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| **Shortened Sleep Duration and Adverse Infant and Maternal Outcomes**  |
| **Author/Year/****Citation** | **Study Type** | **Hypothesis** | **Major Findings** | **Framework** | **Notes/Methodological Issues** |
| **2017** |
| Cai et al. (2017)Sleep 40: 1-8. | Cohort from Growing Up Singapore Towards healthy Outcomes Study (n=1247)Subset of pregnant women with OGTT and PSQI at 26-28 weeks gestation. (n=686)Sleep duration assessed by asking “During the past month, how many hours of actual sleep did you get a night?” Shortened sleep defined as < 6hrs HS  | Exposure to short sleep duration (<6 hrs per night) would associate with increased risk of GDM | 19% of women had GDM, 11% were short sleepers. Unadjusted OR was 1.7 (CI 0.99-2.93); aOR was 1.96 (1.05-3.66) | None noted  | No comparisons done between women not included and included women regarding outcomes. Selected population could have more disease than non-selected. Marginally statistically significant in univariate analysis p=0.53  |
| **2016** |
| Rawal et al. (2016)Am J Obstet Gynecol 2016;volume:x.ex-x.ex. | Prospective cohort study from the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Fetal Growth Studies-Singleton CohortPregnant women in 1st -2nd trimesters(n=2581)Self-reported sleep duration assessed by “What is your typical sleep duration?”≤5 hrs, 6, 7, 8, 9, ≥10 hrs  | Examine the trimester-specific associations between self-reported sleep duration and clinically diagnosed GDM risk | In non-obese women but not obese women, both short and long sleep significant for developing GDM; 5-6 hrs. (aRR# 2.52, 95% CI®, 1.27-4.99)7 hrs. (aRR 2.01, 95% CI 1.09-3.68)≥10 hrs. (2.17, 95% CI 1.01-4.67) | None noted | Large sample sizeRacially diverse analytic sample  |
| **2015** |
| Blair, Porter, Leblebicioglu, & Christian (2015)Sleep 38: 1259-1267. | Secondary data analysis of two concurrent studies examining health and risk in pregnancy. Study one cross sectional, study two longitudinal, women recruited from Ohio State University Wexner Medical Center. Final sample (n=138) Total sleep time assessed by the PSQI subscale mid pregnancy. Outcome variable PTB | 1. Poorer sleep quality is associated with shorter gestation, measured continuously as well as categorically.
2. The relationship between sleep quality and length of gestation would be partially mediated by elevations in serum proinflammatory markers
3. The relationship between sleep quality and length of gestation would be moderated by race, with stronger associations among African American women compared to European Americans
 | Shorter gestation was associated with poorer overall sleep quality (rs = -0.35 p=0.002) and the subscales of subjective sleep quality (rs =-0.34 p=0.002) Sleep latency (rs= -0.27 p=0.02) and sleep efficiency (rs= -0.27 p=0.02)AA women w/poor sleep quality (PSQI >5) had 10.2 times the odds of PTB compared to those with good sleep quality. Sleep quality and PTB was not associated in white women. IL8 mediated the association between sleep quality and PTB in AA women but not in white women.  | **None noted** | Low rates of PTB in the sample Small sample size Only gave PSQI scale scores and not total sleep time.  |
| **2014** |
| Haney, Buysse, Rosario, Chen & Okun 2014Sleep Medicine 15(4) 444-450. | Secondary analysis of prospective observational study examining sleep disturbance and inflammation in early pregnancy (n=161)Sleep assessed at 10-12 weeks, 14-16 weeks, and 18-20 weeks using sleep diaries and actigraphy. Outcome of interest in this analysis was BMI and blood pressures | -Examine whether women with poor sleep defined as short sleep duration, longer wake after sleep onset or longer sleep onset latency (measured by both diary and actigraphy) would have higher blood pressures or BMI across early pregnancy. -Examine whether women with persistent sleep disturbance would have greater increases in BMI or blood pressure compared to women with intermittent sleep disturbance or no sleep disturbance  | No association with total sleep time (either by actigraphy or diary) and blood pressure (See paper for WASO and SOL findings)  | None noted  | -sleep measurements taken in early pregnancy only-BP assessed in early pregnancy before BP changes typically happen  |
| Qiu et al. (2014)The Journal of Maternal and Neonatal Medicine. Published online 22 May 2014  | Multicenter, population-based case-control study of women with live births delivering in three large referral maternities in Lima, Peru (n=164 cases, n=160 controls)Sleep duration assessed by the following question: “During the first 6 months of your pregnancy, how many hours per night did you sleep?”  | Not explicitly stated. Study examined sleep duration and vital exhaustion as risk factors for placental abruption  | 22% of cases and 14% of controls reported short sleep duration.Short sleep duration (≤ 6 hrs.) compared to normal sleep duration (7-8hrs) was associated with abruption (OR 2.0, 95% CI 1.1-3.7)  | None noted | -First study to examine abruption and shortened sleep duration-Case control design; could be subject to recall bias  |
| **2013** |
| Balserak, Jackson, Ratcliffe, Pack & Pien (2013)Sleep and Breathing17: 1093-1102. | Case-control study by secondary analysis of a cohort study of sleep disordered breathing (SDB) among pregnant women (n=104) Women stratified by glucose challenge test (GCT) levels; ≥ 135 mg/dl (n=11 cases) and <135 mg/dl and (n=93) controls Sleep duration in hours determined by subtracting total wake time from time in bed  | Primary hypothesis: To test whether SDB is associated with increased 1-h GCT Secondary hypotheses:Investigate any associations between high GCT levels and nocturnal sleep duration and daytime nap duration  | Mean self-reported sleep duration was not significantly different between women with hyperglycemia (7.45 hrs. ±2.7) and women with normoglycemia (7.71 ±2.10 (p=0.7)  In bivariate analysis self-reported sleep duration was not significantly associated with hyperglycemia (OR 0.95 95% CI =0.70-1.27)  | None noted  | -Study primarily concerned with sleep disordered breathing. Only 20 individuals in the total sample reported sleeping less than 6 hours a night. The study might be underpowered to assess shortened sleep duration  |
| Guendelman et al. (2013)Matern Child Health J | -Nested population based case control study of postpartum women delivering at < 37 weeks (cases=344) and 698 term controlsSleep duration was assessed by the question “How many hours of sleep did you typically get each night during the second 3 months of your pregnancy?”Categorized as less than 7 hours (short) 7-8 hours (normal) more than 8 hours (long) | Not explicitly stated. Examined several modifiable risk factors among working pregnant women to determine individual and joint associations with preterm birth  | Sleep duration was not associated with PTB (OR 1.09 95% CI =0.80-1.48 for <7 hrs.; OR 0.88 95% CI =0.57-1.48 for > 8hrs vs. 7-8 hours | None noted | --effects of sleep duration on PTB might be seen only at the extreme values of either short or long sleep duration. Because of the cut points selected, there might be a bias towards the null. -Second trimester sleep duration was asked after delivery. Subject to recall bias. -- excluded women who were not in prenatal care by 20 weeks and excluded those with extreme pre-pregnancy obesity. Therefore the sample was predominantly White. These sociodemographic and health characteristic exclusions are also potential risks for preterm birth and for shortened sleep duration  |
| Okun et al. (2013)J Women Health22: 1028-1036 | Longitudinal cohort study of pregnant women (N=160) with no underlying sleep or psychological disorder. Sleep variables collected at 10-12, 14-16, or 18-20 weeks of pregnancy. Sleep deficiency was defined as having at least one of the following: shortened sleep duration, insomnia, or sleep insufficiency. Sleep duration was assessed by Pittsburgh sleep diary and actigraphy. Self-reported sleep duration dichotomized as less than 7 hours and ≥7 hours. Insomnia was based on ISQ scoring criteria and Sleep insufficiency was assessed by the Likert scored (never to always) question “How often do you feel your sleep is unrefreshing?”  | Sleep deficiency in early gestation will be associated with greater depressive symptoms and perceived stress.  | Approximately 28-38% of women met the criteria for sleep deficiency Women who were sleep deficient across all three time points had more perceived stress (p<0.01) and more depressive symptoms (p<0.02) than women who were not sleep deficient.  | None noted | Well done study, but sleep duration is a component of sleep deficiency and its contributions to stress and depression cannot be separated out from insomnia and sleep quality. Relatively small sample size  |
| Tsai, Lin, Kuo, Lee & Landis (2013)Research in Nursing and Health 36: 612-622.  | Prospective hospital based, observational study among Taiwanese nulliparous women (n=120). Women completed sleep questionnaires and wore wrist actigraphy for up to 7 days in their third trimester. Labor length and type of delivery were assessed. Total nighttime sleep hours was derived from PSQI questions and treated as a continuous variable  | Research question: “What are the effects of third trimester nighttime, daytime, and 24 hour sleeping patterns on labor duration and type of delivery in healthy pregnant women in Taiwan?  | Neither actigraphy nor any self-reported sleep variables were associated with labor duration in women with C-sections. Labor duration was associated with 24 hour total sleep time ß=-0.25 p<0.01 and nap durations ß=-0.35 p<0.01 but not with nighttime sleep hours ß=-0.10 p=0.39Neither objective or subjective measures of sleep were significantly associated with mode of delivery  | Conceptual framework defined as: “The negative influence of disturbed sleep and the positive influence of daytime napping influenced by cultural differences in sleep and napping behaviors.”  | Small sample size-Small numbers of some outcomes of interest (small cell sizes) -most women were healthy, higher SES, married, educated, and employed. This study population might not be representative of women at risk for sleep deficiencies  |
| **2012** |
| Okun et al.( 2012)J Women’s Health 21: 54-60 | -Secondary analysis of a prospective observational study of depression and antidepressant medication use in pregnancy (n= 217)-Assessed sleep onset latencies, total sleep time, insomnia symptoms, and sleep efficiency derived from the SIGH-ADS instrument  | Sleep disturbance in the second and third trimester will be associated with increased risk for preterm birth  | -12% of sample delivered preterm-Time in bed was associated with preterm delivery OR 1.43 95% CI 1.08-1.88 but after controlling for several factors association no longer significant OR 1.26 95% CI 0.92-1.71 -No other relationships (including shortened sleep duration) significant  | -none noted  | -Preterm birth only found in 26 women; lack of associations might reflect lack of study power-Study cannot answer whether sleep is an independent or mediating factor of preterm birth  |
| Qiu, Gelaye, Fida & Williams (2012)BMC Pregnancy and Childbirth 12:104 | Cross sectional retrospective cohort study of pregnant women < 20 weeks gestation in a NW US hospital setting. (N=1332) Those with preexisting psychiatric illness were compared to those without illness to assess differences in sleep duration and perceived stress. Sleep duration assessed by asking “Since becoming pregnant, how many hours per night do you sleep?” Self-reported sleep duration classified as ≤ 6 hours (short), 7-8 hours (normal) and ≥9 hours (long).  | Pregnant women with a history of physician diagnosed clinical mood or anxiety disorders will be more likely than women without such history to report **shorter sleep durations,** higher frequencies of daytime sedation, vital exhaustion and perceived stress.  | In multivariate analysis, women with psychiatric illness were almost twice as likely as women without illness to sleep ≤ 6 hours. (OR 1.95 95% CI 1.03-3.69)This effect more pronounced in overweight/obese women. (AOR 2.88, 95% CI 1.14-7.32)  | None noted | -Stress and anxiety information collected at the same time as the sleep information (causality not determined)Potential misclassification by reliance on medical records to establish mood disorders Nicely done study, but might not be generalizable since population was NHW an well educated  |
| Zafarghandi et al. (2012)J Mat Fet and Neonat Med 25: 535-537.  | Cross-sectional study of primigravid pregnant women at least 37 weeks gestation seeking care in referral hospitals in Tehran. (n=457)Associations with sleep duration and sleep quality and the outcomes of length and type of delivery, neonate weight and apgar were assessed. Sleep duration was assessed by maternal questionnaire (no specifics on how asked). Sleep duration dichotomized into < 8 hours or ≥ 8 hours Sleep quality assessed by asking if a woman’s sleep was “refreshing, relatively refreshing, or not refreshing”.  | Not specifically stated. The aim of the study was to assess effects of sleep disturbance on labor and fetal outcomes.  | Authors conclude that there is a statistical difference between sleep duration (less than 8 hrs. or 8 hours or more) and length of delivery stages, type of delivery and APGAR (however no correlation coefficients are given), just p values and a frequency count.  |  | Difficult to interpretation of results.The p values cited as significant correlations between short sleep and the outcomes indicate there is a difference between the cells being compared, but it is difficult to determine where the differences among the comparisons existDichotomized sleep duration. Most likely will bias towards the null.  Poorly done study with limited applicability  |
| **2011** |
| Kennelly, Fallon, Farah, Stuart & Turner (2011)J Obstet & Gynecol 31:125-127 | Retrospective, hospital based observational study among 200 postpartum women in Ireland Unclear how sleep duration was assessed.  | Not explicitly stated Assessed the prevalence and type of sleep disturbances in pregnancy and pregnancy outcomes (labor, delivery, birth weight) | -As pregnancy progressed, sleep duration declined from 8.1 hours pre-pregnancy to 6.7 hours 3rd trimester (SD 2.2)-Among normal weight (18.5-24.9 BMI) women there were statistically significant differences in each trimester in sleep duration; from 8.0 prepregnancy to 8.4 hours 1st trimester (p=0.007), 7.8 hours 2nd trimester (p=0.023) and 6.5 hours 3rd trimester (p=0.000) In the 24.9 -40 BMI group, only in the prepregnancy to 3rd trimester comparison showed a significant difference p=0.000No differences in birth weight or mode of delivery were noted  | None noted  | -Sleep variables collected postpartum. Chance of recall bias -small sample size -unable to assess how sleep variables collected -unsure why overweight to morbidly obese all collapsed together  |
| Micheli et al. (2011)Epidemiology 22: 738-744. | -Secondary analysis of population based cohort study of pregnant Greek women residing in Crete. (n=1091)-Likert scale responses to three questions “During the past month, how many hrs. do you sleep per day?” “How often do you snore during your sleep?”“How fresh do you feel when you wake up…?”  | Not explicitly stated.Assessed the prevalence of sleep deprivation and snoring in the third trimester and determined the associations between sleep disturbances and preterm, LBW, or IUGR infants.  | -7% reported sleep deprivation (≤5 hrs. HS) -Sleep duration of ≤5 hrs. HS associated with preterm birth RR 1.7 95% CI 1.1-2.8-Sleep duration was not associated with fetal growth restriction or low birth weight | None noted  | --First study to examine shortened sleep duration and quality of sleep in relation to preterm birth  |
| Reutrakul et al. (2011) Diabetes Care 34: 2454-2457 | -Hospital-based (conducted in IL) cohort study of pregnant women undergoing OGTT in second trimester (n=169)-Four validated sleep questionnaires given (ESS, Berlin, PSQI, Nocturia, Noctural Enuresis, and Sleep Interruption Questionnaire -Pregnancy outcomes assessed in women with normal OGTT (n=108) via records review  | -Not explicitly stated.Aim was to evaluate sleep duration and quality and assess associations with glucose intolerance and pregnancy outcomes.  | -In women with normal GT, the risk of preterm delivery was associated with: -Higher ESS score OR 1.2 95% CI 1.0-1.3 p=.02-Higher PSQI score OR 1.2, 95% CI 1.0-1.3 p=.02 -Shortened sleep OR 4.3 95% CI = 1.1-16.7 p=.003SDB not associated with preterm birth in this study  | None noted  | -One of few studies to examine shortened sleep duration and quality of sleep in relation to preterm birth -subjective measures only -SDB statistically higher in women diagnosed with GDM, by excluding women with GDM, an underestimate of preterm birth attributed to SDB is highly likely -Sleep data collected at one point in 2nd trimester. Sleep changes in third trimester, confounding might be present |
| Williams et al. 2011 Sleep 33; 1363-1371. | Prospective, hospital based cohort study among 1272 healthy pregnant women in NW USSleep duration was assessed by maternal questionnaire in early pregnancy (18-22 weeks gestation) Pre-pregnancy sleep was ascertained by asking “During the year prior to pregnancy, how many hours per night did you sleep?” Pregnancy sleep was ascertained by asking “Since becoming pregnant, how many hours per night do you sleep?” Sleep duration defined as ≤ 6 hours (short) 7-8 hours (intermediate) 9 hours (normal) and ≥10 (long)For PIH and PE Used <5 hours, 5-6 hours, 7-9 hours, and ≥10 hours  | Short and long sleep duration is associated with increased mean blood pressures across all three trimesters. Risk for incident pregnancy –induced hypertension (without proteinuria) and pre-eclampsia would be elevated among women with short and long sleep duration in early pregnancy | -In adjusted multivariate modeling, SBP in the third trimester showed a 3.72 ↑ difference in short sleepers versus the referent. (95% CI 2.1-5.8). In intermediate sleepers 2.07 ↑ difference (95% CI 1.3-2.9) and long sleepers 3.88 ↑ difference (95% CI 2.6-5.2). No differences were found in the first or second trimesters-In adjusted multivariate modeling, DBP in the third trimester showed a 3.04 ↑ difference in short sleepers versus the referent. (95% CI 1.9-4.2). In intermediate sleepers 2.13 ↑ difference (95% CI 1.4-2.9) and long sleepers 3.43 ↑ difference (95% CI 2.3-4.6) No differences were found in the first or second trimesters-Mean arterial pressures revealed similar patterns. -Women sleeping <5 hours had an increased risk for PE (aOR 9.52, 95% CI 1.83-49.40). No associations with any other duration category was significant for PE. No sleep duration category was statistically significant for PIH. In stratified analysis by overweight, very short and long sleepers were statistically significant for PE (aOR 12.7 95% CI 1.04-154.4 and aOR 5.14, 95% CI 1.20-22.10 respectively)  | None noted  | -referent group (9 hours) is not a typical comparison referent. -For the PE and PIH analyses, there were small cell sizes in the extreme short duration categories, CI were extremely wide. -since there was a reliance on clinically obtained data, there might be some errors in measurement. -Mostly white, well educated women in cohort.  |
| **2010** |
| Facco, Grobman, Kramer, Ho & Zee (2010)Am J Obstet Gynecol 203; 142e1-142e5 | Prospective outpatient, hospital based cohort of nulliparas in the NE US. (n=189)Sleep questionnaires filled out at 6-20 weeks and then again at 28-40 weeks. Sleep duration assessed by the question “During the past month, how many hours of actual sleep did you get at night?” Shortened sleep duration defined as < 7 hours a nightOutcomes were 1 hr. GTT > 130 and diagnosis of GDM.  | Not specifically stated, but the objective was to evaluate the impact of short sleep duration on glucose metabolism  | 48% of the sample reported sleeping less than 7 hours Compared with women sleeping 7 hours or more, women with short sleep duration were more likely to have an OGT value >130 (OR 2.6, 95% CI 1.3-5.7) and had a greater frequency of overt GDM (OR 10.6, 95% CI 1.3-85.5)  | None noted  | -Good study but small sample size -Not a diverse population of pregnant women, findings might not be generalizable.  |
| Qiu, Enquobahrie, Frederick, Abetew & Williams (2010)BMC Women’s Health 10;17 | Cross sectional retrospective cohort study of pregnant women < 20 weeks gestation in a NW US hospital setting. (N=1290) Women with shortened sleep duration were compared to those without short sleep to assess differences in mean 1 hr. plasma glucose and overt GDM. Sleep duration assessed by asking “Since becoming pregnant, how many hours per night do you sleep?” Self-reported sleep duration classified as ≤ 4 hours, 5-8 hours, 9 hours and ≥10 hours  | Maternal habitual short sleep duration in early pregnancy will be positively associated with post load glucose concentrations and with increased risk of clinically diagnosed GDM.  | Maternal mean glucose values were highest among women sleeping less than 4 hours (but all the SEs overlapped) -In women sleeping ≤ 4 hours mean glucose concentrations were 16.3mg/dl higher than the referent 9 hours (95% CI 1.1-31.6). For GDM women sleeping ≤ 4 hours had a 5.56 increased risk compared to the referent (95% CI 1.31-23.69). This relationship was attenuated by adjustment for BMI (RR 4.18 95% CI 0.94-18.60)  | None noted  | -Really weird definition of shortened sleep duration. Suspect that categories were not apriori and were tweaked to show extremes. -Overlapping SEs indicate that there might not be an association as reported-Wide CI question the validity of the findings |
| **2009** |
| Abeysena, Jayawardana, & Seneviratne (2009)ANZJOG49; 382-387 | Prospective cohort study in Sri LankaWomen ≥16 weeks pregnant n=550 How sleep duration assessed is not clear. Short sleep defined as ≤ 8 hours a day Outcome of SGA was defined as <10th centile and as < 5th centile  | Determine the trimester-specific effect of physical activity and psychological status of the mother on the delivery of SGA infants based on the customised birthweight standards. | Sleeping ≤ 8 hours a day was associated with SGA <10th centile in crude but not adjusted modeling Crude OR 1.66 95% CI 1.04–2.67 Adjusted OR 1.53 95% CI 0.92-2.54 For SGA <5th centile, both crude and adjusted were associated Crude OR 2.26 95% CI 1.16–4.39 Adjusted OR 2.23 1.08–4.60 | None noted  | Unclear why 5th centile chosen Approximately 1/3 of women slept less than 8 hours a night. This is an atypical cut point Attrition and ineligibility reduced the analytic sample by almost ½  |
| Strange, Parker, Moore, Strickland & Bliwise (2009)Clin Exp Obstet & Gyn  | Convenience sample of 220 women assessed at 20-29 weeks gestation recruited from 15 obstetric practices in Atlanta. Sleep duration assessed by the PSQI and examined sleep quality and PTB | Disturbed sleep is a significant summary indicator of the risk of preterm birth  | General lack of association with PTB and PSQI total score, total sleep time, sleep efficiency.  | None noted  | -Sleep measurements taken in second trimester only; sleep dynamic and worsens over course of pregnancy -small sample size -no demographic information is provided  |
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| **2004** |
| Lee & Gay (2004)Am J Obstet Gynecol 191;2041-2046 | Prospective observational study of women in the 9th month of pregnancy. (n=131)Self-reported sleep time was derived from sleep logs (bed times and wake times) 48 hour weekday actigraphy was used to determine objective sleep measures Outcomes were labor length and type of delivery.  | Sleep disturbance and fatigue in late pregnancy are associated with labor duration and type of delivery | Self-reported time in bed was not associated with labor duration or cesarean birth (Pearson correlation coefficients -.15 and .06 respectively)Objective TST was significant. Women with < 6 hours sleep had significantly longer labors and higher c-sec rates than women sleeping 7 hours or more Labor duration: Pearson Corr Coeff 29.0 ±12.5 for < 6hrs and 17.7 ±15.6 for 7+ hours. C-sec < 6hrs (OR 4.54, 95% CI 1.36-15.21) compared to 7+ hours.  | None noted | -well done study, but limited to small sample size  |
| **1995** |
| Evans, Dick & Clark (1995)Clin Nurs Res 4;238-252. | Correlational study in hospital childbirth educational class attendees (n=174)Used the VSH sleep scale to determine Sleep disturbance, sleep effectiveness, and sleep supplementation Women were asked to fill out the VSH scale daily for a least a week prior to delivery (given to respondents two weeks prior to due Pearson’s correlations between VSH subscales and delivery outcomes were examined the night before and week before labor | Not specifically notedStudy examined relationships between quality of sleep during the week before onset of labor and outcomes of labor and delivery  | Concluded that lack of sleep played no significant part in length of labor or perceptions of labor Length of labor and sleep effectiveness:Night before labor (n=78): Pearson’s r 0.030Week before labor (n=67): Pearson’s r 0.048Perceptions of labor and sleep effectiveness:Night before labor (n=83): Pearson’s r -0.009Week before labor (n=69): Pearson’s r -0.009 | None noted | -Problematic study-parity not controlled for -small sample size with lots of missing values -unable to parse out sleep duration from other characteristics (e.g. restfulness, subjective quality) -VHS scale was un-validated in pregnant women |