

RESEARCH ARTICLE

Characteristics of women age 15-24 at risk for excess weight gain during pregnancy

Tammy Chang^{1*}, Michelle H. Moniz², Melissa A. Plegue³, Ananda Sen⁴, Matthew M. Davis⁵, Eduardo Villamor⁶, Caroline R. Richardson¹

1 Department of Family Medicine, Medical School, Institute for Healthcare Policy and Innovation, University of Michigan, Ann Arbor, Michigan, United States of America, **2** Department of Obstetrics and Gynecology, Medical School, Institute for Healthcare Policy and Innovation, University of Michigan, Ann Arbor, Michigan, United States of America, **3** Department of Family Medicine, University of Michigan, Ann Arbor, Michigan, United States of America, **4** Department of Family Medicine and Biostatistics, University of Michigan, Ann Arbor, Michigan, United States of America, **5** Northwestern University Feinberg School of Medicine, Ann & Robert H. Lurie Children's Hospital of Chicago, Chicago, Illinois, United States of America, **6** Department of Epidemiology, School of Public Health and Center for Human Growth and Development, University of Michigan, Ann Arbor, Michigan, United States of America

☯ These authors contributed equally to this work.

* tachang@med.umich.edu



OPEN ACCESS

Citation: Chang T, Moniz MH, Plegue MA, Sen A, Davis MM, Villamor E, et al. (2017) Characteristics of women age 15-24 at risk for excess weight gain during pregnancy. PLoS ONE 12(3): e0173790. <https://doi.org/10.1371/journal.pone.0173790>

Editor: Rebecca A Krukowski, University of Tennessee Health Science Center, UNITED STATES

Received: August 25, 2016

Accepted: February 27, 2017

Published: March 14, 2017

Copyright: © 2017 Chang et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: Medical records data was a part of the Fragile Families and Child Wellbeing Study dataset used in our study. As a result, legal and ethical restrictions exist in the use of this data to ensure patient confidentiality. All necessary contact information where an interested researcher would need to apply to gain access to the relevant data are located at the following web address: <http://fragilefamilies.princeton.edu/restricted>.

Funding: Research reported in this publication was supported by the Eunice Kennedy Shriver National

Abstract

Purpose

Excess weight gain during pregnancy is a serious health concern among young pregnant women in the US. This study aimed to characterize young women at highest risk for gaining over the recommended amount of weight during pregnancy.

Methods

Using a database that is representative of births in large U.S. cities, The Fragile Families and Child Wellbeing Study, we identified mothers of singleton term-infants age 15–24 years at the time of delivery. Institute of Medicine guidelines were used to categorize each mother's weight gain as less than, within, or more than recommended during pregnancy. Multinomial logistic regression models for weight gain category were performed, controlling for age, race/ethnicity, federal poverty level (FPL), health status, and prepregnancy BMI.

Results

Among the weighted sample ($n = 1,034$, $N = 181,375$), the mean (SD) age was 21 (3) years, 32% were black, 39% were Hispanic, 44% reported income under the Federal Poverty Level, 45% were overweight or obese before pregnancy, and 55% gained more weight than recommended during pregnancy. Women who were overweight or obese before pregnancy were at increased risk for gaining more pregnancy weight than recommended, compared to normal-weight women (adjusted Relative Risk Ratio (RRR) = 3.82, $p = 0.01$; RRR = 3.27, $p = 0.03$, respectively). Hispanics were less likely than non-Hispanics to gain more weight than recommended (RRR = 0.39, $p = 0.03$).

Institute of Child Health and Human Development (NICHD) of the National Institutes of Health under award numbers R01HD36916, R01HD39135, and R01HD40421, as well as a consortium of private foundations. Additionally, Tammy Chang received funding from the National Institutes of Health - grant number 5 K23 HD083527-05. The funders had no role in the design and conduct of the study; collection, management, analysis and interpretation of the data preparation, review, or approval of the manuscript, and decision to submit the manuscript for publication.

Competing interests: The authors have declared that no competing interests exist.

Conclusions

The majority of mothers ages 15–24 gained excess weight during pregnancy, a strong risk factor for later obesity. Prepregnancy overweight or obesity and non-Hispanic ethnicity predicted excess pregnancy weight gain. Interventions and policies should target these high-risk young women to prevent excess weight gain.

Introduction

Weight gain during pregnancy has lasting health implications for both mothers and infants. Excessive weight gain during pregnancy increases the risk of dangerous complications during pregnancy, including diabetes, hypertensive disease, fetal growth abnormalities, operative delivery, and stillbirth, and contributes to the risk of long-term obesity in both mother and child[1–9]. Inadequate weight gain is associated with low birth weight, preterm birth and failure to initiate breastfeeding[10]. As a result, the Centers for Disease Control and Prevention (CDC) and the Institute of Medicine (IOM) have called for more effective interventions to promote healthy weight gain during pregnancy to address this critical public health issue [9,11].

In the US, less than 40% of women gain within the IOM recommended guidelines, while nearly 50% gain over the recommended weight during pregnancy[9,10,12–14]. Promoting healthy pregnancy weight gain among young women is particularly important, as the US has one of the highest rates of adolescent pregnancy among high-income countries and rising rates of obesity among women and adolescents[15–17]. Despite recent declines in teen birth in the US, in 2014, nearly 1 in 15 births in 2014 was to a teenager (age 15–19 years)[18]. As a result, morbidity related to inappropriate weight gain continues to contribute to poor health among at-risk young mothers and their children.

Some interventions designed for adult women have been shown to be effective at maintaining healthy weight gain during pregnancy[19–22]. However, few interventions have been designed specifically for pregnant adolescents or young women. Pregnant adolescents and young women likely have different needs and preferences than pregnant adults, and as a result, interventions for this at-risk group should be tailored to their distinct needs and preferences to be effective. To appropriately tailor interventions, there is a critical need to understand the characteristics of adolescents and young women who are at greatest risk for inappropriate weight gain during pregnancy.

Risk factors for inappropriate pregnancy weight gain are known among adults and prepregnancy BMI, age, and race[9,23,24]. However, the effects of sociodemographic factors on inappropriate weight gain among pregnant adolescents and young women is unclear. The aim of this study is to use a large national sample to identify risk factors for inappropriate weight gain during pregnancy specifically among adolescents and young women.

Materials and methods

The Fragile Families and Child Wellbeing Study follows a cohort of mother and father dyads and their children born in large US cities between 1998 and 2000 (roughly three-quarters of dyads are unwed parents). “Fragile families” denotes that these families are at greater risk of breaking up and living in poverty than more traditional families[25]. National weights make the data representative of births in the 77 US cities with populations over 200,000[26].

The study extracted information from medical records about mothers' pregnancy and delivery (including prepregnancy BMI), and the mother's weight gain during pregnancy. Follow-up interviews gathered additional information, including access to and use of healthcare and childcare services, experiences with local welfare and child support agencies, parental conflict and domestic violence, and child health and well-being. Because this data set provides a unique glimpse into the many factors that may affect weight gain during pregnancy, it has the potential to be used to create a typology of pregnant adolescents and young women who gain appropriate weight versus those who do not.

The cohort of interest was pregnant women between the ages of 15 and 24 at time of delivery to capture adolescents as they transitioned into adulthood[27]. Data was further restricted to those who had medical record information available and carried singleton pregnancies to term (37 weeks or later). Mothers were categorized into BMI categories using prepregnancy height and weight information. Prepregnancy BMI among those who were 18 or older were categorized using standard cut-offs (<18.5 = underweight, 18.5–25 = normal, 25–30 = overweight, 30–40 = obese, 40+ = morbidly obese) and those between the ages of 15–17 were categorized using age-specific percentiles from the CDC (<5th percentile = underweight, 5th–85th percentile = normal, 85th–95th = overweight, 95th+ = obese, BMI of 40+ = morbidly obese) [28,29]. IOM guidelines updated in 2009 for gestational weight gain vary by prepregnancy BMI: underweight women should gain between 28 and 40 lbs., normal weight between 25 and 35 lbs., overweight between 15 and 25 lbs. and obese and morbidly obese between 11 and 20 lbs.[9]. The guidelines have been shown to be appropriate for both adults and adolescents[12]. These guidelines were used to categorize each mother's weight gain as less than recommended, within recommended, or more than recommended during pregnancy.

Factors that contributed to an increased likelihood of gaining more weight than IOM guidelines recommended were assessed with weight gain category (less than recommended, within recommended, more than recommended) during pregnancy as the outcome. Bivariate analyses, Chi-squared tests and ANOVA as appropriate, were performed evaluating factors potentially associated with pregnancy weight gain including baseline age, socioeconomic status (SES), race, ethnicity, federal poverty level (FPL), health status, insurance status, marital status, situational history variables (homelessness, inadequate money, living with biological father), poor nutrition, alcohol use, tobacco use, other drug use, medical comorbidities, preexisting medical conditions, time when prenatal care began, and prepregnancy BMI category.

The final adjusted multinomial logistic regression model included factors that were significant in the bivariate models or have been shown to be associated with weight gain during pregnancy in the IOM's conceptual framework[9]. These included age, race, ethnicity, SES, current health and prepregnancy BMI category as covariates. Interactions between covariates, primarily between prepregnancy BMI and age, were also investigated. All analyses were adjusted using national survey weights with STATA version 13.1 (StataCorp LP, College Station, TX). The University of Michigan IRB determined this study to be not regulated.

Results

There were 1,413 mothers between the ages of 15 and 24 in the national sample with available medical record data. Mothers who carried multiples ($n = 20$), gave birth prior to 37 weeks ($n = 142$) or had unknown gestational age at delivery ($n = 3$) were excluded from analysis. An additional 214 mothers were removed due to missing either prepregnancy BMI or weight gain during pregnancy data, leaving a final unweighted analytic sample size of 1,034.

The average age of the weighted sample was 21 years ($SD = 3.0$) with roughly equal distribution across races and a large proportion (39.0%) being Hispanic and falling below the FPL

Table 1. Demographic characteristics of sample population, Fragile Families and Child Wellbeing Study by gestational weight gain category.

	Unweighted, n(%)	Weighted, %	Gestational weight gain			Chi-squared P-value
			% under, (17.7%)	% within, (27.2%)	% Over, (55.2%)	
Age, n = 1,034						0.66
15–16	23 (2.2)	3.1	1.9	1.7	4.2	
17–18	163 (15.8)	14.2	12.0	12.2	15.8	
19–21	491 (47.5)	49.8	44.8	54.8	48.9	
22–24	357 (34.5)	32.9	41.3	31.3	31.1	
Mean(SD)	20.6 (2.1)	20.6 (3.0)				
Race, n = 1,023						0.95
White	337 (32.9)	36.2	39.7	34.4	35.9	
Black	444 (43.4)	32.3	26.0	34.6	33.1	
Other	242 (23.7)	31.5	34.3	31.0	31.0	
Ethnicity, n = 1,033						0.26
Non-Hispanic	666 (64.5)	61.0	50.8	57.1	66.2	
Hispanic	367 (35.5)	39.0	49.2	42.9	33.8	
Federal Poverty Level, n = 1,034						0.92
0–49%	233 (22.5)	23.0	21.2	21.1	24.5	
50–99%	192 (18.6)	20.9	29.2	17.9	19.7	
100–199%	287 (27.8)	26.7	23.8	28.0	27.0	
200–299%	176 (17.0)	15.6	17.4	17.7	14.0	
300%+	146 (14.1)	13.8	8.4	15.3	14.8	
Health Status, n = 1,031						0.68
Great	310 (30.1)	23.2	24.5	28.5	20.3	
Very Good	388 (37.6)	40.0	38.2	32.3	44.4	
Good	274 (26.6)	26.5	32.8	27.4	24.0	
Fair/Poor	59 (5.7)	10.3	4.5	11.8	11.3	
Prepregnancy BMI Category, n = 1,034						0.002
Underweight	63 (6.1)	5.5	10.2	8.2	2.7	
Normal	528 (51.1)	49.1	65.2	61.4	37.9	
Overweight	237 (22.9)	26.3	9.3	16.0	36.8	
Obese	178 (17.2)	16.6	11.8	11.7	20.5	
Morbidly Obese	28 (2.7)	2.5	3.5	2.7	2.1	

<https://doi.org/10.1371/journal.pone.0173790.t001>

(43.9%). Nearly half of mothers had a normal BMI (49.1%), while another quarter (26.3%) were overweight prior to becoming pregnant (Table 1).

Based on IOM guidelines over half (55.2%) of the weighted sample gained more than recommended during pregnancy, 27.2% gained within guidelines, and 17.7% gained less than recommended. Bivariate analysis found prepregnancy BMI to be the only factor significantly associated with weight gain category (p-value = 0.002), with overweight and obese individuals having higher probabilities of gaining more than the recommended weight compared with other categories. (Table 1)

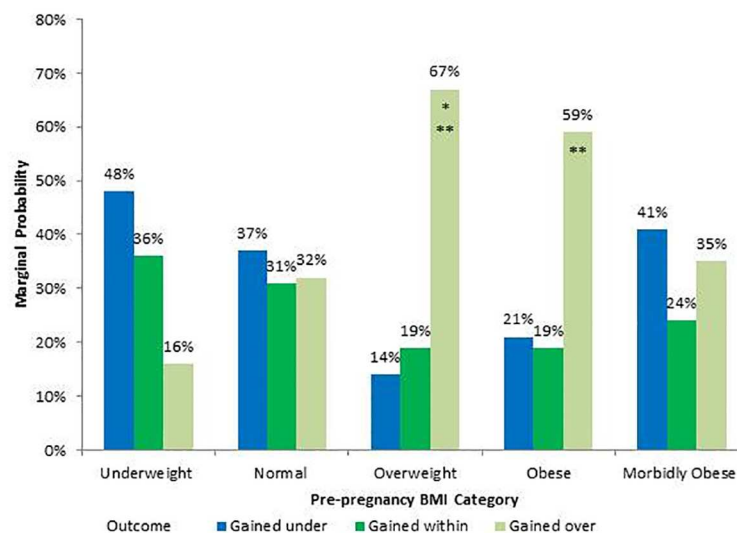
A multinomial logistic regression model including age, race, ethnicity, federal poverty level, current health and prepregnancy BMI category as covariates did not find any significant associations between gaining less than recommended compared to within recommended guidelines (Table 2).

Table 2. Multinomial logistic regression model results.

Predictor	Over Recommended vs. Within		Under Recommended vs. Within	
	RRR (95% CI)	p-value	RRR (95% CI)	p-value
Age	0.94 (0.81, 1.11)	0.497	1.09 (0.87, 1.37)	0.453
Race				
White	Reference			
Black	0.60 (0.22, 1.67)	0.318	0.58 (0.15, 2.25)	0.421
Other	1.70 (0.62, 4.66)	0.292	0.77 (0.22, 2.74)	0.680
Hispanic	0.39 (0.17, 0.90)	0.029	1.23 (0.39, 3.83)	0.716
Poverty Level	0.91 (0.67, 1.22)	0.506	0.80 (0.52, 1.24)	0.308
Health	1.09 (0.51, 2.32)	0.816	1.09 (0.48, 2.46)	0.834
BMI Category				
Underweight	0.41 (0.08, 2.20)	0.289	1.21 (0.18, 7.97)	0.839
Normal	Reference			
Overweight	3.82 (1.39, 10.49)	0.011	0.53 (0.10, 2.68)	0.427
Obese	3.27 (1.15, 9.26)	0.027	0.87 (0.24, 3.10)	0.852
Morbidly Obese	1.39 (0.05, 42.67)	0.846	1.43 (0.03, 71.53)	0.852

<https://doi.org/10.1371/journal.pone.0173790.t002>

Prepregnancy BMI category (p-value = 0.04) and ethnicity (p-value = 0.03) were significantly associated with gaining more than recommended compared to within recommended guidelines. Overweight and obese individuals had higher likelihoods of gaining more than recommended, when compared with normal weight individuals (Relative Risk Ratio (RRR) (95% CI) = 3.82 (1.39, 10.49) and 3.27 (1.15, 9.26), respectively). Hispanics were less likely to gain over the recommended weight (RRR (95% CI) = 0.39 (0.17, 0.90)) than non-Hispanics. Interactions between prepregnancy BMI category and other covariates including age, race, ethnicity, self-reported health and federal poverty level were not found to be significant.



*Denotes statistically significant difference between gaining over compared to gaining within recommended guidelines.
 **Denotes statistically significant difference between gaining over compared to under recommended guidelines.

Fig 1. Marginal probabilities of gaining under, within, or over IOM guidelines by prepregnancy BMI.

<https://doi.org/10.1371/journal.pone.0173790.g001>

The marginal probability of each outcome category was estimated across prepregnancy BMI categories using the final model (Fig 1). Mothers who were overweight or obese prior to getting pregnant had substantially higher probabilities of gaining more than the recommended guidelines, compared to normal-weight women. The other prepregnancy BMI groups showed no significant difference between probabilities of gaining under, within or over the recommended guidelines.

Discussion

Categorical weight gain was similar in our sample of 15–24 year-old women compared to cohorts that include older women (under IOM guidelines: 18% vs 21%; within: 27% vs 32%; over: 55% vs 47%)[30]. Overweight and obese pregnant young women were more likely to gain excess weight during pregnancy compared to normal weight peers, while Hispanic young women were less likely than non-Hispanic peers to gain excess weight during pregnancy. These findings are also consistent with previously reported national and state-level data that included older adults[9,14,31]. No characteristic was associated with gaining too little weight compared to gaining within the guidelines.

Though 15 year olds are arguably different than 24 year olds, younger mothers in our sample did not have a different risk for excess weight gain than older mothers. This finding highlights the importance of prepregnancy BMI at any age for predicting weight gain during pregnancy. Interestingly, Hispanic women in this study were found to be less likely to gain excess weight. Future studies that aim to understand the reason for this distinction could help develop interventions among those at elevated risk for excess weight gain. Our findings also have important implications for the care of pregnant adolescents, young women, and their children today.

First, BMI is objective data that is readily obtained during usual clinical care and can be easily used to identify young pregnant women at-risk for gaining excess weight during pregnancy. There is no need for complicated tests or a prolonged screening process. Based on a Cochrane Systematic Review, high-quality evidence indicates that diet or exercise, or both, during pregnancy can reduce the risk of excessive weight gain in pregnancy[32]. Once at-risk women are identified, available resources to improve diet and exercise habits can be provided to prevent long-term morbidity associated with excess weight gain. Next, pregnancy has been shown to be a time when women are particularly activated and engaged in their health[33,34]. Overweight and obese adolescents and young women would likely benefit from support and resources to achieve healthy diet and exercise habits regardless of pregnancy status. During pregnancy, young women often have increased number of clinical visits and community support which can lead to greater opportunities to address these important issues.

In addition to intrauterine changes that may occur with excess weight gain in pregnancy, poor health habits are often passed on from mothers to their infants[34–36], creating an intergenerational cycle of poor health among these at-risk families. As a result, accurate information, resources and support to achieve healthy weight gain is particularly important for overweight and obese pregnant adolescents and young women. Studies have shown that clinicians may be uncomfortable discussing weight gain with pregnant women[37,38], but that pregnant women are interested in receiving more information about this topic[39]. Adolescent pregnant women in particular may have an even higher need for counseling due to the increased prevalence of body dissatisfaction among this age group[40]. Interventions and programs must be designed that take adolescent-specific factors into account.

Finally, obese adolescents have also been found to be significantly less likely to use birth control compared to normal weight adolescents, despite having similar levels of sexual activity

[40]. Efforts to provide responsible education and resources to all adolescents to prevent unintended pregnancy can have greater effects beyond contraception; these efforts may also reduce the risk of long-term morbidity associated with obesity among this at-risk group.

Limitations

Our findings are subject to certain limitations. First, these data are cross-sectional and cannot be used to infer causation. BMI data was extracted from medical records and may be either patient self-report or anthropometric measurements. These data were also collected in 1998 and 2000 and may no longer represent epidemiologic patterns seen today. However, our study uses a nationally representative sample of births among at-risk adolescents and young women, and includes many social factors that have been hypothesized to be related to weight gain during pregnancy. Finally, our sample may not be sufficiently powered to examine interaction effects as described in our methods, though the results with our current sample ($n = 1,034$) found only small effects that did not approach significance.

Conclusion

Prepregnancy BMI and ethnicity are important factors that predict excess pregnancy weight gain among adolescents and young women age 15–24. Interventions and policies should focus on high-risk women to prevent excess weight gain-related morbidity among these mothers and their children.

Acknowledgments

The authors would like to acknowledge Lauren Nichols for her contributions in preparing this manuscript.

Author Contributions

Conceptualization: TC MP MD CR.

Formal analysis: TC MP AS.

Funding acquisition: TC MD CR EV.

Methodology: TC MP AS EV MD CR.

Writing – original draft: TC.

Writing – review & editing: MM MP AS MD EV CR.

References

1. Siega-Riz AM, Viswanathan M, Moos MK, Deierlein A, Mumford S, Knaack J, et al. A systematic review of outcomes of maternal weight gain according to the Institute of Medicine recommendations: birth-weight, fetal growth, and postpartum weight retention. *Am J Obstet Gynecol*. 2009; 201: 339 e1–14.
2. Oken E, Rifas-Shiman SL, Field AE, Frazier AL, Gillman MW. Maternal gestational weight gain and offspring weight in adolescence. *Obstet Gynecol*. 2008; 112: 999–1006. <https://doi.org/10.1097/AOG.0b013e31818a5d50> PMID: 18978098
3. Nehring I, Schmoll S, Beyerlein A, Hauner H, von Kries R. Gestational weight gain and long-term postpartum weight retention: a meta-analysis. *Am J Clin Nutr*. 2011; 94: 1225–1231. <https://doi.org/10.3945/ajcn.111.015289> PMID: 21918221
4. Fraser A, Tilling K, Macdonald-Wallis C, Hughes R, Sattar N, Nelson SM, et al. Associations of gestational weight gain with maternal body mass index, waist circumference, and blood pressure measured 16 y after pregnancy: the Avon Longitudinal Study of Parents and Children (ALSPAC). *Am J Clin Nutr*. 2011; 93: 1285–1292. <https://doi.org/10.3945/ajcn.110.008326> PMID: 21471282

5. Gould Rothberg BE, Magriples U, Kershaw TS, Rising SS, Ickovics JR. Gestational weight gain and subsequent postpartum weight loss among young, low-income, ethnic minority women. *Am J Obstet Gynecol.* 2011; 204: 52 e1–11.
6. Viswanathan M, Siega-Riz AM, Moos MK, Deierlein A, Mumford S, Knaack J, et al. Outcomes of maternal weight gain. *Evid Rep Technol Assess (Full Rep).* 2008;May(168): 1–223.
7. Sridhar SB, Darbinian J, Ehrlich SF, Markman MA, Gunderson EP, Ferrara A, et al. Maternal gestational weight gain and offspring risk for childhood overweight or obesity. *Am J Obstet Gynecol.* 2014; 211: 259 e1–8.
8. Rong K, Yu K, Han X, Szeto IM, Qin X, Wang J, et al. Pre-pregnancy BMI, gestational weight gain and postpartum weight retention: a meta-analysis of observational studies. *Public Health Nutr.* 2015; 18: 2172–2182. <https://doi.org/10.1017/S1368980014002523> PMID: 25411780
9. National Research Council. *Weight gain during pregnancy: reexamining the guidelines.* Washington: National Academies Press; 2010.
10. Joseph NP, Hunkali KB, Wilson B, Morgan E, Cross M, Freund KM. Pre-pregnancy body mass index among pregnant adolescents: gestational weight gain and long-term post partum weight retention. *J Pediatr Adolesc Gynecol.* 2008; 21: 195–200. <https://doi.org/10.1016/j.jpog.2007.08.006> PMID: 18656073
11. Centers for Disease Control and Prevention. *Pregnancy complications.* <http://www.cdc.gov/reproductivehealth/maternalinfanthealth/pregcomplications.htm>. Accessed: June 14, 2016
12. Harper LM, Chang JJ, Macones GA. Adolescent pregnancy and gestational weight gain: do the Institute of Medicine recommendations apply? *Am J Obstet Gynecol.* 2011; 205: 140.e1–8.
13. Groth SW, Holland ML, Kitzman H, Meng Y. Gestational weight gain of pregnant African American adolescents affects body mass index 18 years later. *J Obstet Gynecol Neonatal Nurs.* 2013; 42: 541–550. <https://doi.org/10.1111/1552-6909.12230> PMID: 24003870
14. Deputy NP, Sharma AJ, Kim SY. Gestational weight gain—United States, 2012 and 2013. *MMWR Morb Mortal Wkly Rep.* 2015; 64: 1215–1220. <https://doi.org/10.15585/mmwr.mm6443a3> PMID: 26540367
15. Sedgh G, Finer LB, Bankole A, Eilers MA, Singh S. Adolescent pregnancy, birth, and abortion rates across countries: levels and recent trends. *J Adolesc Health.* 2015; 56: 223–230. <https://doi.org/10.1016/j.jadohealth.2014.09.007> PMID: 25620306
16. Flegal KM, Kruszon-Moran D, Carroll MD, Fryar CD, Ogden CL. Trends in obesity among adults in the United States, 2005 to 2014. *JAMA.* 2016; 315: 2284–2291. <https://doi.org/10.1001/jama.2016.6458> PMID: 27272580
17. Ogden CL, Carroll MD, Lawman HG, Fryar CD, Kruszon-Moran D, Kit BK, et al. Trends in obesity prevalence among children and adolescents in the United States, 1988–1994 Through 2013–2014. *JAMA.* 2016; 315: 2292–2299. <https://doi.org/10.1001/jama.2016.6361> PMID: 27272581
18. Centers for Disease Control and Prevention. *Reproductive health: teen pregnancy.* <http://www.cdc.gov/teenpregnancy/about/>. Accessed: June 14, 2016
19. Tanentsapf I, Heitmann BL, Adegboye AR. Systematic review of clinical trials on dietary interventions to prevent excessive weight gain during pregnancy among normal weight, overweight and obese women. *BMC Pregnancy Childbirth.* 2011; 11: 81. <https://doi.org/10.1186/1471-2393-11-81> PMID: 22029725
20. Quinlivan JA, Julania S, Lam L. Antenatal dietary interventions in obese pregnant women to restrict gestational weight gain to Institute of Medicine recommendations: a meta-analysis. *Obstet Gynecol.* 2011; 118: 1395–1401. <https://doi.org/10.1097/AOG.0b013e3182396bc6> PMID: 22105270
21. Muktabhant B, Lumbiganon P, Ngamjarus C, Dowswell T. Interventions for preventing excessive weight gain during pregnancy. *Cochrane Database Syst Rev.* 2012;Apr: CD007145. <https://doi.org/10.1002/14651858.CD007145.pub2> PMID: 22513947
22. Brown MJ, Sinclair M, Liddle D, Hill AJ, Madden E, Stockdale J, et al. A systematic review investigating healthy lifestyle interventions incorporating goal setting strategies for preventing excess gestational weight gain. *PLoS One.* 2012; 7: e39503. <https://doi.org/10.1371/journal.pone.0039503> PMID: 22792178
23. Weisman CS, Hillemeier MM, Downs DS, Chuang CH, Dyer AM. Preconception predictors of weight gain during pregnancy: prospective findings from the Central Pennsylvania Women's Health Study. *Womens Health Issues.* 2010; 20: 126–132. <https://doi.org/10.1016/j.whi.2009.12.002> PMID: 20133152
24. Herring SJ, Oken E, Haines J, Rich-Edwards JW, Rifas-Shiman SL, Kleinman ScD KP, et al. Misperceived pre-pregnancy body weight status predicts excessive gestational weight gain: findings from a US cohort study. *BMC Pregnancy Childbirth.* 2008; 8:54. <https://doi.org/10.1186/1471-2393-8-54> PMID: 19102729

25. Fragile Families and Child Wellbeing Study. Princeton University. <http://www.fragilefamilies.princeton.edu/>. Accessed: June 14, 2016.
26. Reichman NE, Teitler JO, Garfinkel I, McLanahan SS. Fragile families: sample and design. *Children and Youth Serv Rev*. 2001; 23: 303–326.
27. Jekielek S, Brown B. The transition to adulthood: characteristics of young adults ages 18 to 24 in America. Baltimore, MD: The Annie E. Casey Foundation, Population Reference Bureau, and Child Trends; 2005.
28. Centers for Disease Control and Prevention. Overweight & obesity: defining adult overweight and obesity. <http://www.cdc.gov/obesity/adult/defining.html>. Accessed: June 14, 2016
29. Centers for Disease Control and Prevention. Overweight & obesity: defining childhood obesity. <http://www.cdc.gov/obesity/childhood/defining.html>. Accessed: June 14, 2016
30. Deputy NP, Sharma AJ, Kim SY, Hinkle SN. Prevalence and characteristics associated with gestational weight gain adequacy. *Obstet Gynecol*. 2015; 125: 773–781. <https://doi.org/10.1097/AOG.0000000000000739> PMID: 25751216
31. Headen IE, Davis EM, Mujahid MS, Abrams B. Racial-ethnic differences in pregnancy-related weight. *Adv Nutr*. 2012; 3: 83–94. <https://doi.org/10.3945/an.111.000984> PMID: 22332106
32. Muktabhant B, Lawrie TA, Lumbiganon P, Laopaiboon M. Diet or exercise, or both, for preventing excessive weight gain in pregnancy. *Cochrane Database Syst Rev*. 2015;Jun: CD007145. <https://doi.org/10.1002/14651858.CD007145.pub3> PMID: 26068707
33. Haakstad LA, Voldner N, Bo K. Stages of change model for participation in physical activity during pregnancy. *J Pregnancy*. 2013; 2013: 193170. <https://doi.org/10.1155/2013/193170> PMID: 23431448
34. Poston L. Maternal obesity, gestational weight gain and diet as determinants of offspring long term health. *Best Pract Res Clin Endocrinol Metab*. 2012; 26: 627–639. <https://doi.org/10.1016/j.beem.2012.03.010> PMID: 22980045
35. Oken E. Maternal and child obesity: the causal link. *Obstet Gynecol Clin North Am*. 2009; 36: 361–377, ix–x. <https://doi.org/10.1016/j.ogc.2009.03.007> PMID: 19501319
36. Ostbye T, Malhotra R, Stroo M, Lovelady C, Brouwer R, Zucker N, et al. The effect of the home environment on physical activity and dietary intake in preschool children. *Int J Obes (Lond)*. 2013; 37: 1314–1321.
37. Chang T, Llanes M, Gold KJ, Fetters MD. Perspectives about and approaches to weight gain in pregnancy: a qualitative study of physicians and nurse midwives. *BMC Pregnancy Childbirth*. 2013; 13: 47. <https://doi.org/10.1186/1471-2393-13-47> PMID: 23433216
38. Whitaker KM, Wilcox S, Liu J, Blair SN, Pate RR. Patient and Provider Perceptions of Weight Gain, Physical Activity, and Nutrition Counseling during Pregnancy: A Qualitative Study. *Womens Health Issues*. 2016; 26: 116–122. <https://doi.org/10.1016/j.whi.2015.10.007> PMID: 26621605
39. Kominariak MA, Gay F, Peacock N. Obesity in Pregnancy: A Qualitative Approach to Inform an Intervention for Patients and Providers. *Matern Child Health J*. 2015; 19: 1698–1712. <https://doi.org/10.1007/s10995-015-1684-3> PMID: 25652058
40. Bucchianeri MM, Arikian AJ, Hannan PJ, Eisenberg ME, Neumark-Sztainer D. Body dissatisfaction from adolescence to young adulthood: findings from a 10-year longitudinal study. *Body Image*. 2013; 10: 1–7. <https://doi.org/10.1016/j.bodyim.2012.09.001> PMID: 23084464