

**Public Health Best Practices that Affect Low Birthweight**

**Literature Review**

**For the Colorado Department of Public Health and Environment**

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# **Public Health Best Practices that Affect Low Birthweight**

## **ABSTRACT**

### **Background**

Effective public health practices targeted to pregnant women, that address risk factors known to impact low birthweight, can provide a significant contribution to reducing low birthweight rates in Colorado.

### **Objectives**

To provide information on effective public health practices that address risk factors for low birthweight. The following topics are the focus of this search: tobacco use in pregnancy, inadequate maternal weight gain, case management and support during pregnancy, and alcohol and illicit drug use in pregnancy.

### **Search Strategy**

OvidSP was used to search MEDLINE and CINAHL databases for all relevant articles published between January 2000 and January 2009. Websites of major government public health entities and evidence based medicine collaboratives were also searched.

### **Main Results**

#### Tobacco Use in Pregnancy

A variety of behavioral smoking cessation interventions appear to be effective at reducing smoking and improving birthweight and other birth outcomes, despite the variation in intensity of the intervention. Interventions shown to be most effective were more intensive and combined counseling with written materials and support. Telephone support, provided by a health professional, as an adjunct intervention in combination with home visits or face-to-face sessions had a beneficial effect on reducing low birthweight and smoking abstinence but no effect on smoking cessation.

Nicotine gum and transdermal nicotine may be effective for women who are motivated yet unable to quit smoking, though there is insufficient data on the health risks to the fetus for using these pharmacotherapies. Alternative therapies and telephone support as the primary intervention were not effective interventions.

### Inadequate Weight Gain in Pregnancy

Nutrition education interventions for improving maternal weight gain during pregnancy showed no consistent benefit of the intervention on weight gain. Interventions resulting in improved gestational weight gain and birth outcomes used intensive, individualized nutrition counseling and follow-up throughout pregnancy. Energy/protein supplementation resulted in increased maternal weight gain and improved birth weight. High protein or balanced protein supplements were not beneficial and may be harmful to the fetus.

### Nutrition Interventions and Birthweight

Iron supplementation in non-anemic women resulted in significant reductions in low birthweight. Milk intake may be beneficial at increasing birthweight. It is not beneficial to restrict energy/protein intake in overweight or obese women, or women with high weight gain during pregnancy, and may be harmful to the fetus.

### Prenatal Case Management

Results of the effectiveness of prenatal case management programs to reduce low birthweight are equivocal. A review of studies showed no reductions in low birthweight and preterm delivery. Several studies identified and not included in the review showed prenatal case management improved birthweight and provided cost savings. There was great variation in the services provided through prenatal case management programs.

### Drug and Alcohol Use in Pregnancy

Insufficient data/studies were available about alcohol and illicit drug use interventions during pregnancy to draw conclusions regarding best practices.

## **INTRODUCTION**

### **Low Birthweight**

Colorado has one of the highest low birthweight rates in the nation,<sup>1</sup> which presents a significant cost to society through health care expenditures, and the contribution low birthweight makes to infant mortality and developmental and neurological disabilities. In 2007, a total of 6,397 babies in Colorado (9.0 percent of all births) were born low birthweight.<sup>2</sup> Babies born 5 pounds, 8 ounces or less (less than 2,500 grams) are considered low birthweight. A baby's low weight at birth is either due to preterm delivery, defined as occurring before 37 weeks gestation, or fetal growth restriction.

In 1998 the Colorado Department of Public Health conducted an analysis that showed that inadequate weight gain during pregnancy and smoking together are the two most important factors in low birthweight among singleton births.<sup>1</sup> Other well-established factors that contribute to low birthweight include multiple gestation, low socioeconomic status, stress during pregnancy, maternal prepregnancy underweight status, alcohol and drug use, and medical complications such as hypertension and diabetes.<sup>3</sup>

### **Preterm Birth**

The preterm birth rate in the United States is a growing public health problem which costs society at least \$26 billion per year,<sup>4</sup> and together with low birthweight is the third leading cause of infant mortality in the United States.<sup>5</sup> Preterm births account for at least 12.5 percent of all births in the United States.<sup>4</sup> In Colorado, 9.8 percent of all births were to preterm infants in 2007, and the majority of preterm births (60.4 percent) were also low birthweight.<sup>2</sup> Preterm infants are at greater risk for multiple short and long-term health and developmental problems compared to infants born full term (infants born between 37 and 42 weeks).<sup>4</sup>

Many of the causes of preterm delivery are similar to those for low birthweight, as the majority of preterm births are also low birthweight. These risk factors include low socioeconomic status, low prepregnancy weight, inadequate weight gain during pregnancy, alcohol consumption before the third trimester of pregnancy, negative attitude about the pregnancy, pregnancy-related anxiety, stress, smoking, multiple gestation, previous preterm delivery, a history of infertility problems, vaginal spotting or light bleeding during pregnancy, cervical factors, problems with fetal membranes, and decreased uteroplacental blood flow.<sup>4,5,6,7</sup>

In addition to the risk factors mentioned, an emphasis on the increasing prevalence of maternal prepregnancy overweight and obesity as a risk factor for preterm delivery has been established.<sup>8,9,10</sup> A recent study of Colorado mothers confirmed these results by showing that obese and morbidly obese women were more likely to deliver prematurely compared to women that were normal weight.<sup>11</sup> Interventions that address the risk

factors associated with preterm births, along with low birthweight, are necessary to reduce significant health care costs, consequences to families, and the costs to society.

### **Purpose of Literature Review**

The purpose of this literature review is to provide information on effective public health practices that address specific risk factors known to affect low birthweight. The specific risk factors which are the focus of the literature review are: tobacco use in pregnancy, inadequate weight gain in pregnancy, case management during pregnancy, and drug and alcohol use in pregnancy. In addition, information is provided on obesity during pregnancy and excessive weight gain as they relate to reducing low birthweight and preterm birth.

### **SEARCH METHODS**

The OvidSP search interface platform was used to search MEDLINE and CINAHL (Cumulative Index to Nursing and Allied Health Literature) databases. The searches were limited to English language papers, using human subjects, published between the years 2000 to 2009. Papers were excluded from consideration if they were a case study, an editorial, published in a non-peer-reviewed journal, or were the result of research using a population of women that differed greatly from women in Colorado or the United States.

The following searches were completed to identify published papers addressing low birthweight reducing interventions, using all relevant MeSH (medical subject headings) terms.

1. Pregnancy
2. "Low birthweight"
3. "Tobacco use cessation" or "smoking cessation"
4. "Weight gain" or "body mass index" or "body weight"
5. "Case management" or "health education" or education
6. "Substance-related disorders" or "alcohol drinking" or "alcoholic intoxication" or alcoholism
7. Low birthweight and pregnancy and weight gain
8. Low birthweight and pregnancy and weight gain and case management
9. Low birthweight and pregnancy and smoking
10. Low birthweight and pregnancy and smoking and case management
11. Low birthweight and pregnancy and case management
12. Low birthweight and pregnancy and alcohol use
13. Low birthweight and pregnancy and alcohol use and case management
14. Low birthweight and pregnancy and substance-related disorders and case management.

The following websites were also used to search pregnancy, low birthweight, and low birthweight prevention programs or reports.

The Center for Maternal and Infant Health  
The Maternal and Child Health Bureau  
The Centers for Disease Control and Prevention  
Institute of Medicine  
Trip Database Resource for Evidence Based Medicine  
The Community Guide to Preventive Services  
Cochrane Collaborative  
Campbell Collaborative  
CityMatCH  
Public Health Reports Journal

## **TOBACCO USE IN PREGNANCY**

### **Reviews of Smoking Cessation Interventions**

A total of four published reviews were identified, which assessed smoking cessation intervention trials during pregnancy. The reviews were published between January 2000 through January 2009, though all included trials published before 2000.

#### Cochrane Collaboration Review, 2004

The most comprehensive review, published in 2004, was from The Cochrane Collaboration.<sup>12</sup> This review included 64 randomized and quasi-randomized trials of smoking cessation programs implemented during pregnancy, which provided data on smoking cessation and/or perinatal outcomes. Table 1 summarizes the review. The main results show that there was a significant reduction in smoking in the intervention groups of the 48 trials included despite the substantial variation in the intensity of the intervention and the extent of reminders and reinforcement through pregnancy. This resulted in an absolute difference of 6 percent of women continuing to smoke. For the 16 trials with information on perinatal outcomes, smoking cessation interventions significantly reduced low birthweight and preterm birth, and there was a 33g increase in mean birth weight. The close to 20 percent reductions in preterm birth and low birthweight in the intervention arm of the smoking cessation trials confirm that smoking cessation can reverse the adverse effects of smoking on perinatal outcomes. A number of trials, however, excluded women who had a preterm delivery or had a perinatal death.

When the studies were subgrouped by level of smoking cessation intervention intensity, the results show no significant difference in smoking cessation rates between the different levels. Of the 48 studies included in this subgrouping, the vast majority (35) of studies provided a high level of smoking cessation intervention intensity. The high level of

**Table 1. Reviews of Smoking Cessation Interventions During Pregnancy**

<b>Review</b>	<b>No. of Trials</b>	<b>Interventions Shown to be Effective</b>	<b>Non-Effective Interventions</b>
Cochrane Review, 2004	64	<p>Most effective were two studies using a combination of social support and rewards</p> <p>Cognitive-behavioral interventions</p> <p>Nicotine replacement therapy was borderline</p>	<p>Stages of change approaches</p> <p>Feedback</p>
Crawford et al., 2008	Not reported	<p>Brief cognitive-behavioral interventions accompanied by pregnancy-specific self-help materials</p> <p>Implementing the 5A's framework.</p> <p>Financial incentives and reward therapy may increase initial cessation rates</p> <p>Caution the use of pharmacotherapies such as nicotine replacement therapy, bupropion, and Varenicline until more is known about risk to the fetus</p>	<p>Telephone hotline numbers</p> <p>Group sessions</p> <p>Videos or interactive computer feedback</p> <p>Hypnotherapy</p> <p>Acupuncture, acupressure, laser therapy, and electrostimulation</p>
Messecar, 2001	5	<p>More intensive intervention with multiple contacts and redundant formats, such as counseling combined with written materials and follow-up calls</p> <p>Materials specifically directed to pregnancy rather than the general audience</p> <p>More focused contacts in the women's early contacts</p> <p>If reluctant to quit, advocate for as much reduction in smoking possible</p>	
Dennis and Kingston, 2008	14	<p>Telephone support, delivered by a health professional, as an adjunct intervention</p>	<p>Telephone support as a primary intervention</p> <p>Telephone support, delivered by a lay provider, for smoking cessation (either as primary intervention or adjunct intervention)</p>
Oncken and Kranzler, 2003	Not reported	<p>For women motivated to quit smoking after having been unable to quit on their own with a behavioral intervention:</p> <ol style="list-style-type: none"> <li>1. Nicotine gum – though limited data were available</li> <li>2. Transdermal nicotine (nicotine patch) – though limited data were available</li> </ol>	<p>Insufficient data to support the use of the following FDA-approved pharmacotherapies for smoking cessation during pregnancy:</p> <ol style="list-style-type: none"> <li>1. Bupropion SR</li> <li>2. Nicotine nasal spray</li> <li>3. Nicotine inhaler</li> <li>4. Nicotine lozenge</li> </ol>

intensity was defined as pregnant women receiving personal follow up on smoking cessation (telephone calls, counseling, peer support) and strategies to quit, personal advice to quit and written information.

When studies were grouped by intervention strategies, the cognitive behavioral group, which was the largest, showed a similar effect on smoking cessation when compared to the entire pooled group of trials. The two most effective studies, in terms of the effect on smoking cessation, included a social support component and a reward component to the intervention. The seven trials that used the “stages of change” model were not effective, nor were the three trials using feedback. The trials using nicotine replacement therapy were borderline.

### Crawford et al., 2008

Crawford et al. reviewed the effectiveness of the following interventions on smoking cessation in pregnancy: counseling, pharmacotherapy, and alternative therapies (Table 1).<sup>13</sup> A major limitation of this review was the methodology for the selection or assessment of the studies reviewed was missing. Counseling interventions shown to be effective at increasing smoking cessation rates, based on a meta-analysis of randomized clinical trials, include brief counseling sessions with a trained provider supplemented by self-help materials. The counseling sessions should include problem solving techniques and coping strategies. Brief behavioral counseling interventions to reduce smoking in pregnancy resulted in reduced rates of low birthweight and preterm birth. For women unable to quit with brief counseling alone, a referral for additional behavioral counseling was recommended, though the most effective amount and intensity of additional therapy are unknown.

Most nicotine replacement therapy (NRT) studies investigated the use of nicotine patches in pregnancy. NRT patches and other forms of NRT should not be routinely recommended for use in the first trimester of pregnancy. The authors caution against use of NRT until more is known about the effects on the fetus, and suggests the lowest effective dose only when nonpharmacologic treatments have failed. The use of the antidepressant bupropion and the drug Varenicline show promise in smoking cessation and have no known fetal risks, but the authors warn more research is necessary to evaluate the risk/benefit relationship before widespread use is recommended.

Alternative therapies, such as acupuncture and hypnotherapy have been promoted as nonpharmacologic methods to aid smoking cessation. The authors conclude that clinical trials show no clear evidence that acupuncture, acupressure, laser therapy, or electrostimulation are more effective than a placebo for smoking cessation. And most studies in the scientific literature regarding hypnotherapy are either case reports or are poor quality uncontrolled trials. Thus, there is insufficient evidence to support the use of hypnotherapy as an effective smoking cessation intervention for pregnant women.

The authors also discussed the effectiveness of using biomarkers to validate smoking status due to the high proportion of non-disclosure among pregnant women about

smoking during pregnancy. Due to cost and time constraints, however, the use of appropriate screening tools for smoking during pregnancy is a more realistic goal than testing for biochemical markers. The use of multiple choice questions regarding smoking status were shown to be more effective for disclosure of smoking than asking “Do you smoke?”, with a yes or no response.

#### Messecar, 2001

Five studies taken from a meta-analysis of prenatal smoking cessation interventions, with information on smoking cessation and the outcome of low birthweight, were examined by Messecar (Table 1).<sup>14</sup> These studies show several key features of smoking cessation interventions appear to improve quit rates. More intensive intervention with multiple contacts and counseling combined with written materials or follow-up calls produce a larger effect on quit rates and reductions in low birthweight rates. Early quitting in pregnancy resulted in the greater reduction in low birthweight, which suggests that interventions should be more focused in the women’s early contacts in the system. One study reported an additional positive effect on low birthweight with the reduction in the number of cigarettes smoked. Therefore, for women unable to quit, women should be counseled on as much reduction in smoking as possible. The author recommended the “5 A’s” as a method to use when counseling pregnant women on smoking cessation.

#### Dennis and Kingston, 2008

This systematic review of 14 randomized controlled trials focused on the assessment of the effects of telephone-based support on perinatal outcomes, including smoking, preterm birth, and low birthweight (Table 1).<sup>15</sup> The trials were published between 1986 and 2004. When looking at the pooled telephone support interventions compared to usual care, there was a significant reduction in the number of women who delivered low birthweight infants, with a 22 percent reduction in the number of women who gave birth to a low birthweight infant. There were no significant reductions, however, in preterm delivery or smoking cessation, smoking abstinence, or smoking relapse for the pooled data. Examination of the telephone interventions revealed a wide diversity in the nature, frequency, and duration of the telephone support provided.

When the studies were subgrouped by intervention type, those studies that used telephone support as an adjunct intervention in combination with home visits or face-to-face sessions had a beneficial effect on reducing low birthweight, on smoking abstinence, and on relapse, but had no effect on increasing smoking cessation rates. When telephone support was used as the primary intervention, there was no beneficial effect found on reducing preterm birth, smoking abstinence, smoking relapse, or cessation rates. Telephone support provided by a lay provider, versus a health professional, had no effect on smoking abstinence, relapse, or cessation. These results suggest that proactive telephone support in conjunction with other strategies, provided by a health professional, may assist in smoking abstinence and relapse as well as reducing low birthweight, but not smoking cessation.

### Oncken and Kranzler, 2003

This article reviewed the available efficacy and safety data for the use in pregnancy of pharmacotherapies recommended for smoking cessation in non-pregnant smokers.<sup>16</sup> Though this was not a systematic review of the published literature, it did summarize the limited data available regarding the application of pharmacotherapies for pregnant smokers. This information is summarized in Table 1. The majority of pregnant smokers do not quit smoking during pregnancy, even with augmented behavioral interventions. Pregnant smokers who continue to smoke after the first trimester may be more resistant to treatment and may benefit from pharmacotherapy for smoking cessation. The decision to use pharmacotherapies, the authors note, should be made by the pregnant smoker and her health care provider after a discussion of risk of smoking during pregnancy and potential risks and benefits of such treatment. The preferred treatment, based on available data, is the use of the nicotine replacement therapies nicotine gum or nicotine patches (transdermal nicotine).

### **Smoking Cessation Intervention Studies**

#### Behavioral Interventions

Two additional studies of smoking cessation interventions during pregnancy, and one study assessing social support and smoking in pregnancy, were identified and were not included in the review articles mentioned earlier.

Two studies were randomized controlled trials measuring the effect of intensive individual anti-smoking counseling, delivered by midwives in the home, on smoking cessation for pregnant women.<sup>17,18</sup> Polanska et al. used 4 home visits with the possibility of five additional visits for non-quitters, and showed a significant increase in smoking cessation with the intervention. Women who discontinued smoking delivered infants with significantly higher birth weights. The intervention focused on counseling plus written materials. A major limitation to this study, however, is that self-reported smoking status was not verified using biomarkers of exposure to tobacco smoke, which may have caused over-reporting of smoking cessation. Tappin et al. used midwives trained in motivational interviewing to offer between two and five home visits to pregnant smokers. Results show that motivational interviewing provided by midwives was not effective at helping pregnant smokers with smoking cessation, decreasing the number of cigarettes smoked, or improving birth weight.

Elsenbruch et al. studied the effects of social support during pregnancy on maternal and pregnancy outcomes.<sup>19</sup> This well-conducted study showed that perceived social support during pregnancy had a significant effect on birth weight in smokers. Among women who smoked during pregnancy, those with low social support during pregnancy had significantly reduced birth weights, compared to smokers who had high levels of social support during pregnancy. This study speaks to the complex network of risk factors that

effect birth weight that must be addressed together to ameliorate the problem of delivering low birthweight infants.

### Nicotine Replacement Therapy

One study was identified that was not included in the review articles mentioned earlier, related to nicotine replacement therapy for pregnant smokers.<sup>20</sup> This randomized controlled trial used nicotine gum versus a placebo, along with behavioral counseling. The findings show that though use of 2-mg nicotine gum during pregnancy did not increase quit rates, there were significant increases in birth weight and gestational age among the women who used nicotine gum.

### **Smoking Cessation Best Practices Papers**

Three papers were identified which described smoking cessation interventions for prenatal care providers, focusing on best practices.<sup>21,22,23</sup> All papers discussed implementation of the 5A's as a best practice for addressing smoking cessation with pregnant women.

## **WEIGHT GAIN DURING PREGNANCY**

### **Reviews of Interventions for Inadequate Weight Gain**

Two published reviews were identified that assessed interventions to address inadequate weight gain during pregnancy. The reviews were published between January 2000 through January 2009, though they include studies published before 2000.

#### Cochrane Collaboration Review, 2003 (Updated November, 2006)

The Cochrane Collaboration reviewed energy and protein intake in pregnancy, as it relates to gestational weight gain and birth outcomes.<sup>24</sup> This review included 26 randomized and quasi-randomized trials to assess the effects of nutrition advice, supplementation, or restriction during pregnancy on gestational weight gain and pregnancy outcomes. Table 2 summarizes the review. The overall findings suggest nutritional advice to women and balanced energy/protein supplementation may be beneficial but that high protein supplementation for pregnant women may be harmful.

Five trials on nutritional advice were included in the review. Advice to increase energy and protein intakes seemed to be successful at achieving these goals. There was limited data available, however, to show a consistent benefit of nutritional advice on maternal weight gain or fetal growth.

Thirteen trials on balanced energy/protein supplementation were assessed. Results show a significant increase in gestational weight gain with supplementation. Also, the incidence of small-for-gestational-age (SGA) birth was significantly reduced.

**Table 2. Reviews of Interventions Addressing Inadequate Weight Gain During Pregnancy**

<b>Review</b>	<b>No. of Trials</b>	<b>Interventions Shown to be Effective</b>	<b>Non-Effective Interventions</b>
Cochrane Review, 2003 (Updated 11/2006)	5 trials regarding nutritional advice  13 trials regarding balanced energy/protein supplementation  2 trials regarding high-protein supplementation  3 trials regarding isocaloric protein supplementation (without energy supplementation)	Nutrition advice was effective at increasing energy and protein intake, but showed no consistent benefit on maternal weight gain or fetal growth  Balanced energy/protein supplementation	High-protein supplementation  Isocaloric protein supplementation
Nielsen et al., 2006	27 articles	Overall improvements in outcomes measured for prenatal care programs enhanced with nutrition education counseling/classes  2 studies reported + weight gain: Individualized, intensive nutrition education with follow-up provided throughout pregnancy increased gestational weight gain and reduced the incidence of low birth weight	7 studies showed no effect on weight gain (interventions were not well described)

Two trials regarding the use of high-protein supplementation, and three trials regarding isocaloric protein supplementation were included. Isocaloric protein supplementation indicates a supplement in which the protein/energy content is balanced, but replaces an equivalent amount of energy in the diet. This results in an overall higher protein intake without higher calorie intake. The results for both types of supplements show no beneficial effect on maternal weight gain or birth weight, and the evidence suggests they may even be harmful.

This review also covered energy/protein restriction in women with overweight or high weight gain, which will be discussed later in this report.

Nielsen et al., 2006

This review evaluated 27 articles of nutrition education interventions targeting pregnant adolescents on diet quality, gestational weight gain, and birth outcomes (Table 2).<sup>25</sup> Of note is that many of the studies in this review included adult women in addition to adolescents and used weak methodologies in the study design. The majority of the studies involved interventions based on a medical model that included enhanced prenatal services with specialized nutrition counseling. Enhanced prenatal care programs addressed the special psychosocial and nutrition needs of adolescents, including

individualized risk assessment and counseling. Results from the 19 controlled trials identified, four of which were randomized controlled trials, suggests a positive influence of prenatal nutrition interventions; the majority detected improvements in outcomes tested, although the data collected did not allow the measurement of the independent contribution of nutrition elements to the improved outcomes.

Of the nine studies including the outcome measurement of gestational weight gain, two showed significant increases in weight gain, and a reduction in low birthweight births, in the intervention group. These successful programs used a low SES population of women and included intensive, individualized nutrition counseling and follow-up throughout pregnancy.

A total of eight studies were identified which used a small sample size and/or had no control group. Due to the limited power of each of these studies and lack of comparison groups, the authors could not draw conclusions about the effect of their nutrition interventions.

## **Inadequate Weight Gain Intervention Studies**

### Nutrition Education Interventions

Three additional studies regarding nutrition education interventions for improving maternal weight gain, and one study regarding other influences on weight gain, were identified and not included in the reviews mentioned earlier.

Joyce et al. measured whether greater exposure to the WIC Program is associated with maternal factors, improved weight gain during pregnancy, and better birth outcomes.<sup>26</sup> This analysis of data from nine states addresses limitations in previous studies of the effectiveness of the WIC Program. Results show a positive but modest effect of participation in WIC on fetal growth, and the program improves maternal weight gain only in underweight women. The authors conclude that WIC may work to improve birth outcomes, but with less of an impact than has been claimed by policy analysts and advocates. These results support the WIC Program, but speak to the need for additional enhanced services for women at risk for poor birth outcomes in addition to providing WIC services.

Luke reported the results of a comprehensive prenatal program for women pregnant with multiples.<sup>27</sup> The program augmented usual prenatal care through bimonthly visits with a nurse and nutritionist where women were educated about nutrition and fetal growth, provided individualized diet therapy, and advised to consume a daily multivitamin and mineral supplement. Compared to controls, women enrolled in the program were significantly more likely to meet the BMI-specific weight gain goals and reduce the incidence of low birthweight births and preterm deliveries. Moreover, the cost savings at birth for twins whose mothers participated in the intervention was \$14,023, significantly reducing hospital costs compared to non-program controls.

Ricketts et al. assessed a program that provided enhanced prenatal services, using a multidisciplinary approach including referrals to a registered dietitian for nutrition education, for Medicaid-eligible women at risk for delivering a low birthweight baby.<sup>28</sup> Results show that the majority of program participants with inadequate weight gain were able to gain the recommended amount of weight by delivery, resulting in significantly fewer low birthweight births for this group of women.

Hickey examined factors associated with, and may influence the risk of, low prenatal weight gain among women with low and normal body mass index.<sup>29</sup> Low maternal weight gain may be associated with certain psychosocial characteristics (depression, trait anxiety, and low levels of self-esteem). Low prenatal weight gain may be more amenable to intervention if those interventions recognize the interacting influences of biomedical, psychosocial, and lifestyle factors, such as the comprehensive programs mentioned above.

## **Nutrition Interventions Related to Reducing Low Birthweight**

### Micronutrient Supplementation

Five studies and one position paper were identified that related to the effect of micronutrient supplementation on birth weight. Though these studies do not address inadequate weight gain during pregnancy, they do address additional potential nutrition interventions as they relate to birth weight.

Three studies were identified using pregnant women from developed countries, to assess whether iron and folic acid supplementation reduced the risk of low birthweight in women without anemia.<sup>30,31,32</sup> Results from all of the studies show iron supplementation for non-anemic pregnant women significantly decreased the risk for low birthweight. And there was a significant trend toward lower risk of low birthweight with longer use of iron supplementation during pregnancy.<sup>30</sup> The American Dietetic Association recommends supplementation with 27 mg iron daily during pregnancy, and anemic women may need 60 mg daily until anemia is resolved.<sup>33</sup>

Three studies testing the effects of providing multiple micronutrient supplementation to pregnant women in developing countries improved fetal growth.<sup>34,35,36</sup> Results from all the studies of undernourished pregnant women show multiple micronutrient supplementation significantly increases fetal growth.

### Milk Consumption

One large prospective study was identified which examined the relationship of milk intake to fetal growth.<sup>37</sup> Results showed milk intake in pregnancy was inversely associated with the risk of SGA and directly related to higher infant birth weight. Furthermore, birth weight was constant across the spectrum of non-dairy protein consumption, which suggests that the association with dairy protein is unlikely due to the effect of protein.

## Interventions for Obesity During Pregnancy and Excessive Weight Gain

Just as a low BMI and low weight gain during pregnancy has been associated with an increased risk of spontaneous preterm delivery,<sup>38</sup> a high BMI also is associated with an increased risk for preterm delivery.<sup>8,9,10,11</sup> Obesity during pregnancy is also associated with significantly increased use of health care services, including length of hospital stay for delivery, thereby increasing health care costs.<sup>39</sup> It is therefore appropriate to report on interventions during pregnancy to limit weight gain in obese women during pregnancy to improve maternal and infant outcomes.

Two published reviews were identified, which assessed dietary interventions to limit weight gain during pregnancy in overweight and obese women.

Cochrane Collaboration Review, 2003 (Updated November, 2006)

The Cochrane Collaboration reviewed energy and protein restriction in pregnancy as it relates to gestational weight gain and birth outcomes.<sup>24</sup> Three trials were identified, which showed that energy/protein restriction in pregnant women who were overweight or had excessive weight gain significantly reduced weekly maternal weight gain and mean birth weight, but had no positive effect on maternal or fetal outcomes.<sup>24</sup> Table 3 provides summary information. The overall findings suggest protein/energy restriction of pregnant women who are overweight, or exhibit high weight gain, is unlikely to be beneficial and may be harmful to the developing fetus.

**Table 3. Reviews of Interventions Addressing Excessive Weight Gain During Pregnancy for Overweight or Obese Women**

Review	No. of Trials	Interventions Shown to be Effective	Non-Effective Interventions
Cochrane Review, 2003 (Updated 11/2006)	3 trials		Energy/protein restriction in overweight women or with high weight gain may be harmful to the developing fetus
Dodd et al., 2008	2 randomized controlled trials		Restricting energy intake to 70% of recommended daily intake  Dietary counseling, focusing on low fat dietary intake and increasing exercise to limit weight gain

Dodd et al., 2008

Dodd and colleagues conducted a systematic review to identify the risks and benefits of dietary interventions to limit weight gain in overweight and obese women during pregnancy, and to improve maternal and fetal health outcomes<sup>40</sup> (Table 3). Two randomized controlled trials were identified. Interventions to limit weight gain in overweight and obese women resulted in no significant reductions in preterm delivery, low birthweight rates, maternal hypertension, pre-eclampsia, or cesarean section delivery.

#### Preventing Excessive Weight Gain for All Pregnant Women

Kinnunen et al. investigated whether individual counseling on diet and physical activity during pregnancy could have a positive effect and prevent excessive gestational weight gain above the BMI-specific recommendations.<sup>41</sup> Results show no effect of this intervention, by a public health nurse, on preventing excessive weight gain during pregnancy or on the birth weight of infants.

### **CASE MANAGEMENT DURING PREGNANCY**

One systematic review, and 10 studies not included in the review, were identified as assessing the effect of case management interventions on low birthweight rates. The review includes studies published prior to the year 2000.

#### **Reviews of Case Management Interventions**

Cochrane Collaboration Review, 2003

This review of 18 randomized controlled trials focused on evaluation of programs, for pregnant women believed to be at high-risk of delivering a preterm or low birthweight baby, that provide support services to improve birth outcomes.<sup>42</sup> These programs could include advice and counseling (e.g., on diet, rest, alcohol use), tangible assistance (e.g., transportation to clinic appointments), and emotional support. The types of interventions included were either standardized or individualized programs provided in the home, clinic, or by telephone. The programs could have been delivered by multidisciplinary teams of health care professionals, by specifically trained lay workers, or by a combination of professional and lay workers.

Results of the review show social support interventions for pregnant women have not been associated with a reduction in preterm delivery or low birthweight babies. The only improvement in any medical outcome of pregnancy was a decreased likelihood of caesarean birth. Also, women who received support were more likely to terminate their pregnancies. It should be noted that these outcomes are not risk factors for low birthweight. Individual trials found psychosocial benefits, including reduced anxiety, women less likely to report being worried about their babies, and less likely to be dissatisfied with their prenatal care.

There are several potential limitations to the trials included in this review. Because there was only one trial in which support was delivered by a lay person, and in another trial the support was provided by a multidisciplinary team, a subgroup analysis by provider type could not be performed for this review. The vast majority of trials used a nurse or midwife to provide the support intervention. These health professionals are trained to provide medical care and perhaps another type of provider would result in different outcomes. None of the trials specified using specific ancillary health care professionals in the intervention, such as a registered dietitian or licensed therapist. In addition, trials included in this review may not have adequately identified those at highest risk of delivering a low birthweight or preterm baby. Enhanced prenatal support services may be most effective for a subgroup with high risk for low birthweight.<sup>43</sup>

### **Case Management Intervention Studies**

Nine studies were identified, that were not included in the Cochrane review, which evaluated the effects of providing enhanced prenatal case management services on the birth outcomes of either low birthweight or preterm delivery and/or healthcare costs. Table 4 provides a summary of the studies. None of the studies were randomized controlled trials, and there was a high level of heterogeneity among the studies with regard to study design and data analysis.

Eight studies provided information on the effect of prenatal case management programs on the outcomes of low birthweight and/or preterm delivery. Two of these studies also provided information on the effect of the program on hospital/NICU costs. One study was a cost benefit analysis and evaluated the outcome of return on investment for the intervention. Six of eight studies showed a significant improvement in birth weight, reduction in low birthweight rates, and/or reduced risk of preterm delivery comparing women who received the enhanced prenatal services compared to women who did not receive these services.<sup>28,44,45,46,47,48</sup> Two studies showed no effect on reducing low birthweight or preterm delivery, however, one of these studies showed an increase in overall birthweight,<sup>49</sup> and the other study showed a cost savings in the average hospital expenditure for program participants compared to non-participants.<sup>50</sup> These results demonstrate the need for more comprehensive measures of the programs' effects than the dichotomous outcomes of low birthweight and preterm delivery.

Of the three studies that evaluated the effect of prenatal case management on health care costs, all reported cost savings as a result of the programs.<sup>44,50,51</sup> Sackett et al. completed a cost benefit analysis, and showed a return on investment of 37% for women who participated in a prenatal case management program versus non-participants. Newman et al. reported significant reductions in the frequency and mean duration of neonatal intensive care unit (NICU) stays for participants of a case management program, and Cramer et al. determined a 31 percent cost savings in the average hospital expenditure for participants compared to nonparticipant groups.

**Table 4. Prenatal Case Management Program Interventions**

<b>Authors, Year Published</b>	<b>Study Design</b>	<b>Intervention Provided</b>	<b>Outcomes</b>
Keeton et al., 2004	<p>Intervention group: n=42,683 Women participating in Medicaid who received case management.</p> <p>Comparison group: n=31,982 Women participating in Medicaid who did not receive case management services.</p>	Case manager (Bachelor's level degree) completes risk assessment, develops individual care plan with the client, refers to needed services, and provides follow-up throughout pregnancy in the home or case management office.	<p>Significant reduction in low birthweight and very low birthweight rates.</p> <p>Did not reduce risk of infant mortality.</p>
Carabin et al., 2005	<p>Intervention group: n=8,598 First time mothers who received case management, and could be linked to birth certificate data.</p> <p>Comparison group: n= 55,737 Birth certificate data was used to identify first time mothers.</p>	Nurse Home Visitor Program model: Enrolled prior to 28 weeks RNs provided home visits following visit-by-visit protocol.	<p>For single mothers without pregnancy risk factors: Significant reductions in preterm delivery, very preterm delivery, low birthweight, very low birthweight, and infant mortality.</p> <p>No positive outcomes for married or higher risk women.</p>
Newman et al., 2008	<p>Intervention group: n=317 Medicaid recipients at risk for preterm delivery and enrolled in case management program in 2006.</p> <p>Comparison group: n=13,363 (reported in table) Women from the same region before the program was implemented (2004) for which outcomes were collected.</p> <p>An additional comparison of women from another region, comparing data from 2004 to 2006.</p>	<p>Telephone risk assessment, education, provision of written educational materials, and instruction in the availability of use of perinatal hotline 24 hours per day.</p> <p>Case management offered to women at high-risk for preterm delivery.</p>	<p>Significant reduction in the rate of preterm births less than 28 weeks.</p> <p>Significantly reduced in the frequency and duration of neonatal intensive care unit admissions.</p> <p>Did not reduce the overall frequency of preterm birth less than 37 weeks or low birthweight delivery.</p>
Wells et al., 2008	<p>Intervention group: n=48 African American women enrolled in case management program prior to delivery.</p> <p>Comparison group: n=61 African American women enrolled in the case management program after delivery.</p>	Nurse home visiting program. Provides education, support, and referral to community services.	<p>Significant reduction in preterm deliveries.</p> <p>No significant reductions were observed in low birthweight deliveries.</p>
Ricketts et al., 2005	<p>Intervention groups: Total n=2,377 Medicaid-eligible women assessed to be high-risk for delivering a low birthweight infant, comparing low birthweight rates for groups of clients on the basis of their success at resolving the risk factors of smoking, psychosocial factors, and</p>	A multidisciplinary team of a case manager (Bachelor's level degree), registered dietitian, and mental health counselor provide risk assessment, education, and client-centered care coordination throughout pregnancy.	<p>Over 50 percent of women with smoking, psychosocial, or inadequate weight gain risk factors were able to resolve their risks by program completion.</p> <p>Low birthweight rates were significantly lower for</p>

Authors, Year Published	Study Design	Intervention Provided	Outcomes
	inadequate weight gain.		<p>women who resolved either smoking or weight gain risks. Low birthweight rates were also lower for women who resolved psychosocial risks, but the difference was not significant.</p> <p>Low birthweight rates were significantly lower for women who resolved any combination of risks.</p>
Silva et al., 2006	<p>Intervention groups: Total n=6,440 Medicaid eligible women enrolled in case management program, comparing an increased number of visits and time spent with case managers to improvements in birth outcomes.</p>	<p>Case managers (BSW or RN) perform risk assessments, educational sessions, and referrals to appropriate services.</p>	<p>Lower rate of low birthweight for case management participants compared to county rates.</p> <p>No benefits observed by increasing time spent with a case manager or by increasing the number of visits.</p>
Sackett et al., 2004	<p>Intervention group: n=2,338 MCO hospital claims data for women who participated in the case management program, determined to be at risk for poor birth outcomes by their medical provider.</p> <p>Comparison group: n=3,753 MCO hospital claims data for pregnant women from the same years who did not participate in the case management program.</p>	<p>A managed care organization (MCO)-administered case management program.</p> <p>Case managers (Bachelor's level RNs) provided risk assessment, education, referrals, and an individualized plan of care. Participants had access to a registered dietitian or social worker.</p>	<p>The program had a positive return on investment of 37%, by averting low birthweight births. The net cost benefit of the program was \$216,266 for two years.</p>
Reichman and Teitler, 2005	<p>Intervention group: n=88,196 Medicaid eligible women who participated in the program with single live births, comparing timing of entry into care.</p> <p>Comparison group: n=650 Medicaid eligible women receiving no care. (was not explained in paper)</p>	<p>Program is administered through Medicaid provider offices and clinics. Provides diagnostic and medical procedures and a range of health support services. Did not specify case coordinator.</p>	<p>Initiating prenatal care in the first or second trimester resulted in a significant increase in birth weight of 56g.</p> <p>No significant effect of early initiation of care on low birth weight or preterm deliveries.</p>
Cramer et al., 2007	<p>Intervention groups: n=79; n=157 Low income women who received case management services.</p> <p>Comparison groups: n=746; n=774 Women in the census tract who gave birth and did not participate in the program.</p> <p>n=7,962; n=7,987 Women who gave birth in the county during the study period.</p>	<p>Case managers (social workers or public health nurses) provided screening for risk factors, education, referrals, transportation to appointments, and follow-up to care. Contact was through home visits, office visits, or telephone calls.</p>	<p>No significant differences in low birthweight rates for women who participated in the program.</p> <p>There was a 31% cost saving in the average hospital expenditure for participants compared to non-participants.</p>

## **DRUG AND ALCOHOL USE IN PREGNANCY**

Two papers were identified that focus on substance abuse interventions for pregnant women, a randomized trial for alcohol use and a description of a managed care organization's substance abuse intervention program.

Chang et al. used a randomized controlled study to test the effectiveness of a brief intervention in the reduction of prenatal alcohol consumption, enhanced by including a partner chosen by the pregnant woman.<sup>52</sup> Prenatal alcohol consumption declined for both the treatment and control groups after study enrollment. Brief intervention for prenatal alcohol use significantly reduced subsequent consumption, most for the women with the highest consumption initially. The effects of the brief intervention were significantly enhanced when a partner participated. The single session brief intervention took about 25 minutes and involved providing education, answering questions about alcohol consumption during pregnancy and mutual goal setting.

Armstrong et al. described a managed care organization-administered program for substance using pregnant women.<sup>53</sup> The program has not yet been evaluated for its effectiveness at improving birth outcomes.

## **CONCLUSION**

Effective public health practices targeted to pregnant women that address smoking cessation, inadequate maternal weight gain, case management and support, and alcohol and illicit drug use can provide a significant contribution to ameliorating the high low birthweight rate in Colorado. A systematic review of the published literature from January, 2000 through January, 2009 identified interventions that may be effective at improving birth outcomes. Due to the limited information provided about the interventions, however, it is difficult to discern the quality of the interventions evaluated in the studies and the specific components of interventions that were effective.

A vast amount of information has been published regarding smoking cessation interventions for pregnant women. Overall the studies of behavioral interventions show a significant reduction in smoking in the intervention groups despite the considerable variation in the intensity of the intervention. There were significant reductions in low birthweight and preterm births as a result of the smoking cessation interventions. A review of telephone-delivered smoking cessation interventions found that effective telephone interventions were delivered by a health professional as an adjunct to one-on-one counseling. For women unable to quit smoking during pregnancy, the use of nicotine gum or transdermal nicotine combined with smoking cessation counseling has encouraging results, though more studies are needed related to effectiveness and potential risks to the fetus.

Results from published reviews and individual studies regarding nutrition education interventions for improving maternal weight gain during pregnancy showed no consistent

benefit of the intervention on weight gain. The nutrition education interventions resulting in improved gestational weight gain and birth outcomes used intensive, individualized nutrition counseling and follow-up throughout pregnancy. Balanced energy/protein supplementation was associated with an increase in maternal weight gain, infant birth weight, and reduced risk of SGA. High protein supplements and isocaloric protein supplementation did not benefit maternal weight gain or fetal growth, and may be harmful to the fetus. The WIC Program may improve weight gain during pregnancy and improve birth outcomes, but with less of an impact than has been claimed by policy analysts and advocates.

Regarding nutrition interventions and birthweight, iron supplementation in non-anemic women resulted in significant reductions in low birthweight. One large study showed milk intake was inversely associated with the risk of SGA and directly related to higher infant birth weight. There is no evidence to support restricting energy/protein intake in overweight or obese women or women with high weight gain during pregnancy, and this may be harmful to the fetus.

Studies of prenatal case management programs overall provided equivocal results for reducing low birthweight and preterm delivery, and consistently showed cost savings. There are large differences, however, in the services provided through prenatal case management programs. This may explain some of the differences in outcomes studied. The risk status of participants, quality of services provided, and types of interventions included in prenatal case management programs should be taken into consideration.

There is insufficient data available about alcohol and illicit drug use interventions during pregnancy to draw conclusions regarding best practices.

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