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Tobacco Consumption during Pregnancy and Its Adverse Pregnancy Outcomes: A Systematic Review

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ABSTRACT

Background: Maternal smoking is known to pose risks to both baby and mother affecting aspects from fertility and pregnancy outcome to fetal and child development.
Objective: To study the prevalence of maternal smoking globally and its adverse pregnancy outcomes.
Materials and methods: Health sciences electronic databases PubMed and Google Scholar were searched for studies published between 2006 to March 2020. Keywords used for the search were (“tobacco”), ("maternal smoking"), ("effects of maternal smoking") and (“globally”). A total of 29 articles were included in the review based on the eligibility criteria. Statistical software SPSS-V.23 was used for the statistical application.
Result: A total of 29 studies met the inclusion criteria with a total of 11,34,769 women, age ranged from 12-45 years and above. Maternal smoking was reported by 22.26% women. Those women who reside in rural areas, illiterate, homemaker, from low economic status and whose husband smoke have higher maternal smoking prevalence and its adverse pregnancy outcomes were reported as 23.27% low maternal weight, 62.46% anaemic mother, 8.76% low birth weight, 12.86% preterm birth, 79% low birth length and 15.77% obesity among children.
Conclusion: Maternal tobacco use in any form increases risk of ill effects on mother and child health. Tobacco cessation during pregnancy is necessary to reduce morbidity and mortality related to tobacco use.
Key words- Maternal smoking, cigarette, smokeless tobacco, prevalence, effects of maternal smoking, Globally

INTRODUCTION

Exposure to tobacco smoke is harmful as it contains thousands of compounds that have toxic effects [(1)]. Tobacco consumption is one of the major preventable causes of mortality and morbidity around the world, affecting developed as well as developing countries [(2)]. Tobacco consumption is killing more than 8 million people every year around the world. Direct tobacco use kills more than 7 million of deaths whereas second hand smoking kills 1.2 million people every year [(3)]. Health professionals have long before considered maternal tobacco consumption harmful to reproduction, affecting aspects

from fertility and pregnancy outcome to fetal and child development [(4)]. Smoking during pregnancy is a public health problem because of many adverse effects on mother and child. These include abortions, low maternal weight, Anemia [(5)], [(6)], [(7)]. It is a known risk factor for many pediatric conditions including preterm delivery, low birth weight, still birth and SUID [(8)], [(9)], [(10)]. Majority of studies have shown that illiteracy, unemployment, husband smoke, early pregnancy, addiction and lack of awareness regarding the ill effects are the causes of maternal smoking [(11)] [(12)]. There is also one false belief that smokeless tobacco consumption is safe and less harmful compared to cigarette smoking which lead to increased consumption of smokeless tobacco use [(13)]. Mortality and morbidity due to maternal smoking is preventable by educating and advocating mothers. Tobacco Cessation, prevention of second hand smoke exposure and prevention of going back to smoking after quitting are important intervention strategies that should be implemented in every PHC and antenatal care clinics [(14)]. This will surely decrease maternal smoking prevalence Globally. There is dearth of studies regarding this topic, so this study is being conducted to provide awareness regarding adverse pregnancy outcomes of maternal smoking.

MATERIALS AND METHODOLOGY

A comprehensive search of quantitative literature was undertaken independently using PubMed and Google scholars for appropriate English publications. Our systematic review was done according to PRISMA guidelines [(15)]. Inclusion criteria consists of population-based studies (Case-control, cohort, Observational studies, Randomized control studies, conducted in diverse settings like hospitals, PHC, communities published from 2006 till 2020 in English language. Exclusion criteria consists of Case reports, case studies, Cross sectional studies and reviews. Articles published in languages other than English, studies reporting maternal smoking prevalence only and not including outcome were also excluded. (Figure 01) shows the selection process of the articles retrieved. Studies that met the inclusion criteria was finally included for the review [(16-44)].

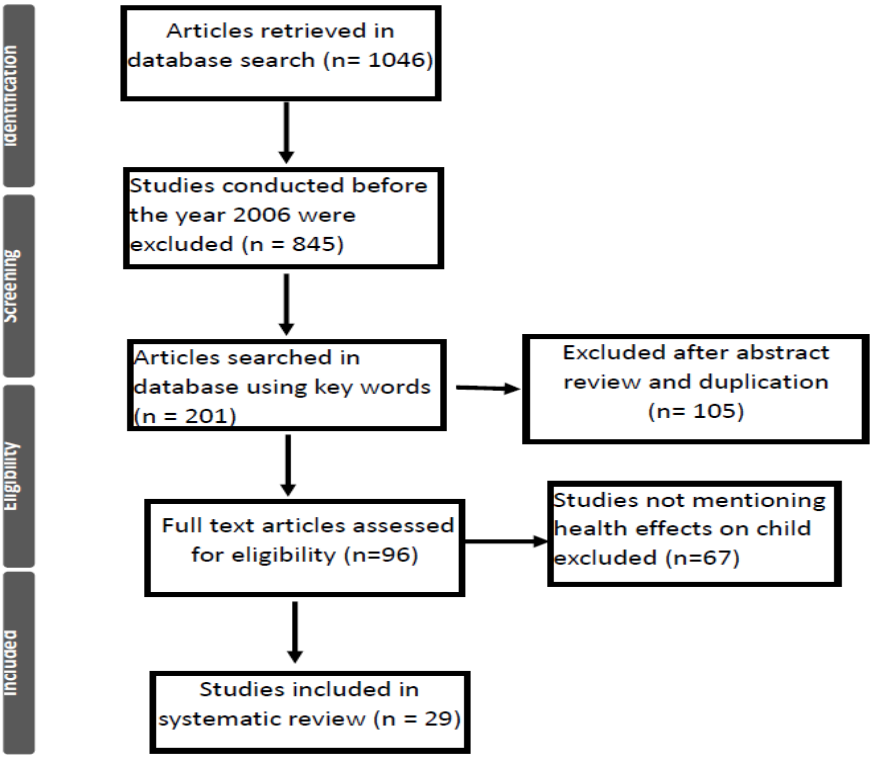


Figure 01: Summary of literature search and review process

RESULTS

Our literature review yielded 29 studies eligible for inclusion in the meta-analysis of maternal smoking and its adverse pregnancy outcome (Table 01). These studies included a population of total 11,34,769 women. Data was collected from India and other developed and developing countries (Bangladesh, Japan, USA, South Africa, Brazil, and European countries including Norway, Sweden, Australia, Poland, Belgium, France and the United Kingdom. A majority of studies are cohort (22), 5 case control, 1 observational and 1 randomized control study.

Studies from India: Maternal smoking prevalence was reported as 50% [(18),(20)] in Maharashtra and Delhi. Majority of studies were conducted in Maharashtra [(16),(17),(19),(20),(21)]. The most recent study conducted in 2018 [(21)] reported 16% maternal smoking prevalence whereas study conducted in 2010 [(17)] reported 30.92%. This revealed that there is a decrease in maternal smoking year by year. **In India smokeless tobacco consumption during pregnancy is more prevalent than cigarette smoking. Out of 6 studies no study reported maternal cigarette smoking.** Maternal smoking adverse effects were reported as Anemic mother [(19),(20),(21)], Abortion [(17),(18)] Miscarriage [(18)] , Low maternal weight [(17)], Pregnancy Induced Hypertension [(17)] and Pre-eclampsia [(18)], Low birth weight <2500g [(17),(18),(20)], Still birth [(16),(17)], Low birth length <50cm [(20)] and Preterm birth [(17)].

Study from Bangladesh: Maternal smoking prevalence was reported as 61.75% which is more than India. Here also smokeless tobacco consumption is more prevalent, this may reflect cultural differences in acceptability of cigarette smoking, perhaps contributing to under-reporting. Adverse pregnancy outcome was Still birth [(22)].

Studies from Japan: Maternal smoking prevalence ranged from 3.85% to 41.48%. Its effects were reported as low maternal weight [(23)], low birth weight [(25),(27)], Preterm birth [(25)], Neonatal asphyxia [(24)], ADHD [(26)]. There was one unique finding that revealed 4.9% of children exposed to smoke during prenatal period were having missing teeth or decayed teeth [(25)].

Studies from USA: Maternal smoking prevalence in 2015 was reported as 50% [(28)] and in 2018 as 5.24% [(30)] indicating a decrease in prevalence of maternal smoking. Its effects were reported as low maternal weight [(30)], low birth weight [(28)], low total body iron content [(28)], preterm birth [(29),(30)]. It was also revealed that exposure to smoke during pregnancy creates effects on fetus organs development and leads to respiratory problems and coronary heart disease [(30)].

Studies from South Africa: Maternal smoking prevalence in 2015 was 42.37 % [(31)] and in 2017 it reduced to 31.43% [(33)]. Ill effects were reported as Antenatal depression [(32),(33)], low birth weight [(32),(33)], preterm birth [(32),(33)], respiratory distress [(31),(32)], proteinuria [(32)] and neonatal asphyxia [(32)].

Studies from Brazil: Maternal smoking prevalence was reported as 14.42% [(34)] and 31.5% [(35)]. Harmful effects were Anaemic mothers [(35)] , low birth weight [(34)] and pre-eclampsia [(35)]. Here it was reported that prenatal smoking can also cause long term effects on children such as Obesity [(34)].

Studies from European countries: Maternal smoking prevalence ranged from 7.56% [(37)] to 51% [(43)]. Studies from **Sweden and Norway** reported its effects as miscarriage [(44)]. Here also like Brazil, it was revealed that maternal smoking leads to long term effects on children such as ADHD [(37)], Obesity [(43)] and short stature [(43)].

Maternal smoking prevalence in **Australia** [(41)] was reported as 51.75%. Antenatal depression, low birth weight, preterm birth were adverse pregnancy outcomes. Here also long term effects on exposed children was revealed. There were 5.5% children who faced trouble in sleeping, 8.3% reported sleeplessness and 20.9% reported night walking during sleep.

Maternal smoking prevalence was noted as 50% in **Poland** [(42)]. Here the study

reported low birth weight <2500g, low birth length <50cm, small head circumference and low iron content among exposed infants.

Study from **Belgium** [38] reported 33.24% maternal smoking prevalence and its effects were low birth weight and low birth length.

Based on a single study from **France** [39] reported 94.6% maternal smoking prevalence which is the highest prevalence among all other countries taken in this review. Its effect was reported as low birth weight.

A study in the **United Kingdom** [36] reported very low maternal smoking prevalence as 4.7%. The effect on exposed infants was reported as preterm birth.

Table 01: Detailed characteristics of studies on maternal smoking and its adverse pregnancy outcomes included in the systematic review

S.No.	Author/Year	Study Design	Sample size	Maternal Smoking prevalence	Population Characteristics	Result
INDIA						
1.	Prakash chandra gupta et al, 2006 [16]	Cohort study	1,217	16.92%	State:MaharashtraIndia Age: 18-45	Stillbirth 8.9%
2.	Asha Pratinidhi et al, 2010 [17]	Cohort study	705	218 (30.92%)	State:MaharashtraIndia Age: 18-45 Education: 30.7% illiterate Employment: 88.9% Homemaker	Low maternal weight (30.7%), Abortion 9.6% Operative Delivery (10.6%) Pregnancy Induced Hypertension 2.3% Preterm birth 9.6% Stillbirth 2.7% LBW 19.3%
3.	Ayalur Gopalakrishnan Radhika et al, 2014 [18]	Cohort study	184	92 (50%)	State: Delhi India Age: 15-35 Education: 56.98% illiterate	Miscarriage 2.25% Abortion 2.12% Operative deliveries 18% Pre-eclampsia 2% LBW 37.49%
4.	Hemlata shedg et, ol, 2017 [19]	Case control study	591	191 (32.31%)	State: Maharashtra, India Age: 18-33 + Education: >65% illiterate Employment: 98.95% Homemaker	Anemia (86.18%)
5.	Praveen Ganganahalli et al, 2017 [20]	Cohort study	210	105 (50%)	State:Maharashtra India Age: 20-25 Education: 15.2% illiterate Employment: 80% Homemaker	Anemia (62%) Low Birth Weight (75.2%) Low Birth Length (79%)
6.	Ritesh Mistry et al, 2018 [21]	Observational study	100	16 (16%)	State:Maharashtra India Age: 18-45 Education: 62% Literate Employment: 71 % Homemaker, 28% employed	Anemia (88%)
BANGLADESH						
7.	Mohammad Shakhawat hossain et al 2018 [22]	Case control study	1,012	625 (61.75%)	Country: Bangladesh Age: 18 + Education: 55.7% illiterate population Employment:Homemaker 97.6%	Still Birth
JAPAN						
8.	Emi Akahoshi et al 2015 [23]	Cohort study	621	45 (7.24%)	Country: Japan Age: 16-44	Low Maternal Weight 16.7%
9.	Maki Shinzawa et al, 2017 [24]	Retrospective cohort study	44,595	9417 (21.11%)	Country: Japan	Neonatal asphyxia 1.1%
10.	Junka Nakagawa Kang et al 2019 [25]	Cohort study	772	46(6%)	Country: Japan Age: <20- 40+	Operative deliveries 26.5% LBW 8.3% Preterm birth 8.3% Missing Teeth 4.9%
11.	Machiko Minatoya et al 2019 [26]	Cohort study	3,216	1334 (41.48%)	Country: Japan Education: 66% Literate population	ADHD
12.	Tadao Ooka et al 2019 [27]	Cohort study	20,276	782 (3.85%)	Country: Japan Age: <19-40+	Low Birth Weight 21%

Table 1: Continued…

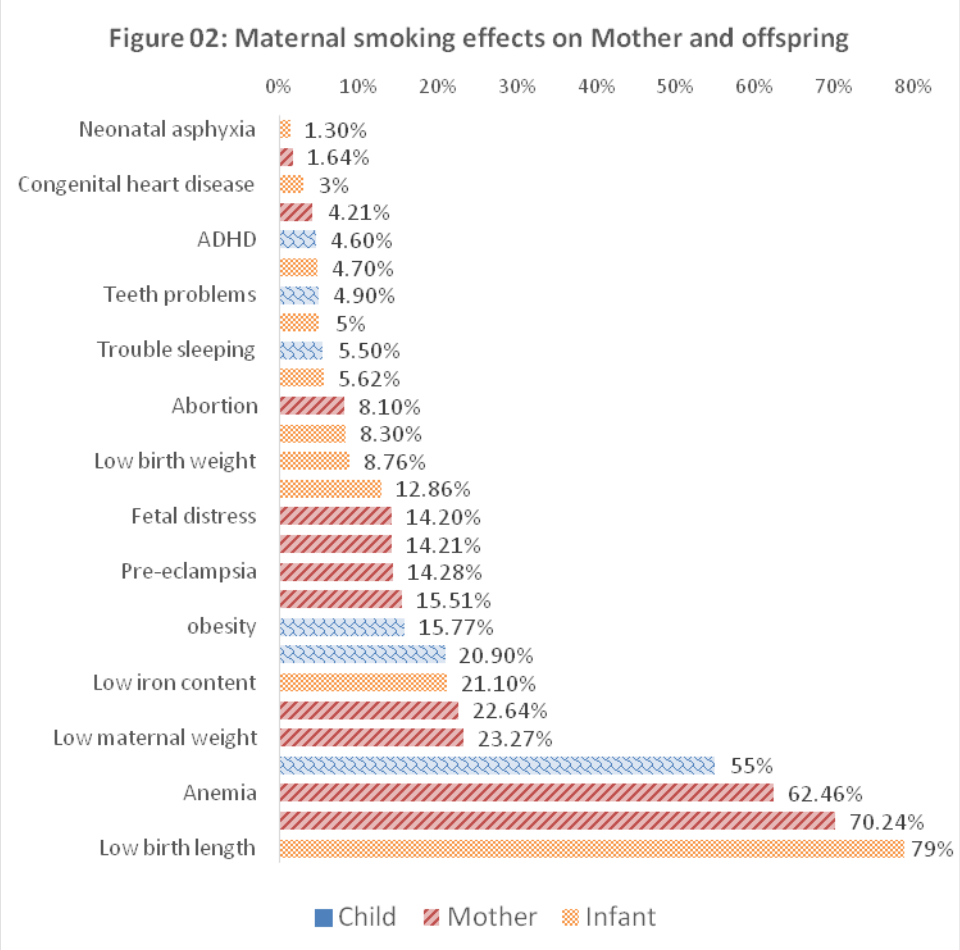
USA						
13.	Irina B. Pateva et al, 2015 [28]	Cohort study	144	72 (50%)	Country: USA Education: Literate population (till 12.5 years)	LBW Low Iron content in infants
14.	Elizabeth Moore et al 2016 [29]	Retrospective cohort study	9,13,757	216491 (23.69%)	Country: USA Age: <20-35+ Education: 15.3% illiterate	Preterm birth 13.62%
15.	Leili Behrooz et al, 2018 [30]	Case-control design	1,353	71 (5.24%)	Country: USA Education: 70% Literate	Low maternal weight 6% Operative deliveries 16% Preterm birth 8% Bronchiolitis Coronary Heart Disease 3%
SOUTH AFRICA						
16.	DIANE GRAY et al 2015 [31]	Cohort study	177	75 (42.37%)	Country: South Africa	Respiratory problem
17.	A. Vanker et al, 2016 [32]	Cohort study	789	250 (31.68%)	Country: South Africa Education: 9% Illiterate Employment: 74% Homemaker	Antenatal Depression 21% LBW 15% Preterm birth 16% Respiratory Distress 5% Proteinuria 1.7% Neonatal Asphyxia 1.1%
18.	S Budree et al, 2017 [33]	Cohort study	789	248 (31.43%)	Country: South Africa Education: 9% Illiterate Employment: Homemaker 74%	Antenatal Depression 26% LBW 15% Preterm birth 15%
BRAZIL						
19.	Ana Paula Muraro et al, 2016 [34]	Cohort study	2,405	347 (14.42%)	Country: Brazil	LBW 6.4% Obesity 0.45%
20.	Mariana Lopes de Brito et al 2017 [35]	Case control study	273	86 (31.5%)	Country: Brazil Education: 51.2% Literate	Anemia 2.6% Pre-eclampsia 17.5%
European countries						
21.	Uttara Partap et al 2016 [36]	Cohort study	3,892	183 (4.7%)	Country: United Kingdom	Preterm birth 9.2%
22.	Kristin Gustavson et al 2017 [37]	Cohort study	1,04,846	7930 (7.56%)	Country: Norway Age:<24- 35+ Education: 27% Literate	ADHD 4.6%
23.	Bram G. Janssen et al 2017 [38]	Cohort study	382	127 (33.24%)	Country: Belgium Age: 18-42 Education: 30.6% illiterate population	LBW Low Birth Length
24.	Ivan Berlin et al, 2017 [39]	Randomized control	371	351 (94.6%)	Country: France Age: 18+	LBW
25.	Yasmine Arbad et al, 2018 [40]	Case control study	55	22 (40%)	Country:Denmark	Low Maternal Weight LBW
26.	Frances O'Callaghan et al 2019 [41]	Cohort study	7,223	3738 (51.75%)	Country:Australia Age: 15-35+ Education: 18.2% Illiiterate	Antenatal Depression 11.6% LBW 4.3% Preterm birth 4.1% Sleeplessness 8.3% Trouble Sleeping 5.5% Night Walking 20.9%
27.	Magdalena Chełchowska et al, 2019 [42]	Cohort study	80	40 (50%)	Country: Poland	LBW Low Birth Length Small Head Circumference Low Iron content in infant 15.5%
28.	Sarah E. Maessen et al 2019 [43]	Cohort study	22,421	9311 (41.52%)	Country: Sweden Age:18+	Obesity 15.2% Short Stature 55%
29.	Ina Kreyberg et al 2019 [44]	Cohort study	2,313	252 (10.89%)	Country: Norway & Sweden Education: 32.4% Literate	Miscarriage 4.9%

The Socio demographic characteristics of the women are shown in Table 02. Sample size is 11,34,769 women, age ranging from 12 years to 45 years and above. Maternal smoking prevalence was 22.26% including 0.57% smokeless tobacco users and 99.42% cigarette smokers. There were 76.59% women who reported no

smoking during pregnancy. There were 22.92% literate population and 30.69% illiterate population who consume tobacco. Employment status of mothers who smoke during pregnancy was categorized as homemaker (79.86%) and employed women (5.91%). Economic status was categorized as Low (32.55%) and High (12.90%). There were 46.40% women whose husband smokes and 60.83% women were exposed to second-hand smoking.

Table 02: Socio demographic characteristics of study population

Variables	**Number**		**%**
Total sample size	11,34,769		
No. Of smokers	2,52,671		22.26
No. Of non-smokers	8,69,210		76.59
Total smokeless tobacco users	1,453		0.57
Total cigarette smokers	2,51,218		99.42
Age range	12-45 years		
Education	Total (N)	Smokers (n)	%
Literate	19,128	4,385	22.92
Illiterate	1,51,410	46,468	30.69
Employment			
Homemaker	2,448	1,955	79.86
Employed	541	32	5.91
Economic status			
Low	6,854	2,231	32.55
High	4,147	535	12.90
Husband smoke	4,754	2,206	46.40
Exposure to second-hand smoking	45,444	27,644	60.83



Maternal smoking effects on mother's health (Figure 02): This review reported various health issues occurred due to consumption of tobacco during pregnancy. The most common health complications were Anemia (62.46%), Low maternal weight (23.27%), Antenatal depression (22.64%), and, followed by Pre-eclampsia (14.28%), Maternal health complications (14.21%), Fetal distress (14.20%), Abortion (8.10%) and miscarriage (4.21%). Normal vaginal deliveries (70.24%) were more common than operative deliveries (15.51%).

Effects on infants (Figure 02): The most common adverse effects were reported as Low birth weight (8.76%), Preterm birth (12.86%), Low iron content (21.1%), and Low birth length (79%), followed by Sleeplessness (8.3%), Still birth (5.6%), Respiratory distress (5.0%), Neonatal death (4.7%), Congenital heart disease (3%) and Neonatal asphyxia (1.3%).

Effects on children and adolescents (Figure 02): There were several adverse effects on children and adolescents including, Proteinuria (1.64%), ADHD (4.6%), Teeth problems (4.9%), Trouble sleeping (5.5%), Obesity (15.77%), Night walking and talking (20.9%) and Short stature in 55% children.

DISCUSSION

This review reported the prevalence of maternal smoking ranged from 3.85% to 61.75% (Table 01). In this review we found that mothers who were illiterate, housewives and from low Socioeconomic status were more likely to continue smoking during pregnancy (Table 02). This finding was supported by M.Mohsin (2011) and Erin Passmore (2015) in their respective studies reporting women from low Socio- economic status continued smoking during pregnancy [(45)] [(46)]. S.Agazba (2020) reported that maternal smoking prevalence is high in less educated women [(47)]. J.Smedberg (2015) and T.Strini (2005) in their respective studies reported that women with low education, low socioeconomic status and housewife were more likely to smoke during pregnancy [(48)] [(49)].

Our review revealed that maternal smoking leads to adverse pregnancy outcomes to mother as well as child. Some most common effects on mother's health are Anemia (62.46%) and low maternal weight (23.27%). This finding was supported by majority of studies. S.Subramoney (2007) reported 26% Anemia [(50)]. Another study by Prakash (2004) reported 41.1% Anaemia and 31.7% low maternal weight [(51)]. Ting jung Ku (2014) in his study revealed 16.6% low maternal weight <10kg [(52)]. The prevalence varied in different studies due to different sample size.

Our review revealed preterm birth (12.9%) and low birth weight (8.8%) are most common maternal smoking outcomes. S.Soneji (2019) in his study reported 9.8% preterm births occurred due to maternal smoking hence supported our findings [(53)]. Wei zhang (2016) reported 16.3% low birth weight [(54)]. Another study conducted by Shih hui huang (2017) reported 4.7% low birth weight and 28.1% preterm birth [(55)].

Our review also revealed long term effects on children and adolescents. Most common outcomes were short stature (55%), sleep problems(5.50%) and obesity (15.77%). This finding of our review was supported by O.Robinson (2016) in his study where 15.4% children were overweight at the age of 4 years [(56)]. Another study by Rudiger von Kries (2008) reported 19% exposed children were found to be obese [(57)]. Another study by S.Rayfield (2016) reported the prevalence of obesity from 2.6-17% [(58)]. Association between maternal smoking and sleep problems among children were reported by Kristen C.Stone (2010). Higher levels of prenatal nicotine exposure predicted more sleep problems, specifically difficulty falling and staying asleep, from 1 month to 12 years [(59)]. E.S.Blanchard (2008) stated that neonates born to smoker mothers had disrupted sleep structure and continuity and they slept less over all [(60)]. Association between maternal

smoking and short stature was reported by Toshihiro (2011), where it was concluded that those children whose mother smoked during pregnancy were shorter and were obese [61]. Aimin chain (2006) also reported in the study that children of smoker mothers were consistently shorter and heavier than children of mothers who did not smoke during pregnancy [62].

In this review, several findings are important. First, our results are an important reminder that maternal smoking is still prevalent in women globally, despite continuous efforts from health care professionals. Currently, a huge number of infants are exposed to tobacco during fetal life each year, resulting in morbidity and mortality. Therefore continued attention from the respective government authorities is needed. Second, detection of maternal characteristics that act as barriers to tobacco cessation during pregnancy, focus in increasing the education level among women is an important societal effort needed to achieve healthier pregnancies that can be beneficial for mother and child. Awareness regarding harmful effects is important as from this study we came to know that a majority of women are unaware of harmful effects of tobacco consumption on fetus growth and development.

CONCLUSION

The systematic review concludes that Tobacco consumption during pregnancy in any form increases risk of adverse effects on mother and child health. Health care professionals and community efforts is required to educate and aware mothers regarding harmful effects. Tobacco cessation during pregnancy is necessary to reduce morbidity and mortality related to tobacco use.

Strength:

To our knowledge it is one of the first reviews that provide an insight into maternal smoking adverse pregnancy outcomes on mother's health as well as on child growth and development on a global level. It will serve as a guiding knowledge for health care professionals to execute tobacco cessation during pregnancy and bring awareness in women regarding its ill effects, thus resulting in the decline in mortality and morbidity due to smoking during pregnancy.

Limitations:

Maternal smoking is known to be under-reported by mothers, thus the magnitude of the association between maternal smoking and effects is likely to be underestimated. The data from which values are predicted are from different geographical area and heterogeneity of diversified population data collected and pooled from various studies. Variations such as age range, sampling techniques, were also not uniform. Merging such data may lead to high heterogeneity which is a potential source of bias.

Conflict of Interest

There is no conflict of Interest.

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REFERENCES

1. https://www.ncbi.nlm.nih.gov/books/NBK53022/ [Last accessed on 5/05/2020]
2. Gupta S, Mishra P, Nagarajappa S, Lalani A. Prevalence of Tobacco and associated risk factors among university law students in Indore City. Indian J dent res 2019;30:10-4
3. https://www.who.int/news-room/fact-sheets/detail/tobacco [Last accessed on 5/05/2020]
4. Centers for Disease Control and Prevention (US); National Center for Chronic Disease Prevention and Health Promotion (US); Office on Smoking and Health (US). How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General. Atlanta (GA): Centers for Disease Control and Prevention (US); 2010. 8, Reproductive and Developmental Effects.

5. Coleman-Cowger VH, Oga EA, Peters EN, Mark K. Prevalence and associated birth outcomes of co-use of Cannabis and tobacco cigarettes during pregnancy. Neurotoxicol Teratol. 2018;68:84-90. doi:10.1016/j.ntt.2018.06.001
6. Agarwal, Gagan,Ahmad, Sartaj, Maternal Risk Factors Associated with Low Birth Weight Neonates in a Tertiary Care Hospital, Northern India, 2012/01/01, JOUR Journal of Community Medicine & Health Education, 10.4172/2161-0711.1000177,vol 02
7. Praveen Ganganahalli and Asha K Pratinidhi and Jyotsna A. Patil and Satish V. Kakade (2015), Smokeless Tobacco Use & Anaemia among Pregnant Women in Karad taluk Western Maharashtra: A cross sectional study, National journal of community medicine, volume 6, pages 622-625
8. Sanjeev Singh, Gomathyamma K. Mini, Kavumpurathu R. Thankappan, Tobacco use during pregnancy in rural Jharkhand, India 2015, International Journal of Gynecology and Obstetrics, vol-131, issue 2
9. Kondracki AJ, Hofferth SL. A gestational vulnerability window for smoking exposure and the increased risk of preterm birth: how timing and intensity of maternal smoking matter. Reprod Health. 2019;16(1):43. Published 2019 Apr 16. doi:10.1186/s12978-019-0705-x
10. Anderson TM, Lavista Ferres JM, Ren SY, et al. Maternal Smoking Before and During Pregnancy and the Risk of Sudden Unexpected Infant Death. Pediatrics. 2019; 143(4):e20183325
11. Nair S, Schensul JJ, Begum S, Pednekar MS, Oncken C, Bilgi SM, et al. (2015) Use of Smokeless Tobacco by Indian Women Aged 18–40 Years during Pregnancy and Reproductive Years. PLoS ONE 10(3): e0119814. doi:10.1371/journal. pone.0119814
12. Chawla RM, Mitra P, Shetiya SH, Agarwal DR, Narayana DS, Bomble N. Knowledge, Attitude, and Practice of Women in Slums of Pimpri, Chinchwad, Pune, Maharashtra, India, regarding Usage of Mishri. J Contemp Dent Pract 2017;18(3):218-221.
13. Mutti S, Reid JL, Gupta PC, Pednekar MS, Dhumal G, Nargis N, et al. Patterns of use and perceptions of harm of smokeless tobacco in Navi Mumbai, India and Dhaka, Bangladesh. Indian J Community Med 2016;41:280-7
14. https://www.acog.org/-/media/project/acog/acogorg/clinical/files/committee-opinion/articles/2017/10/smoking-cessation-during-pregnancy.pdf [last seen on 5th may 2020]
15. Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. BMJ 2009; 339 : b2535
16. Gupta PC, Subramoney S. Smokeless tobacco use and risk of stillbirth: A cohort study in Mumbai, India. Epidemiology 2006;17:47-51
17. Pratinidhi A, Gandham S, Shrotri A, Patil A, Pardeshi S. Use of 'mishri' a smokeless form of tobacco during pregnancy and its perinatal outcome. Indian Journal of Community Medicine. 2010;35(1):14-18
18. Radhika, A.G., et al. (2014) Pregnancy Outcomes in Smokeless Tobacco Users Cohort Study in a Tertiary Care Hospital. Open Journal of Obstetrics and Gynecology, 4, 371-378
19. Shedge, H. and Kulkarni, S. 2017. Impact of smokeless tobacco use on pregnant Indian women. Journal of Biological Sciences and Medicine. 3, 4 (Dec. 2017), 26-34
20. Praveen Ganganahalli, Asha Pratinidhi, Jyotsna Patil, Satish V. Kakade J Clin Diagn Res. 2017 Mar; 11(3): LC16–LC19. Published online 2017 Mar 1. doi: 10.7860/JCDR/2017/23340.9534
21. Mistry R, Jones AD, Pednekar MS, et al. Antenatal tobacco use and iron deficiency anemia: integrating tobacco control into antenatal care in urban India. Reprod Health. 2018;15(1):72. Published 2018 May 2. doi:10.1186/s12978-018-0516-5
22. Hossain, Mohammad Shakhawat; Kypri, Kypros; Rahman, Bayzidur & Milton, Abul Hasnat. "Smokeless tobacco consumption and stillbirth: population-based case-control study in rural Bangladesh" Published in Drug and Alcohol Review, Vol. 37, Issue 3, pp. 413-420, (2018)
23. Emi Akahoshi , Kazuhiko Arima , Kiyonori Miura, Takayuki Nishimura, Yasuyo Abe, Naoko Yamamo et al, Association of maternal pre-pregnancy weight, weight gain during pregnancy, and smoking with small-for-gestational-age infants in Japan (2016),

journal of Early Human Development 92 (2016) 33–36
24. Shinzawa M, Tanaka S, Tokumasu H, et al. Maternal Smoking during Pregnancy, Household Smoking after the Child's Birth, and Childhood Proteinuria at Age 3 Years. Clin J Am Soc Nephrol. 2017;12(2): 253-260. doi:10.2215/CJN.05980616
25. Nakagawa Kang J, Unnai Yasuda Y, Ogawa T, et al. Association between Maternal Smoking during Pregnancy and Missing Teeth in Adolescents. Int J Environ Res Public Health. 2019;16(22):4536. Published 2019 Nov 16. doi:10.3390/ijerph16224536
26. Machiko Minatoya, Atsuko Araki, Sachiko Itoh, Keiko Yamazaki, Sumitaka Kobayashi, Chihiro Miyashita et al, Prenatal tobacco exposure and ADHD symptoms at pre-school age: the Hokkaido Study on Environment and Children's Health, 2019, journal of Environmental Health and Preventive Medicine (2019) 24:74
27. Ooka T, Akiyama Y, Shinohara R, Yokomichi H, Yamagata Z. Individual and Regional Characteristics Associated with Maternal Smoking During Pregnancy in Japan: Healthy Parents and Children 21. Int J Environ Res Public Health. 2019;17(1): 173. Published 2019 Dec 25. doi:10.3390/ijerph17010173
28. Pateva IB, Kerling EH, Reddy M, Chen D, Carlson SE, Tancabelic J. Effect of Maternal Cigarette Smoking on Newborn Iron Stores. Clin Res Trials. 2015;1(1):4-7.
29. Moore E, Blatt K, Chen A, et al. Relationship of trimester-specific smoking patterns and risk of preterm birth. Am J Obstet Gynecol 2016;215:109.e1-6.
30. Behrooz L, Balekian DS, Faridi MK, Espinola JA, Townley LP, Camargo CA Jr. Prenatal and postnatal tobacco smoke exposure and risk of severe bronchiolitis during infancy. Respir Med. 2018;140:21-26. doi:10.1016/j.rmed.2018.05.013
31. Gray D, Czövek D, Smith E, et al. Respiratory impedance in healthy unsedated South African infants: effects of maternal smoking. Respirology. 2015;20(3):467-473. doi:10.1111/resp.12463
32. Vanker, W. Barnett, K. Brittain, R. P. Gie, N. Koen, Myers et al, Antenatal and early life tobacco smoke exposure in an African birth cohort study, 2016, The International Journal of Tuberculosis and Lung Disease , Volume 20, Number 6, 1 June 2016, pp. 729-737(9)
33. S Budree (bdrshr001@myuct.ac.za), DJ Stein, K Brittain, E Goddard, N Koen, W Barnett, Maternal and infant factors had a significant impact on birthweight and longitudinal growth in a South African birth cohort, 2017, journal- Acta Pædiatrica ISSN 0803-5253
34. Muraro AP, Gonçalves-Silva RM, Ferreira MG, Silva GA, Sichieri R. Effect of the exposure to maternal smoking during pregnancy and childhood on the body mass index until adolescence. Rev Saude Publica. 2015;49:41. doi:10.1590/S0034-8910.2015049005423
35. Kataoka, M.C., Carvalheira, A.P.P., Ferrari, A.P. et al. Smoking during pregnancy and harm reduction in birth weight, BMC Pregnancy Childbirth 18, 67 (2018). https://doi.org/10.1186/s12884-018-1694-4
36. Uttara Partap, Ulla Sovio, Gordon C. S. Smith, Fetal Growth and the Risk of Spontaneous Preterm Birth in a Prospective Cohort Study of Nulliparous Women, American Journal of Epidemiology, Volume 184, Issue.
37. Gustavson K, Ystrom E, Stoltenberg C, et al. Smoking in Pregnancy and Child ADHD. Pediatrics. 2017; 139(2):e20162509
38. Janssen BG, Gyselaers W, Byun HM, et al. Placental mitochondrial DNA and CYP1A1 gene methylation as molecular signatures for tobacco smoke exposure in pregnant women and the relevance for birth weight. J Transl Med. 2017;15(1):5. Published 2017 Jan 4. doi:10.1186/s12967-016-1113-4
39. Berlin I, Golmard JL, Jacob N, Tanguy ML, Heishman SJ. Cigarette Smoking During Pregnancy: Do Complete Abstinence and Low Level Cigarette Smoking Have Similar Impact on Birth Weight?. Nicotine Tob Res. 2017;19(5):518-524. doi:10.1093/ntr/ntx033
40. Vella, Yasmine,Association Between Infant Birth Weight and Maternal Health: Effects by Maternal Smoking, 2018/12/01
41. O'Callaghan F, O'Callaghan M, Scott JG, Najman J, Al Mamun A. Effect of maternal smoking in pregnancy and childhood on child and adolescent sleep outcomes to 21 years: a birth cohort study. BMC Pediatr. 2019;19(1):70. Published 2019 Mar 6. doi:10.1186/s12887-019-1439-1
42. Chełchowska M, Maciejewski TM, Mazur J, et al. Active Tobacco Smoke Exposure in

Utero and Concentrations of Hepcidin and Selected Iron Parameters in Newborns. Int J Environ Res Public Health. 2019;16(11): 1996. Published 2019 Jun 5. doi:10.3390/ijerph16111996

43. Maessen, S.E., Ahlsson, F., Lundgren, M. et al. Maternal smoking early in pregnancy is associated with increased risk of short stature and obesity in adult daughters. Sci Rep 9, 4290 (2019). https://doi.org/10.1038/s41598-019-39006-7
44. Ina Kreyberg, Katarina Hilde, Karen Eline S. Bains, Kai-
Håkon Carlsen, Berit Granum, Guttorm Hau gen, Gunilla Hedlin, Christine
M. Jonassen, Live
S. Nordhagen, Björn Nordlund, Corina
S. Rueegg, Katrine D. Sjøborg, Håvard O. Skjerven, Anne
C. Staff, Riyas Vettukattil, Karin C. Lødrup Carlsen, the PreventADALL Study Group ERJ Open Research Oct 2019, 5 (4) 00255-2019; DOI: 10.1183/23120541.00255-2019
45. Mohsin M, Bauman AE. Socio-demographic factors associated with smoking and smoking cessation among 426,344 pregnant women in New South Wales, Australia. BMC Public Health. 2005;5:138. Published 2005 Dec 21. doi:10.1186/1471-2458-5-138
46. Passmore E, McGuire R, Correll P, Bentley J. Demographic factors associated with smoking cessation during pregnancy in New South Wales, Australia, 2000-2011. BMC Public Health. 2015;15:398. Published 2015 Apr 18. doi:10.1186/s12889-015-1725-2
47. Azagba S, Manzione L, Shan L, King J. Trends in smoking during pregnancy by socioeconomic characteristics in the United States, 2010-2017. BMC Pregnancy Childbirth. 2020;20(1):52. Published 2020 Jan 23. doi:10.1186/s12884-020-2748-y
48. Smedberg, J., Lupattelli, A., Mårdby, A. et al. Characteristics of women who continue smoking during pregnancy: a cross-sectional study of pregnant women and new mothers in 15 European countries. BMC Pregnancy Childbirth 14, 213 (2014).
49. Tomislav Strini, Damir Bukovi, Lada [umilin1, Ante Radi}, Dinko Hauptman and Ante KlobuSocio-Demographic Characteristics and Lifestyle Habits of Pregnant Women Smokers, 2005, Coll. Antropol. 29 (2005) 2: 611–614
50. Subramoney, Sreevidya & Gupta, Prakash. (2008). Anemia in pregnant women who use smokeless tobacco. Nicotine & tobacco research : official journal of the Society for Research on Nicotine and Tobacco. 10. 917-20. 10.1080/14622200802027206
51. Gupta, P. C., & Subramoney, S. (2004). Smokeless tobacco use, birthweight and gestational age: A population based prospective cohort study of 1217 women in Mumbai, India. British Medical Journal, 328, 1538–1540.
52. Ting-Jung Koa,b, Li-Yi Tsaia,c, Li-Ching Chud, Shu-Jen Yehb,Cheung Leungb, Chien-Yi Chen et al, Parental Smoking During Pregnancy and Its Association with Low Birth Weight, Small forGestational Age, and Preterm Birth Offspring: A Birth Cohort Study, 2014, journal of pediatrics and neonatology-55, vol 20-27.
53. Samir Soneji, Association of maternal cigarette smoking and smoking cessation with preterm birth 2019, journal of Obstetrics and Gynecology, 2019.2514
54. Zheng W, Suzuki K, Tanaka T, Kohama M, Yamagata Z, The Okinawa Child Health Study Group (2016) Association between Maternal Smoking during Pregnancy and Low Birthweight: Effects by Maternal Age. PLoS ONE 11(1): e0146241. doi:10.1371/ journal.pone.0146241
55. Shih hui huang, ken pen weng, shih ming huang, huei han liou, chung cheng wang, shah fu ou et al, The effects of maternal smoking exposure during pregnancy on postnatal outcomes: A cross sectional study, 2017, journal of the Chinese medical association, issue 12, vol-80
56. Oliver Robinson, David Martínez, Juan J. Aurrekoetxea, Marisa Estarlich et al, The association between passive and active tobacco smoke exposure and child weight status among Spanish children, 2016, obesity a research journal.
57. Rüdiger von Kries, Gabriele Bolte, Ladan Baghi, André Michael Toschke, for the GME Study Group, Parental smoking and childhood obesity—is maternal smoking in pregnancy the critical exposure?, International Journal of Epidemiology, Volume 37, Issue 1, February 2008, Pages 210–216,
58. Rayfield S, Plugge E Systematic review and meta-analysis of the association between maternal smoking in pregnancy and

childhood overweight and obesity J Epidemiol Community Health 2017;71:162-173

59. Stone KC, LaGasse LL, Lester BM, et al. Sleep problems in children with prenatal substance exposure: the Maternal Lifestyle study. Arch Pediatr Adolesc Med. 2010; 164(5):452-456. doi:10.1001/archpediatrics.2010.52
60. Stephan-Blanchard E, Telliez F, Leke A, et al. The influence of in utero exposure to smoking on sleep patterns in preterm neonates. Sleep. 2008 Dec 1;31(12):1683–1689
61. Ino T1, Shibuya T, Saito K, Ohtani T, Effects of maternal smoking during pregnancy on body composition in offspring, 2011, journal of Pediatrics International © 2011 Japan Pediatric Society,
62. Aimin Chen, Michael L Pennell, Mark A Klebanoff, Walter J Rogan, Matthew P Longnecker, Maternal smoking during pregnancy in relation to child overweight: follow-up to age 8 years, International Journal of Epidemiology, Volume 35, Issue 1, February 2006, Pages 121–130.

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