Epidemiology and Prevalence of Preterm Births: A Systematic Review

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Authors’ contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Objective: The aim of this study was to explore dispersion of effect sizes regarding reported preterm births and to find out pooled prevalence estimate of preterm birth using meta-analysis.  
Methods: For meta-analysis a total of 1106 published studies were initially found related to the preterm births, after careful screening 41 methodologically sound studies were selected for meta-analysis.  
Results: In this study 41 published studies were taken with overall sample size of 6781976. Using meta-analysis the overall prevalence of preterm birth was found as 11.3% with significant ergogenous results. Rosenthal method showed there exist significant publication bias in pre-term prevalence studies.  
Conclusions: Based on meta-analysis results it can be evidently concluded that there exists enormous heterogeneity in pre-term prevalence reporting and the overall pooled prevalence is too high. The health care providers must focus on preventive measures and early screening of high-risk pregnancy.  

Keywords: Pregnancy; gestational age; last menstrual period; dating scan; preterm birth; preterm babies.

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1. INTRODUCTION

All births within 21 days before and 14 days after 40 weeks are defined as “term” births and have the best short and long-term health outcomes and as opposed to term birth, preterm birth (PTB) defined as childbirth occurring at less than 37 completed weeks or 259 days of gestation [1]. Most preterm births are spontaneous that are related to preterm labor or preterm premature rupture of membranes (PROM). The remainder is iatrogenic that are performed because of medical or obstetrical complications that endanger the health of the mother or fetus or both.2 The prevalence of medically indicated or iatrogenic preterm birth is 25% [2]. Across 184 countries, the rate of preterm birth ranges from 5% to 18% of new born babies [3]. Almost 15 million infants are born preterm every year in all over the world. While more than 60% of preterm births occur in Sub-Saharan Africa and South Asia in some of the developed countries such as the United States of America [4]. The occurrence of preterm births rose steadily from 9.4% of all pregnancies in the developed countries in 1981 to 12.8% in 2006, before declining to 12.7% in 2007 and 12.3% in 2008 [5]. Despite of much work done in past and also being done currently, no consistency can yet be established regarding prevalence of preterm birth worldwide, as the range of the preterm birth prevalence has been reported to be as low as 1.52% [6] to as high as 41.5% [7].

We planned this to find prevalence of preterm birth in Pakistan and to determine pooled prevalence of preterm birth using meta-analysis.

2. METHODOLOGY

For systematic review and meta-analysis literature was searched out with key words “preterm birth, prematurity, prevalence and mortality in preterm birth” through Web of Science, PubMed, eMedicine, and Higher Education Commission of Pakistan’s digital library. Only recent, peer reviewed and methodologically sound studies were short listed for meta-analysis. Studies with copyright or permission issues were excluded. The detailed information is presented in PRISMA flow diagram [Fig. 1]. A total of 1106 published studies were found initially that were related to the pre-term births, after careful screening 46 studies were found most relevant. Data was entered and analyzed using MetaXL and R Language to find pooled prevalence estimate using restricted maximum likelihood random effect model. I-squared statistics and Cochran’s Q was also used. I² > 75% was considered as high heterogeneity [8]. So to test the null hypothesis for all studies Cochran’s Q (based on Chi-square distribution) was used and p-value<0.05 was considered significant.

Fig. 1. PRISMA flow diagram showing flow of information through the different phases
3. RESULTS
Forty one articles were taken with overall sample size 6781976. Using meta-analysis the overall prevalence of preterm birth was found as 12.5%. Enormous heterogeneity is observed in prevalence rates based on I-squared statistics (that was > 75%) and Cochran’s Q (that was also too high). Chi-square heterogeneity test was significant P-value < 0.001. The detailed graphical description prevalence of preterm birth is given in Forest plot Fig. 2. Both Fail-safe N method and Kendall’s test of funnel plot asymmetry showed significant publication bias. Publication bias is also evident from funnel plot Fig. 3. It is evident that the chance that a statistically significant result is published is higher than a statistically non-significant result. Hence, the combined prevalence might be larger than it is in reality.

![Forest plot depicting prevalence of preterm birth in different studies using fixed effect heterogeneity technique](image)

| Study                                      | Fixed Effects, heterogeneity | Prev (95% CI)          | % Weight |
|--------------------------------------------|------------------------------|------------------------|----------|
| (Roberts et al., 2003)                    |                              | 0.06 ( 0.05, 0.06)     | 0.6      |
| (Shah et al., 2014)                       |                              | 0.22 ( 0.22, 0.23)     | 0.5      |
| (Akhbar et al., 2009)                     |                              | 0.18 ( 0.13, 0.23)     | 0.0      |
| (Passini Jr et al., 2014)                 |                              | 0.12 ( 0.12, 0.13)     | 0.5      |
| (do Camo Leal et al., 2012)              |                              | 0.13 ( 0.12, 0.13)     | 0.4      |
| (Silva et al., 2010)                      |                              | 0.13 ( 0.12, 0.14)     | 0.1      |
| (Silveira et al., 2013)                   |                              | 0.15 ( 0.14, 0.16)     | 0.1      |
| (Barros et al., 2006)                     |                              | 0.15 ( 0.14, 0.16)     | 1.6      |
| (Zou et al., 2014)                        |                              | 0.07 ( 0.07, 0.07)     | 12.1     |
| (Xu et al., 2015)                         |                              | 0.09 ( 0.09, 0.09)     | 0.0      |
| (Abdelhady and Abdelwahid, 2015)          |                              | 0.08 ( 0.08, 0.08)     | 0.1      |
| (Mengesha et al., 2016)                   |                              | 0.08 ( 0.08, 0.08)     | 0.0      |
| (Rao et al., 2014)                        |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Telapragada et al., 2016)                |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Padhi et al., 2015)                      |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Singh et al., 2007)                      |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Tehranian et al., 2016)                  |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Pasdar et al., 2012)                     |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Hesamedin, 2012)                        |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Ajljan et al., 2014)                     |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Jandaghi et al., 2011)                   |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Mansourghanaei, 2011)                    |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Bayat et al., 2009)                      |                              | 0.06 ( 0.06, 0.06)     | 0.0      |
| (Sohrabi and Ghanbari Gorkani, 2011)      |                              | 0.07 ( 0.07, 0.07)     | 0.0      |
| (Afrakhteh et al., 2002)                  |                              | 0.07 ( 0.07, 0.07)     | 0.0      |
| (Rajae et al., 2010)                      |                              | 0.08 ( 0.08, 0.08)     | 0.0      |
| (Sehati-Shalai et al., 2013)              |                              | 0.13 ( 0.12, 0.14)     | 0.0      |
| (Ganjii et al., 2009)                     |                              | 0.14 ( 0.14, 0.16)     | 0.0      |
| (Mohammadzadeh et al., 2005)             |                              | 0.16 ( 0.15, 0.18)     | 0.0      |
| (Amini et al., 2013)                      |                              | 0.30 ( 0.28, 0.33)     | 0.0      |
| (Mirzaie and Mohammad-Alizadeh, 2007)     |                              | 0.39 ( 0.36, 0.42)     | 0.0      |
| (Eluk et al., 2005)                       |                              | 0.08 ( 0.07, 0.07)     | 0.0      |
| (Mokudui et al., 2010)                   |                              | 0.12 ( 0.11, 0.13)     | 0.0      |
| (Butali et al., 2016)                     |                              | 0.17 ( 0.16, 0.18)     | 0.0      |
| (Olusanya and Olowo, 2010)                |                              | 0.20 ( 0.19, 0.21)     | 0.1      |
| (Wong et al., 2015)                       |                              | 0.04 ( 0.04, 0.04)     | 0.5      |
| (Lengyl et al., 2016)                     |                              | 0.08 ( 0.08, 0.08)     | 0.0      |
| (Dole et al., 2003)                       |                              | 0.12 ( 0.11, 0.13)     | 0.0      |
| (Bastek et al., 2015)                     |                              | 0.41 ( 0.38, 0.45)     | 0.0      |
| (Russell et al., 2007)                    |                              | 0.13 ( 0.13, 0.13)     | 0.0      |
| (Feresu et al., 2004)                     |                              | 0.17 ( 0.15, 0.18)     | 0.0      |
| Overall                                   |                              | 0.11 ( 0.06, 0.17)     | 100.0    |

Q=51050.55, p=0.00, I²=100%

Fig. 2. Forest plot depicting prevalence of preterm birth in different studies using fixed effect heterogeneity technique
Table 1. Random-Effects Model (k = 41 studies)

| Estimate | se    | Z     | CI Lower Bound | CI Upper Bound |
|----------|-------|-------|----------------|----------------|
| Intercept | 0.125 | 0.0137 | 9.14 | P<.001 | 0.098 | 0.152 |

Heterogeneity Statistics

| Tau | Tau² | I² | H² | df | Q | P<.001 |
|-----|------|----|----|----|---|-------|
| 0.087 | 0.0076 | 0.0017 | 99.99% | 8592.621 | 40.000 | 70069.749 |

Publication Bias Assessment

Fail-safe N: 2134687.000, P<.001; Kendall's Tau = 0.359, P<.001

Note: Tau² Estimator: Restricted Maximum-Likelihood, Fail-safe N Calculation Using the Rosenthal Approach

Table 2. Prevalence of preterm birth in different studies

| Studies | Countries | Sample Size (n) | Prevalence (%) | Weights |
|---------|-----------|----------------|----------------|---------|
| (Pais, 11.2012) [9] | Iran | 32450 | 2 | 0.025 |
| (Barros et al. 2006) [11] | Brazil | 4521 | 15 | 0.025 |
| (Shah et al. 2014) [13] | Bangladesh | 33216 | 16.4 | 0.024 |
| (Mohammadzadeh et al., 2005) [15] | Iran | 1979 | 16.6 | 0.024 |
| (Feresu et al. 2004) [17] | Zimbabwe | 3103 | 16.6 | 0.024 |
| (Zou et al. 2014) [19] | China | 107905 | 7.1 | 0.025 |
| (Amini et al., 2013) [21] | Iran | 990 | 30.4 | 0.024 |
| (Butali et al., 2016) [23] | Nigeria | 5561 | 16.8 | 0.025 |
| (Passini Jr et al. 2014) [25] | Brazil | 33740 | 12.3 | 0.025 |
| (Tehranian et al. 2016) [6] | Iran | 13281 | 1.52 | 0.025 |
| (Sohrabi and Ghanbari Gorkani, 2011) [28] | Iran | 3102 | 7 | 0.025 |
| (Tellapragada et al. 2016) [30] | India | 790 | 7.6 | 0.024 |
| (do Carmo Leal et al. 2012) [32] | Brazil | 23940 | 12.5 | 0.025 |
| (Xu et al. 2015) [33] | China | 818481 | 940 | 0.025 |
| (Bayat et al. 2009) [35] | Iran | 720 | 6.1 | 0.024 |
| (Silveira et al. 2013) [37] | Brazil | 6109 | 14.8 | 0.025 |
| (Hesamedin, 2012) [39] | Iran | 5400 | 2.4 | 0.025 |
| (Rao et al. 2014) [41] | India | 488 | 5.8 | 0.024 |
| (Mirzae and Mohammad-Alizadeh, 2007) [43] | Iran | 988 | 39.4 | 0.024 |
| (Russell et al. 2007) [45] | USA | 4611400 | 12.8 | 0.025 |
| (Mengesha et al. 2016) [47] | Ethiopia | 1152 | 8.1 | 0.024 |
| (Akhter et al. 2009) [10] | Bangladesh | 226 | 17.69 | 0.023 |
| (Dole et al. 2003) [12] | USA | 2444 | 12 | 0.025 |
| (Olusanya and Ofoewe, 2010) [14] | Nigeria | 4314 | 19.9 | 0.025 |
| (Padhi et al. 2015) [16] | India | 670 | 19.4 | 0.024 |
| (Lengyel et al. 2016) [18] | USA | 892733 | 7.6 | 0.025 |
| (Silva et al. 2010) [20] | Brazil | 5149 | 12.9 | 0.025 |
| (Roberts et al. 2003) [22] | Australia | 37500 | 5.5 | 0.025 |
| (Sehhati-Shafaii et al., 2013) [24] | Iran | 960 | 13.4 | 0.024 |
| (Etuk et al. 2005) [26] | Nigeria | 2640 | 8.48 | 0.025 |
| (Singh et al. 2007) [27] | India | 416 | 20.9 | 0.023 |
| (Alijahan et al. 2014) [29] | Iran | 6705 | 5.1 | 0.025 |
| (Mansourghanaei, 2011) [31] | Iran | 62841 | 5.99 | 0.025 |
| (Bastek et al. 2015) [7] | USA | 817 | 47.1 | 0.024 |
| (Jandaghi et al. 2011) [34] | Iran | 10913 | 5.6 | 0.025 |
| (Mokuolu et al. 2010) [36] | Nigeria | 2589 | 11.8 | 0.025 |
| (Rajaee et al. 2010) [38] | Iran | 1117 | 8.3 | 0.024 |
| (Ganjii et al. 2009) [40] | Iran | 1237 | 13.9 | 0.024 |
| (Wong et al. 2015) [42] | USA | 34630 | 3.80 | 0.025 |
| (Abdelhady and Abdelwahid, 2015) [44] | Egypt | 511 | 8.2 | 0.024 |
| (Afrakhteh et al. 2002) [46] | Iran | 5628 | 7.23 | 0.025 |
4. DISCUSSION

The prevalence is raising in all over the world because of increased frequency of multiple births due to assisted reproductive techniques (ART), more working mothers, increasing psychological stress and medically induced prematurity [48]. According to given prevalence in different studies we observe no consistency in reported prevalence of preterm birth worldwide, as the lowest and highest prevalence of PTB in recent literature is reported as 1.52% [6] and 41.5% [7] respectively. Thigh prevalence in different regions is may be due to various risk factors during pregnancy and definition of PTB. Published data from global studies are also recorded and meta-analysis for all 41 studies including the prevalence of current study was done. The overall prevalence of preterm birth across the world tends to 11.3%. This pooled statistics is greater than 5% and less than 18% that is reported among 184 countries across the world [3].

The reason of increasing prevalence of PTB may be the assessment methods of gestational age using latest techniques like ultrasonography [49]. Especialtions must be given to minimize the risk preterm birth as there are various complications in these children. It is also measured as a major cause of neonatal death / mortality and disability / morbidity [50,51]. Of all early neonatal deaths (deaths within the first 7 days of life) that are not related to congenital malformations, 28% are due to preterm birth [52]. Infants born preterm are more likely than infants born full term to die during the neonatal period (first 28 days) and infancy (first year), and mortality rates increase proportionally with decreasing gestational age or birth weight. [53-55]. The morbidity associated with preterm birth often extends to later life, resulting in enormous physical, psychological and economic costs [56,57]. Lungs (being last organ to be developed in utero) are the most common affected organ of the baby after preterm birth. The other consequences of preterm birth are cerebral palsy, blindness (impaired vision), and developmental difficulties, including cognitive, sensory, learning and language deficits [51].

Children born preterm are more likely to have white matter brain abnormalities early on causing higher risks of cognitive dysfunction. White matter connectivity between the frontal and posterior brain regions is critical in learning to identify patterns in language. Preterm children are at a greater risk for having poor connectivity between these areas leading to learning disabilities [58]. Another most serious gastrointestinal complication affecting preterm infants is necrotizing Enterocolitis (NEC). Mortality rates for infants who develop NEC range from 15% to 30% [59,60]. Retinopathy of prematurity (ROP) is a major cause of severe visual impairment or blindness in infants born prematurely, with approximately 50,000 infants affected worldwide each year. The disease is characterized by abnormal vascular proliferation in the immature retina, likely due to the presence...
of increased local reactive oxygen species and angiogenic growth factors [61]. In sum, preterm infants, particularly those who experience one or more of the complications, are at risk for neurodevelopmental disabilities such as CP, developmental delay, and mental retardation [62,63].

5. CONCLUSION

On the basis of our study we conclude that PTB is reported with huge variability but the pooled prevalence is too high. The health care providers must focus on preventive measures and early screening of high risk pregnancy. Reducing preterm birth can result in improvement of overall neonatal health and significantly reduce neonatal mortality in future.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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