

# Maternal, Foetal and Service-Related Risk Factors for Stillbirths During Conflict Situation, Yemen, 2015-2016

Ahmed Hamood Al-Shahethi (✉ [alshahethi71@yahoo.com](mailto:alshahethi71@yahoo.com))

Ministry of Public Health and Population <https://orcid.org/0000-0002-2588-7336>

Rafdzah Ahmad Zaki

Universiti Malaya

Abdullwahed Abdulgabar Al- Serouri

Sana'a Medical and Science University

Awang Bulgiba Mahmud

Universiti Malaya

---

## Research article

**Keywords:** Stillbirth, risk factors, community-based study, cohort study Sana'a, Yemen.

**Posted Date:** August 25th, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-58907/v1>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

# Abstract

**Background:** Stillbirth is a silent traumatic canker which is a major concern of various individuals, health institutions and the country as a whole. Stillbirth remains a Global major problem responsible for nearly three million deaths.

**Study objectives:** To estimate the stillbirth rate (SBR) in Sana'a, Yemen and to identify potential risk factors for stillbirth.

**Methods:** A community-based prospective cohort study was carried out between 8/2015 and 12/2016. Nine-hundred and eighty pregnant women were identified for the outcome of their pregnancy. We employed binomial regression together with generalised linear models.

**Results:** The study included 952 pregnant women with 44 stillbirths. The stillbirth rate was 46.2 per 1000 and 45.2 per 1000. In multivariable analysis teenage mothers' age at first childbirth (< 20 years) (RR 3.70), women with anemia (RR=2.23), smoking snuff (RR = 4.27), prolonged labour (> 24 hours) (RR = 2.02), prolonged rupture of membranes ( $\geq$  24 hours) (RR = 2.22), foetal malposition (RR = 4.60), low birth weight (RR = 14.90) and foetal gestational age (weeks) (RR = 5.60) were significant factors associated with increased risk of stillbirths.

**Conclusions:** This study identified many risk factors of stillbirth that are amenable to intervention. Encouraging women to deliver at health facilities, providing better management of obstetrical complications, proper antenatal care, and prompt referral services are essential for reduction of stillbirths in Yemen.

## Introduction

Stillbirths represent a devastating pregnancy outcome and has a high burden for women, families, communities, and health system. The estimated average global stillbirth (SB) rate in 2015 was 18.4 per 1000 births with an estimated 2.6 million babies were stillborn at 28 weeks or more in 2015 [1]. Everyday more than 7,300 babies are stillborn which place stillbirth as fifth on the list of causes of death worldwide [2].

About 98% of stillbirths occur in low and middle-income countries (LMIC), where the birth registration coverage was low [1]. The SB rate in the LMIC (which includes Yemen) was 32/1000 births compared to < 5/1000 births in the High Income Countries (HIC) [3]. Stillbirth is closely related to maternal and neonatal mortality and with the care received during pregnancy and delivery [4]. Previous study shows an increase of 17% in stillbirth during the prior four years in Yemen [5]. Recent report by the United Nations Population Fund (NFP) revealed that about 14.8 million people lack access to basic health services [6].

Four years into conflict, an estimated two million pregnant and lactating women will be at risk of death if famine strikes. Some 1.1 million are already acutely malnourished, heightening the chance of miscarriage

and stillbirth [7].

Yemen's health indicators are among the lowest in the region and reproductive health situation is one of the least favourable in the Arab world. One hundred forty eight women per 100,000 live births die as a result of complications of pregnancy and childbirth, making maternal death the leading cause of death among women of reproductive age in Yemen [8]. with a lifetime risk of death of 1 in 60 compared with a ratio of 12 and lifetime risk of 1 in 4900 in the developed countries [9] and under-five mortality rate was 42 deaths per 1000 live births compared with a rate of 6 in the developed countries [10]. Neonatal mortality currently represents nearly half of the infant mortality with 26 neonatal deaths per 1000 live births and among all under-five deaths in 2013 in Yemen, 48 percent occurred during the neonatal period [8].

Yemen rank 158 out of 193 countries and one of the first Arabic countries with a highest stillbirth rate. of 23/1000 live birth [11]. Furthermore, only 45% of all deliveries are attended by skilled personnel [8].

In Yemen, 30% of births take place at a health facility with just 45% of deliveries attended by skilled birth attendants. In order to plan effective interventions, it is crucial to estimate the rate and determine the risk factors linked with stillbirth via a community-based prospective study. Previous estimation of SBR in Yemen were either from retrospective hospital-based study by non-governmental organization (NGO) household surveys; which have limitation with selection and recall bias. In addition, risk factors for stillbirths in Yemen were poorly recorded and not well understood. Therefore, the aim of this prospective follow up community-based study was to estimate the stillbirth rate and identify the potential risk of stillbirth in Yemen's communities.

## Methods

### Study design and study population

This is a prospective community-based cohort study, which was conducted in Sana'a City, the capital of Yemen from 1 August 2015 to 31 December 2016. It was conducted among pregnant women of age 15 years to 49, residing in the five districts of the Sana'a City Governorate, Yemen. Sana'a City [12]. All pregnant women were followed up to seven days post-delivery or 7 days following termination of their pregnancies (spontaneous or induced abortion). Sana'a City governorate has an estimated population of 2.35 million, with approximately 521,862 being in the reproductive age group, according to an annual statistic health 2014 reported by ministry of public health and population (MoPHP) of Yemen [13]. In Sana'a city there are 234,020 households with 1,619 Enumeration Areas (EAs) [12]. Five districts were chosen by simple random sampling account for 863 EAs which cover 53% of the selected households of total. Within the 5 districts the sample was selected in two stages. In the first stage, 49 EAs were selected from the 863 EAs within the 5 districts using probability proportional to size (PPS) method (Fig. 2). In second stage, twenty households were picked from each EA (cluster) by systematic probability sampling (SPS) [14] from a list of houses provided by the Sana'a city authority [15]. Finally, one respondent fitting

eligible criteria was selected from each household. Only women with singleton fetuses were included in the study.

Ethical approval was obtained from the institutional review board in the Ministry of Public Health and Population, Yemen. A consent form was signed by all participants before conducting interviews.

### **Data collection**

Data were collected by a trained midwife. Total of thirteen midwives were trained in local cultures, languages, privacy belief confidentiality and instructed in how to build relationships. In addition, they were trained in how to use the questionnaires and conduct interview. The questionnaire sought information concerning socio-demographic characteristics (age, residence, education, parity, etc.), along with past awareness of stillbirths, both prenatal and antenatal care, traditional practices, current birth methods, breastfeeding and condition of newborns soon after birth. Information's were gathered through face-to-face interview using a semi-structured form. Baseline information were collected at recruitment stage and follow up information were collected at monthly interval up to seven days post-delivery or 7 days following termination of their pregnancies (spontaneous or induced abortion). Information at baseline and after delivery were collected by face to face interview. All women were contacted by telephone during monthly follow up by the interviewers with the supervision of the principal investigators. Women were contacted within three to four days of the scheduled day and at least 5 attempts, at different times of the day and early evening, before they were considered to be lost-to follow-up from the study. The completed questionnaires were checked on daily basis by the investigator before left the study field and any inconsistencies and inaccuracies were corrected.

This study aimed to estimate stillbirth rate and look into the factors linked to stillbirth during conflict situation. Stillbirth was defined as: pregnancy loss taking place following 7 completed months of gestation (stillbirth); and calculated the stillbirth rate as (this is the number of babies born with no indication of life after 28 weeks or 7 months' gestation per 1000 pregnancies).

### **Data management and analysis**

Raw data were entered into SPSS Software (SPSS Inc., Chicago.II. USA, version 23.0) for data management. The data were checked prior to being analysed and cleaned; described using frequencies and percentages tables along with identifying outliers. Only subjects with complete information on variables included in the final analysis. The quantitative variables were handled in the analysis by grouped (e.g. age was grouped into less than 18 years, between 18 and 34 years and 35 years and more).

Cleaned data were then transferred into Stata 12 (Stata-Corp, Texas 77845 USA) in order to estimate adjusted Relative Risk (RR) and 95% confidence intervals (CIs) of the independent variables on stillbirth. Adjusted RR was estimate using multivariable generalised linear models (GLMs) regression analysis with a log link and binomial distribution.

All variables were initially included in the analyses. However, only variables associated with stillbirth giving a P-value < 0.25 were retained in the model, and as well as the step-wise backward elimination method was performed to build the final multi-variable model [16]. Two-sided test with level of significant at alpha = 0.05 was used.

## Results

### Outcome pregnancy:

A total of 980 pregnant women were identified in the 49 clusters. Nine hundred and fifty-two (952) pregnant women were included in the final analysis (Figure 1). This study included a total of 44 stillbirth (SBR = 46.2 per 1000 births, 95% CI: 32.7–59.3) and the remaining nine hundred eight (908) mothers with live single birth completed the 7 days follow-up (Table 1).

**Table 1** Outcome of pregnancy in a cohort of 952 births, Sana'a City, Yemen, 8/2015–12/2016.

Pregnancy outcomes	Total number	Mortality rate	(95% confidence interval)
Total singletons births 952	952		
Total live singletons birth	908		
Still births	44/908	46.2 per 1000 birth	(32.7–59.3)

### Characteristics of mothers

More than three quarters (85.3%) of the births in the sample were women aged 18–34. The mean age of women at recruitment was 26.0 years (SD 5.7). Stillbirths were more likely to be born to mothers aged less than 18 year and 35 years and older. Only 3.3% of the births were to women less than 18 years. The proportion of mothers aged less than 18 years at first marriage was 36.1% while 27.8% was mothers aged less than 18 years at first pregnancy. Most mothers came from slum areas (59.3%), and the proportion of illiteracy was 18.3%. Only 26.3% of the women were nulliparous. Around 9% of multiparous mothers had previously experienced a stillbirth. A total of 642 women (72%) went for antenatal care (ANC) prior to birth. ANC attendance differed according to parity and 33.2% of nulliparous mothers completed in excess of four ANC visits. This compared to 66.8% among multiparous mothers. Among births whose mothers received ANC, nearly half (48.2%) received the initial visit during the first trimester of pregnancy, whereas 31.6% waited until the third trimester of pregnancy to seek care. In spite of high attendance at antenatal clinics, 41.3% (393) of births were delivered at home where 21% (200) of births were assisted by untrained health personnel. Nine percent of women were cigarettes smokers, while 20.2% were water pipe tobacco smokers. Around half of the women (50.0%) were khat chewers, and 3% of the women had a history of female genital mutilation. Detail of other characteristics are shown in Table 2.

**Table 2** distribution of factors analysed with experiencing stillbirth among 952 pregnant women in Sana'a City, Yemen, 8/2015–12/016.

Variables/factors	Total births (n = 952)		Stillbirths (n=44)	
	n	%	n	%
<b>A.Socio-demographic factors</b>				
<b>Maternal age at birth (years)</b>	26.0± 5.70		28.0 ± 8.14	
< 18	31/952	3.3	4/31	12.9
18 - 34	812/952	85.3	26/812	3.2
35 or more	109/952	11.4	14/109	12.8
<b>Mother's age at first marriage (years)</b>	19.0± 3.75		19.0 ± 4.31	
< 18	344/952	36.1	22/344	6.4
18 - 34	605/952	63.6	22/605	3.6
35 or more	3/952	0.3	0	0.0
<b>Mother's age at first pregnancy (years)</b>	20.0 ± 3.87		20.0 ± 4.71	
< 18	265/952	27.8	17/265	6.4
18 - 34	681/952	71.5	26/681	3.8
35 or more	6/952	0.6	1/6	16.7
<b>Place of residence (district)</b>				
Urban	387/952	40.7	18/387	5.7
Slum	565/952	59.3	26/565	4.6
<b>Mother's level of education</b>				
Illiteracy	174/952	18.3	9/174	5.2
Primary/Intermediate	382/952	40.1	15/382	3.9
Secondary	283/952	(29.7)	14/283	4.9
University and above	113/952	11.9	6/113	5.3
<b>Mother's work</b>				
Yes	69/952	7.2	4/69	5.8
No	883/952	92.8	40/883	4.5
<b>Monthly income <sup>a</sup>(YR)</b>				
Most poor (<35000)	243/952	25.5	7/243	2.9
Middle poor (35000-74000)	549/952	57.7	27/549	4.9

Least poor (= $\geq$ 75000)	160/952	16.8	10/160	6.3
<b>Number of Family Member</b>				
2-4	372/952	39.1	12/272	3.2
5-7	297/952	31.2	16/297	5.4
8 or more	283/952	29.7	16/283	5.7

**Table 2** distribution of factors analysed with experiencing stillbirth among 952 pregnant women in Sana'a City, Yemen, 8/2015–12/016 **(Continued)**

<b>Family type</b>				
Multi-nuclear	427/952	44.9	24/427	5.6
Nuclear	525/952	55.1	20/525	3.8
<b>B. Prenatal and past obstetric factors</b>				
<b>Gravidity</b>				
Primigravida	222/952	23.3	16/222	7.2
Multigravida	730/952	76.7	28/730	3.8
<b>Parity</b>				
Primipara 0	250/952	26.3	17/250	6.8
1	231/952	24.3	3/231	1.3
2 - 4	387/952	40.7	16/387	4.1
≥ 5	84/952	8.8	8/84	9.5
<b>History of stillbirths</b>				
Yes	104/952	14.2	7/104	6.7
No	626/952	85.8	21/626	3.4
<b>Female genital mutilation</b>				
Yes	24 (2.5)		3/24	12.5
No	928 (97.5)		41/928	4.4
<b>Spacing (n=730, primigravidae excluded)<sup>1</sup></b>				
< 24 months	317 /730	43.4	8/317	2.5
24 to 60 months	283/730	38.8	10/283	3.5
> 60 months	130/730	17.8	10/130	7.7
<b>Number of antenatal visits</b>				
	3.3 ± 0.71		3.6 ± 2.17	
Not visit	32/952	3.4	0/32	0
≤4	682/952	71.6	34/682	5.0
≥5	238/ 952	25.0	10/238	4.2
<b>Time of 1st ANC visit <sup>2</sup> (n=917)</b>				
First trimester	442/917	48.2	16/422	3.6
Second trimester	185/917	20.2	10/185	5.4

Third trimester	290/917	31.6	18/290	6.2
-----------------	---------	------	--------	-----

**Table 2** distribution of factors analysed with experiencing stillbirth among 952 pregnant women in Sana'a City, Yemen, 8/2015–12/016 **(Continued)**

<b>Maternal <sup>b</sup>TT vaccine (at least 1 dose)</b>				
Received	747/952	78.5	27/747	3.6
Not Received	205/952	21.5	17/205	8.3
<b>Maternal Anaemia (g/dl) <sup>3</sup>(n=951)</b>				
< 12.3 g/dl	282/951	29.7	19/282	6.7
≥ 12.3 g/dl	669/951	70.0	25/669	3.7
<b>Maternal arm circumference<sup>4</sup>(MUAC, cm)</b>				
< 21 CM <sup>b</sup>	15/951	1.6	0	0.0
21 - 22.9 CM <sup>c</sup>	41/951	4.3	1/41	2.4
23 or more CM <sup>d</sup>	895/951	94.1	43/895	4.8
<b>C. Special habits factors</b>				
<b>Cigarette smoking</b>				
Smoker	81/952	8.5	4/81	4.9
Not smoker	871/952	91.5	40/871	4.6
<b>Water pipe smoker (Shisha)</b>				
Yes	192/952	20.2	8/192	4.2
No	760/952	79.8	36/760	4.7
<b>Orange snuff (smokeless tobacco) Smoker</b>				
Yes	16/952	1.7	3/16	18.8
No	936/952	98.3	41/936	4.4
<b>Khat chewer during this pregnancy</b>				
Yes	476/952	50.0	25/476	5.3
No	476/952	50.0	19/476	4.0
<b>D. Birth factors</b>				
<b>Place of birth</b>				
Home birth	393/952	41.3	13/393	3.3
Health facility birth	559/952	58.7	31/559	5.5

**Table 2** distribution of factors analysed with experiencing stillbirth among 952 pregnant women in Sana'a City, Yemen, 8/2015–12/016 **(Continued)**

<b>Birth attendants</b>				
Trained personnel	752/952	79.0	35/752	4.7
Untrained personnel	200/952	21.0	9/200	4.5
<b>Vaginal bleeding at third trimester</b>				
Yes	105/952	11.0	10/105	9.5
No	847/952	89.0	34/847	4.0
<b>Prolonged Labour <sup>5</sup> (n=906)</b>				
Yes	327/906	36.1	22/327	6.7
No	579/906	63.9	16/579	2.8
<b>Baby's position <sup>6</sup>(n=789)</b>				
Normal position	760/789	96.3	26/760	3.4
Malposition	29/789	3.7	7/29	24.1
<b>E. Foetal factors</b>				
<b>Birth weight (g) <sup>7</sup> (n=947)</b>				
Low birth weight (< 2500 g)	169/947	17.8	31/169	18.3
Normal birth weight (≥ 2500 g)	778/947	82.2	8/778	1.0
<b>Sex of newborn</b>				
Male	517/952	54.3	30/517	5.8
Female	435/952	45.7	14/455	3.2
<b>Gestation age (weeks)</b>				
Preterm (< 37 weeks)	101/952	10.6	20/101	19.8
Term (≥ 37 weeks)	851/952	89.4	24/851	2.8
<p><sup>1</sup> Primigravidae excluded (n=222), <sup>2</sup> There were 32 cases never on antenatal care visits,</p> <p><sup>3,4</sup> One mother was not Hb tested and one mother did have MUAC recorded, <sup>5</sup> In 46 cases it was unknown whether there was prolonged labour, <sup>6</sup> 160 births not counted (caesarean section) and 3 cases were unknown,</p> <p><sup>7</sup> For 5 cases birth weight was not recorded.</p> <p><sup>a</sup>(YR)- Yemeni Riyal (1 USD\$ = 250 YR), <sup>b</sup>TT-Tetanus Toxoid, <sup>b</sup> Severe acute malnutrition, <sup>c</sup>Moderate acute malnutrition, <sup>d</sup>Normal</p>				

## Distribution of stillbirths

There were a total of 44 stillbirths that occurred in 27 out of 49 clusters. The highest observed risk in a cluster was 166.7 per 1000 births within Al-Tahreer district was 66.7 per 1000 births (Table 3). Twelve clusters seem to have the highest stillbirth's rate and represent 66 % of the total stillbirths. Seven clusters are slum areas and form around one third (32%) of the total stillbirths. There was no remarkable differences in proportion of stillbirths between urban (4.7%) and slum areas (4.6%).

**Table 3** Outcome of pregnancy in a cohort of 952 births, Sana'a City, Yemen, 8/2015–12/2016.

No.	District	No. of clusters	Number of births/expected total birth (%)	SBR N(/1000)
1	Al-Safyah	6	118/120 (93.3)	6/118 (50.8)
2	Al-Thawrah	10	194/200 (97.0)	7/194 (36.1)
3	Shu'ub	13	253/260 (97.3)	6/253 (23.7)
4	Al-Tahreer	4	75/80 (93.8)	5/75 (66.7)
5	Ma'ain	16	312/320 (97.5)	20/312 (64.1)
Total		49	952/980 (97.1)	44/952 (46.2 per 1000 births)

## Socio-demographic factors (Table 4A)

There is a highly significant association between stillbirth and mother age at birth. With regards to age at birth, teenage mothers (aged < 18) and older women (aged 35 and above) were observed to have higher stillbirths (RR 4.03; 95% CI: 1.15–10.81) and (RR 4.01; 95% CI: 2.16–7.44), respectively. Residence slums areas of Sana'a City ( $p= 0.972$ ), family type ( $p=0.188$ ) did not appear to be associated with.

**Table 4A** Risk factors for stillbirths (SB) in bivariate analysis in a cohort of 952 births, Sana'a City, Yemen, 8/2015–12/2016.

Variable/Factor	<sup>a</sup> SB/total (%)	Stillbirth rate per 1000	Unadjusted <sup>b</sup> RR	(95% CI) <sup>c</sup>	P-value
<b>A. Socio-demographic</b>					
<b>Maternal age at birth (Years) (n=952)</b>					
< 18	4/31 (12.9)	129.0	<b>4.03</b>	<b>1.51-10.84</b>	<b>0.006</b>
18 - 34	26/812 (3.2)	32.0		1.00	
≥ 35	14/109 (12.8)	128.4	<b>4.01</b>	<b>2.16-7.44</b>	<b>&lt;0.001</b>
<b>Place of residence (district) (n=952)</b>					
Slum	26/565 (4.6)	46.0	0.99	0.55-1.78	0.972
Urban	18/387 (4.7)	46.5		1.00	
<b>Mother's education (n=952)</b>					
Illiteracy	9/174 (5.2)	51.7	0.97	0.36-2.66	0.959
Primary/Intermediate	15/382 (3.9)	39.3	0.74	0.29-1.86	0.522
Secondary	14/283 (4.9)	49.5	0.93	0.37-2.36	0.882
University and above	6/113 (5.3)	53.1		1.00	
<b>Mother's work (n=952)</b>					
Yes	4/69 (5.8)	58	1.28	0.47-3.47	0.628
No	40/883 (4.5)	45.3		1.00	
<b>No. of Family member (n=952)</b>					
2-4	12/272 (3.2)	32.3		1.00	
5-7	16/297 (5.4)	53.9	1.67	0.80-3.48	0.170

Variable/Factor	<sup>a</sup> SB/total (%)	Stillbirth rate per 1000	Unadjusted <sup>b</sup> RR	(95% CI) <sup>c</sup>	P-value
<b>A. Socio-demographic</b>					
≥ 8	16/283 (5.7)	56.5	1.75	0.84-3.65	0.133
<b>Family type (n=952)</b>					
Multi-nuclear	24/427 (5.6)	56.2	1.48	0.83-2.63	0.188
Nuclear	20/525 (3.8)	38.1	1.00		
<sup>a</sup> SB-Stillbirth, <sup>b</sup> RR- Relative risk, <sup>c</sup> CI- Confidence interval					

#### Prenatal and past obstetric factors (Table 4B)

Mothers with Multigravida increased the risk of stillbirths (RR 1.88; 95% CI: 1.04-3.41) compared to primigravida. The result also indicates that mothers with higher parities (five and above) were 2.30 times more likely to experience a stillbirth (95% CI: 1.02–5.21).

Further, inter-pregnancy interval more than 60 months led to an increase in the risk of stillbirth by 3.05 times (95% CI: 1.23-7.55) whereas mothers who received tetanus toxoid vaccine had decreased risk of stillbirths by 56% relative to the mothers who had not received tetanus toxoid vaccine (RR 0.44; 95% CI: 0.24-0.78). Furthermore, women with a low Hb (< 12.3 g/dl) had a significantly increased risk of stillbirth (RR 1.80; 95% CI: 1.01-3.21) in the univariate analysis compared to the women with normal haemoglobin. Female genital mutilation (RR 2.82; 95% CI: 0.94-8.47, p =0.065) did not appear to be significant factor for stillbirths.

**Table 4B** Risk factors for stillbirths (SB) in bivariate analysis in a cohort of 952 births, Sana'a City, Yemen, 8/2015–12/2016

Variable/Factor	<sup>a</sup> SB/total (%)	Stillbirth rate per 1000	Unadjusted <sup>b</sup> RR	(95% CI) <sup>c</sup>	P-value
<b>B. Prenatal and past obstetric</b>					
<b>Gravidity (n=952)</b>					
Primigravida	16/222 (7.2)	72.1	<b>1.88</b>	<b>1.04-3.41</b>	<b>0.038</b>
Multigravida	28/730 (3.8)	38.4		1.00	
<b>Parity (n=952)</b>					
Primipara 0	17/250 (6.8)	68	1.64	0.84-3.19	0.142
1	3/231 (1.3)	13	0.31	0.09-1.07	0.063
2 - 4	16/387 (4.1)	41.3		1.00	
≥ 5	8/84 (9.5)	95.2	<b>2.30</b>	<b>1.02-5.21</b>	<b>0.045</b>
<b>Female genital mutilation (n=952)</b>					
Yes	3/24 (12.5)	125	2.82	0.94-8.47	0.065
No	41/928 (4.4)	44.2		1.00	

Table 4B (Continued)

<b>Inter-pregnancy interval<sup>1</sup> (n=730)</b>						
< 24 months	8/302 (2.6)	26.5		1.00		
24 to 60 months	10/298 (3.4)	33.6	1.27	0.51-3.17	0.613	
> 60 months	10/130 (7.7)	76.9	<b>2.90</b>	<b>1.17-7.19</b>	<b>0.021</b>	
<b>Maternal <sup>c</sup>TT vaccine (n=952)</b>						
Received	27/747 (3.6)	36.1	<b>0.44</b>	<b>0.24-0.78</b>	<b>0.006*</b>	
Not Received	17/205 (8.3)	82.9		1.00		
<b>Maternal anaemia (n=951)<sup>2</sup></b>						
Hb < 12.3 g/dl	19/282 (6.7)	67.4	<b>1.80</b>	<b>1.01-3.21</b>	<b>0.046</b>	
Hb ≥ 12.3 g/dl	25/669 (3.7)	37.4		1.00		
<sup>a</sup> SB-Stillbirth, <sup>b</sup> RR- Relative risk, <sup>c</sup> CI- Confidence interval, *Protective effect, <sup>c</sup> TT-Tetanus Toxoid, <sup>1</sup> Excludes primipara (222 cases), <sup>2</sup> One mother was not Hb tested.						

### Special habits factors (Table 4C)

The unadjusted analysis showed that mothers who used orange snuff (smokeless tobacco) had a significantly increased risk of stillbirth (RR 4.28; 95% CI: 1.48-12.39), whereas Khat chewers RR 1.32; 95% CI: 0.73-2.36, p =0.356) did not appear to be significant factor for stillbirths.

**Table 4C** Risk factors for stillbirths (SB) in bivariate analysis in a cohort of 952 births,

Sana'a City, Yemen, 8/2015–12/2016

Variable/Factor	<sup>a</sup> SB/total (%)	Stillbirth rate per 1000	Unadjusted <sup>b</sup> RR	(95% CI) <sup>c</sup>	P-value
<b>C. Special habits</b>					
<b>Orange snuff (smokeless tobacco) smoker (n=952)</b>					
Yes	3/16 (18.8)	187.5	<b>4.28</b>	<b>1.48-12.39</b>	<b>0.007</b>
No	41/936 (4.4)	43.8		1.00	
<b>Khat chewer (n=952)</b>					
Yes	25/476 (5.3)	52.5	1.32	0.73-2.36	0.356
No	476 (4.0)	39.9		1.00	
<sup>a</sup> SB-Stillbirth, <sup>b</sup> RR- Relative risk, <sup>c</sup> CI- Confidence interval					

#### Birth factors (Table 4D)

The result indicates the three reasons for home birth where unavailability of birth services placed births at the greatest risk, at nearly nine times the risk of stillbirth as compared to births to women without this reason (RR 9.23; 95% CI: 1.69-50.44). This association was statistically significant.

One of the birth attendant categories showed significant protective effect of stillbirth. These was the birth attendant by the midwife (RR 0.21; 95% CI: 0.06-0.66).

Prolonged labour (> 24 hours) (RR 2.43, 95% CI: 1.30-4.57), Births to women experiencing longer duration of water breaks ( $\geq$  24 hours) before births (RR 4.41, 95% CI: 2.23-8.74), Baby's abnormal presentation (RR 8.18, 95% CI: 4.35-15.40) were statistically associated with stillbirths.

**Table 4D** Risk factors for stillbirths (SB) in bivariate analysis in a cohort of 952 births, Sana'a City, Yemen, 8/2015–12/2016

Variables/factors	<sup>a</sup> SB/total (%)	Stillbirth rate per 1000	Unadjusted <sup>b</sup> RR	(95% CI) <sup>c</sup>	P-value
<b>D. Birth factors</b>					
<b>Place of birth (n=952)</b>					
Home birth	13/393 (3.3)	33.1	0.60	0.32-1.13	0.111
Health facility birth	31/559 (5.5)	55.5		1.00	
<b>Reason for home birth <sup>1</sup> (n=388)</b>					
Service not available	2/13 (15.4)	153.8	<b>9.23</b>	<b>1.69-50.44)</b>	<b>0.010</b>
Service too far	0/17 (0.0)	0.0		0	
High cost	5/153 (3.3)	32.7	1.96	0.48-8.07	0.351
Premature/sudden birth	2/25 (8.0)	80	4.80	0.84-27.34	0.077
Home is better	2/180 (1.1)	11.1		1.00	
<b>Birth attendants (n=952)</b>					
Female/male doctor	31/500 (6.2)	62		1.00	
Midwife	3/236 (1.3)	12.7	<b>0.21</b>	<b>0.06-0.66</b>	<b>0.008*</b>
Nurse	1/16 (6.3)	62.5	1.00	0.15-6.93	0.994
Traditional birth attendant (TBA)	4/95 (4.2)	42.1	0.68	0.25-1.88	0.456
Relatives	5/105 (4.8)	47.6	0.77	0.31-1.93	0.574

Table 4D (Continued)

<b>Prolonged labour (n=906)<sup>2</sup></b>					
Yes	22/327 (6.7)	67.3	<b>2.43</b>	<b>1.30-4.57</b>	<b>0.006</b>
No	16/579 (2.8)	27.6		1.00	
<b>Prolonged rupture of membranes (<math>\geq</math> 2 hours) (n=754)<sup>3</sup></b>					
Yes	13/106 (12.3)	122.6	<b>4.41</b>	<b>2.23-8.74</b>	<b>&lt;0.001</b>
No	18/648 (2.8)	27.8		1.00	
<b>Baby's position (n=789)<sup>4</sup></b>					
Normal presentation	26/760 (3.4)	34.2		1.00	
Abnormal presentation	9/29 (31.0)	310.0	<b>8.18</b>	<b>4.35-15.40</b>	<b>&lt;0.001</b>
<sup>a</sup> SB-Stillbirth, <sup>b</sup> RR- Relative risk, <sup>c</sup> CI- Confidence interval, *Protective effect, <sup>1</sup> Only mothers who those at home birth, <sup>2</sup> For 46 of mothers the prolonged labour was unknown, <sup>3</sup> There were 198 cases of unknown prolonged rupture of membranes, <sup>4</sup> Excluding 160 cases with caesarean and 3 cases with unknown baby presentation.					

### Foetal factors (Table 4E)

The risk of stillbirth was 17.84 (95% CI: 8.35-38.11) times greater among 'low birth weight' births compared to the normal birth weight babies. In addition, babies with gestational age < 37 weeks at the time of birth experienced significantly higher stillbirths (RR 6.31; 95% CI: 3.61-11.05) as compared to term births.

**Table 4E** Risk factors for stillbirths (SB) in bivariate analysis in a cohort of 952 births, Sana'a City, Yemen, 8/2015–12/2016

Variables/factors	<sup>a</sup> SB/total (%)	Stillbirth rate per 1000	Unadjusted <sup>b</sup> RR	(95% CI) <sup>c</sup>	P-value
<b>E. Foetal factors</b>					
<b>Birth weight (g) (n=947)<sup>1</sup></b>					
Low birth weight (< 2500 g)	31/169 (18.3)	183.4	<b>17.84</b>	<b>8.35-38.11</b>	<b>&lt;0.001</b>
Normal birth weight (≥ 2500 g)	8/778 (1.0)	10.3		1.00	
<b>Sex of newborn</b>					
Male	30/517 (5.8)	58	1.80	0.97-3.36	0.063
Female	14/435 (3.2)	32.2		1.00	
<b>Foetal gestational age (weeks) (n=952)</b>					
Preterm (< 37 weeks)	20/100 (18.0)	180.2	<b>6.31</b>	<b>3.61-11.05</b>	<b>&lt;0.001</b>
Term (≥ 37 weeks)	24/847 (2.9)	28.5		1.00	
<sup>a</sup> SB-Stillbirth, <sup>b</sup> RR- Relative risk, <sup>c</sup> CI- Confidence interval, <sup>1</sup> Excludes 5 cases was not obtained birth weight					

### Population attributable risk percentage (PAR%)

Table 5 shows population attributable risk percentage (PAR%) for stillbirths where among the stillbirth factors, the low birth weight (< 2500 g), Orange snuff smoker resulted in the greatest PAR (76.9 , 66.2 percent), respectively, followed by maternal anemia (Hb g/dl) (41.8 percent) , and elimination their help to eliminate the proportion of stillbirths.

**Table 5** Population attributable risk percentage for stillbirths

Variables /Factors	B <sup>a</sup>	Unadjusted RR <sup>b</sup>	Adjusted RR <sup>b</sup>	Prevalence (%)	PAR% <sup>d</sup>
Mother's age at birth (years)					
< 20 y vs. 20 y+	1.309	3.88	3.7	8.2	18.1
Maternal anemia (Hb g/dl)					
< 12.3 g/dl vs. ≥ 12.3 g/dl	0.801	1.64	2.23	58.5	41.8
Orange snuff smoker					
Yes vs. No	1.451	4.28	4.27	0.6	66.2
Newborn birth weight (g)					
LBW vs. Normal birth weight	2.702	17.84	14.9	23.9	76.9
B <sup>a</sup> - Coefficient for adjusted RR, RR <sup>b</sup> - Relative Risk, PAR <sup>d</sup> - Population Attributable Risk percentage, LBW-Low birth weight					

### Multivariable analysis: predictors of stillbirths

In the multivariate analysis, the risk of perinatal death was adjusted for socio-demographics factors, prenatal and past obstetric factors, special habits factors, birth factors and foetal factors. Backward elimination of the variables one by one was done to obtain the final model (Table 6). In this model, the variables that are observed to significantly influence perinatal deaths are mother's age at birth, maternal anaemia, prolonged labour, baby's position, newborn birth weight and foetal gestational age.

**Table 6** Risk factors for stillbirth in multivariable analysis in a cohort of 952 births, Sana'a City, Yemen, 8/2015–12/2016.

Variable /Factor	Unadjusted RR <sup>b</sup>	Adjusted RR <sup>b</sup>	( 95% CI <sup>c</sup> )	Adjusted P-value
<b>Mother's age at birth(years)</b>				
< 20 vs. 20-34	3.88	3.70	1.76-7.76	<0.001
<b>Maternal anaemia (Hb g/dl)</b>				
< 12.3 g/dl vs. ≥ 12.3 g/dl	1.64	2.23	1.67-2.98	< 0.001
<b>Orange Snuff (smokeless tobacco)</b>				
Yes vs. No	4.28	4.27	1.17-15.55	0.028
<b>Prolonged Labour (&gt; 24 hours)</b>				
Yes vs. No	2.43	2.02	1.38-2.96	<0.001
<b>Prolonged rupture of membranes (≥ 24 hours)</b>				
≥ 24 hours vs. < 24 hours	4.42	2.22	1.66-2.98	<0.001
<b>Baby's position</b>				
Malposition vs. Normal position	9.07	4.60	2.97-7.12	<0.001
<b>Newborn birth weight (g)</b>				
*LBW vs. Normal birth weight	17.84	14.90	4.30-51.75	<0.001
<b>Foetal gestational age (weeks)</b>				
Preterm vs. Term	7.02	5.60	2.52-12.41	<0.001
RR <sup>b</sup> - Relative Risk , 95% CI <sup>c</sup> – Confidence interval, *LBW-low birth weight Deviance= 0.1393951, Pearson = 1.789529 , BIC = -4107.343				

## Discussion

The stillbirth rate (SBR) of 46.2 per 100 births (95% CI:32.7–59.3) found in our study is higher than the data reported by hospital - based study in 2005 [5] and the data collected from a sub-national household survey conducted in six rural districts of four Yemeni provinces in 2008–2009 [17]. It is also higher than SBR in other EMR countries such as Kuwait [18], Palestine [19] and Pakistan [20]. Our study was a community-based study within households in Yemen, and the burden of stillbirths can be expected to be much higher at home than the hospital setting. In Yemen, the majority of deliveries (70%) occur at home. However, the majority of stillbirths in the study occurred in health facilities compared to home birth (5.5% vs. 3.3%). The hypothetical explanation to this is that, pregnant women probably sought medical care

only when complications arose during labour and after a protracted period [21]. Hence, coupled with the unavailability of specialized perinatal care units in many hospitals in Yemen, by the time these women arrived at the hospital much damage could have been done and rarely would the child be safe from stillbirths. In addition, the possibility that mothers might be harmed at facilities, due for example to poor infection control or other human errors, cannot be ruled out [22]. This may explain why the level of stillbirth in this study is different between home and hospital deliveries. In addition, Essential public services, including healthcare crucial to support mothers and childbirth, are on the brink of total collapse. Only 51 per cent of all health facilities are fully functional due to ongoing war and even these face severe shortages in medicines, equipment, and staff. Since the mothers and babies are amongst the most highly vulnerable in Yemen. Every two hours, one mother and six newborns die because of complications during pregnancy or birth [23].

Previous study conducted in Yemen reported that women who suffered complication during home birth and were taken to the hospital were at a high risk of death, and that 44% of home births developed delivery complications [5]. In addition, there is inadequate number and poor quality of health facilities and services due to the limited financial resources needed for improving the health sector. This is exacerbated by the high population growth rate of 4.4%, and very low health awareness at the community level, especially with respect to maternal and infant health care [8]. These structural challenges, as well as the war, security problems and the food crisis in Yemen may raise concern on the effectiveness and deliverability of antenatal and childbirth services in Sana'a city, hence, play a role in the high rate of stillbirth. This emphasises the need to minimize delays in referral and transportation of mothers in labour as well as putting appropriate measures in place to ensure efficient intrapartum management of high-risk cases.

In multivariable analysis the risk factor for stillbirths were young maternal age, anaemia, smoking orange snuff, prolonged labour, prolonged rupture of membranes, mal-position of baby at delivery, newborn birth weight and foetal gestational age.

In present study, babies born to women younger than 20 years had a significantly increased risk of stillbirth (aRR 3.70, 95% CI: 1.76–7.76) compared to those 20–34 years old. Similar findings have been reported in a study from Nigeria that examined pattern and correlates of stillbirth in a hospital setting where young maternal age (< 20 years) was reported to increase the risk of stillbirth (OR 2.50; 95% CI 1.22–5.14) but this was not corrected for other risk factors [24]. There was also a higher proportion of stillbirths reported among teenage mothers when compared with older mothers (5.1% versus 0.9%, respectively) in a hospital setting in India [25]. Also, in a national survey involving 8481 deliveries in China, mothers 40 years or older (OR 2.98; 95% CI 2.67–3.32) and teenage mothers (OR 2.57; 95% CI 2.29–2.89) were both reported to have an increased risk of stillbirth [26].

Thirty percent of the mothers had haemoglobin < 12.3 g/dl at the time of current birth. Women with a low haemoglobin Hb (< 12.3 g/dl) had a significantly increased risk of stillbirth (RR 1.80; 95% CI: 1.01–3.21) in the univariate analysis compared to the women with normal haemoglobin. This association remained

significant in the multivariable analysis (aRR 2.23; 95%CI: 1.67–2.98). Our finding of higher stillbirth rate among anemic women support the findings of previous studies that reported that anemic mothers and those with poor antenatal care had 8 times higher risk to have stillbirth compared to non-anemic mother and those with adequate antenatal care [27–30].

Such a great proportion of anaemia may be explained as follows: teenage pregnant women rarely receive an education so there is a high possibility they come from a poor and under-privileged family. Therefore, it is unlikely they will realise just how crucial it is to have regular antenatal care, blood tests for anaemia. In addition, taking iron and folic acid supplements during pregnancy prevents and treats anaemia.

The use of non-cigarette forms of tobacco is prevalent or gaining in popularity in many parts of the world, including many low- and middle-income countries (LMICs) [31, 32]. Non-cigarette tobacco products are often less expensive than manufactured cigarettes, and may be viewed by some as a safer alternative to smoking [33].

In Yemen commonly used smokeless tobacco are: Orange snuff (or shamma) made of powdered tobacco, lime, ash, black pepper, oils and flavourings. In Yemen smoking prevalence is 11 percent of household members age 15 and older where 16% of men and 5.3% of women use smokeless tobacco in chewing form [8]. In this study, the stillbirth rate was significantly higher among smokeless tobacco (orange snuff) mothers than among non-users' mothers (188/1000 vs. 44/1000) with relative risk identified in multivariable analysis of 4.27 (95% CI: 1.17–15.55). This is consistent with other studies that found snuff has been linked to immune dysfunction, reproductive impacts such as stillbirth and preterm birth, and cardiovascular effects, among other adverse health outcomes [34]. The cohort study of pregnant women by Gupta PC., in India found that the cumulative incidence rate of stillbirth was significantly higher among smokeless tobacco users than among non-users [35].

Use of non-cigarette tobacco products is a cultural norm in some areas. This has made its use to be socially acceptable in those areas. Non-cigarette tobacco may constitute some element of nicotine, and its subsequent use may result in nicotine addiction. This raises concern, particularly for non-tobacco products with high nicotine content [36]. There is also evidence suggesting that the use of smokeless tobacco products during pregnancy may increase the risk of adverse pregnancy outcomes [31].

Women who had prolonged labour ( $\geq 24$  hours) and mal-position appeared to increase risk of stillbirths in this study of (aRR 2.02; 95% CI: 1.38–2.96) and (aRR 4.60; 95% CI: 2.97–7.12), respectively. These findings are consistent with findings of other studies done in Yemen as hospital-based study in 2005 where the total cases admitted to the hospital for birth were 3622 women of them, the obstructed labour was reported in 330 cases (9.1%) making the incidence approximately 1 in 11 deliveries. The most common cause of obstructed labour was cephalopelvic disproportion (46%) followed by mal-presentation and mal-position (38.8%), thereby 164 (49.7%) were stillbirth [37], and elsewhere [3, 38, 39].

Prolonged rupture of membrane (PROM) defined as rupture of membrane before onset of labour occurs in 10% of the pregnancies and increases the risk of stillbirths due to sepsis [40–43]. The latency time

between rupture of membrane and birth was a significant risk factor for stillbirth in this study (aRR 2.22; 95% CI: 1.66–2.98). In many developing countries, the infectious disease burden during pregnancy is extremely high, and it appears that in many countries the stillbirth rate is high as a result of these infections [44]. It is also likely that reduction in amniotic fluid infections due to prolonged rupture of membranes, if achievable, will also have a substantial impact on stillbirth rates. Perinatal outcomes due to preterm premature rupture of membranes (PPROM) include prematurity, neonatal sepsis, respiratory distress syndrome (RDS), intraventricular haemorrhage (IVH), risk of foetal and neonatal death [45].

Our results in the multivariable analysis indicated that the low birth weight was a leading risk factor for stillbirth and low birth weight babies were 15 times more likely to die in the perinatal period than babies weighing 2500 grams or more (95% CI: 4.30-51.75). Similarly, other studies identified that the low birth weight as risk of stillbirth [39, 46].

Another important variable influencing stillbirth was foetal gestational age, with the SBR reaching almost 180.2 per 1000 births among preterm babies and premature birth at the gestation age of less than 37 weeks were 6 times more likely to be associated with stillbirth compared to those who delivered at 37 weeks of gestation or more (95% CI: 2.52–12.41). Likewise, these findings has been previously reported by other authors [47].

## Strengths And Limitations

Some of the deaths that occurred at home involved did not received death certificate and not recorded in any formal system. Therefore, many of these deaths would have been missed by facility-based studies. The stillbirths of mothers dying during or shortly after birth would also have been missed. These retrospective surveys are the main sources of data concerning stillbirth in low and middle-income countries. All these factors were able to be taken into account in this prospective community-based cohort study and provide a thorough description of likely risk factors for stillbirth.

## Conclusion

In terms of public health, stillbirth is a major problem both Yemen and other low middle-income countries. In this study, stillbirths were linked with teenage mothers (aged < 20), women with haemoglobin (Hb) below 12.3 g/dl, smoking snuff, prolonged labour (> 24 hours), prolonged rupture of membranes ( $\geq$  24 hours), baby's malposition, low birth weight (< 2500 g) and preterm gestational age (< 37 weeks).

Our findings lend weight to arguments for sets the minimum age for marriage at 18 in accordance with the definition of a child in the convention on the Rights of the Child.

In addition, improving maternal nutrition and provision of universal care during pregnancy and birth by trained personnel to all pregnant women are areas where priority actions should be given, and directed particularly at the most vulnerable such as the poor, the slum-dwellers and the marginalized.

Urgent action is necessary to be done by the local authority and NGOs to control smoking snuff and khat cultivation and chewing by creating awareness and increasing knowledge on the harmful effects of smoking snuff and khat chewing especially among women and the younger generations. Further, urgent need is imperative there be sustainable interventions in order to improve the country's maternal and newborn health. Urgent request is calling on all parties to the conflict and the international community to focus resources on the poor, marginalized and internally displaced communities and to protect the health care system in the country, with specific attention to maternal and newborn health as well as primary healthcare.

## **Abbreviations**

SBR

stillbirth rate; SB:Stillbirth; LMIC:Low and middle-income countries; HIC:High income countries; NFPA:United nations population fund; NGO:Non-governmental organization; MoPHP:Ministry of public health and population; EAs:Enumeration Areas; PPS:Probability proportional to size; SPS:Systematic probability sampling; ANC:Antenatal care; EMR:Eastern Mediterranean Region; RDS:Respiratory distress syndrome; PPROM:Preterm premature rupture of membranes; IVH:Intraventricular haemorrhage; PAR%:Population attributable risk percentage.

## **Declarations**

### **Acknowledgment**

I would like to thank those who participated in the study. All the data collectors are recognised and thanked for their tremendous contribution during data collection.

### **Authors' contributions**

AHA was the primary author, initiated the study and carried out the analysis of results and wrote the first draft of the paper. RHZ, AAA, AB all contributed towards the design, agreed the survey structure, participated in the analysis of the data and contributed to the final writing of the script. The authors read and approved the final manuscript.

### **Funding**

No funding was obtained for this study.

### **Availability of data and materials**

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

### **Ethics approval and consent to participate**

Ethics approval was granted on 15/06/2015 from the Ethical Review Board of Ministry of Public Health and Population of Yemen (G 7/77). Approval also was obtained from the local district administrative and Sana'a City health offices. The mothers or guardians of those participating in the study gave their verbal consent. Consent to participate was incorporated in the survey itself.

## Declaration

I, declare that the manuscript is my original work and was conducted as part of large study that explore the perinatal mortality among pregnant women in Yemen.

## Consent for Publication

Not applicable

## Conflict of interest

No conflict of interest was declared.

## References

1. Flenady V, Koopmans L, Middleton P, et al. Major risk factors for stillbirth in high-income countries: a systematic review and meta-analysis. *The lancet*. 2011;377(9774):1331-40. doi:[https://doi.org/10.1016/S0140-6736\(10\)62233-7](https://doi.org/10.1016/S0140-6736(10)62233-7)
2. Blencowe H, Cousens S, Jassir FB, et al. National, regional, and worldwide estimates of stillbirth rates in 2015, with trends from 2000: a systematic analysis. 2016;4(2):e98-e108. doi:[http://dx.doi.org/10.1016/S2214-109X\(15\)00275-2](http://dx.doi.org/10.1016/S2214-109X(15)00275-2)
3. Yakoob MY, Lawn JE, Darmstadt GL, Bhutta ZA. Stillbirths: epidemiology, evidence, and priorities for action. *Seminars in perinatology*. 2010;34(6):387-94. doi:10.1053/j.semperi.2010.09.010
4. McClure EM, Goldenberg RL, Bann CM. Maternal mortality, stillbirth and measures of obstetric care in developing and developed countries. *J International Journal of Gynecology Obstetrics*. 2007;96(2):139-46.
5. Banajeh S, Al-Rabee A, Al-Arashi I. Burden of perinatal conditions in Yemen: a 12-year hospital-based study. *East Mediterr Health J*. 2005;11(4):680-9.
6. UNFPA. Key Figures, UNFPA Response in Yemen Monthly Situation Report January 2017. Available at: [https://www.unfpa.org/sites/default/files/resource-pdf/UNFPA\\_Yemen\\_-\\_Monthly\\_SitRep\\_1\\_January17\\_.pdf](https://www.unfpa.org/sites/default/files/resource-pdf/UNFPA_Yemen_-_Monthly_SitRep_1_January17_.pdf). Accessed 20 Jul 2019.
7. UNFPA. Looming famine threatens the lives of 2 million pregnant women in Yemen 2018. Available at: <https://yemen.unfpa.org/en/news/looming-famine-threatens-lives-2-million-pregnant-women-yemen>. Accessed 30 Jun 2019.
8. YMoPHP & CSO. National Health and Demographic Survey (YNDHS), 2013, final report Sana'a, Yemen: Ministry of Public Health and Population, Central Statistical Organization, 2015; 2013. Available at: <https://dhsprogram.com/pubs/pdf/FR296/FR296.pdf>. Accessed 23 May 2019.

9. WHO, UNICEF, UNFPA, UN, The World Bank. Trends in maternal mortality: 1990 to 2015: Estimates by WHO, UNICEF, UNFPA, World Bank Group and United Nations Population Division. Geneva: WHO; 2015. Available at: <http://www.who.int/reproductivehealth/publications/monitoring/maternal-mortality-2015/en/>. Accessed 12 Jun 2019.
10. UNICEF. Levels and trends in child mortality. Report 2015. Estimates developed by the UN Inter-agency Group for Child Mortality Estimation.; 2015.
11. WHO. World health statistics. Geneva: WHO; 2010. Available at: [http://www.who.int/gho/publications/world\\_health\\_statistics/EN\\_WHS10\\_Full.pdf](http://www.who.int/gho/publications/world_health_statistics/EN_WHS10_Full.pdf). Accessed 23 May 2019.
12. Central Statistical Organization. Population and Housing Census 2004. Sanaa, Yemen; 2004.
13. MoPHP of Yemen. Annual statistic health report 2014. Sana'a, Yemen; 2014.
14. WHO. The World Health Survey, sampling guidelines for participating countries Geneva: WHO; 2002. Available at: <http://apps.who.int/healthinfo/systems/surveydata/index.php/catalog/95/sampling>. Accessed 2 Aug 2019.
15. Central Statistical Organization. Sana'a City Administrative Units. Sana'a, Yemen; 2004.
16. Bursac Z, Gauss CH, Williams DK, Hosmer DW. Purposeful selection of variables in logistic regression. *Source code for biology and medicine*. 2008;3(1):17. doi:10.1186/1751-0473-3-17
17. Alosaimi AN, Luoto R, Al Serouri AW, Nwaru BI, Mouniri H. Measures of Maternal Socioeconomic Status in Yemen and Association with Maternal and Child Health Outcomes. *Maternal and child health journal*. 2016;20(2):386-97. doi:10.1007/s10995-015-1837-4
18. AlSeidan M, Al Wotayan R, Christophi CA, et al. Birth Outcomes in a Prospective Pregnancy–Birth Cohort Study of Environmental Risk Factors in Kuwait: The TRACER Study. *Paediatric and perinatal epidemiology*. 2016;30(4):408-17. doi:doi: 10.1111/ppe.12296
19. Assaf S, Khawaja M, DeJong J, Mahfoud Z, Yunis K. Consanguinity and reproductive wastage in the Palestinian Territories. *Paediatric and perinatal epidemiology*. 2009;23 (2):107-15. doi:10.1111/j.1365-3016.2008.00988.x
20. Ghazi A, Ali T, Jabbar S, et al. Perinatal mortality contributors in singleton gestation. *Journal of the College of Physicians and Surgeons Pakistan*. 2009;19(11):711-3. doi:11.2009/JCPSP.711713
21. Abdulghani N. Risk factors for maternal mortality among women using hospitals in North Yemen. London: Faculty of Medicine University of London; 1993.
22. Lohela TJ, Campbell OM, Gabrysch S. Distance to care, facility delivery and early neonatal mortality in Malawi and Zambia. *Public Library of Science*. 2012;7(12):e52110. doi:10.1371/journal.pone.0052110
23. UNICEF. Yemen: Parenting in a war zone 1/4 crossroads at childbirth 2018. Available at: <https://www.unicef.org/mena/media/4876/file/YEM-ParentingInA War Zone-Pamphlet1-June 2019.pdf.pdf>. Accessed 23 Jul 2019.
24. Olusanya BO, Solanke OA. Predictors of term stillbirths in an inner-city maternity hospital in Lagos, Nigeria. *Acta obstetrica et gynecologica Scandinavica*. 2009;88(11):1243-51. doi:10.3109/

00016340903287474

25. Mukhopadhyay P, Chaudhuri R, Paul B. Hospital-based perinatal outcomes and complications in teenage pregnancy in India. *Journal of health, population, and nutrition*. 2010;28(5):494.
26. Hu I-J, Chen P-C, Jeng S-F, et al. A nationwide survey of risk factors for stillbirth in Taiwan, 2001–2004. *Pediatrics & Neonatology*. 2012;53(2):105-11. doi:10.1016/j.pedneo.2012.01.007
27. Salihu HM, Wilson RE, Alio AP, Kirby RS. Advanced maternal age and risk of antepartum and intrapartum stillbirth. *Journal of Obstetrics and Gynaecology Research*. 2008;34 (5):843-50. doi:10.1111/j.1447-0756.2008.00855.x
28. Huang DY, Usher RH, Kramer MS, Yang H, Morin L, Fretts RC. Determinants of unexplained antepartum fetal deaths. *Obstetrics & Gynecology*. 2000;95(2):215-21. doi: [https://doi.org/10.1016/S0029-7844\(99\)00536-0](https://doi.org/10.1016/S0029-7844(99)00536-0)
29. Kapoor S, Anand K, Kumar G. Risk factors for stillbirths in a secondary level hospital at Ballabgarh, Haryana: a case control study. *The Indian Journal of Pediatrics*. 1994;61 (2):161-6.
30. Kousar T, Memon Y, Sheikh S, Memon S, Sehto R. Risk factors and causes of death in Neonates. *Rawal Medical Journal*. 2010;35(2):205-8.
31. IARC. Smokeless tobacco and some tobacco-specific N-nitrosamines. *Humans WGotEoCRT, Organization WH, Cancer IAfRo, editors: World Health Organization; 2007.*
32. Warren CW, Jones NR, Peruga A, et al. Global youth tobacco surveillance, 2000-2007. *Morbidity and mortality weekly report. Surveillance summaries (Washington, DC: 2002)*. 2008;57(1):1-28.
33. Øverland S, Hetland J, Aarø LE. Relative harm of snus and cigarettes: what do Norwegian adolescents say? *Tobacco Control*. 2008;17(6):422-5.
34. Willis D, Popovech M, Gany F, Zelikoff J. Toxicology of smokeless tobacco: Implications for immune, reproductive, and cardiovascular systems. *Journal of Toxicology and Environmental Health, Part B*. 2012;15(5):317-31. doi:10.1080/10937404.2012.689553
35. Gupta PC, Subramoney S. Smokeless tobacco use and risk of stillbirth: a cohort study in Mumbai, India. *Epidemiology*. 2006;17(1):47-51.
36. Djordjevic MV, Doran KA. Nicotine content and delivery across tobacco products. *Nicotine Psychopharmacology: Springer; 2009.* p. 61-82.
37. Al-Harazi AH. Obstructed labor. A real problem in Yemeni s rural areas. *Saudi medical journal*. 2006;27(9):1435-6.
38. Laughon SK, Berghella V, Reddy UM, Sundaram R, Lu Z, Hoffman MK. Neonatal and maternal outcomes with prolonged second stage of labor. *Obstetrics and gynecology*. 2014;124(1):57. doi:10.1097/AOG.0000000000000278
39. Jammeh A, Vangen S, Sundby J. Stillbirths in rural hospitals in the gambia: a cross-sectional retrospective study. *Obstetrics and gynecology international*. 2010;2010:186867. doi:10.1155/2010/186867

40. Alexander JM, Cox SM, editors. Clinical course of premature rupture of the membranes. Seminars in Perinatology; 1996: Elsevier.
41. Ansari FNAS. NEONATAL COMPLICATIONS OF PREMATURE RUPTURE OF MEMBRANES. Acta Medica Iranica. 2003;41(3):175-9.
42. Tanir H, Sener T, Tekin N, Aksit A, Ardic N. Preterm premature rupture of membranes and neonatal outcome prior to 34 weeks of gestation. International Journal of Gynecology & Obstetrics. 2003;82(2):167-72. doi:10.1016/S0020-7292(03)00125-5
43. Weiner R, Ronsmans C, Dorman E, Jilo H, Muhoro A, Shulman C. Labour complications remain the most important risk factors for perinatal mortality in rural Kenya. Bulletin of the World Health Organization. 2003;81(8):561-6.
44. Mathews J, Mathai M, Peedicayil A, Mathews K, Ponnaiya J, Jasper M. Subclinical chorioamnionitis as a causal factor in unexplained stillbirths. International Journal of Gynecology & Obstetrics. 2001;74(2):195-7.
45. Weissmann-Brenner A, O'Reilly-Green C, Ferber A, Divon MY. Values of amniotic fluid index in cases of preterm premature rupture of membranes. Journal of perinatal medicine. 2009;37(3):232-5.
46. Bhattacharya S, Prescott GJ, Black M, Shetty A. Recurrence risk of stillbirth in a second pregnancy. BJOG: An International Journal of Obstetrics & Gynaecology. 2010;117(10):1243-7. doi:10.1111/j.1471-0528.2010.02641.x
47. McClure EM, Saleem S, Pasha O, Goldenberg RL. Stillbirth in developing countries: a review of causes, risk factors and prevention strategies. The journal of maternal-fetal & neonatal medicine. 2009;22(3):183-90. doi:10.1080/14767050802559129

## Figures

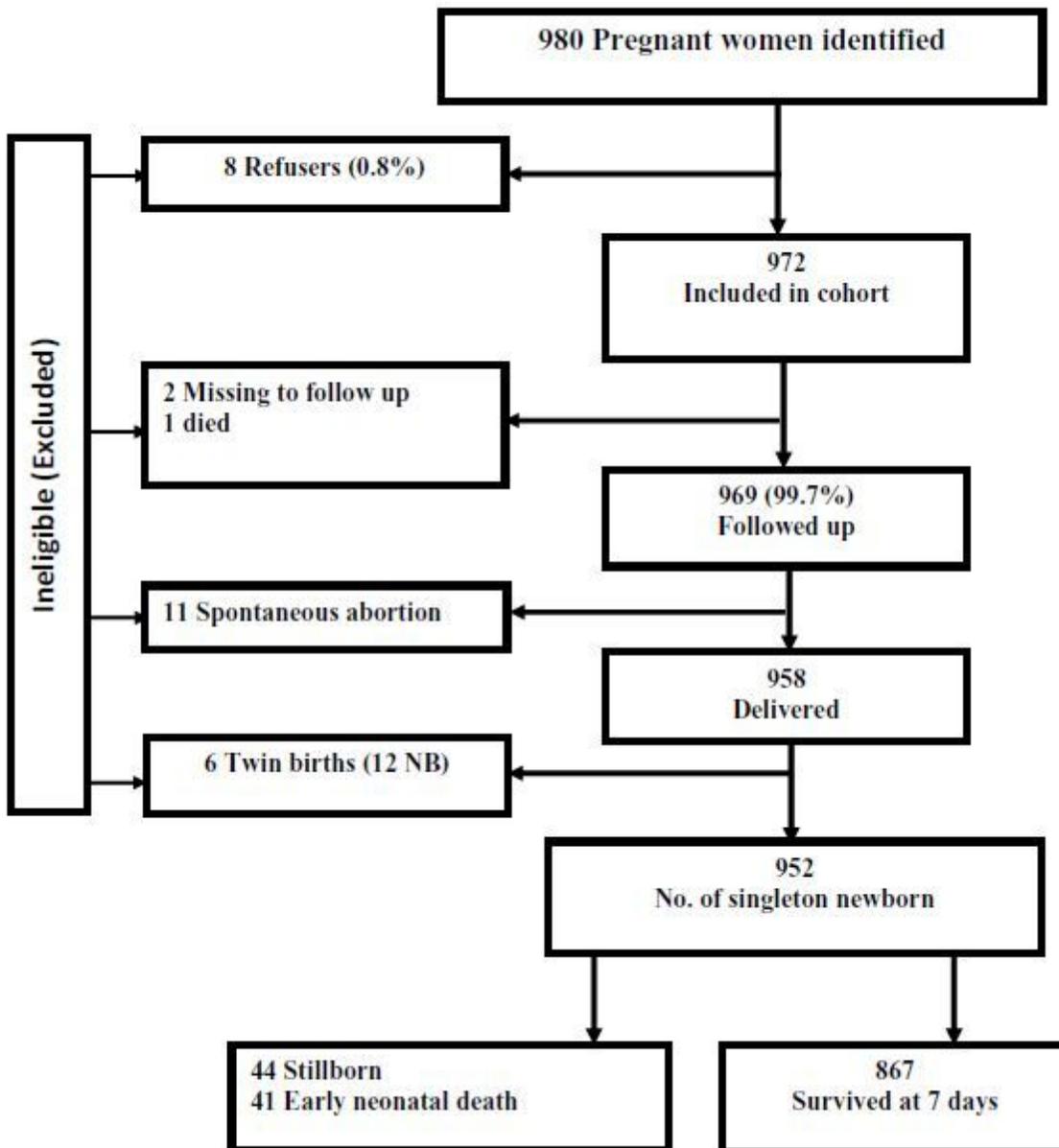


Figure 1

Flow chart of recruitment, follow up and outcomes of the study.

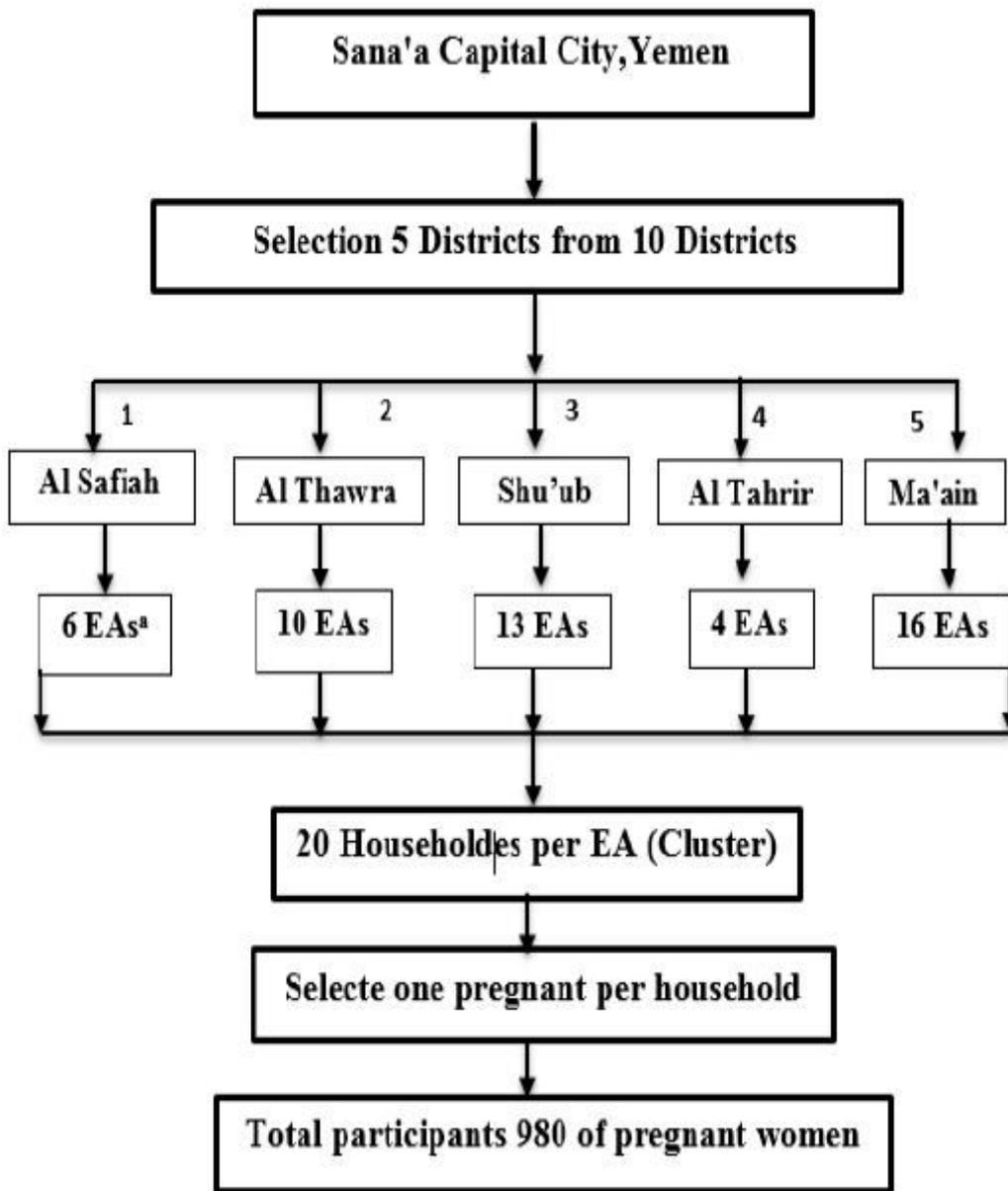


Figure 2

Flow char of participants selection. (EA: Enumerations Area).