: 5 (9%) Control: 15 (26%)	Effect size: 0.03 Intervention group: 3 (5%) Control: 4 (7%)				Effect size: 0.02 Intervention group: 6 (11%) Control: 7 (12%)	Control: 2 (4%)	Control: 1 (2%)	

LGA=Large-for-gestational age, SGA = Small for gestational age.

a lack of information on the impact of interventions on neonatal outcomes. Interventions had less effect on the implications related to fetal weight and other neonatal diseases and deaths. The number of newborns weighing more than 4000 g in the intervention group was lower than the control group. This is an important consideration given the negative outcomes associated with macrosomia, that is, higher incidence of postpartum hemorrhage, cesarean sections, shoulder dystocia, birth traumas, or the risk of developing obesity and diabetes mellitus later in life,[50] and there was no evidence, showing that interventions would reduce the rate of cesarean or induced delivery.

Most published studies zoom in on the effects of dietary, physical activity, and lifestyle interventions on pregnancy outcomes (maternal, neonatal, and embryo) in pregnant women with indicators of MetS. There was evidence of undesirable dietary effects during pregnancy, but usually found in studies with severe diets for weight loss, or for those who consumed food with high or low glycemic index.[52] It was also found that weight loss during pregnancy was not associated with increased number of infants who were small based on gestational age. The findings suggested that multifaceted intervention is adopted, compared with stand-alone dietary advice, exercise modification, or behavioral strategies during pregnancy that were more effective on limiting pregnancy weight gain and reducing maternal complications such as preeclampsia, gestational diabetes, gestational hypertension, and preterm delivery.[47] Besides, one of the main concerns of mothers was recognized to be the impact of dietary interventions and lifestyle changes on child's weight. There was no evidence in terms of any relationship between these interventions with adverse maternal or fetal outcomes during pregnancy and childbirth.

Conclusion

Thus far, there have been no precise recommendations to manage MetS during pregnancy in order to improve pregnancy outcomes. Our overall results indicated that physical activity, proper diet, and lifestyle changes can improve the outcome of pregnancy in pregnant women with risk factors for MetS. Amongst these, safe and effective dietary interventions can be potentially more effective than physical activity. Unfortunately, the available data are not sufficient to determine the important risks or other potential benefits of interventions for the mother or baby. There are also no studies on the cost–benefits of a health-care system potent enough to implement interventions to reduce pregnancy complications. However, there is a need to conduct more randomized controlled clinical trials on this issue.

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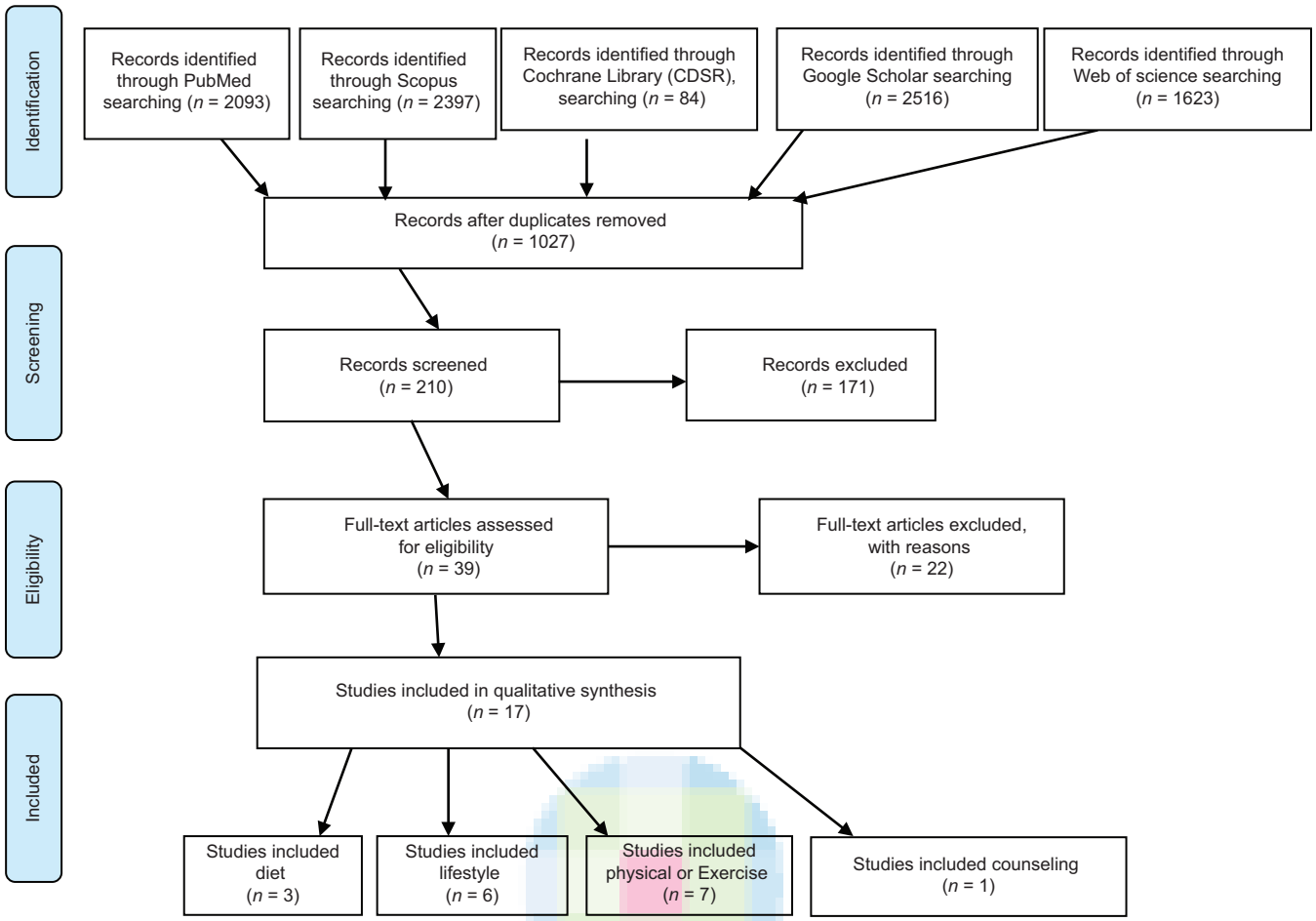

Figure 1: Chart to select the article

Table 6: Summary of intervention recommendations in reviewed studies

Intervention	Aim	Intervention recommendations	Gestational age at recruitment	Person delivering intervention	Method of intervention delivery	Intervention intervals and no. of sessions/visits	intervention guidance	Outcomes measurable
Lifestyle	The aims of the interventions were to reduce complication pregnancy, increase outcome pregnancy, and improve maternal metabolic status in this women	Physical exercise: 5-min warm-up Standing on the floor Flexibility exercises Breathing exercises 35-min aerobic dance Low-impact aerobic on the floor or Step aerobic No running or jumping Borg Scale: 12-14 (somewhat hard) 15-min muscular strength exercises	<15 weeks	Nutritionist with the assistance of an obstetrician	Intervention sessions and counseling	3 sessions/week and 60-min sessions for physical exercise and 2 consultation sessions with a dietitian at weeks 15-20 and 24-28 weeks		Maternal outcomes, neonatal outcomes

Contd...

Table 6: Contd...

Intervention Aim	Intervention recommendations	Gestational age at recruitment	Person delivering intervention	Method of intervention delivery	Intervention intervals and no. of sessions/visits	intervention guidance	Outcomes measurable
	Upper/Lower extremities Back Pelvic floor Deep abdominals 12-15 repetitions with three sets 5-min cool-down Stretching Relaxation Body awareness Diet: dietary Recommendations (9-11% of the energy should come from proteins, 30-35% from fat, and 50-55% from carbohydrates)					The American College of Obstetricians and Gynecologists guidelines for physical activity during pregnancy through increasing walking and developing a more active lifestyle; the dietary by the American Dietetic Association	

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Conflicts of interest

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