BMJ Open

Association of tobacco use and other determinants with pregnancy outcomes: a multicentre hospital-based case–control study in Karachi, Pakistan

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To cite: Rozi S, Butt ZA, Zahid N, *et al*. Association of tobacco use and other determinants with pregnancy outcomes: a multicentre hospital-based case–control study in Karachi, Pakistan. *BMJ Open* 2016;**6**:e012045. doi:10.1136/bmjopen-2016-012045

▸ Prepublication history for this paper is available online. To view these files please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2016-012045).

Received 28 March 2016
Revised 9 August 2016
Accepted 23 August 2016

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ABSTRACT

Objectives: The study aimed to identify the effects of maternal tobacco consumption during pregnancy and other factors on birth outcomes and obstetric complications in Karachi, Pakistan.

Design: A multicentre hospital-based case–control study.

Setting: Four leading maternity hospitals of Karachi.

Participants: A random sample of 1275 women coming to the gynaecology and obstetric department of selected hospitals for delivery was interviewed within 48 hours of delivery from wards. Cases were women with adverse birth outcomes and obstetric complications, while controls were women who had normal uncomplicated delivery.

Primary and secondary outcome measures: Adverse birth outcomes (preterm delivery, low birth weight, stillbirth, low Apgar score) and obstetric complications (antepartum haemorrhage, caesarean section, etc).

Results: Final multiple logistic regression analysis revealed that with every 1 year increase in age the odds of being a case was 1.03 times as compared with being a control. Tobacco use (adjusted OR (aOR): 2.24; 95% CI 1.56 to 3.23), having no slits in the kitchen (proxy indicator for indoor air pollution) (aOR=1.90; 95% CI 1.05 to 3.43), gravidity (aOR=0.83; 95% CI 0.73 to 0.93), non-booked hospital cases (aOR=1.87; 95% CI 1.38 to 2.74), history of stillbirth (aOR=4.06; 95% CI 2.36 to 6.97), miscarriages (aOR=1.91; 95% CI 1.27 to 2.85) and preterm delivery (aOR=6.04; 95% CI 2.52 to 14.48) were significantly associated with being a case as compared with control.

Conclusions: This study suggests that women who had adverse pregnancy outcomes were more likely to have exposure to tobacco, previous history of adverse birth outcomes and were non-booked cases. Engagement of stakeholders in tobacco control for providing health education, incorporating tobacco use in women in the tobacco control policy and designing interventions for tobacco use cessation is warranted. Prenatal care and health education might help in preventing such adverse events.

Strengths and limitations of this study

- Our study included a robust method of recruitment to reduce classification of the outcome.
- Being a multicentre hospital-based study catering to patients from different ethnic and socioeconomic backgrounds indicates that our results can be generalised.
- One of the limitations of this study was that most of the information was self-reported; therefore, it was prone to reporting bias. However, we had given extensive training to our data collectors to retrieve participant's information as accurately as possible. Numerous studies have shown that self-reported smoking is reliable method of gathering information.
- Ideally, serum cotinine levels would have been a better measure; however, it was not possible to obtain blood samples in our study.

INTRODUCTION

Low birth weight (LBW) of the infant is a challenging multifaceted public health problem, as it varies from 4.5% in most developed countries to almost 50% in some of the least developed countries.[1] The prevalence of LBW is high in developing countries (18.5%), with the highest prevalence in South Asia (27%) including Pakistan[2] and India.[1] Stillbirth is another important adverse birth outcome. Globally, 3.9 million stillbirths are reported and unfortunately 97% of them are occurring in the developing world.[3]

There are a number of risk factors that may be associated with adverse birth outcomes and obstetric complications. Among them, tobacco use is a major public health problem globally. According to the WHO, there are about one billion smokers worldwide.[4] Smoking prevalence among women varies markedly across countries; it is 7% in developing countries and 24% in developed countries.[5] Tobacco use is common in Pakistan; about 34% of men and 12.5% of women use different forms of tobacco regularly.[5] Notably, 3.2% of pregnant women had ever been a regular cigarette smoker in Pakistan.[6] Women

who smoke cigarettes have higher rate of gynaecological complications[7] and decreased fertility potential.[8–10] Smoking increases the level of nicotine and carbon monoxide in the blood, which causes serious complications including increased rate of spontaneous abortion,[11] premature delivery,[11 12] LBW,[11 13 14] placenta praevia, bleeding during pregnancy, premature rupture of membranes and stillbirths.[15–17] Other adverse outcomes include small for gestational age (SGA) babies,[13 18] miscarriages,[19] lipid abnormalities,[20] increased risk for hypertension and gestational diabetes.[21]

Another important aspect is the increasing use of alternative forms of tobacco. According to the National Health Survey (NHS) of Pakistan, nearly 10% of females aged 25–64 years reported regular use of chewing tobacco or snuff, and over 7% of women smoked 'chillum' or 'huqqa' which is also a concern as smokeless tobacco use is increasingly associated with maternal cigarette smoking.[22–27] Additionally, tobacco, either chewed, applied orally, or smoked actively or passively, increases stillbirths by nearly three folds, reduces birth weight by 100–400 g, significantly increases placental weight and is also associated with high foetal mortality.[24] The NHS of Pakistan reported that 31% of pregnant women who had ever tried cigarette smoking had transitioned to regular use and among these regular users, 76.9% admitted that they are currently smoking.[5] Notably, the majority (92%) of these women reported that smoking cigarettes or other tobacco products was permitted in their home. About half of the women reported that they and their young children were frequently or always exposed to indoor tobacco smoke. This has important implications as women and children are the most vulnerable in terms of experiencing the adverse effects of tobacco use. Second-hand smoke has been found to be associated with preterm birth[28 29] and LBW[30] among pregnant women.

There are other risk factors that may also be associated with such adverse pregnancy outcomes and could also be potential confounders of the association between tobacco use and birth outcomes. Malnourishment among females living in resource poor settings predisposes them to anaemia and infections due to inadequate food intake.[31 32] Studies from Zimbabwe and Bangladesh reported that maternal mid-arm circumference was strongly related with LBW[33] and preterm birth.[34] Moreover, females undergoing antenatal complications are at an increased risk of adverse pregnancy outcomes.[34]

Another important factor is indoor air pollution (IAP) from solid fuel use which has been linked to acute lower respiratory infections in children and adverse pregnancy outcomes. Systematic reviews with meta-analyses have reported the association between IAP and increased risk of LBW and stillbirth.[35] Additional maternal risk factors such as primiparity, poor socioeconomic status, multiple gestations, premature rupture of membranes, hypertension and undernutrition can also contribute to adverse pregnancy outcomes.[36 37]

The majority of studies conducted in Pakistan on tobacco use have either been cross-sectional surveys[5] or have focused primarily on school children[38] and adolescents.[39 40] Very few studies have focused on pregnant women and tobacco consumption.[5] Awareness about tobacco use and its effect on women's health especially during pregnancy is lacking in Pakistan. Smoking and smokeless tobacco use among women is given low priority in public health programmes in Pakistan and scant attention is given to this issue by media. Even the public health messaging on media is focused on male members of the society and discussion of second-hand smoke is limited. To our knowledge, this is the first case–control study from Pakistan to identify the effects of maternal tobacco consumption and other factors during pregnancy on birth outcomes and obstetric complications.

MATERIAL AND METHODS

The study was designed as a multicentre hospital-based case–control study in Karachi, Pakistan. Karachi is the largest metropolitan city of Pakistan with a population estimated to be about 20 million.[41] Study participants were enrolled from four leading maternity hospitals of Karachi (Civil Hospital, Jinnah Postgraduate Medical College Hospital, Lyari General Hospital and Sobhraj Maternity Hospital), from March to December 2011. The study population comprised all pregnant women aged 16–45 years, coming to the selected hospitals from different ethnic, social, cultural and economic groups.

Inclusion criteria

Cases

Cases were pregnant women with singleton pregnancy presenting with the following outcomes:

(1) LBW (<2.5 kg) babies, (2) stillbirths (any child delivered after the 28th week of pregnancy who did not breathe afterwards or show any signs of life), (3) intra uterine deaths (foetus dies in uterus before the labour starts), (4) caesarean section due to foetal distress (decreased heart rate<100 bpm and/or passing meconium during labour), (5) antepartum haemorrhage (bleeding from the vagina occurring at any time after 28th week of pregnancy and before the birth of the child), (6) abruptio placentae (haemorrhage due to the partial separation of a placenta normally situated on the upper segment of the uterus), (7) placenta praevia(haemorrhage due to partial separation of a placenta abnormally situated on the lower segment of the uterus), (8) preterm labour (labour occurring before the 37th week of pregnancy) and (9) abnormal uterine action-prolonged labour (failed indication (delay in labour) due to primary uterine hypotonia in which contractions are weak, short and infrequent).

Controls

Controls were women with singleton term deliveries (37–40 weeks) having the following outcomes:

(1) normal vaginal deliveries with or without episiotomy, (2) normal vaginal assisted (forceps or vacuum) deliveries and (3) caesarean sections due to cephalopelvic disproportion (obstructed labour), malpresentation of foetus and cord around the neck.

Exclusion criteria

Women with history of diabetes mellitus, gestational diabetes, hypertension before pregnancy, pre-eclampsia, eclampsia, severe anaemia (haemoglobin <8 mg), cardiovascular diseases (valvular defects, congestive failures etc), chronic obstructive pulmonary disease, renal diseases, active infections (tuberculosis, hepatitis), epilepsy and severe complications in previous pregnancies and multiple births were excluded from the study.

Sample size and sampling strategy

Each hospital was treated as a stratum, cases and controls were selected randomly from hospitals. To determine sample size, a value of α=0.05 and β=0.2 was specified and an OR of 1.6 was assumed. In Pakistan, ~25% of newborns have LBW.[42] Using these values, the required sample size was 1275 individuals with a design effect of 1.1[42] and 10% non-response rate. A case to control ratio of 1:3 was used. A proportionate stratification technique was used to draw the samples from each hospital. In this technique, sample size of each stratum is proportionate to the population size of the stratum. The average number of delivered ladies was calculated in all five hospitals. Proportions (weight) of delivered ladies in each hospital were calculated by taking ratio between number of delivered ladies in each hospital and total number of delivered ladies in all five hospitals. The total number of deliveries was multiplied by calculated proportions (weight) of each hospital.

Enrolment of cases and controls

Trained data collectors interviewed mothers in obstetrics and gynaecology wards of the selected hospitals within 48 hours of delivery. Based on the case and control definition, the registers of the wards were searched for study participants who were selected randomly and then approached for interviews after receiving their consent.

Definition of tobacco users

All pregnant women who had regularly used tobacco products (smoke and smokeless) for the past 6 months,[43] at least three times per week, were considered as tobacco users.

Data collection procedure/tool

One research coordinator and three female data collectors were hired for data collection who were trained by the principal investigator. Data collectors checked hospital records daily to obtain information about the expected number of women delivering babies on the day of visit to the hospitals. Field team visited the normal vaginal delivery room, recovery room and intensive care unit on a daily basis to gather the required information. After selection, an informed consent was taken from each woman. Study participants were explained the purpose of the study and any queries were addressed. Although this was not an intervention study, after the interview, data collectors provided information to participants about ill effects of tobacco use during pregnancy to make them aware of the health issues related with tobacco use.

Questionnaire

The questionnaire was developed in English and then translated into Urdu. The questionnaire contained questions regarding maternal sociodemographic information, previous and current obstetric characteristics, physical condition and tobacco consumption in any form during pregnancy. The last part of questionnaire focused on the main outcome of the study; Apgar score (<7), weight of newborn, caesarean section, preterm birth and stillbirth.

Ethical consideration

Ethical approval for the study was obtained from the Aga Khan University's Ethical Review Committee. Written consent was obtained from all the hospitals' administration and individuals before an interview. Every precaution was taken to respect the privacy of participant.

Data editing and entry

The principal investigator and the data collectors edited filled questionnaires on a daily basis in the field and office. Data were double entered by two data entry operators in Epi Info V.6.04.[44]

Statistical analysis

Analyses were performed using Stata V.12.0. Descriptive analysis was carried out by calculating mean and SD for continuous variables and proportions for categorical variables. Logistic regression analysis was performed to study the associations between tobacco use and other factors and adverse pregnancy outcomes.[45] Crude OR and their 95% CI were calculated. Those variables with p value $\leq$0.25, or biological or social importance, were selected for multiple logistic regression analysis.[45] Adjusted ORs (AOR) and their 95% CIs were obtained from multiple logistic regression model. All potential confounders and biologically plausible interactions were evaluated.

RESULTS

A total of 1275 women (312 cases and 963 controls) with singleton births were recruited for this study. The median duration of marriage were 3 years (IQR=1.0–7.0 years) among cases, and 5 years (IQR=3.0–9.0 years) among controls with median gravidity of 2 children in both groups. Proportion of tobacco use was 42.3% among cases and 24.4% among controls. Tobacco use

Table 1 Characteristics of cases and controls presenting at selected hospitals in Karachi, Pakistan

Characteristics	Cases n (%)	Controls n (%)
Age of mother (years)		
Mean (SD)	25.3 (4.8)	26.0 (4.6)
Mother tongue of respondent		
Urdu	168 (53.8)	492 (51.1)
Sindhi	31 (9.9)	88 (9.1)
Punjabi	20 (6.4)	79 (8.2)
Balochi	28 (9.0)	99 (10.3)
Pashto	31 (9.9)	111 (11.5)
Others	34 (10.9)	94 (9.8)
Educational level		
No formal education	114 (36.5)	353 (36.7)
Primary and secondary	160 (51.3)	519 (53.9)
Intermediate	26 (8.3)	66 (6.9)
Graduate and post graduate	12 (3.8)	25 (2.6)
Religion		
Muslim	302 (96.8)	937 (97.3)
Christian	1 (0.3)	8 (0.8)
Hindu	9 (2.9)	18 (1.9)
Family system		
Nuclear	106 (34.0)	356 (37.0)
Joint	206 (66.0)	607 (63.0)
Nature of house		
Kachchaa (made by mud and wood)	14 (4.5)	21 (2.2)
Pakka (made by bricks and cement)	298 (95.5)	942 (97.8)
Work currently		
No	307 (98.4)	952 (98.9)
Yes	5 (1.6)	11 (1.1)
Gravidity median (IQR)	2.0 (1.0–3.0)	2.0 (3.0–4.0)
Years of marriage median (IQR)	3.0 (1.0–7.0)	5.0 (3.0–9.0)
No. of antenatal care visits		
Mean (SD)	6.6 (3.6)	6.5 (3.2)
Ever domestic violence		
No	306 (98.1)	947 (98.3)
Yes	6 (1.9)	16 (1.7)
Gestational age when foetal movement started (weeks)		
Mean (SD)	20.7 (2.3)	20.7 (2.2)
Complication during current pregnancy		
No	192 (61.5)	765 (79.4)
Yes	120 (38.5)	198 (20.6)
Immunisation done during this pregnancy		
No	65 (20.8)	216 (22.4)
Yes	247 (79.2)	747 (77.6)
Ultrasound done during this pregnancy		
No	8 (2.6)	19 (2.0)
Yes	304 (97.4)	944 (98.0)
Duration between water break and delivery of baby (hours)		
Median (IQR)	13.0 (6.0–36.0)	6.0 (2.0–14.0)
Material/fuel use for cooking		
Gas	291 (93.3)	905 (94.0)
Wood and others	21 (6.7)	58 (6.0)
Slits/window in the kitchen		
No	29 (9.3)	54 (5.6)
Yes	283 (90.7)	909 (94.4)
Slits/window in the house		
No	12 (3.8)	26 (2.7)
Yes	300 (96.2)	937 (97.3)
Exhaust fan in kitchen		
No	277 (88.8)	834 (86.6)
Yes	35 (11.2)	129 (13.4)
Average time spent in kitchen while stove burning (hours)		
Mean (SD)	1.9 (0.9)	1.9 (0.9)
Tobacco use		
No	180 (57.7)	728 (75.6)
Yes	132 (42.3)	235 (24.4)

between case (with adverse birth outcome) and controls was found to be significantly different (table 1).

Cases included 312 participants consisting of 62 preterm, 15 stillbirths, 9 intrauterine deaths and 137 with weight <2.5 kg. The average weight of baby among cases was 2.5 kg (SD=0.6 kg) and there were a total of 216 babies delivered by caesarean section. The control group comprised 963 women without any of these conditions (table 2).

Binary logistic regression analysis showed a significant association between tobacco use (smoke or smokeless) and adverse pregnancy outcome at the univariable level (OR: 2.27; 95% CI 1.73 to 2.97). The estimated ORs of women who had history of any illness or previous adverse pregnancy or birth outcome were significantly higher among cases compared with controls (table 3).

Age of women was also associated with adverse pregnancy outcome. For educational level, family history of illness and gestational age, there were no significant difference found between cases and controls. Cases were more likely to cook in kitchens without a slit/window (a proxy indicator for indoor pollution) (OR=1.7; 95% CI 1.1 to 2.8) as compared with controls.

The final multiple logistic regression analysis indicated that the odds of tobacco use among cases were 2.24 times compared with controls (OR: 2.24; 95% CI 1.56 to 3.23) after adjusting for other variables in the model. Age (AOR=1.03; 95% CI 1.0 to 1.1), no slits in the kitchen (AOR: 1.90; 95% CI 1.05 to 3.43), gravidity (AOR=0.83; 95% CI 0.73 to 0.93), non-booked hospital cases (AOR=1.87; 95% CI 1.38 to 2.74), history of stillbirth (AOR=4.06; 95% CI 2.36 to 6.97), miscarriages (AOR=1.91; 95% CI 1.27 to 2.85) and history of preterm delivery (AOR=6.04; 95% CI 2.52 to 14.48) were significantly associated with being a case as compared with control (table 4).

DISCUSSION

In our study, tobacco use was significantly associated with adverse pregnancy and obstetrics complications.

Table 2 Distribution of adverse pregnancy outcomes and obstetric complications among cases and controls at selected hospitals in Karachi, Pakistan

Outcome	Cases n (%)	Controls n (%)
Preterm delivery		
No	250 (80.1)	963 (100)
Yes	62 (19.8)	–
Caesarean section		
No	96 (30.8)	596 (61.9)
Yes	216 (69.2)	367 (38.1)
Status of baby at birth		
Alive	288 (92.3)	963 (100.0)
IUD	9 (2.9)	–
Stillbirth	15 (4.8)	–
Birth weight of baby (kg)		
Mean (SD)	2.5 (0.6)	3.0 (0.4)

IUD, intrauterine device.

Previous epidemiological studies have also reported that tobacco use[14 36 46 47] is associated with preterm delivery. Smoking during pregnancy releases carbon monoxide and/or nicotine which induce foetal hypoxia. Foetal haemoglobin has a higher affinity for carbon monoxide than adult haemoglobin and the impact on the foetus is more severe than on the mother.[48] Therefore, counselling of pregnant females about the detrimental effects of tobacco use is warranted.

Our study also reported that having no slits or windows in the kitchen; a proxy indicator for IAP resulted in an increased risk of adverse birth outcomes. IAP is one of the major risk factors for pneumonia-related morbidity, LBW and death in children worldwide.[49] In Pakistan, the use of wood for cooking as fuel is common (>53%) and overall biomass use including wood, crop residues and animal dung is >70%.[49] Inhalation of smoke or particulate matter during cooking could have an adverse effect on pregnant women.[35] Research from developing countries have described an association between the use of biomass fuels in open fires for cooking and LBW[50 51] preterm birth[52] and SGA.[53] Reports from surveys in India have shown an association between the use of biomass cooking fuel[54] and stillbirths and LBW,[55] findings which are consistent with our study. Therefore, in our context, awareness about IAP should be created especially among women as they are more likely to cook using biomass fuels; whereas, a general awareness campaign about IAP can be implemented through media.

In our study, we found that increasing age of the female was significantly associated with adverse pregnancy outcomes, a finding supported by several studies.[56–58] Our study also identified women having previous history of stillbirth, miscarriage and preterm deliveries to be associated with adverse birth outcomes which is consistent with previous research.[59]

We found that the cases were less likely to be booked at the hospital as compared with controls. These cases had a history of previous pregnancy complications predisposing them to higher risk of adverse pregnancy outcomes. Plausibly, non-booking of women in hospitals, especially with previous history of adverse birth outcomes, is an indicator of lack of awareness of future pregnancy complications and could be a function of scarce resources. Therefore, creating awareness among these vulnerable women and frequent antenatal visits are essential to prevent such complications.

Another important finding was that blood transfusion was significantly associated with adverse pregnancy outcomes. Anaemia, a proxy indicator for blood transfusion is usually detected at the first antenatal visit. If anaemia persists, the foetus may not receive enough oxygen, and the risk of preterm is increased. In our study, cases may be unaware of their haemoglobin status and may have been severely anaemic because of missed prenatal checkups, therefore, at the time of delivery may be in desperate need of blood transfusion which could have led to the adverse pregnancy outcomes. However, in our study, we were unable to retrieve information regarding the haemoglobin levels of the pregnant female. Gravidity showed an inverse association with adverse birth outcomes which needs to be explored further to determine if women who were previously pregnant are more likely to take better care of themselves during future pregnancies.

Strengths of our study included a robust method of recruitment to reduce misclassification of the outcome and being a multicentre study catering to patients from different ethnic and socioeconomic backgrounds, thereby indicating that our results can be generalised. Most of the information in our study was self-reported, therefore, it was prone to reporting bias.[60] However, any such bias is likely to be a non-differential misclassification, and the potential effect might be underestimation of the association because such biases tend to distort the associations towards null. So the potential effect of tobacco and other risk factors may even be more pronounced on adverse pregnancy outcomes, given that we assume that such misclassification exist in our study. Furthermore, we were not able to obtain serum cotinine levels which would have been a better measure. Although the effects of smoking and smokeless tobacco use are different on birth outcomes, we were unable to construct separate models for each exposure due to small numbers of smokers in our sample.

This study identified tobacco use as a very important risk factor for adverse birth outcomes in Pakistan. Commonly, tobacco use is either associated with respiratory disorders or oral cancers in Pakistan and is not associated with adverse birth outcomes. Our study highlights this issue and advocates for awareness among pregnant women and general population about the ill effects of tobacco use during pregnancy. Stakeholders in tobacco control including government, NGO's and health professionals should be made aware of this issue and should be engaged in order to prevent adverse outcomes in

Table 3 Univariate analysis of factors associated with adverse birth outcomes and obstetric complications among cases and controls at selected hospitals in Karachi, Pakistan

Characteristics	Controls n=963	Cases n=312	Crude OR	95% CI
Age of mother (years)				
Mean (SD)	26.0 (4.6)	25.3 (4.8)	0.96	(0.90 to 1.0)
Educational level				
No formal education	353 (36.7)	114 (36.5)	1	–
Primary and secondary	519 (53.9)	160 (51.3)	0.95	(0.73 to 1.25)
Intermediate	66 (6.9)	26 (8.3)	1.22	(0.74 to 2.01)
Graduate and post graduate	25 (2.6)	12 (3.8)	1.49	(0.72 to 3.05)
Nature of house				
Kachchaa (made by mud and wood)	21 (2.2)	14 (4.5)	1	–
Pakka (made by bricks and cement)	942 (97.8)	298 (95.5)	2.11	(1.10 to 4.21)
Mother's history of illness				
No	959 (99.6)	305 (97.8)	1	–
Yes	4 (0.4)	7 (2.2)	5.50	(1.60 to 18.92)
Family history of illness				
No	556 (57.7)	191 (61.2)	1	–
Yes	407 (42.3)	121 (38.8)	0.86	(0.72 to 1.10)
Years of marriage				
Mean (SD)	6.1 (5.5)	4.6 (4.6)	0.90	(0.91 to 1.00)
Gravidity				
Mean (SD)	3.1 (0.1)	2.4 (0.1)	0.82	(0.80 to 0.91)
History of miscarriage				
No	565 (74.0)	110 (64.0)	1	–
Yes	198 (26.0)	62 (36.0)	1.61	(1.13 to 2.31)
History of preterm delivery				
No	752 (98.6)	158 (91.9)	1	–
Yes	11 (1.4)	14 (8.1)	6.00	(2.71 to 13.60)
History of stillbirth				
No	718 (94.1)	142 (82.6)	1	–
Yes	45 (5.9)	30 (17.4)	3.34	(2.13 to 5.52)
Complication during previous pregnancy				
No	855 (88.8)	261 (83.7)	1	–
Yes	108 (11.2)	51 (16.3)	1.52	(1.10 to 2.21)
Booked in the hospital				
Yes	732 (76.0)	204 (65.4)	1	
No	231 (24.0)	108 (34.6)	1.70	(1.32 to 2.20)
Gestational age when foetal movement started (weeks)				
Mean (SE)	20.7 (0.1)	20.7 (0.1)	0.99	(0.94 to 1.11)
No. of antenatal care visits	6.5 (0.1)	6.6 (0.2)	1.02	(0.99 to 1.04)
Micturition problem during pregnancy				
No	793 (82.3)	229 (73.4)	1	
Yes	170 (17.7)	83 (26.6)	1.71	(1.33 to 2.30)
Taken folic acid tablets				
No	611 (63.4)	199 (63.8)	1	
Yes	352 (36.6)	113 (36.2)	1.02	(0.81 to 1.30)
Complication during current pregnancy				
No	765 (79.4)	192 (61.5)	1	
Yes	198 (20.6)	120 (38.5)	2.40	(1.80 to 3.22)
Blood transfusion done				
No	914 (94.9)	286 (91.7)	1	
Yes	49 (5.1)	26 (8.3)	1.70	(1.0 to 2.80)
Duration between water break and delivery of baby (hours)				
Mean (SE)	12.3 (0.7)	27.8 (4.6)	1.03	(1.02 to 1.03)
Slits/window in the kitchen				
Yes	909 (94.4)	283 (90.7)	1	
No	54 (5.6)	29 (9.3)	1.72	(1.11 to 2.76)
Tobacco use				
No	728 (75.6)	180 (57.7)	1	
Yes	235 (24.4)	132 (42.3)	2.27	(1.73 to 2.97)

Table 4 Multivariate analysis of factors associated with adverse birth outcomes and obstetric complications among cases and controls at selected hospitals in Karachi, Pakistan

Characteristics	Adjusted OR	95% CI
Tobacco use		
No	1	
Yes	2.24	(1.56 to 3.23)
Gravidity	0.83	(0.73 to 0.93)
Age of mother	1.03	(1.0 to 1.10)
Booked in hospital		
Yes	1	
No	1.87	(1.38 to 2.74)
History of preterm births		
No	1	
Yes	6.04	(2.52 to 14.48)
History of miscarriage		
No	1	
Yes	1.91	(1.27 to 2.85)
History of stillbirth		
No	1	
Yes	4.06	(2.36 to 6.97)
Slit/window in kitchen		
Yes	1	
No	1.90	(1.05 to 3.43)
Blood transfusion done		
No	1	
Yes	3.06	(1.68 to 5.57)

pregnant women. We also found previous history of birth complications and non-booking in hospital as additional important predictors which suggest gaps in awareness of mothers about tobacco use during pregnancy. Improper ventilation (no slits in the kitchen) that is used as a proxy indicator for IAP was another significant predictor for adverse birth outcomes. Preventative measures either in the form of reducing the use of biomass fuels or reducing the time spent in kitchen during pregnancy could be warranted. However, future research is required on this issue to evaluate the feasibility of these measures and also to come up with a contextually relevant intervention.

CONCLUSION

Our study underscores the importance of antenatal care and health education about the effects of tobacco use and other factors during pregnancy which may lead to adverse pregnancy outcomes. We recommend engagement of stakeholders in tobacco control for providing health education and awareness, incorporating tobacco use among women in the tobacco control policy and for designing interventions for tobacco use cessation among women. Interventions aimed at improving prenatal care and health education during the antenatal period could be immediate measures which might help in reducing the burden of tobacco use and also prevent such adverse pregnancy-related events.

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Acknowledgements The authors acknowledge all selected hospitals for their participation and support and are indebted to all pregnant women and our data collection team for their contribution.

Contributors SR contributed to analysis, interpretation, manuscript drafting and reviewing. ZAB and NZ were responsible for manuscript writing and reviewing the paper. SW helped in data cleaning, management and analysis. KS contributed to manuscript drafting and reviewing the paper. All authors saw and approved the final version of manuscript.

Funding This work was supported by a Seed Grant from the Aga Khan University. The funding agency had no role in the study design, data collection, data analysis, manuscript writing or publication.

Competing interests None declared.

Patient consent Obtained.

Ethics approval Ethical Review Committee (ERC) of Aga Khan University.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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BMJ Open 2016 6:
doi: 10.1136/bmjopen-2016-012045