Prevalence of perinatal depression and its determinants in Mainland China: A systematic review and meta-analysis

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Abstract:

Background: Perinatal depression is a maternal mental health condition that is associated with various adverse health outcomes both for the mothers and the babies. The study aim was to estimate the prevalence of perinatal depression and its risks and determinants in Mainland China.

Methods: Systematic searches were conducted in 10 major databases and random effect meta-analysis was performed to achieve the pooled variance of perinatal depression. Subgroup analyses were conducted based on region, scale, methods of diagnosis and study design. Meta-regression was performed with the variables such as age, quality assessment score and gross domestic product (GDP) of the province.

Results: Pooled prevalence of perinatal depression was 16.3% (CI=95%; 14.7% to 18.2%, $P < 0.001$), with antenatal depression 19.7% (CI=95%; 15.8% to 24.2%, $P < 0.001$) and postnatal depression 14.8% (CI=95%; 13.1% to 16.6%, $P < 0.001$). Significant publication bias was found and heterogeneity was I^2= 98.13%. Lower socioeconomic status, poor physical health, anxiety about pregnancy and reduced social support were major risk factors while better living conditions and education were protective factors. The prevalence of perinatal depression showed a significant increasing trend in the last decade.

Limitations: The review does not include studies with small sample size (n <250). Moreover a narrative review of risk and protective factors was done, these were not included in meta-analysis.

Conclusion: The prevalence of perinatal depression in China is similar to low and middle-income countries. Urgent attention is needed to address this public health priority in China.

Keywords:

Perinatal depression, Prevalence, Risk factors, Maternal mental health, China

Introduction

Perinatal depression is an episode of depression experienced by women during pregnancy and up till one year after giving birth (Gaynes et al., 2005). Initiation into pregnancy, with its incumbent social role of motherhood accompanied by potential physical stresses, places females at an increased risk of depressive disorder, particularly in low- and middle-income (LAMICs) countries (Fisher et al., 2012). Anxiety, depression and distress during the perinatal period are associated with several harmful consequences including poor diet and social support, increased risk of preeclampsia, pregnancy and labor complications for the mother (Beijers et al., 2010; Bergman et al., 2007). In infants and newborns, its effects may include preterm birth, low birth weight, poor breastfeeding practices, high rates of diarrheal and infectious illnesses and poor cognitive development (Rahman et al., 2007; Sanchez et al., 2013). Despite these intergenerational concerns, depression remains under detected and under-treated during the perinatal period in most LAMICs.

The prevalence of perinatal depression has been reported to range from 15-20% in China (Mu et al., 2019). As per 2017 pregnancy and birth records, this translates into around 5 million to 7 million Chinese women with perinatal depression – the largest numbers for any single country (National Bureau of Statistics of China, 2018). China's rate of hospital delivery has been 99% since last 6 years (Xinhua News, 2019). Several factors peculiar to China would offer a unique platform to study perinatal depression. The first generation post-family planning policies has reached childbearing age in the last decade, and most of them embraced motherhood for the first time (Ding, 2015). Primiparas may be at an increased risk of perinatal anxiety and depression and some studies from China indicate approximately 50–70% of them may experience a period of unstable mood and accompanying varying degrees of physical symptoms and may require more effective preventive strategies (Cui, 2013). Furthermore, China has seen remarkable social and economical development in recent decades. This has meant rapid urbanization and potentially an erosion of traditional support structures for many people (Gong et al., 2012; Lee et al., 2004). On the other hand, economic development has improved the lives of a vast number of people so they enjoy a better quality of life. The impact of these changes on the psychological well being of women in the perinatal period needs to be examined in the current historical context of China.

To the best of our knowledge, till date, there is no review of prevalence of perinatal depression that includes both Chinese and English language studies. Mainland China is the region of China excluding Taiwan, Hong Kong and Macau with total population of 1.4 billion including 51.9% male while 48.1% female population (United Nations Department of Economic and Social Affairs, Population Division, 2019). We did a systematic review and meta-analysis of the prevalence of perinatal depression in Mainland China to provide important information for policy planning on effective preventive and curative services for this public health priority in the most populous country in the world.

Methods

A systematic review and meta-analysis was done according to PRISMA guidelines (Strewart, 2015). The protocol of this review was registered with PROSPRO CRD42018111466 (Nisar et al., 2019). Bilingual systematic search was done of ten electronic bibliographic databases: Medline, EMBASE, Scopus, CINAHL, PsycINFO, Web of Science, Cochrane Central Register, the China National Knowledge Infrastructure, the VIP Database for Chinese Technical Periodicals, and the Wan Fang Database for Chinese Periodicals, using a pretested search strategy (Appendix 1). The inclusion criteria of the studies as per PICOS format was as follows; Participants: studies focusing on pregnant women or women within 12 months after delivery were included. Intervention: studies reporting prevalence of perinatal

depression were included. Control: None. Outcomes: Measurement and reporting of perinatal depression scores using a validated self-report scale (e.g., EPDS, SDS, PHQ-9) or clinician-administered measure. Study design: Studies with longitudinal and cohort designs (only baseline data) were included.

There were no restrictions on design, language and publication date of the studies available till April 20, 2019. After removing duplicate articles using EndNote, two investigators working independently from one another screened the titles and abstracts for inclusion in the study, followed by the full text screening process. Then, a manual searching of the bibliography of all included articles was done. Mutual discussions were conducted to reach agreements, and a third researcher was involved when required (Figure 1 shows the process of study selection).
Research studies reporting prevalence estimates among pregnant women or women within 12 months after delivery were included. We included all those studies that surveyed communities; reported administrative or service-based data (e.g., province, districts, clinics, hospitals, social services and large cities of Mainland China) and institution based studies such as residential care and nursing facilities, for estimating perinatal depression at national or sub-national level. Only those studies were included that had a cross-sectional and longitudinal cohort designs (only baseline data). Studies from the Hong Kong and Macau were excluded. Studies focusing on a specific sub-populations such as ethnic minorities and patients with comorbid medical and mental disorders were excluded from this review. We also included only those studies that had a minimum sample size of 250 participants to ensure studies with representative study sample, high confidence levels (95 to 99%), precise prevalence estimates and low margin of errors (Saha et al., 2008). In addition, we included those studies that established clinical diagnoses of perinatal depression using DSM, ICD, and Chinese Classification of Mental Disorders as well as validated psychometric instruments including Patient Health Questionnaire-9 items and Edinburgh Postnatal Depression Scale. We only included those studies that were either published in English or Chinese language.

Data extraction & Meta-analysis

Two independent reviewers extracted the following information using a standard form. General information including study design, characteristics of the study sample, geographical setting (region) and geographical location's income classification (according to Chinese government's administrative records), study setting, (hospital or community), sampling method (random vs convenience), response rate, year of publication and the details of study outcome measures including the type of diagnostic or screening instruments utilized to ascertain perinatal depression. Quantitative data for meta-analysis to ascertain study specific prevalence rates such as the total sample size of studies and number of respondents with depression. Any differences in data extraction were resolved by discussion between the reviewers and the second author. To ascertain risk factors for perinatal depression in China, we enumerated the specific risk factors for narrative synthesis.

Quality assessment of the included studies was done independently by two reviewers, using an adapted version of the Newcastle-Ottawa risk of bias tool (Stang, 2010) against the following matrices: representativeness of the study sample, adequacy of the sample size, comparability between respondent and non-respondent characteristics and satisfactory response rate, ascertainment of depression or depressive symptoms and suicidal ideation using a commonly employed psychometric tool with a valid cut-off score, quality of descriptive statistics reporting, informed consent status, ethical approval taken and reliability and validity of scale utilized in the studies.

The Cohen's k ranged from 0.62-0.73, calculated for a range of variables from matrices in quality assessment of studies and categorical variables pertaining to characteristics of studied population.

Meta-analysis was conducted using the Comprehensive Meta-analysis Software (version 3, BIOSTATS, 2014). Using the frequency of depressed women and total sample size reported in each study, event rates and 95% confidence intervals were calculated for each study. Based on heterogeneity in geographic setting and variability in screening and diagnostic tools, we assessed random effects model for meta-analysis as a better choice. Weights were assigned to each study using the random effects model. The pooled effect sizes and event rates for each study were graphically presented as a forest plot, where each study was presented with sizes proportional to their weights. Statistical heterogeneity was quantified by the I^2 statistic and formally tested by Cochran's Q statistic. Publication bias was visually judged by the symmetry of a funnel plot and the result of Egger's linear regression test, considered significant at $P < 0{\cdot}1$. In case of significant publication bias, Duwall & Tweedie's Trim & Fill method was used to adjust the effect sizes. Post-hoc sensitivity analyses were performed (using leave-one-out analyses) to test the impact of each study with a disproportionately large effect.

Subgroup analyses were used to explore the sources of heterogeneity based on quality of the study, scale, methods of diagnosis and study design. Moreover, meta-regression analysis was performed with quantitative variables such as age, gross domestic product (GDP) of geographical region, publication date and quality assessment used as predictors of effect sizes. Statistical significance was set at P value $< 0{\cdot}05$ (two– tailed test). Studies were dichotomized according to their publication year into two categories; before and after the year 2010, in order to understand the effects of one child policy in China, which was enacted in the year 1980. This cut-off was chosen based on the assumption that the studies reporting data before 2010 would have a majority of the respondents reaching reproductive age and giving birth between the period of enactment (1980) and relaxation (2013) of one child policy.

Results

Our initial search yielded 10,902 records, 2,143 duplicate records were removed. After title and abstract screening, 104 studies were found eligible for full text screening. Ninety-five studies were included in data analysis. Details of study selection process are shown in Figure 1. A total of 95 studies from 23 regions of Mainland China were included in meta-analysis, with a pooled sample size of 96,096 Chinese women in perinatal period (figure 2).

Most studies were cross sectional (n=87), with eight studies using a longitudinal design. A total of 90 studies used reliable and validated measures for the assessment of the studies, while five studies did not report on the reliability and validity of the scales used. The most commonly employed scales to assess perinatal depression were Edinburgh Postnatal Depression Scale (EPDS) (n=55), followed by the Zung Self Rating Depression Scale (ZSRD) (n=18), the Center for Epidemiological Studies Depression (CESD) Scale (n=5), Hospital Anxiety and Depression Scale (HADS) (n=5), General Health Questionnaire (GHQ-12) and others (n=5). Only two studies used a Diagnostic interview using Structured Clinical Interview for DSM-IV (SCID) or the Symptom Checklist (SCL-90). Seventy-eight studies were conducted in hospital setting, 13 in community settings and 4 in both hospital and community settings. Mean age of subjects was $27{\cdot}5$ years.

Sixty-three studies out of 95 (66%) had a representative sample. Sixty-three studies (66%) reported non-respondents while 32 studies (33%) did not report nonrespondents. Twenty (21%) of the studies reported an ethical review process while 75 (78%) of studies did not do so. Fifty-three (55%) studies described the informed consent process while 42 (44%) studies did not. Sixty-six studies (69%) reported descriptive statistics while 29 (30%) did not. Majority of studies reported postnatal depression (n=61), antenatal depression (n=33) and perinatal depression (n=1). Most of the studies used non-random sampling techniques (n=68) instead of random sampling (n=27).

Using random effects model, the pooled prevalence of perinatal depression was 16.3% (CI=95%; 14.7% to 18.2%, P<0.001). The data presented substantial heterogeneity with an I^2 value of 98.13% (Q=4968.35, df= 93, P < 0.001), (Figure 3). The prevalence of antenatal depression reported in 33 studies (n=27,020), yielding a pooled prevalence of 19.7% (CI=95%; 15.8% to 24.2%, I^2=98.60%, P < 0.001). Postnatal depression was reported in 61 studies (n=68,774), yielding a pooled prevalence of 14.8% (CI=95%; 13.1% to 16.6%, I^2=97.50%, P < 0.001). Sensitivity analysis involving removal of studies one by one did not reveal any significant changes in prevalence rates of perinatal depression. Visualization of Begg's funnel plot and Egger's regression statistic (intercept (S.E)=-3.49 (1.35); P=0.01) revealed publication bias (Figure 4). Using Duval and Tweedie's trim and fill method with random effects model, there was no variation in adjusted effect sizes.

Subgroup analysis revealed that studies employing diagnostic interviews for diagnoses yielded lower prevalence of perinatal depression 14.2% (6.3% to 29.0%) than screening tools 16.3% (14.6% to 18.2%), and this difference was marginally significant (P=0.073, Q=12.1, df=1). The highest prevalence was reported by using Beck's Depression Inventory, followed by Zung Self Rating Scale and the Symptom Checklist-90 the least (details are given in Table 1). There was no difference in prevalence of perinatal depression on basis of sampling technique (Q=0.04, df=1, P=0.84). Longitudinal studies reported a lower prevalence of perinatal depression (14.4%, 9.7% to 20.8%) than cross-sectional study designs 16.4% (14.7% to 18.4%). This difference was statistically significant (P=0.051, Q-value=0.44). Studies conducted in community settings (n=13) reported the lowest prevalence of perinatal depression (10.7%; 7.7% to 14.7%) followed by mixed settings (12.9%; 7.2% to 22.1%) and hospital settings (17.6%; 15.5% to 19.8%). This subgroup difference was statistically significant (Q=9.02, df=2, P=0.01). Province wise subgroup analysis revealed significant differences in prevalence of perinatal depression, with the highest prevalence of perinatal depression reported in Anhui and the lowest in Hebei (Details in table 2). Subgroup analysis by publication date showed that the prevalence of studies published after 2010 (17%, 15% to 19.5%, n=63) was significantly higher than those before (14%, 10.8% to 17.12%, n=32).

Meta-regression analysis showed a significant inverse association between provincial Gross Domestic Product (GDP) and depression rates among Chinese mothers (R^2 = 4%, Z=-1.98, P=0.048), regions with higher GDP had lower prevalence of perinatal depression (Figure 5). Quality assessment score of studies was not associated significantly with prevalence rates of perinatal depression (B=-0.031, P= 0.57, R^2= 0%). Mean age of Chinese women was not significantly associated with prevalence rates of perinatal depression (P=0.22, R^2= 2%).

Risk factors of perinatal depression

Significant risk and protective factors of perinatal depression were reviewed systematically and divided into three categories: (i) Maternal-related factors; (ii) Infant-related factors, and; (iii) Sociocultural factors (Shown in Table 3).

Maternal-related factors: Five studies reported older maternal age (above 29 years of age) as a risk factor associated with perinatal depression during pregnancy (Bao Bin, 2012; Liu Xiu Ying, 2018; Qiu Chunbo, 2014; Qiu Jian Yin, 2001; Qiu Jianang, 2001). Poor education level was also mentioned a risk factor by three studies (Chen Xiaodi, 2017; He Rubi, 2016; Wei et al., 2018). Fourteen studies found associations with low family income, poor living conditions or unemployment during perinatal period (Bao Bin, 2012; Chen Xiaodi, 2017; Hu Cheng Zhen, 2013; Ji Fang, 2013; Jiang Fan, 2015; Lan, 2014; Lau et al., 2010; Liu Xiu Ying, 2018; Wei et al., 2018; Yu, 2010; Yu Jin, 2010; Zhang Xiao Song, 2009; Zhang Xin, 2001). Fourteen studies found associations with poor physical health or existence of any illness before pregnancy (Bao Bin, 2012; Guo Sufang, 2003; Ji Fang, 2013; Jiang Fan, 2015; Lan, 2014; Lau et al., 2010; Liu, 2015; Qiao et al., 2012; Qiu Chunbo, 2014; Qiu Jian Yin, 2001; Tuo Ming Hua, 2017; Wang Wei, 2017; Ying, 2014; Zhang Xian, 2017). Other physical factors associated with perinatal depression included poor sleep in the first month after childbirth, labor pain, drinking during pregnancy, apnea or breathlessness during sleep, severe vomiting in early pregnancy, pregnancy complications and unplanned pregnancy (Chen Li Shan, 2018; Jiang Lei, 2008; Lau et al., 2010; Liu, 2015; Song Yuping, 2014; Wang Wei, 2017; Wu Yi Hong, 2017; Zhou Hui Er, 2017). Difficulties in childbirth were also identified as a risk factor for postnatal depression (Deng et al., 2014; Ji Fang, 2013; Jiang Fan, 2015; Qi Guo É, 2009; Zhang Xian, 2017; Zhou Hui Er, 2017). Presence of anxiety in perinatal period was identified by eight studies as a potential risk factor for developing postnatal depression (Jiang Lei, 2008; Lau et al., 2010; Liu, 2015; Song Yuping, 2014; Wang Wei, 2017; Wu Yi Hong, 2017; Zhang Xian, 2017; Zhou Hui Er, 2017).

Infant-related factors: Lack of confidence in child-care abilities, feeling anxious when the child was crying, baby's difficult feeding patterns and sleep cycle (Deng et al., 2014; He Hai Zhen, 2012; Zhang Xiao Song, 2009) and lack of confidence in breast-feeding abilities (Lau et al., 2010; Pang Shu Lan, 2003; Zhou Hui Er, 2017) were associated with postnatal depression. Five studies reported that infant's poor health and problematic development was linked with postnatal depression (Bao Bin, 2012; Jiang Fan, 2015; Li Shan Shan, 2016; Qi Guo É, 2009; Zhang Xiao Song, 2009). One study found that mothers of infants hospitalized in the neonatal intensive care unit (NICU) experienced postnatal depression at a higher rate with more elevated symptomatology than mothers of healthy infants (Zhang Hongwei, 2014).

Sociocultural factors: Five studies found male gender preference in offspring as a stressor associated with perinatal depression (Chen Xiaodi, 2017; Deng et al., 2014; Gao Yang, 2014; Jiang Lei, 2008; Qi Guo É, 2009). Seven studies found associations with marital tension, marital dissatisfaction and marital conflicts in both perinatal and postnatal time periods (He Hai Zhen, 2012; Hu Cheng Zhen, 2013; Lau et al., 2010; Qi Guo É, 2009; Qiu Jian Yin, 2001; Qiu Jianang, 2001; Wu Yi Hong, 2017). Eight studies reported relationship difficulties with husband (Bao Bin, 2012; He Hai Zhen, 2012; Hu Cheng Zhen, 2013; Lau et al., 2010; Qi Guo É, 2009; Qiu Jian Yin, 2001; Qiu Jianang, 2001; Wu Yi Hong, 2017), while seven studies found an association with frequent family conflicts, poor family relationships, and disharmony with parents-in-law, especially the mother-in-law as a risk factor for maternal depression (Bao Bin, 2012; Lau et al., 2010; Qi Guo É, 2009; Qiu Jian Yin, 2001; Wu Yi Hong, 2017; Ying, 2014; Zhang Xin, 2001). Two studies found associations with interpersonal violence during pregnancy (Guo Sufang, 2003; Qian Fang, 2016).

Protective factors of perinatal depression

Better economic and living conditions, easy access to good quality healthcare and emotional support during and after pregnancy, better childcare facilities, were all protective factors for

perinatal depression (Gao Yang, 2014; He Qing, 2016; Jiang Fan, 2015; Liu Xiao Cui, 2009; Qiu Chunbo, 2014; Ying, 2014; Zhang Xin, 2001). Advanced education level and knowledge related to pregnancy were also found as protective factors for mothers (Guo Sufang, 2003; He Hai Zhen, 2012; Huang Zhaolan, 2015; Jiang Fan, 2015; Jiang Lei, 2008; Ling, 2016; Zhang Hongwei, 2014). Social support before and after childbirth was a strong protective factor for perinatal depression (He Qing, 2016; Jiang Fan, 2015; Jiang Lei, 2008; Lan, 2014; Liu Xiao Cui, 2009; Wu Yi Hong, 2017; Ying, 2014; Zhang Xin, 2001; Zhou Hui Er, 2017; Zhu Zhenling, 2015).

Discussion

Perinatal depression is a public health priority, which has received significant global attention in recent years. To our knowledge, this is the first evidence synthesis effort pertaining to this condition in Mainland China. Key findings are that the weighted prevalence in Chinese women is 16.3%, with 19.7% of women in the antenatal period and 14·8% women in the postnatal period suffering from depression. There is a rise in prevalence reflected in studies conducted in the last decade, with the evidence of greater prevalence in under-developed regions. Modifiable risk factors include maternal education and income, maternal anxiety, social support, poor physical health, marital and family relationships, intimate partner violence and domestic violence. Improved access to healthcare services and education about pregnancy, including perinatal mental health, are protective factors.

The prevalence of perinatal depression in China lies between those of High Income countries, reported between 7% to 15% (Evans et al., 2001; Fisher et al., 2012; Grote et al., 2010) and low and middle-income countries, reported in the range of 19 and 25% (Fisher et al., 2012; Gelaye et al., 2016). However, more women have antenatal depression, which is consistent with the findings of other studies in LIMCs (Gelaye et al., 2017; Underwood et al., 2016; Woody et al., 2017). There is some evidence that antenatal depression can resolve spontaneously after childbirth in some women (Rahman et al., 2003; Sikander et al., 2019), potentially explaining the lower prevalence seen in the postnatal period. The prevalence of perinatal depression in Chinese women is negatively associated with economic status and social support, which is consistent with global literature about the condition (Özcan et al., 2017).

Some culture-specific norms and traditions like gender preference for the male child were found to be a potential risk factor of perinatal depression in Chinese mothers. Roots of male child preference lie in Chinese culture. Traditionally bloodline passes through male child, while girls have to leave the family when they marry. Parents also prefer male child because conventionally men provide for the family and take care of parents (Bo, 2018). This may be pertinent in the context of the single-child policy operant in China from 1980s till 2015. Family support was consistently found to be a protective factor. In China the family is considered to be a central institution. China's unique situation of one child with multiple-carers at a population-level might be both protective, providing support from multiple sources, as well as stressful if accompanied by excessive family conflicts. Protective traditions like "sitting the month", the Chinese practice of confinement during the first month after childbirth where mothers are not allowed to leave home and take prolonged rest and a special diet for healing and recovery, might be changing as more and more women join the workforce. On the other hand, education and greater economic prosperity in women might be protective. The marginal increase in prevalence in studies conducted in the last decade may be a reflection of the interplay of these factors. Equally, it may indicate increased awareness of mental health issues as more women attain education and awareness.

The economic gradient of prevalence within regions of China is also significant, reflecting somewhat higher rates in the more under-developed regions. China has shown remarkable progress in maternal and child healthcare indicators. According to a recent report, maternal mortality ratio dropped from 111 deaths per 100,000 live births in 1990 to 21.8 per 100,000 live births in 2015 while child mortality ratio for children younger than 5 years declined from 54·1 deaths per 1000 live births in 1990 to 12·5 per 1000 live births in 2015 (Ministry of Foreign Affairs of People's Republic of China, 2015). China is well on path towards achieving millennium development goal 3 of ensuring health and well being for all but equity of health care still remains a big challenge in the healthcare system. Socio economic disparity among different regions of China is an important factor responsible for inequity of maternal health inequity among different provinces of China (Guo and Huang, 2019). A recent report shows that total number of health institutions in Eastern and Western China was the same but health care workforce was much higher in the Eastern region (3·7 million) than in the Western region (2·2 million) (Guo and Huang, 2019). Furthermore, recent reviews have shown that service-provision for mental health in China is poor in the under-developed regions (Patel et al., 2016).

The scale-up of the most promising and evidence-based interventions is critical to address the needs of the millions of mothers with perinatal depression in the country. Appropriate screening as well as a good understanding of the preference for care would be important (Personal communication, Yin Juan et al. 2019). Task shifting to community based non-specialist health care workers can be a potential solution towards achieving universal health coverage.

Limitations

A few limitations of this review need to be mentioned. Studies of sample size below 250 participants were not included. Moreover, the study provides only a narrative review of the risk and protective factors of perinatal depression in Mainland China. These were not included in meta-analysis, which may have added further information about the differential impact of each risk factor.

For a precise calculation of the prevalence, randomized sampling in community is recommended instead of convenient sampling. Majority of the studies included in this review defined “perinatal depression” using a psychometric scale, with the score higher than a cut-off value. Only a few studies identified with a diagnosis interview based on clinical criteria (CCMD-3, DSM-5 or ICD-10). We recommend future studies to combine the screening tools with diagnosis interviews.

A distinguishing feature of this review is that it is first review on the topic containing studies published in English and Chinese languages. We adhered strictly to PRISMA guidelines. Our findings are limited by the very substantial heterogeneity amongst the studies that may be accounted for by several factors including different sites of study (hospital vs. community), study designs, variability in study samples, different regions and most importantly different screening and diagnostic systems utilized to recognize the condition among Chinese mothers. Quality of study was not an important predictor of heterogeneity in these results.

Conclusion

In summary, our systematic review and meta-analysis suggests that the prevalence of perinatal depression in Chinese women is higher than high-income countries and not dissimilar to low- and middle-income countries. Perinatal depression has seen a rise during the last decades. Since China has made great strides in improving the health and prosperity of its citizens in recent decades, we believe maternal mental health is a very important public health priority that needs immediate attention. Strategies to reduce the burden of mental health disorders in China should also include efforts to prevent, detect, and treat perinatal depression.

Declaration of interests

We declare no competing interests.

Source of funding

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Figure 1. Study selection process for prevalence of perinatal depression in Mainland China.

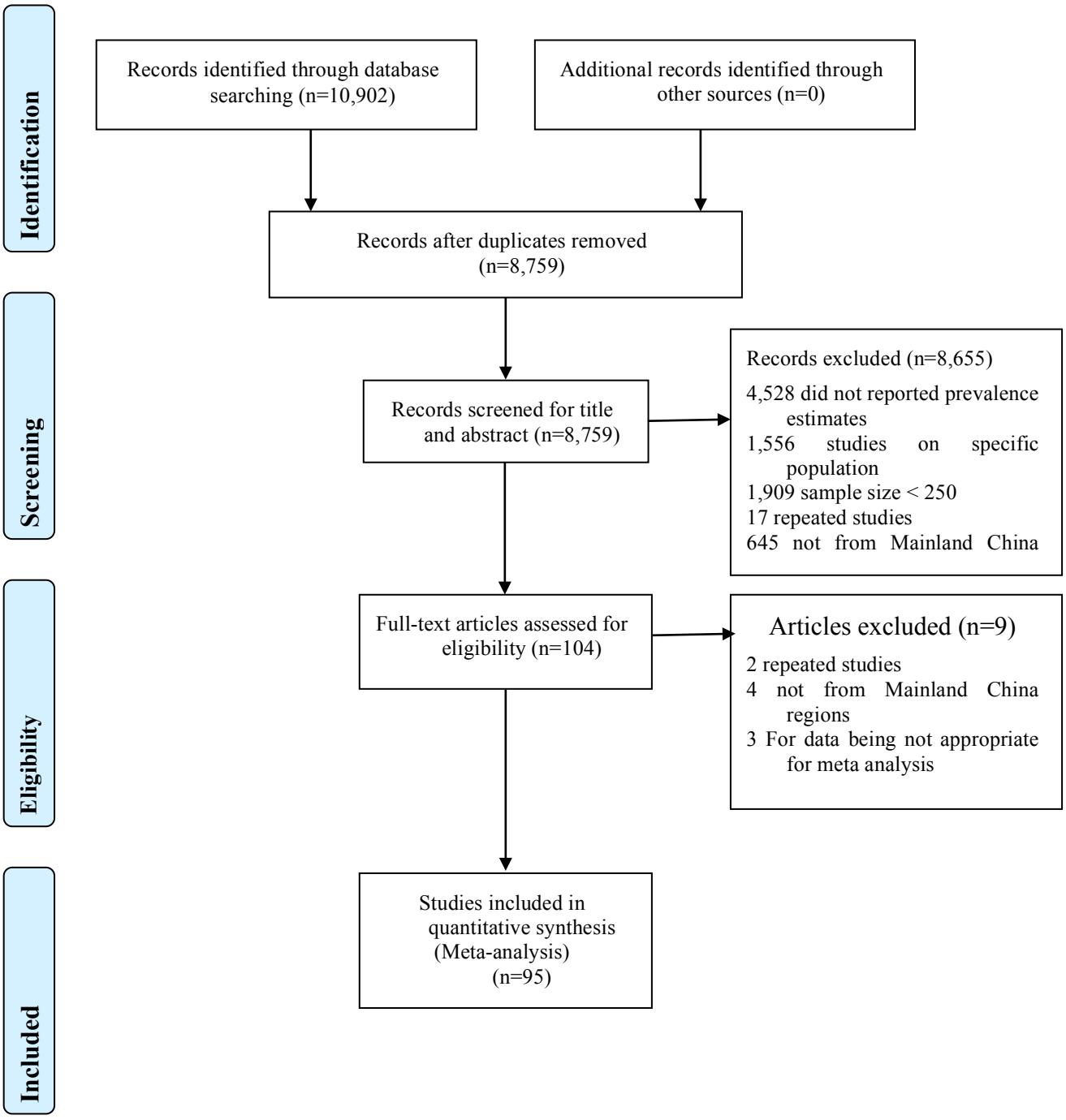


Figure 2: Distribution of perinatal depression across the provinces of Mainland China.

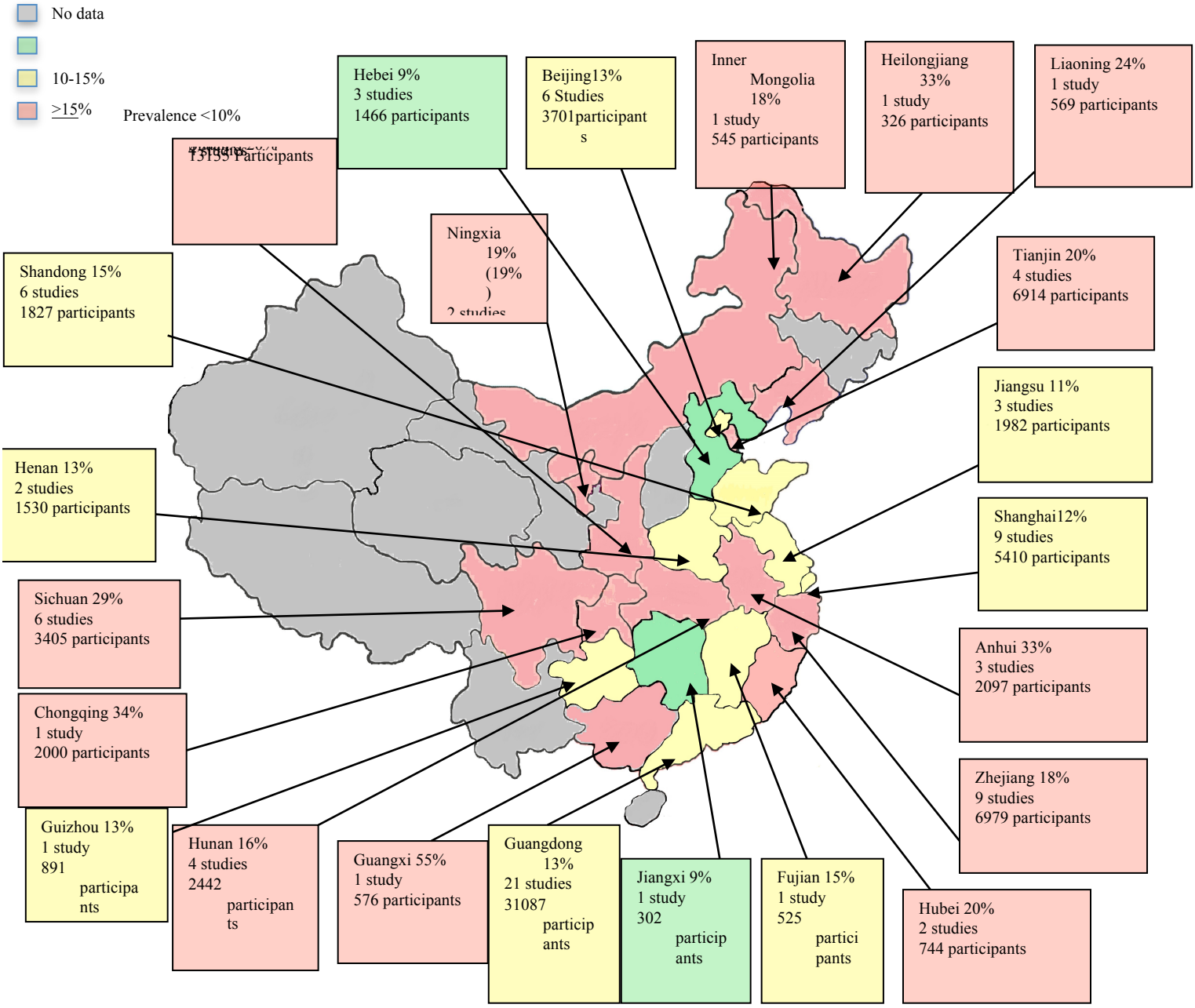


Figure 3: Forest plot

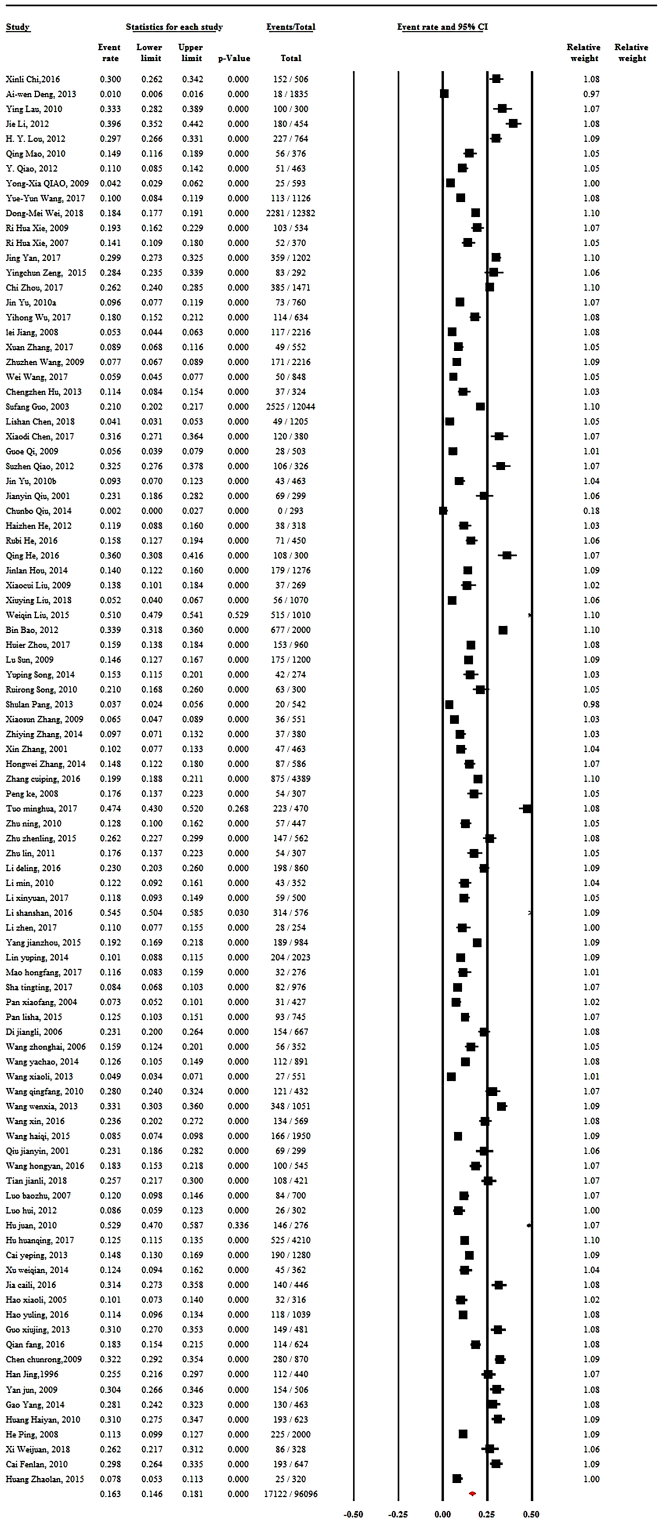


Figure 4: Funnel plot of studies

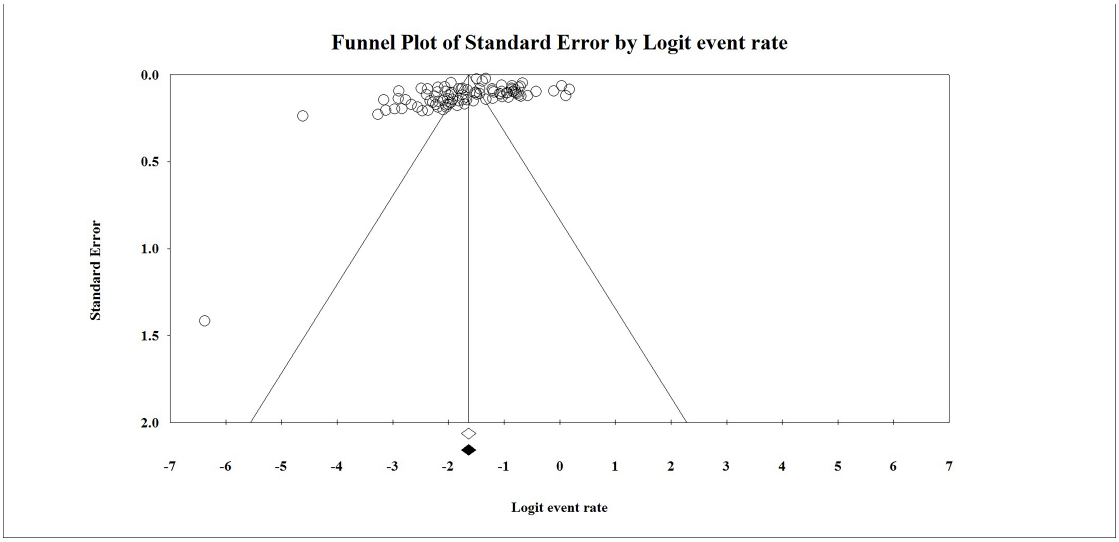


Figure 5: Regional income and prevalence

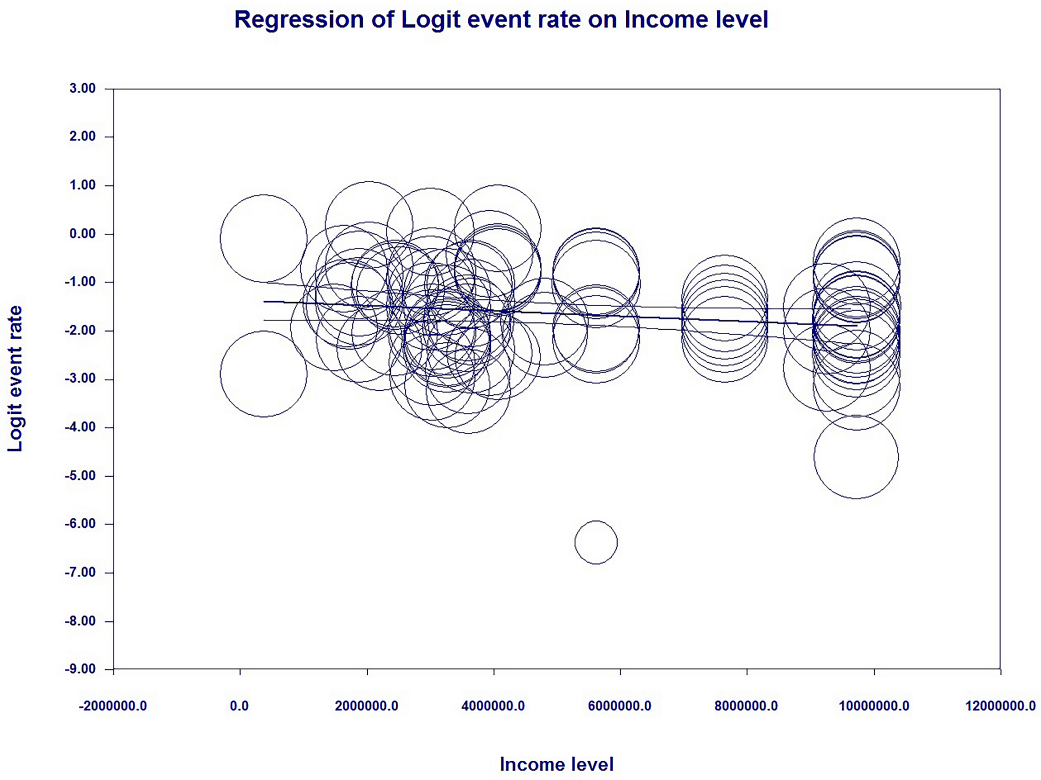
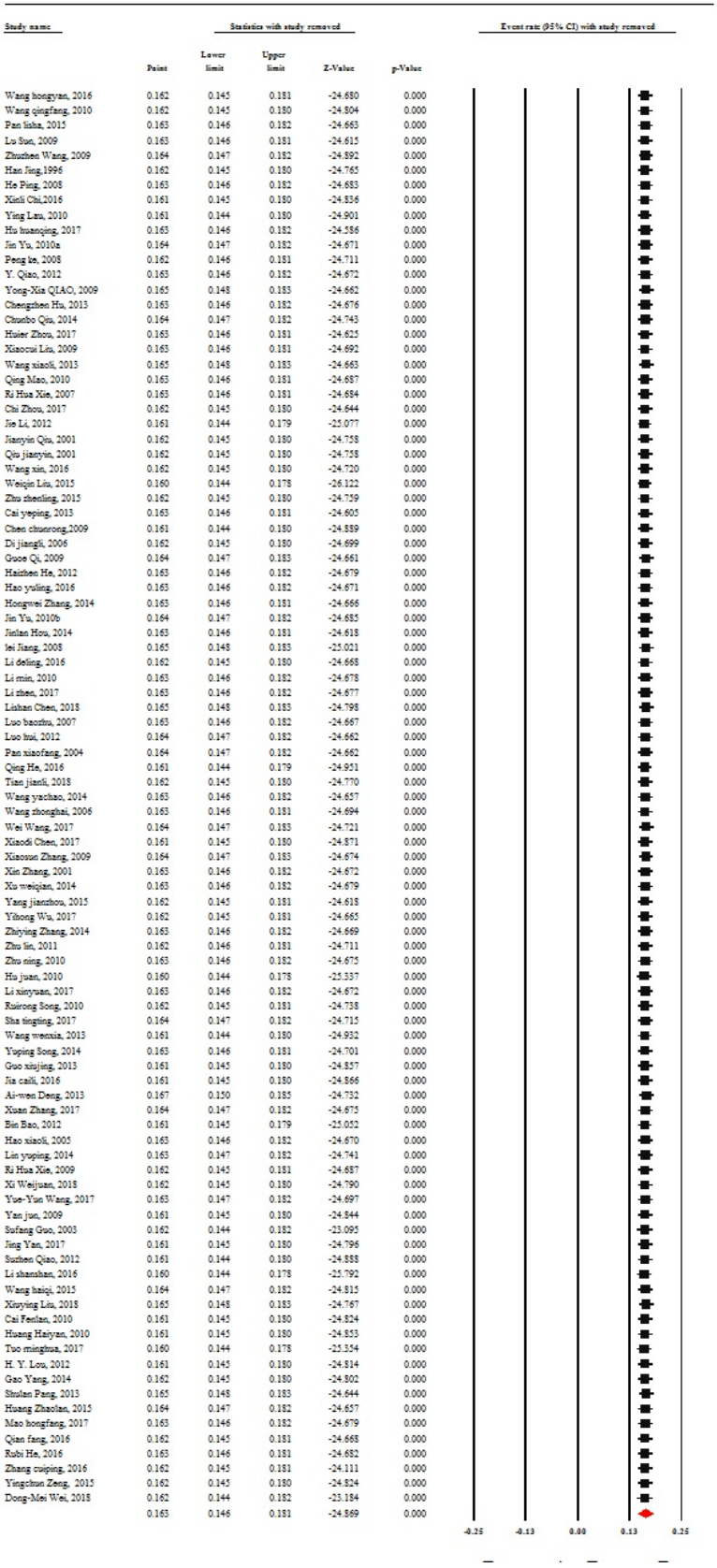


Figure 6: Sensitivity Analysis


Study name
Statistics with study removed
Point
Lower limit
Upper limit
Z-Value
p-Value
Event rate (95% CI) with study removed
Wang hongyan, 2016 0.162 0.145 0.181 -24.680 0.000
Wang qingfang, 2010 0.162 0.145 0.180 -24.804 0.000
Pan lisha, 2015 0.163 0.146 0.182 -24.663 0.000
Lu Sun, 2009 0.163 0.146 0.181 -24.615 0.000
Zhuzhen Wang, 2009 0.164 0.147 0.182 -24.892 0.000
Han Jing,1996 0.162 0.145 0.180 -24.765 0.000
He Ping, 2008 0.163 0.146 0.182 -24.683 0.000
Xinli Chi,2016 0.161 0.145 0.180 -24.836 0.000
Ying Lan, 2010 0.161 0.144 0.180 -24.901 0.000
Hu huanqing, 2017 0.163 0.146 0.182 -24.586 0.000
Jin Yu, 2010a 0.164 0.147 0.182 -24.671 0.000
Peng ke, 2008 0.162 0.146 0.181 -24.711 0.000
Y. Qiao, 2012 0.163 0.146 0.182 -24.672 0.000
Yong-Xia QIAO, 2009 0.165 0.148 0.183 -24.662 0.000
Chengzhen Hu, 2013 0.163 0.146 0.182 -24.676 0.000
Chunbo Qiu, 2014 0.164 0.147 0.182 -24.743 0.000
Huier Zhou, 2017 0.163 0.146 0.181 -24.625 0.000
Xiaocui Liu, 2009 0.163 0.146 0.181 -24.692 0.000
Wang xiaoli, 2013 0.165 0.148 0.183 -24.663 0.000
Qing Mao, 2010 0.163 0.146 0.181 -24.687 0.000
Ri Hua Xie, 2007 0.163 0.146 0.181 -24.684 0.000
Chi Zhou, 2017 0.162 0.145 0.180 -24.644 0.000
Jie Li, 2012 0.161 0.144 0.179 -25.077 0.000
Jianyin Qiu, 2001 0.162 0.145 0.180 -24.758 0.000
Qiu jianyin, 2001 0.162 0.145 0.180 -24.758 0.000
Wang xin, 2016 0.162 0.145 0.180 -24.720 0.000
Weiqin Liu, 2015 0.160 0.144 0.178 -26.122 0.000
Zhu zhenling, 2015 0.162 0.145 0.180 -24.759 0.000
Cai yeping, 2013 0.163 0.146 0.181 -24.605 0.000
Chen chunrong,2009 0.161 0.144 0.180 -24.889 0.000
Di jiangli, 2006 0.162 0.145 0.180 -24.699 0.000
Guoe Qi, 2009 0.164 0.147 0.183 -24.661 0.000
Haizhen He, 2012 0.163 0.146 0.182 -24.679 0.000
Hao yuling, 2016 0.163 0.146 0.182 -24.671 0.000
Hongwei Zhang, 2014 0.163 0.146 0.181 -24.666 0.000
Jin Yu, 2010b 0.164 0.147 0.182 -24.685 0.000
Jinlan Hou, 2014 0.163 0.146 0.181 -24.618 0.000
lei Jiang, 2008 0.165 0.148 0.183 -25.021 0.000
Li deling, 2016 0.162 0.145 0.180 -24.668 0.000
Li min, 2010 0.163 0.146 0.182 -24.678 0.000
Li zhen, 2017 0.163 0.146 0.182 -24.677 0.000
Lishan Chen, 2018 0.165 0.148 0.183 -24.798 0.000
Luo baozhu, 2007 0.163 0.146 0.182 -24.667 0.000
Luo hui, 2012 0.164 0.147 0.182 -24.662 0.000
Pan xiaofang, 2004 0.164 0.147 0.182 -24.662 0.000
Qing He, 2016 0.161 0.144 0.179 -24.951 0.000
Tian jianli, 2018 0.162 0.145 0.180 -24.770 0.000
Wang yachao, 2014 0.163 0.146 0.182 -24.657 0.000
Wang zhonghai, 2006 0.163 0.146 0.181 -24.694 0.000
Wei Wang, 2017 0.164 0.147 0.183 -24.721 0.000
Xiaodi Chen, 2017 0.161 0.145 0.180 -24.871 0.000
Xiaosun Zhang, 2009 0.164 0.147 0.183 -24.674 0.000
Xin Zhang, 2001 0.163 0.146 0.182 -24.672 0.000
Xu weiqian, 2014 0.163 0.146 0.182 -24.679 0.000
Yang jianzhou, 2015 0.162 0.145 0.181 -24.618 0.000
Yihong Wu, 2017 0.162 0.145 0.181 -24.665 0.000
Zhiying Zhang, 2014 0.163 0.146 0.182 -24.669 0.000
Zhu lin, 2011 0.162 0.146 0.181 -24.711 0.000
Zhu ning, 2010 0.163 0.146 0.182 -24.675 0.000
Hu juan, 2010 0.160 0.144 0.178 -25.337 0.000
Li xinyuan, 2017 0.163 0.146 0.182 -24.672 0.000
Ruirong Song, 2010 0.162 0.145 0.181 -24.738 0.000
Sha tingting, 2017 0.164 0.147 0.182 -24.715 0.000
Wang wenxia, 2013 0.161 0.144 0.180 -24.932 0.000
Yuping Song, 2014 0.163 0.146 0.181 -24.701 0.000
Guo xiujing, 2013 0.161 0.145 0.180 -24.857 0.000
Jia caili, 2016 0.161 0.145 0.180 -24.866 0.000
Ai-wen Deng, 2013 0.167 0.150 0.185 -24.732 0.000
Xuan Zhang, 2017 0.164 0.147 0.182 -24.675 0.000
Bin Bao, 2012 0.161 0.145 0.179 -25.052 0.000
Hao xiaoli, 2005 0.163 0.146 0.182 -24.670 0.000
Lin yuping, 2014 0.163 0.147 0.182 -24.741 0.000
Ri Hua Xie, 2009 0.162 0.145 0.181 -24.687 0.000
Xi Weijuan, 2018 0.162 0.145 0.180 -24.790 0.000
Yue-Yun Wang, 2017 0.163 0.147 0.182 -24.697 0.000
Yan jun, 2009 0.161 0.145 0.180 -24.844 0.000
Sufang Guo, 2003 0.162 0.144 0.182 -23.095 0.000
Jing Yan, 2017 0.161 0.145 0.180 -24.796 0.000
Suzhen Qiao, 2012 0.161 0.144 0.180 -24.888 0.000
Li shanshan, 2016 0.160 0.144 0.178 -25.792 0.000
Wang haiqi, 2015 0.164 0.147 0.182 -24.815 0.000
Xinying Liu, 2018 0.165 0.148 0.183 -24.767 0.000
Cai Feelan, 2010 0.161 0.145 0.180 -24.824 0.000
Huang Haiyan, 2010 0.161 0.145 0.180 -24.853 0.000
Tuo minghua, 2017 0.160 0.144 0.178 -25.354 0.000
H. Y. Lou, 2012 0.161 0.145 0.180 -24.814 0.000
Gao Yang, 2014 0.162 0.145 0.180 -24.802 0.000
Shulan Pang, 2013 0.165 0.148 0.183 -24.644 0.000
Huang Zhaolan, 2015 0.164 0.147 0.182 -24.657 0.000
Mao hongfang, 2017 0.163 0.146 0.182 -24.679 0.000
Qian fang, 2016 0.162 0.145 0.181 -24.668 0.000
Rubi He, 2016 0.163 0.146 0.181 -24.682 0.000
Zhang cuiping, 2016 0.162 0.145 0.181 -24.111 0.000
Yingchun Zeng, 2015 0.162 0.145 0.180 -24.824 0.000
Dong-Mei Wei, 2018 0.162 0.144 0.182 -23.184 0.000
0.163 0.146 0.181 -24.869 0.000
-0.25
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0.00
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Table 1: Subgroup analysis based on scales

Scale	Frequency	Prevalence	95% CI	Column 1	I2	P-value	Q-value	df	P-value2
Beck Depression Inventory (BDI)	2	0.23	0.11	0.42	92.12	0.01	15.83	7.00	0.03
Center for Epidemiological Studies Depression (CES-D)	5	0.16	0.10	0.25	98.25	0.00			
Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV)	1	0.33	0.12	0.64	0.00	0.28			
Hospital Anxiety and Depression Scale (HADS-D)	5	0.10	0.06	0.17	90.92	0.00			
Other	5	0.11	0.06	0.19	75.86	0.00			
Symptom Checklist 90 (SCL-90)	1	0.05	0.01	0.16	0.00	0.00			
The Edinburgh Postnatal Depression Scale (EPDS)	57	0.16	0.14	0.18	98.12	0.00			
Zung Self-Rating Depression Scale (Zung-	19	0.20	0.16	0.25	98.48	0.00			

SDS)						
Total within						
Total between						
Overall	95	0.16	0.15	0.18	98.12	0.00

Table 2: Subgroup analysis based on regions

Region	No. Of studies	Prevalence	95% CI		I2	Q-value	df	P-value
			Lower	Higher				
Guangdong	21	0.13	0.10	0.17	98.03			
Jiangsu	3	0.11	0.06	0.20	95.94			
Shandong	6	0.15	0.09	0.22	72.43			
Zhejiang	9	0.18	0.12	0.25	97.58			
Henan	2	0.13	0.06	0.26	38.50			
Sichuan	6	0.29	0.20	0.41	96.55			
Hubei	2	0.20	0.09	0.37	98.75			
Hunan	4	0.16	0.09	0.26	96.48			
Hebei	3	0.09	0.04	0.16	98.22			
Fujian	1	0.15	0.05	0.37	0.00			
Shanghai	9	0.12	0.08	0.17	94.08			
Beijing	6	0.13	0.08	0.20	97.44			
Anhui	3	0.31	0.18	0.48	98.92	45.66	23.00	0.00
Liaoning	1	0.24	0.08	0.51	0.00			
Shaanxi	4	0.20	0.12	0.31	89.88			
Jiangxi	1	0.09	0.03	0.25	0.00			
Chongqing	1	0.34	0.13	0.63	0.00			
Guangxi	1	0.55	0.26	0.80	0.00			
Tianjin	4	0.20	0.12	0.31	96.64			
Inner Mongolia	1	0.18	0.06	0.43	0.00			
Heilongjiang	1	0.33	0.12	0.62	0.00			
Guizhou	1	0.13	0.04	0.33	0.00			
Ningxia	2	0.19	0.09	0.35	99.65			
(Studies from multiple locations)	3	0.20	0.11	0.34	98.89			
Total within								
Total between								
Overall	95	0.16	0.15	0.18	98.12			

Table 3: Risk and protective factors of perinatal depression in Mainland China

Risk Factors	Reported Odds Ratio (Minimum – Maximum)	Studies
Older maternal age, *(Above 29 years)*	**1.16** (Qiu Jianang, 2001) – **1.28** (Liu Xiu Ying, 2018)	(Bao Bin, 2012; Liu Xiu Ying, 2018; Qiu C Jianang, 2001)
Poor education level	**1.92**(Wei et al., 2018) – **4.45** (He Rubi, 2016)	(Chen Xiaodi, 2017; He Rubi, 2016; Wei et al
Poor health before pregnancy	**2.31** (Zhang Xin, 2001)- **5.5** (Jiang Fan, 2015)	(Bao Bin, 2012; Guo Sufang, 2003; Ji Fang, 2 al., 2010; Liu, 2015; Qiao et al., 2012; Qiu Ming Hua, 2017; Wang Wei, 2017; Ying,
Vomiting, sleep problems and drinking in early pregnancy	**1.37** (Liu Xiu Ying, 2018)-**1.72** (Ji Fang, 2013)	(Chen Li Shan, 2018; Ji Fang, 2013; Jiang Le Xiu Ying, 2018; Song Yuping, 2014; Wa Hui Er, 2017)
Unplanned pregnancy and pregnancy complications	**1.8** (Chen Li Shan, 2018)- **21.015** (Bao Bin, 2012)	(Bao Bin, 2012; Chen Li Shan, 2018; Jiang Le Yuping, 2014; Wang Wei, 2017; Wu Yi H
Presences of diseases in pregnancy	**1.70** (Liu, 2015) – **12.158** (Wang Wei, 2017)	(Guo Sufang, 2003; Lan, 2014; Liu, 2015; Q Jian Yin, 2001; Wang Wei, 2017; Yu Yany
Presence of anxiety and depression in perinatal period	**2.604** (Zhou Hui Er, 2017) – **19.987** (Zhang Xian, 2017)	(Jiang Lei, 2008; Lau et al., 2010; Liu, 2015; S Yi Hong, 2017; Zhang Xian, 2017; Zhou H
Difficulties in pregnancy and childbirth	**3.71**(Zhou Hui Er, 2017)-**2.99** (Qi Guo É, 2009)	(Deng et al., 2014; Ji Fang, 2013; Jiang Fan, 2 Zhou Hui Er, 2017)
Male child preference	**1.021**(Deng et al., 2014) – **4.261**(Chen Xiaodi, 2017)	(Chen Xiaodi, 2017; Deng et al., 2014; Gao 2009)
Presence of any neonatal disease	**1.45** (Qi Guo É, 2009) – **3.502** (Zhang Xiao Song, 2009)	(Bao Bin, 2012; Jiang Fan, 2015; Li Shan Sh Song, 2009)
Breast feeding problems	**1.353**(Zhou Hui Er, 2017) – **1.75**(Pang Shu Lan, 2003)	(Pang Shu Lan, 2003; Zhou Hui Er, 2017)
Difficulties in taking care of newborn	**2.757** (Zhang Xiao Song, 2009)– **3.74** (He Hai Zhen, 2012)	(He Hai Zhen, 2012; Zhang Xiao Song, 2009)
Difficulties in relationships with husband	**1.58** (Bao Bin, 2012) – **7.584** (Wu Yi Hong, 2017)	(Bao Bin, 2012; He Hai Zhen, 2012; Hu Chen 2009; Qiu Jian Yin, 2001; Qiu Jianang, 20
Family conflicts	**1.87** (Qi Guo É, 2009) – **11.73** (Zhang Xiao Song, 2009)	(Bao Bin, 2012; Lau et al., 2010; Qi Guo É, 2017; Ying, 2014; Zhang Xiao Song, 2009

Low Family income	**1.318** (Bao Bin, 2012) – **4.803** (Jiang Fan, 2015)	(Bao Bin, 2012; Hu Cheng Zhen, 2013; Ji Fan 2018; Yu, 2010)
Poor living conditions	**1.85** (Lan, 2014) – **2.87** (Chen Xiaodi, 2017)	(Chen Xiaodi, 2017; Lan, 2014; Zhang Xin, 20
Unemployment during pregnancy or after childbirth	**1.45** (Li Shan Shan, 2016) – **47.727** (Zhang Xiao Song, 2009)	(Li Shan Shan, 2016; Wei et al., 2018; Zhang X
Postpartum violence	**1.92**(Guo Sufang, 2003)	(Guo Sufang, 2003; Qian Fang, 2016)
Protective factors		
Advance education level (Undergraduate – graduate)	**0.175** (Wei et al., 2018)– **0.923** (Zhang Hongwei, 2014)	(Guo Sufang, 2003; He Hai Zhen, 2012; Huan Lei, 2008; Ling, 2016; Zhang Hongwei, 20
Education related to pregnancy	**0.475** (Jiang Lei, 2008) – **0.694** (Jiang Fan, 2015)	(He Hai Zhen, 2012; Jiang Fan, 2015; Jiang Le
Better family income	**0.035** (He Qing, 2016) – **0.98** (Jiang Fan, 2015)	(Gao Yang, 2014; He Qing, 2016; Jiang Fan, 2
Good living conditions	**0.016** (He Qing, 2016) - **0.52** (Huang Hai Yan, 2010)	(He Qing, 2016; Huang Hai Yan, 2010; Jian 2014)
Better preparation for baby's arrival	**0.15** (Ying, 2014)	(Ying, 2014; Zhang Xin, 2001)
Appropriate healthcare during pregnancy	**0.52** (Huang Hai Yan, 2010) – **0.911** (Jiang Fan, 2015)	(Huang Hai Yan, 2010; Jiang Fan, 2015; Jian 2014; Zhang Xin, 2001; Zhou Hui Er, 201
Good relationships and support from family	**0.1** (He Qing, 2016) – **0.638** (Jiang Lei, 2008)	(He Qing, 2016; Jiang Fan, 2015; Jiang Lei, 2 Yi Hong, 2017; Ying, 2014; Zhang Xin, 2015)

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