Epidemiology and aetiology of maternal bacterial and viral infections in low- and middle-income countries

Citation for published version:
Velu, PP, Gravett, CA, Roberts, TK, Wagner, TA, Zhang, JSF, Rubens, CE, Gravett, MG, Campbell, H & Rudan, I 2011, 'Epidemiology and aetiology of maternal bacterial and viral infections in low- and middle-income countries', Journal of Global Health, vol. 1, no. 2, pp. 171-88.

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Publisher's PDF, also known as Version of record

Published In:
Journal of Global Health

General rights
Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.
Epidemiology and aetiology of maternal bacterial and viral infections in low- and middle-income countries

Prasad Palani Velu1*, Courtney A. Gravett2*, Tom K. Roberts1, Thor A. Wagner3, Jian Shayne F. Zhang1, Craig E. Rubens2,3*, Michael G. Gravett2,4*, Harry Campbell1*, Igor Rudan1*

1 Centre for Population Health Sciences and Global Health Academy, The University of Edinburgh, Scotland, UK
2 Global Alliance to Prevent Prematurity and Stillbirth (GAPPS), Seattle Children’s Hospital, Seattle, Washington, USA
3 Department of Pediatrics, University of Washington, Seattle, Washington, USA
4 Department of Obstetrics and Gynecology, University of Washington, Seattle, Washington, USA
* Joint first or senior authorship

Background Maternal morbidity and mortality in low and middle income countries has remained exceedingly high. However, information on bacterial and viral maternal infections, which are important contributors to poor pregnancy outcomes, is sparse and poorly characterised. This review aims to describe the epidemiology and aetiology of bacterial and viral maternal infections in low and middle income countries.

Methods A systematic search of published literature was conducted and data on aetiology and epidemiology of maternal infections was extracted from relevant studies for analysis. Searches were conducted in parallel by two reviewers (using OVID) in the following databases: Medline (1950 to 2010), EMBASE (1980 to 2010) and Global Health (1973 to 2010).

Results Data from 158 relevant studies was used to characterise the epidemiology of the 10 most extensively reported maternal infections with the following median prevalence rates: Treponema pallidum (2.6%), Neisseria gonorrhoeae (1.5%), Chlamydia trachomatis (5.8%), Group B Streptococcus (8.6%), bacterial vaginosis (20.9%), hepatitis B virus (20.9%), hepatitis C virus (1.4%), Cytomegalovirus (95.7% past infection), Rubella (8.9% susceptible) and Herpes simplex (20.7%). Large variations in the prevalence of these infections between countries and regions were noted.

Conclusion This review confirms the suspected high prevalence of maternal bacterial and viral infections and identifies particular diseases and regions requiring urgent attention in public health policy planning, setting research priorities and donor funding towards reducing maternal morbidity and mortality in low and middle income countries.

Correspondence to:
Prasad Palani Velu
Centre for Population Health Sciences
University of Edinburgh
Teviot Place
Edinburgh EH8 9AG
Scotland, UK
P.Palani-Velu@sms.ed.ac.uk

Maternal morbidity and mortality in low and middle income countries are still unacceptably high. It was estimated that 529,000 maternal deaths occurred throughout the world annually in 2000 (1). This estimate was recently updated with a figure of 273,500 deaths in 2011, the majority of which occurred in poor countries (2). The problem of maternal health has gained the attention of the global community, as exemplified by United
Nations Millennium Development Goal (MDG) 5, which is aimed at reducing the maternal mortality ratio by three quarters and ensuring universal access to reproductive healthcare by 2015 (3). With only 5 years left to achieve MDGs, progress towards the maternal health MDG has been one of the most disappointing, leading to its being highlighted as an urgent global priority at the September 2010 UN Summit on MDGs (4).

The disparity in maternal health between the developed and developing world can be attributed largely to poor access and quality of reproductive healthcare in developing countries (5). As a result, maternal mortality in developing countries remains high due to largely preventable causes such as haemorrhage, hypertensive disorders, abortion related complications and sepsis/infection (6).

An estimated 9.7% of maternal deaths in Africa are due to puerperal sepsis (6). Bacterial and viral infections during pregnancy contribute towards maternal morbidity and mortality and are associated with adverse pregnancy outcomes including spontaneous abortion, stillbirth, prematurity and low birth weight. Furthermore, some infections can be transmitted vertically to neonates, leading to subsequent neonatal morbidity and mortality (7). Most maternal infections can be diagnosed and treated during pregnancy, preventing morbidity and mortality of both mother and child. The reduction of maternal infections in the developing world is highly dependent on the effective use of limited health resources to diagnose and treat these infections.

The planning of effective public health measures is currently limited by the lack of information available on the precise epidemiology and aetiology of bacterial and viral maternal infections. Lack of information can also negatively impact donor interest and international commitment. This review aims to summarize published literature on the aetiology and epidemiology of bacterial and viral maternal infections in low and middle income countries. Additionally, the review aims to identify gaps in available information on the subject. This epidemiological information can subsequently be used to identify similarities and differences in the causes of maternal infection within and between geographic regions, and to guide local and international public health initiatives to reduce the prevalence and burden of these infections.

**METHODS**

**Literature search terms**

Initial searches were conducted to identify suitable keywords and MeSH headings to use in the final search (Table 1). The search strategy was prepared with input from a librarian. Searches were conducted in parallel by two reviewers (using OVID) in the following databases on 1 August 2010: Medline (1950 to August Week 4 2010), EMBASE (1980 to 2010 Week 30) and Global Health (1973 to August 2010).

**Study inclusion and exclusion criteria**

Studies were screened by title and then by abstract for relevance. Studies were deemed relevant if they provided information on the aetiology or epidemiology of bacterial and viral infections in pregnant women in developing countries. These studies were then grouped according to pathogen studied, with some studies providing information on multiple pathogens. Studies providing information on the epidemiology of parasitic infections in pregnant women were identified but not analyzed, as they were addressed in a separate review. Studies reporting the prevalence of maternal HIV infection were identified but not included for analysis, as this information is available through other sources. Relevant English language papers were analyzed...
in this work, along with the Chinese electronic databases, with the intention of translating and analyzing non-English papers, too. The inclusion criteria were:

**Subjects**: Pregnant women at any stage of pregnancy or labour, including the puerperium (up to 42 days after labour);

**Study location**: Low and middle income countries (as defined by The World Bank in 2010);

**Study design and sampling methods**: No restrictions applied;

**Data collection**: Only studies that provided evidence of bacterial or viral infection using microbiological or serological test results were included;

**Results**: Papers were selected if they provided information on the burden of a particular pathogen (the prevalence of a particular infection in pregnant women in the community over time/incidence) and/or the aetiology of bacterial and viral maternal infections (prevalence of a specific pathogen/infection).

### Quality criteria

Only studies with more than 500 subjects were included, because we wanted to protect strongly against implausible proportional contributions of certain pathogens which could have occurred due to chance in smaller data series. Papers were required to describe their samples and methods in detail, and provide microbiological or serological evidence of the aetiology of infection.

### Data extraction

Information on pathogen studied, sample population (pregnant women studied during pregnancy or at labour) and size, study setting, duration and type, microbiological/serological test used and results were extracted from abstracts and full papers for analysis.

### Data analysis

Epidemiology and aetiology of bacterial and viral maternal infections were summarized according to the pathogen studied. Only pathogens with 5 or more studies reporting on its epidemiology and/or aetiology were analyzed. Median prevalence of each infection was calculated and trends in the prevalence of maternal infections were noted.

### Selection of studies

The final search yielded 8580 relevant titles. **Figure 1** outlines the results of the search process and application of inclusion and exclusion criteria, resulting in the final panel of studies from which data was extracted.

Studies retained for data extraction (n=158) characterized the prevalence of 5 bacterial pathogens (*Treponema pallidum*, *Neisseria gonorrhoeae*, *Chlamydia trachomatis*, Group B *Streptococcus*, bacterial vaginosis) and 5 viral pathogens (hepatitis B virus, hepatitis C virus, *Cytomegalovirus*, *Rubella*, *Herpes simplex*) among pregnant women in developing countries, with three further reports providing secondary cross-sectional insights or reviews of the literature in this field which were considered useful (8–168). Studies reporting prevalence maternal HIV infection (n=167) were not included in the analysis.

### RESULTS

#### Prevalence of bacterial infections

**Syphilis** (*Treponema pallidum*). Seventy-two studies characterizing the prevalence of maternal syphilis in 36 developing countries were identified (Supplementary Table 1). The features and results of these studies are summarised in Figures 2–5.

In terms of study design, 58.3% of the identified studies were cross sectional, whilst 18.1% were screening studies. The majority of the studies (90.3%) were conducted in healthcare facilities (58.3% in antenatal or prenatal clinics), suggesting either awareness towards the need for antenatal screening for maternal syphilis infection, or merely that it is much easier to recruit study subjects in health care facilities. The remaining studies (5.6%) were community-based and the study setting was not specified in 4.2%.

Rapid Plasma Reagent (RPR) testing was used to detect antitreponemal antibodies in many studies (49%), often in combination with another test, most commonly the *Treponema*
pallidum Haemagglutination Assay (TPHA) (Figure 4). This is because RPR is cheap and simple to perform, but false positive results are common, necessitating confirmatory testing (7). Particularly high prevalence of maternal syphilis was reported in studies from Cameroon, South Africa and Zimbabwe (around 15.0%). Both studies from Cameroon were conducted in the Yaounde province, and show an increase in the prevalence of maternal syphilis from 15.9% in 1992 to 17.4% in 1998 (17,66,107,130).

Gonorrhoea (Neisseria gonorrhoeae). Twenty-one studies providing information of the prevalence of maternal Neisseria gonorrhoeae infection were identified (Supplementary table 2). The characteristics of these studies and the prevalence reported are summarized in the Figures 6–9.

With regards to study design, 20 studies (95.2%) were cross sectional and 1 was a randomized controlled trial (data from the control group was extracted). The majority of the studies (80.9%) were carried out in healthcare facilities and a minority was community-based (19.1%). Median prevalence of maternal gonococcal infection was relatively low, at 1.5% (Figure 9). However, higher prevalence of maternal gonococcal infection was reported in studies from Mongolia (6.1%), Vanuatu (5.9%) and Zimbabwe (5.8%) suggesting the need for targeted action in these countries (12,79,145).

Chlamydia trachomatis. Nineteen studies reporting the prevalence of maternal Chlamydia trachomatis (CT) infection were identified (Table 2). These studies diagnosed maternal infection by detecting antibodies towards C. trachomatis or by pathogen detection in urine samples or endocervical swabs using PCR. The median prevalence of maternal C. trachomatis infection is 5.80%. Particularly high prevalence of maternal C. trachomatis...
Table 2: Characteristics and results of studies (n=19) reporting prevalence of maternal *Chlamydia trachomatis* infection

| Article | Location, setting of study | Type, duration of study | Population | Results / Prevalence | Technique used |
|---------|----------------------------|-------------------------|------------|----------------------|----------------|
| Muaya et al, 2009 (100) | Tanzania, 2 primary health clinics | Cross sectional study; 7 months | 2654 pregnant women | 17.5% | ELISA detecting anti-chlamydial IgG |
| Jall et al, 2008 (63) | Brazil, prenatal services in 6 cities | Cross sectional study; 1 year | 3003 pregnant women | CT prevalence of 9.4% | Hybrid capture technique |
| Kinoshita-Moleka et al, 2008 (70) | Democratic Republic of Congo, 2 maternity clinics | Cross sectional study; 10 months | 529 pregnant women | 1.7% | PCR |
| Lugan et al, 2008 (89) | Mozambique, antenatal clinic | Cross sectional study, singular time point | 835 first void urine samples from pregnant women | 4.1% | PCR |
| Romoren et al, 2007 (127) | Botswana, antenatal clinic | Cross sectional study | 703 pregnant antenatal care attendees | 8% prevalence | LCR |
| Chen et al, 2006 (27) | China, antenatal clinic | Cross sectional study, 3 months | 504 pregnant women | 10.1% | PCR |
| Thammalangsy et al, 2006 (136) | Laos, 2 hospitals | Cross sectional study, 7 months | 500 antenatal attendees | 10.2% by nucleic acid hybridisation and 9.6% by PCR | Nucleic acid hybridisation, PCR |
| Amindavaa et al, 2005 (12) | Mongolia, prenatal clinics | Cross sectional survey, 11 months | 2000 pregnant women | 19.3% | PCR |
| Apea-Kubi et al, 2004 (14) | Ghana, gynaecology clinics at teaching hospital | Cross sectional study, singular time point | 517 pregnant women | 3% prevalence | RNA detection kit |
| Sullivan et al, 2003 (145) | Vanuatu, antenatal clinic | Cross sectional study, 12 months | 547 pregnant women | 21.5% | PCR |
| Gray et al, 2001 (53) | Uganda, community based | Randomised control trial, duration not specified | 1576 pregnant women in the control arm of the study | 2.7% | LCR |
| Mayank et al, 2001 (97) | India, community based | Cross sectional study, duration not specified | 600 pregnant women | 4.3% | ELISA |
| Latif et al, 1999 (70) | Zimbabwe, Antenatal and primary care clinics | Cross sectional study | 1189 asymptomatic pregnant women | 5.8% (and/or Gonococcal infection) | Not specified |
| Mulanga-Kabeya et al, 1999 (101) | Mali, community based | Cross sectional study, 1 month | 549 pregnant women | 5.0% | EIA |
| Bourgeois et al, 1998 (21) | Gabon, 3 antenatal clinics | Cross sectional study, 5 months | 646 pregnant women | 9.9% | EIA |
| Kilmarx et al, 1998 (60) | Thailand, antenatal clinics | Cross sectional study, singular time point | 500 pregnant mothers in Chiang Rai | 5.7% prevalence | PCR |
| Diallo et al, 1997 (38) | Ivory Coast, antenatal clinic | Cross sectional study, 4 months | 546 pregnant women | 5.5% | Culture, EIA |
| Mea et al, 1997 (98) | Burkina Faso, 2 antenatal clinics | Cross sectional study, duration not specified | 645 pregnant women | 3.1% | EIA |
| Joesoef et al, 1996 (65) | Indonesia, prenatal clinic | Cross sectional study, 15 months | 599 pregnant women | 8.2% | Direct immuno-fluorescence |

EIA – enzyme immunoassay, ELISA – enzyme-linked immunosorbent assay, LCR – ligase chain reaction, PCR – polymerase chain reaction

Table 3: Characteristics and results of studies (n=12) reporting prevalence of maternal Group B *Streptococcus* (GBS) colonisation

| Article | Location, setting of study | Type, duration of study | Population | Results / Prevalence | Technique used |
|---------|----------------------------|-------------------------|------------|----------------------|----------------|
| Seoud et al, 2010 (134) | Lebanon, 3 hospitals | Cross sectional study; 8 months | 775 pregnant mothers | 17.7% positive for GBS colonisation | Not specified |
| Mavenengwa et al, 2010 (96) | Zimbabwe, 3 communities | Cohort study, duration not specified | 780 women (one or more samples collected) | 60.3% positive for GBS colonisation | Culture |
| Mansouri et al, 2008 (94) | Iran, 3 major non-private hospitals | Cross sectional study, 11 months | 602 pregnant women | 9.1% were colonised by GBS | Culture |
| Namavar et al, 2008 (105) | Iran, hospital | Cross sectional study; 6 months | 1197 pregnant women at childbirth | 9.1% had rectovaginal colonisation with GBS | Culture |
| Zusman et al, 2006 (168) | Brazil, 2 hospitals | Prospective study, 5 months | 998 pregnant women | 17.9% maternal colonisation rate | Culture |
| Goto et al, 2005 (52) | Vietnam, community based | Survey; duration not specified | 505 pregnant women | 4% | Culture |
| Larcher et al, 2005 (78) | Argentina, hospital | Prospective study, 18 months | 1228 pregnant women | 1.4% maternal colonisation rate | Culture |
| Sidney & Thomas, 2002 (139) | UAE, hospital | Cross sectional study, 2 months | 891 pregnant women at delivery | 21.5% maternal colonisation rate | Culture |
| Teresani et al, 2001 (158) | Argentina, hospital | Cross sectional study; 25 months | 531 pregnant women | 3.2% were positive for GBS | Culture |
| Wierawatkalul et al, 2001 (164) | Thailand, hospital | Cross sectional study; 5 months | 902 pregnant women presenting at labour | 6.2% maternal colonisation rate | Culture |
| Ocampo-Torres et al, 2000 (111) | Mexico, 3 public hospitals | Cross sectional study, 8 months | 910 pregnant women at delivery | 8.6% GBS colonisation rate | Culture, Latex agglutination |
| Olaniwe & Adeosoye, 1988 (113) | Nigeria, 4 government hospitals | Cross sectional study, duration not specified | 500 pregnant women (2nd and 3rd trimester) | 1.6% positive for GBS | Culture |

UAE – United Arab Emirates
M. matus infection was identified in Vanuatu (21.5%), Mongolia (19.3%) and Tanzania (17.5%) (12,100,145).

**Group B Streptococcus.** Twelve studies reporting the prevalence of maternal Group B Streptococcus (GBS) (*S. agalactiae*) colonisation were identified (Table 3).

The majority of studies diagnosed GBS colonization by direct culture of vaginal swabs. Median prevalence of maternal GBS colonization was 8.85%. The highest prevalence of maternal GBS colonization reported was 60.3% in 3 communities across Zimbabwe, which was significantly higher than the prevalence reported by other studies. However this prevalence was reported as not significantly associated with adverse perinatal outcomes (96). Higher prevalence was also noted in Lebanon and the United Arab Emirates (136,139).

**Bacterial vaginosis.** Eleven studies reported the prevalence of bacterial vaginosis (Table 4).

The median prevalence of maternal bacterial vaginosis was 20.9%. Especially high prevalence was reported in Uganda, Botswana and Zimbabwe, highlighting high prevalence of bacterial vaginosis in sub-Saharan Africa. The majority of studies used microscopy of vaginal wet mounts in combination with established criteria for diagnosing bacterial vaginosis (53,75,126).

**Prevalence of Viral Pathogens**

**Hepatitis B virus.** Thirty-nine studies characterizing the prevalence of maternal Hepatitis B infection were identified (Supplementary Table 3), and their features and results are summarized in Figures 10–13.

The majority of identified studies were conducted in a healthcare facility (87.2%) whilst 5.1% were community based and 7.7% of studies did not specify the setting. Most of the studies were also cross sectional (69.2%) in nature, with remaining studies being retrospective observational
### Table 4: Characteristics and results of studies (n=11) reporting prevalence of bacterial vaginosis in pregnant women

| Article                     | Location, setting of study                               | Type, duration of study       | Population | Results / Prevalence | Technique used     |
|-----------------------------|----------------------------------------------------------|------------------------------|------------|-----------------------|--------------------|
| Kurewa et al, 2010 (75)     | Zimbabwe, peri-urban clinics                             | Cross sectional study, 19 months | 691 women  | 32.6%                 | Amsel's criteria   |
| Msuya et al, 2009 (100)     | Tanzania, 2 primary health clinics                       | Cross sectional study, 21 months | 2654 women | 20.9%                 | Amsel's criteria   |
| Kirakoya-Samadoulougou et al, 2008 (71) | Burkina Faso, 4 primary health centres | Cross sectional study, 3 months | 2133 pregnant women | 6.4% | Nugent scoring method |
| Romoren et al, 2007 (127)   | Botswana, multiple antenatal clinics                     | Cross sectional study, 5 months | 703 pregnant women | 38.0% | Microscopy |
| Azargoan & Darvishzadeh, 2006 (16) | Iran, hospital                        | Cohort study, duration not specified | 1223 pregnant women | 16.0% | Vaginal pH, saline wet mount, Amsel tests |
| Thammalangsy et al, 2006 (156) | Laos, 2 hospitals                                      | Cross sectional study, 7 months | 500 pregnant antenatal attendees | 14.4% by Amsel's criteria and 22.0% by Nugent's score | Amsel's criteria, Nugent's score |
| Thammalangsy et al, 2006 (156) | Vietnam, community based                              | Survey, duration not specified | 505 pregnant women in 10 communes | 7% | Nugent criteria |
| Goto et al, 2005 (52)       | Uganda, community based                                 | Randomised control trial, duration not specified | 1576 pregnant women in the control arm of the study | 48.5% | Microscopy |
| Mayank et al, 2001 (97)     | India, community based                                  | Cross sectional study, duration not specified | 600 pregnant women | 18% | Microscopy |
| Taha et al, 1999 (150)      | Malawi, hospital                                        | Cross sectional study, 25 months | 9126 pregnant women | 30% | Vaginal wet mounts |
| Meda et al, 1997 (98)       | Burkina Faso, 2 antenatal clinics                       | Cross sectional study, duration not specified | 645 pregnant women | 13% | Microscopy |

### Figure 10: Geographical distribution of studies (n=39) providing information on prevalence of maternal hepatitis B virus (HBV) infection; “no data” in the legend refers to low and middle-income countries only, as data from high-income countries were not the subject of this study.

### Figure 11: Techniques used to identify hepatitis B virus (HBV) infection in 39 studies.

### Figure 12: Sizes of study populations in 39 studies reporting maternal hepatitis B virus (HBV) infection prevalence.

### Figure 13: Box plot showing prevalence of hepatitis B virus (HBV) infection detected in relevant studies (n=37). Only 30 of 37 relevant studies measured prevalence by detecting hepatitis B surface antigen (HBsAg) in pregnant women. The following number summaries are depicted in the boxplot: the smallest observation (sample minimum), lower quartile (25%), median (50%), upper quartile (75%), and largest observation (sample maximum). Asterisk indicates an outlier.
The majority of studies screened for the presence of maternal HBV infection by detecting Hepatitis B surface antigen (HBsAg) in maternal serum. Particularly high maternal HBV prevalence (25%) was identified in Zimbabwe (90), Brazil (20) and Taiwan (83).

**Hepatitis C virus.** Twenty-one studies reporting the prevalence of maternal Hepatitis C virus (HCV) infection were identified ([Supplementary Table 4](#supplementary-table-4)). The features and findings of these studies are summarized in [Figures 14 to 17](#figures-14-to-17).

Almost all studies reporting maternal HCV prevalence were conducted in healthcare facilities (95.2%) and one did not specify the study setting. The majority of studies were also cross sectional (80.9%), with the remaining studies being case control studies (14.3%), prospective studies (9.5%) and one serological survey (4.8%). Median maternal exposure to HCV (anti-HCV) prevalence reported was 1.4%. Active infection prevalence (HCV RNA) was reported in 6 studies and median active HCV infection prevalence from these studies was 1.2%. Two studies from Egypt reported especially high prevalence of maternal HCV exposure (15.8% and 15.7%) and active infection rates (10.8% and 10.9%), highlighting a local problem with maternal HCV infection in Egypt (136,143).

**Rubella virus.** Fifteen studies characterizing the epidemiology of maternal rubella were identified ([Table 5](#table-5)).

These studies detected the presence of maternal anti-rubella IgG as a marker of past infection or immunization and mothers who did not possess these antibodies were susceptible to rubella infection. Maternal IgM was detected in some studies as a marker of recent or current infection, which is associated with an increased risk of vertical transmission. Median maternal susceptibility to rubella was

| Article | Location, setting of study | Type, duration of study | Population | Results / Prevalence | Technique used |
|---------|---------------------------|-------------------------|------------|----------------------|----------------|
| Lin et al, 2010 (86) | Taiwan, hospital | Cross sectional study, 7 years | 10,089 pregnant women | Seropositivity was 14.0% | Microparticle ELISA |
| Tamer et al, 2009 (152) | Turkey, antenatal clinic | Cross sectional study, duration not specified | 1972 serum samples from pregnant women | Seropositivity for anti-rubella IgG, IgM and IgG+IgM together was 96.1%, 0.2% and 1.8%, respectively | Commercial ELISA (detecting IgG and IgM) |
| Ai & Ee, 2008 (8) | Malaysia, antenatal clinics and hospital | Cross sectional study, duration not specified | 500 pregnant mothers | 11.4% were susceptible to Rubella | Rubella IgG studies |
| Majlessi et al, 2008 (92) | Iran, health centres | Cross sectional study, 2 years | 965 pregnant women | Estimated rubella immunity rate was 91.1%, Nonimmunity rate was 8.9% | ELISA |
| Das et al, 2007 (34) | India, hospital | Screening, duration not specified | 1115 pregnant women with bad obstetric history, 500 normal pregnant women | 3.6% seropositivity (*BOH), 0% seropositivity (normal) | ELISA (Detecting IgM) |
| Ocak et al, 2007 (110) | Turkey, antenatal clinic | Retrospective observational, 23 months | 1652 pregnant women | Anti-rubella IgG and IgM antibodies were reactive in 95.0%, and in 0.54% | ELISA (detecting IgG and IgM) |
| Pehlivan et al, 2007 (119) | Turkey, community based | Cross sectional study, 7 months | 824 women from 60 clusters, 803 eligible for serological study | 93.8% positive for anti-rubella IgG, 0.6% were IgM and IgG positive, 3.6% were susceptible | Micro ELISA (detecting IgG and IgM) |
| Tseng et al, 2006 (160) | Taiwan, hospital | Retrospective observational, 4 years | 5007 pregnant women | 13.4% susceptible among Taiwanese women, 29.1% susceptible among non-Taiwanese women | Microparticle ELISA |
| Barreto et al, 2006 (18) | Mozambique, antenatal clinics | Cross sectional serosurvey, 3 months | 974 pregnant women at antenatal clinic attendance | 95.3% positive for Rubella IgG | ELISA |
| Corcoran & Hardie, 2006 (31) | South Africa, antenatal clinics | Cross sectional study, duration not specified | 1200 serum samples from a 2003 HIV/syphilis survey | 96.5% immune | ELISA |
| Desiner et al, 2004 (36) | Haiti, hospital | Cross sectional study, 4 months | 503 pregnant women, 8 excluded leaving 495 | 95.2% were seropositive | EIA |
| Weerasekera et al, 2003 (163) | Sri Lanka, antenatal clinic | Cross sectional study, 2 years | 500 maternal blood samples, before 16th week of gestation | 82% were positive for rubella specific IgG, 73% gave a history of vaccination against rubella before their present pregnancy | ELISA (detecting IgG and IgM) |
| Palihawadana et al, 2003 (116) | Sri Lanka, multiple antenatal clinics | Cross sectional study, duration not specified | 620 pregnant women | 76% of pregnant females were seropositive | ELISA (detecting IgG) |
| Ashrafunnessa Khutun, et al, 2000 (15) | Bangladesh, hospital | Cross sectional study, 11 months | 609 pregnant women | 85.9% were seropositive and 14.1% were seronegative | ELISA |
| Dos Santos et al, 2005 (39) | Brazil, prenatal testing | Cross sectional study, 8 months | 1024 pregnant women | 77.4% | Haemagglutinin Inhibition Assay |

EIA – enzyme immunoassay, ELISA – enzyme-linked immunosorbent assay

---

Table 5: Characteristics and results of studies (n=15) reporting prevalence of maternal rubella infection

(17.9%), surveys (5.1%) and either prospective, cohort or case control studies (2.5% each).
Epidemiology and aetiology of maternal bacterial and viral infections in developing countries

Cytomegalovirus. Five studies on maternal cytomegalovirus (CMV) infection prevalence were identified (Table 6).

The median prevalence of maternal IgG to CMV (calculated from 4 studies that reported this) was 95.7%, indicating a high proportion of mothers with previous exposure to CMV. One hospital-based study in India identified a statistically significant higher prevalence of CMV IgM (indicating active or recent infection) in mothers with Bad Obstetric History (BOH), highlighting a role for maternal CMV infection in adverse pregnancy outcome in this setting (34).

Herpes simplex virus. Five studies outlining the prevalence of maternal Herpes simplex virus 2 (HSV-2) were identified (Table 7).

These studies detected the presence of antibodies to HSV as a marker of maternal infection. Median prevalence of HSV-2 was 20.7%. Higher seroprevalences were noted in Zimbabwe, Vanuatu and Tanzania (56,75,166).

DISCUSSION

Prevalence of bacterial and viral maternal infections

Our search of published literature relevant to the aetiology and epidemiology of bacterial and viral maternal infections in the developing world retrieved 499 titles. Analysis of these titles yielded 158 studies which provided detailed epidemiological information on 10 maternal infections. The 5 bacterial and 5 viral maternal infections identified in this panel represent maternal infections that were most extensively studied, suggesting that these infections have a high burden on pregnancy outcomes in the developing world. These infections also have potential adverse effects on neonates.

Our review confirms the suspected high prevalence of bacterial and viral maternal infections in the developing world, as demonstrated by the median prevalence rates calculated for each pathogen studied. Of particular concern are the
In the process of reviewing the subject, we identified gaps in existing knowledge. High prevalence rates of maternal syphilis (2.6%), C. trachomatis (5.8%), bacterial vaginosis (20.9%), hepatitis B virus (4.3%) and Herpes simplex virus (20.7%).

The prevalence of these infections also showed significant variance between countries and regions. The prevalence of maternal infections in sub-Saharan Africa is especially high, specifically in Zimbabwe (75, 79, 96, 130), Tanzania (101, 166) and Cameroon (66, 107). Previous studies have shown that all-cause obstetric risk and maternal mortality ratio are highest in Sub-Saharan Africa (1). The high prevalence of maternal infections in this region may have an important contributory role towards the high maternal morbidity and mortality seen in Sub-Saharan Africa. Regional differences in the prevalence of maternal infections are likely to be closely related to the quality of reproductive healthcare available in different regions, or unique local scenarios.

Gaps in existing knowledge

In the process of reviewing the subject, we identified several facility-based retrospective studies reporting causes of maternal mortality. Many of these studies attributed a proportion of deaths to infection or sepsis, but were unable to provide microbiological or serological evidence of the specific aetiology of infection. Thus, these studies had to be excluded from the final panel of studies that we reviewed. This highlights a gap in existing knowledge on the epidemiology and impact of maternal infection, especially on the aetiology of infectious agents that lead to puerperal sepsis and subsequent mortality. Increased surveillance and diagnostic capabilities in healthcare facilities and in the community is needed to identify the aetiological agents responsible for puerperal sepsis and maternal mortality.

The prevalence of maternal infection reported by the studies identified in this review may be an underestimate of actual rates of infection as not all pregnant women in developing countries may have access to or choose to access formalized antenatal care. This could be due to financial constraints, difficulties in accessing these facilities and personal or cultural beliefs. In addition, antenatal care services may not have the capacity to routinely screen for maternal infections, especially those that are asymptomatic (such as N. gonorrhoeae and C. trachomatis) and those that require serological tests such as PCR and ELISA to diagnose (Hep-

**Table 6** Characteristics and results of studies (n=5) reporting prevalence of maternal cytomegalovirus (CMV) infection

| Article | Location, setting of study | Type, duration of study | Population | Results / Prevalence | Technique used |
|---------|----------------------------|-------------------------|------------|-----------------------|----------------|
| Tabatabaei et al., 2009 (149) | Iran, hospital | Cross sectional study, 7 months | 1472 pregnant women | 97.69% seropositivity, 3.31% seronegativity, prevalence of active infection 4.35% | Not specified |
| Das et al., 2007 (34) | India, hospital | Cross sectional study | 1113 pregnant women with Bad obstetric history, 500 normal pregnant women | 11% prevalence in women with Bad obstetric history; 4% prevalence in normal pregnant women | Commercial ELISA kit detecting anti-CMV IgM |
| O'cak et al., 2007 (110) | Turkey, hospital | Retrospective observational study, 2 years | 1652 pregnant women | 94.9% seropositivity for anti-CMV IgG, 0.4% positive for anti-CMV IgM | ELISA detecting anti-CMV IgG and IgM |
| Suarez et al., 1994 (144) | Chile, public outpatient department and a special clinic for university students | Cross sectional study, 3 years | 939 pregnant women of a low socioeconomic level, and 123 pregnant university students | 95% in low socioeconomic class; 69.9% in pregnant students; 2 primary infections occurred (1 in each group) | ELISA, initially seronegative women were tested again during 2nd and 3rd trimester to identify primary infections |
| Tamer et al., 2009 (152) | Turkey, antenatal clinics | Cross sectional study, singular time point | 1972 samples of sera from pregnant women | Seroprevalence of anti-CMV IgG, IgM and IgG+IgM together were found in 96.4%, 0.7% and 1.9% of the pregnant women, respectively | Commercial ELISA kit |

ELISA – enzyme-linked immunosorbent assay

**Table 7** Characteristics and results of studies (n=5) reporting prevalence of maternal Herpes simplex virus (HSV) infection

| Article | Location, setting of study | Type, duration of study | Population | Results / Prevalence | Technique used |
|---------|----------------------------|-------------------------|------------|-----------------------|----------------|
| Kurewa et al., 2010 (75) | Zimbabwe, peri-urban clinics | Cross sectional study, 19 months | 691 pregnant women | 51.10% seropositive | ELISA detecting IgG |
| Yahya-Malima et al., 2008 (166) | Tanzania, antenatal clinics (6) | Cross sectional study, duration not specified | 1296 sera collected from pregnant women | 20.7% prevalence of genital herpes | ELISA |
| Chen et al., 2007 (28) | China, antenatal clinic | Cross sectional study, 3 months | 502 pregnant women | 10.8% seroprevalence of HSV-2 | Commercial ELISA to detect IgG |
| Haddow et al., 2007 (56) | Vanuatu, antenatal clinic | Cross sectional study, 1 to 2 years | 535 pregnant women | 32% seroprevalence of HSV-2 | ELISA |
| Joesoef et al., 1996 (65) | Indonesia, prenatal clinic | Cross sectional study, 15 months | 599 pregnant women | 9.9% seroprevalence of HSV-2 | Immunno-blot |

ELISA – enzyme-linked immunosorbent assay
Epidemiology and aetiology of maternal bacterial and viral infections in developing countries

Reducing the prevalence of maternal infections, and consequently maternal and neonatal morbidity and mortality, requires concerted, multifaceted action. Improvements in the provision, accessibility and uptake of antenatal care services are absolutely essential to reduce the prevalence of not only maternal infection but also other causes of maternal morbidity and mortality. This entails an improvement in antenatal booking, the number of antenatal visits and childbearing with professional assistance (40). Wherever possible, routine screening and treatment for maternal infections should be conducted. Alternatives to antenatal screening include syndromic management or risk assessment based approaches to treat maternal infection. Routine immunisation against vaccine-preventable diseases should also be implemented to reduce the eventual burden that these infections may have on pregnancy outcomes and neonates (7, 132).

We hope that the gaps in information highlighted in this study will guide the design and implementation of studies to accurately assess the epidemiology of maternal infections in the developing world, especially in countries where the prevalence of maternal infection is unreported. Ideally, studies should be large, community-based and longitudinal, and investigate the association between pregnancy outcome and microbiological and serological evidence of maternal infection to accurately define the burden of maternal infections and their impact on pregnancy outcome (132). There is also a great need for the design of rapid point-of-care diagnostic tests for use in the field for the diagnosis of maternal infections. Affordable and novel therapeutics and interventions will also be beneficial in reducing the impact of maternal infections. These measures are dependent upon the co-operation of the research community and the altruism of industry to succeed.

More than US$ 40 billion (€ 30 billion) has been pledged towards the newly formed Global Strategy for Women’s and Children’s Health (169). These funds should be spent prudently on effective and sustainable measures to improve maternal health. The majority of this allocation should go towards the strengthening of basic antenatal care systems in developing countries. Because serious maternal infections are a major contributor to maternal morbidity and mortality, the early detection and treatment of infections is an important component of prenatal care. The continued support of the global community is also needed to ensure the improvement of maternal health in the developing world.

CONCLUSION

This review highlights the high bacterial and viral maternal infection rates in the developing world. Urgent, concerted action is required to reduce the burden of these infections. In addition to raising awareness about the severity of the problem of maternal infections in the developing world, data from this review will be beneficial in guiding public health policy, research interests and donor funding towards achieving MDG 5.

Strengths and limitations

This is one of the first reviews to summarise the epidemiology of bacterial and viral maternal infections in the developing world (7). The search strategy devised is sensitive and specific, which allowed for a comprehensive review of available literature on this topic. The information generated in this review can be utilised to guide public health policy and the allocation of resources within local governments and by the international community towards improving maternal health. Limitations of this work include the exclusion of studies with less than 500 participants and the omission of pathogens with less than 5 papers reporting their prevalence. This was done to minimise the potential confounding effect that smaller, underpowered studies may have had on the overall prevalences reported and to increase the statistical robustness of the data presented.

This study could be further improved by analysing smaller studies that were identified and performing a sensitivity analysis of their results prior to inclusion. Also, it is likely that further valuable insights may be obtained from non-English articles of studies conducted in francophone parts of Africa (in French), South America (in Spanish) and in China (in Chinese), which could be accessed from appropriate databases. Reviewing non-English articles may assist in defining the epidemiology of pathogens for which we managed to identify few (<5) studies, as well as providing more robust data on the pathogens presented in this review. In addition, searching grey (unpublished) literature or contacting health officials and researchers in the field may also yield more country specific data on the subject, thus enabling more targeted and context-specific public health measures.

Recommendations and future work

Reducing the prevalence of maternal infections, and consequently maternal and neonatal morbidity and mortality, requires a concerted, multifaceted approach. Improvements in the provision, accessibility and uptake of antenatal care services are absolutely essential to reduce the prevalence of not only maternal infection but also other causes of maternal morbidity and mortality. This entails an improvement in antenatal booking, the number of antenatal visits and childbearing with professional assistance (40). Wherever possible, routine screening and treatment for maternal infections should be conducted. Alternatives to antenatal screening include syndromic management or risk assessment based approaches to treat maternal infection. Routine immunisation against vaccine-preventable diseases should also be implemented to reduce the eventual burden that these infections may have on pregnancy outcomes and neonates (7, 132).

We hope that the gaps in information highlighted in this study will guide the design and implementation of studies to accurately assess the epidemiology of maternal infections in the developing world, especially in countries where the prevalence of maternal infection is unreported. Ideally, studies should be large, community-based and longitudinal, and investigate the association between pregnancy outcome and microbiological and serological evidence of maternal infection to accurately define the burden of maternal infections and their impact on pregnancy outcome (132). There is also a great need for the design of rapid point-of-care diagnostic tests for use in the field for the diagnosis of maternal infections. Affordable and novel therapeutics and interventions will also be beneficial in reducing the impact of maternal infections. These measures are dependent upon the co-operation of the research community and the altruism of industry to succeed.

More than US$ 40 billion (€ 30 billion) has been pledged towards the newly formed Global Strategy for Women’s and Children’s Health (169). These funds should be spent prudently on effective and sustainable measures to improve maternal health. The majority of this allocation should go towards the strengthening of basic antenatal care systems in developing countries. Because serious maternal infections are a major contributor to maternal morbidity and mortality, the early detection and treatment of infections is an important component of prenatal care. The continued support of the global community is also needed to ensure the improvement of maternal health in the developing world.

CONCLUSION

This review highlights the high bacterial and viral maternal infection rates in the developing world. Urgent, concerted action is required to reduce the burden of these infections. In addition to raising awareness about the severity of the problem of maternal infections in the developing world, data from this review will be beneficial in guiding public health policy, research interests and donor funding towards achieving MDG 5.
Acknowledgements: We thank Sheila Fisken, librarian, for her advice on databases and refining of search terms, and Edinburgh medical students Alasdair Campbell and Rachel McKinnon for their consultation on various aspects of the project.

Funding: Bill and Melinda Gates Foundation.

Ethical approval: Not required.

Authorship declaration: All authors designed and conducted the study and contributed to writing the paper.

Competing interests: All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare support from Bill and Melinda Gates Foundation for the submitted work. The authors declare no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; and no other relationships or activities that could appear to have influenced the submitted work.

REFERENCES

1. Ronsmans C, Graham WJ. Maternal mortality: who, when, where, and why. Lancet. 2006;368:1189–1200.
2. Lozano R, Wang H, Foreman KJ, Rajaratnam JK, Naghavi M, Marcus JR, et al. Progress towards Millennium Development Goals 4 and 5 on maternal and child mortality: an updated systematic analysis. Lancet. 2011;378:1139–1165.
3. United Nations. UN Millennium Development Goals. Available at: http://www.un.org/millenniumgoals/maternal.shtml. Accessed: 25 September 2011.
4. World Health Organisation. Millennium Development Goal 5. Available at: http://www.who.int/making_pregnancy_safer/topics/mdg/en/index. Accessed: 25 September 2011.
5. Freedman LP, Waldman RJ, De Pinho H, Wirth ME, Chowdhury AMR, Rosenfield A. Transforming health systems to improve the lives of women and children. Lancet. 2005;365:997–1000.
6. Khan SK, Wojdyla D, Say L, Gulmezoglu AM, Van Look PFA. WHO analysis of causes of maternal death: a systematic review. Lancet. 2006;367:1066–1074.
7. Mullick S, Watson-Jones D, Beksinska M, Mabey D. Sexually transmitted infections in pregnancy: prevalence, impact on pregnancy outcomes, and approach to treatment in developing countries. Sex Transm Infect. 2005;81:294–302.
8. Ai TC, Ec MK. Prevalence of rubella susceptibility among pregnant mothers in a community-based antenatal clinic in Malaysia: a cross-sectional study. Asia-Pacific J Publ Health. 2008;20:340–346.
9. Akani CI, Ojule AC, Opurum HC, Ejilemele AA. Sero-prevalence of hepatitis B surface antigen (HBsAg) in pregnant women in Port Harcourt, Nigeria. Niger Postgrad Med J. 2005;12:266–270.
10. Akhter S, Talukder MQ, Bhuiyan N, Chowdhury TA, Islam MN, Begum S. Hepatitis B virus infection in pregnant mothers and its transmission to infants. Ind J Pediatr. 1992;59:411–415.
11. Amaral E, Faundes A, Goncales NS, Pellegrino Jr J, De Souza CA, Pinto E, et al. Prevalence of HIV and Treponema pallidum infections in pregnant women in Campinas and their association with socio-demographic factors. Sao Paulo Med J. 1996;114:1108–1116.
12. Amindavaa O, Kristensen S, Pak CY, Khaltzan D, Chultemsuren B, Randall AS, et al. Sexually transmitted infections among pregnant women attending antenatal clinics in Mongolia: potential impact on the Mongolian HIV epidemic. Int J STD AIDS. 2005;16:153–157.
13. Anderson KE, Stevens CE, Tseui JJ, Lee WC, Sun SC, Beasley P. Hepatitis B antigen in infants born to mothers with chronic hepatitis B antigenemia in Taiwan. Am J Dis Child. 1975;129:1389–1392.
14. Apea-Kubi KA, Yamaguchi S, Sakyi B, Kismoto T, Ofori-Adjei D, Hagiwara T. Neisseria gonorrhoea, Chlamydia trachomatis, and Treponema pallidum infection in antenatal and gynecological patients at Korle-Bu Teaching Hospital, Ghana. Jpn J Infect Dis. 2004;57:253–256.
15. Ashrafunnessa Khatun S, Islam MN, Chowdhury S. Seroprevalence of rubella antibodies among antenatal population attending a tertiary level hospital in Dhaka City. Bangladesh Med Res Council Bull. 2000;26:75–81.
16. Azargoona A, Darvishzadeh S. Association of bacterial vaginosis, Trichomonas vaginalis, and vaginal acidity with outcome of pregnancy. Arch Iran Med. 2006;9:213–217.
17. Iam RH. Syphilis in pregnant patients and their offspring. Int J Gynecol Obstet. 1994;44:113–118.
18. Barreto J, Sacramento I, Robertson SE, Langa J, De Gouville E, Wolfson L, et al. Antenatal rubella serosurvey in Maputo, Mozambique. Trop Med Int Health. 2006;11:559–564.
19. Barsanti C, Valletaro F, Diniz EM, De A, Succi RCDM. Diagnosis of congenital syphilis: a comparison between serological tests in mother and respective newborn. Rev Soc Brasil Med Trop. 1999;32:605–611.
REFERENCES

20. Bertolini DA, Pinho JRR, Saraceni CP, Moreira RC, Granato CFH, Carrilho FJ. Prevalence of serological markers of hepatitis B virus in pregnant women from Parana State, Brazil. Braz J Med Biol Res. 2006;39:1083–1090.

21. Bourgeois A, Henzel D, Malonga-Mouellet G, Dibanga G, Tsoobu C, Peeters M, et al. Clinical algorithms for the screening of pregnant women for STDs in Libreville, Gabon: which alternatives? Sex Transm Infect. 1998;74:35–39.

22. Bronzan RN, Mwesigwa-Kayongo DC, Narkunas D, Schmid GP, Neilsen GA, Ballard RC, et al. On-site rapid antenatal syphilis screening with an immunochromatographic strip improves case detection and treatment in rural South African clinics. Sex Transm Dis. 2007;34(7 Suppl):S55–S60.

23. Bukar M, Audu BM, Takai UI, Ajayi BB, Kullima AA. Is routine antenatal screening for syphilis in Nigeria still justified clinically and economically? Saudi Med J. 2009;30:1311–1315.

24. Burnett RJ, Ngobeni JM, Francois G, Hoosen AA, Leroux-Roels G, Meheus A, et al. Increased exposure to hepatitis B virus infection in HIV-positive South African antenatal women. Int J STD AIDS. 2007;18:152–156.

25. Chang YK, Chao SL, Huang LW. Gestational and congenital syphilis in Hualien. J Formosan Med Assoc (Taiwan). 1992;91:620–623.

26. Chatterjee S, Ravishankar K, Chatterjee R, Narang A, Kiniikar A. Hepatitis B prevalence during pregnancy. Indian Pediatrics. 2009;46:1005–1008.

27. Chen X, Yin Y, Chen L, Thuy NTT, Zhang G, Shi M, Hu L, Yu Y. Sexually transmitted infections among pregnant women attending an antenatal clinic in Fuzhou, China. Sex Transm Dis. 2006;33:296–301.

28. Chen X, Yin Y, Chen L, Yu W, Thuy NTT, et al. Herpes simplex virus 2 infection in women attending an antenatal clinic in Fuzhou, China. Sex Transm Infect. 2007;83:369–370.

29. Cheng JQ, Zhou H, Hong FC, Zhang D, Zhang YJ, Pan P, et al. Syphilis screening and intervention in 500,000 pregnant women in Shenzhen, the People's Republic of China. Sex Transm Infect. 2007;83:347–350.

30. Cheng JQ, Zhou H, Zhong WM, Hong FC, Zhang D, Zhang YJ, et al. Study on the status of syphilis infection and its influence factors on pregnant women in Shenzhen. Zhonghua Liu Xing Bing Xue Za Zhi. 2008;29:23–26.

31. Corcoran C, Hardie DR. Seroprevalence of rubella antibodies among antenatal patients in the Western Cape. South Afr J Obstet and Gynaecol. 2006;12:26–28.

32. Costa ZB, Machado GC, Avelino MM, Gomes Filho C, Macedo Filho JV, Minuzzi AL, et al. Prevalence and risk factors for Hepatitis C and HIV-1 infections among pregnant women in Central Brazil. BMC Infect Dis. 2009;9:e116.

33. Creek TL, Thuku H, Kolou B, Rahman M, Kilmarx PH. Declining syphilis prevalence among pregnant women in northern Botswana: an encouraging sign for the HIV epidemic? Sex Transm Infect. 2005;81:453–455.

34. Das S, Ramachandran VG, Arora R. Cytomegalovirus and rubella infection in children and pregnant mothers—a hospital based study. J Comm Dis. 2007;39:113–117.

35. De Lima LHM, Viana MC. Prevalence and risk factors for HIV, syphilis, hepatitis B, hepatitis C, and HTLV-1/II infection in low-income postpartum and pregnant women in Greater Metropolitan Vitoria, Espirito Santo State, Brazil. Cadernos Saude Publ. 2009;25:668–676.

36. Desinor OY, Anselme RJP, Laender F, Saint-Louis C, Bien-Aime JE. Seroprevalence of antibodies against rubella virus in pregnant women in Haiti. Rev Panam Salud Publica. 2004;15:147–150.

37. Devjee J, Moodley J, Singh M. Syphilis in pregnancy — prevalence at different levels of health care in Durban. S Afr Med J. 2006;96:1182–1184.

38. Diallo MO, Ettiegne-Traore V, Maran M, Kouadio J, Brattegaard K, Makke A, et al. Sexually transmitted diseases and human immunodeficiency virus infections in women attending an antenatal clinic in Abidjan, Cote d’Ivoire. Int J STD AIDS. 1997;8:636–638.

39. dos Santos JL, Lopes MA, Deliego-Vasconcelos E, Couto-Fernandez JC, Patel BN, et al. Seroprevalence of HIV, HTLV-I/II and other perinatally-transmitted pathogens in Salvador, Bahia. Rev Inst Med Trop Sao Paulo. 1995;37:343–348.

40. Drazanac A. Antenatal care in developing countries. What should be done? J Perinat Med. 2001;29:188–198.

41. Drobeniuc J, Htin YJ, Harpaz R, Favorov M, Melnik A, Iarovoi P, et al. Prevalence of hepatitis B, D and C virus infections among children and pregnant women in Moldova: additional evidence supporting the need for routine hepatitis B vaccination of infants. Epidemiol Infect. 1999;123:463–467.

42. Duarte M, Mussi-Pinhata MM, Martinez R, Lemos C, Leite Figueiredo EM, Quintana SM. Frequency of pregnant women with HBsAg in a Brazilian community. Rev Panam Salud Publ. 1997;1:35–40.

43. El-Magrahe H, Furarah AR, El-Figih K, El-Urshfany S, Ghenghesh KS. Maternal and neonatal seroprevalence of Hepatitis B surface antigen (HBsAg) in Tripoli, Libya. J Infect Dev Ctries. 2010;4:168–170.

44. Eslheimk RM, Daak AA, Elsheikh MA, Karsany MS, Adam I. Hepatitis B virus and hepatitis C virus in pregnant Sudanese women. Virol J. 2007;4:104–107.

45. Evelyn ME, Buseri FL, Wachukwu CK, Nnantuanya IN. Effects of hepatitis B infection on haemtological parameters in pregnancy in Port Harcourt, Nigeria. Res J Med Sci. 2009;3:194–197.

46. Farley TA, Cohen DA, Ellkins W. Asymptomatic sexually transmitted diseases: the case for screening. Prev Med. 2003;36:502–509.

47. Garcia SG, Timajeros F, Revollo R, Yam EA, Richmond K, Diaz-Olavarrieta C, et al. Demonstrating public health at work: a demonstration project of congenital syphilis prevention efforts in Bolivia. Sex Transm Dis. 2007;34(7 Suppl):S37–S41.
48. Gichangi P, Renterghem IV, Karanja J, Bwayo J, Kiragu D, Temmerman M. Congenital syphilis in a Nairobi maternity hospital. East Afr Med J. 2004;81:589–593.
49. Gill HH, Majumdar PD, Dhunjibhoy KR, Desai HG. Prevalence of hepatitis B antigen in pregnant women and patients with liver disease. J Assoc Physicians India. 1995;43:247–248.
50. Gini PC, Chukudebelu WO, Njoku-Obi AN. Antenatal screening for syphilis at the University of Nigeria Teaching Hospital, Enugu, Nigeria – A six year survey. Int J Gynaecol Obstet. 1989;29:321–324.
51. Goh TH, Ngeow YF. Serological screening for syphilis during pregnancy in a multiethnic Asian population. Asia Oceania J Obstet Gynaecol. 1989;15:67–70.
52. Goto A, Nguyen QV, Pham NM, Kato K, Cao TP, Le TH, et al. Prevalence of and factors associated with reproductive tract infections among pregnant women in ten communes in Nghe An Province, Vietnam. J Epidemiol. 2005;15:163–172.
53. Gray RH, Wabwire-Mangen F, Kigozi G, Sewankambo NK, Serwadda D, Moulton LH, et al. Randomized trial of presumptive sexually transmitted disease therapy during pregnancy in Rakai, Uganda. Am J Obstet Gynecol. 2001;185:1209–1217.
54. Greenwood AM, D’Alessandro U, Siy F, Greenwood BM. Treponemal infection and the outcome of pregnancy in a rural area of The Gambia, West Africa. J Infect Dis. 1992;166:842–846.
55. Guidozzi F, Schoub BD, Johnson S, Song E. Should pregnant urban South African women be screened for hepatitis B? S Afr Med J. 1993;83:103–105.
56. Haddow LJ, Sullivan EA, Taylor J, Abel M, Cunningham AL, Tabrizi S. Herpes simplex virus type 2 (HSV-2) infection in women attending an antenatal clinic in the South Pacific island nation of Vanuatu. Sex Transm Dis. 2007;34:238–261.
57. Hernandez-Trejo M, Hernandez-Prado B, Uribe-Salas F, Juarez-Figueroa L, Conde-Gonzalez CJ. Maternal and congenital syphilis in two Mexican hospitals: evaluation of a rapid diagnostic test. Rev Invest Clin. 2006;58:119–125.
58. Hoekstra CE, Riedijk M, Matute AJ, Hak E, Delgado E, Alonso RE, et al. Prevalence of HIV and syphilis in pregnant women in Leon, Nicaragua. Am J Trop Med Hyg. 2006;75:522–525.
59. Ikeme AC, Ezegwui HU, Ogbonna C. Seroprevalence of hepatitis B surface antigen (HBsAg) in pregnant women in Southeast Nigeria. Trop Doctor. 2006;36:128–133.
60. Ikeme AC, Okeke TC. The relevance of VDRL as routine test in pregnant women: a critical study. Niger J Clin Pract. 2006;9:65–67.
61. Inagaki ADDM, De Oliveira LAR, De Oliveira MFB, Santos RCS, Araujo RM, Alves JAB, et al. Seroprevalence of antibodies for toxoplasmosis, rubella, cytomegalovirus, syphilis and HIV among pregnant women in Sergipe. Rev Soc Bras Med Trop. 2009;42:532–536.
62. Jaffery T, Tariq N, Ayub R, Yawar A. Frequency of hepatitis C in pregnancy and pregnancy outcome. J Coll Physicians Surg Pakistan. 2005;15:716–719.
63. Jalil EM, Pinto VM, Benzaken AS, Ribeiro D, Oliveira EC, Garcia EG, et al. Prevalence of Chlamydia and Neisseria gonorrhoeae infections in pregnant women in six Brazilian cities. Rev Bras Ginecol Obstet. 2008;30:614–619.
64. Jenniskens F, Obwaka E, Kirisuah S, Moses S, Mohamedali Yusufali F, Ndinya Achola JO, et al. Syphilis control in pregnancy: decentralization of screening facilities to primary care level, a demonstration project in Nairobi, Kenya. Int J Gynaecol Obstet. 1995;48 Suppl:S121–S128.
65. Joesoef MR, Sumampow H, Limman M, Schmid S, Idjadji A, Louis ME et al. Sexually transmitted diseases in pregnant women in Surabaya, Indonesia. Am J Obstet Gynecol. 1996;174:115–119.
66. Keou FM, Mbu R, Mauclere P, Andela A, Tetanye E, Leke R, et al. Antenatal HIV prevalence in Yaounde, Cameroon. Int J STD AIDS. 1998;9:400–402.
67. Kew MC, Kassianides C, Berger EL. Prevalence of chronic hepatitis B virus infection in pregnant Black women living in Soweto. J Med Virol. 1987;22:263–268.
68. Khokhar N, Baja KS, Javed S. Seroprevalence of Hepatitis C virus infection and its risk factors in pregnant women. J Pak Med Assoc. 2004;54:135–140.
69. Kilmarx PH, Black CM, Limpakarnjanarat K, Shaffer N, Yanpaisarn S, Chaisiwattana P, et al. Rapid assessment of sexually transmitted diseases in a sentinel population in Thailand: prevalence of chlamydial infection, gonorrhoea, and syphilis among pregnant women – 1996. Sex Transm Infect. 1998;74:189–193.
70. Kinoshita-Moleka R, Smith JS, Atibu J, Tshefu A, Hemingway-Foday J, Hobbs M, et al. Low prevalence of HIV and other selected sexually transmitted infections in 2004 in pregnant women from Kinshasa, the Democratic Republic of the Congo. Epidemiol Infect. 2008;136:1290–1296.
71. Kirakoya-Samadoulougou F, Nagot N, Defe MC, Yaro S, Meda N, Robert A. Bacterial vaginosis among pregnant women in Burkina Faso. Sex Transm Dis. 2008;35:985–989.
REFERENCES

94. Mansouri S, Ghasami E, Najad NS. Vaginal colonization of Group B streptococci during late pregnancy in South-
east of Iran: incidence, serotype distribution and susceptibility to antibiotics. J Med Sci. 2008;8:574–578.

93. Lujan J, De Onate WA, Delva W, Claeys P, Sambola F, Temmerman M, et al. Prevalence of sexually transmitted infections in women attending antenatal care in Tete province, Mozambique. S Afr Med J. 2008;98:49–51.

92. Majoko F, Munjanja S, Nystrom L, Mason E, Lindmark G. Field efficiency of syphilis screening in antenatal centres of Tehran University of Medical Sciences. East Mediterran Health J. 2008;14:590–594.

91. Majlessi F, Batebi A, Shariat M, Rahimi A, Azad TM. Rubella serology in pregnant women attending health centres for neonates born to chronically infected immigrant mothers in Hsin-Chu County, Taiwan. Vaccine. 2008;26:e49.

90. Lin CC, Hsieh HS, Huang YJ, Huang YL, Ku MK, Hung HC. Hepatitis B virus infection among pregnant women in Taiwan: comparison between women born in Taiwan and other southeast countries. BMC Publ Health 2008;8:e49.

89. Lin C, Yang C, Shih C, Chen B, Huang Y. Rubella seroepidemiology and catch-up immunization among pregnant women in Taiwan: comparison between women born in Taiwan and immigrants from six countries in Asia. Am J Trop Med Hyg. 2010;82:40–44.

88. Lin H, Hsu H, Lee T, Kao J, Chen P, Chen D. Hepatitis C virus infection in pregnant women: detection by different anti-HCV immunoassays and serum HCV-RNA. Asia Oceania J Obstet Gynaecol. 1994;20:13–18.

87. Lin H, Kao J, Chang T, Hsu H, Chen D. Secular trend of age-specific prevalence of hepatitis B surface and antigenemia in pregnant women in Taiwan. J Med Virol. 2003;69:466–470.

86. Liu C, Chang N, Chou F. Seroprevalence of HBV in immigrant pregnant women and coverage of HBIG vaccine for neonates born to chronically infected immigrant mothers in Hsin-Chu County, Taiwan. Vaccine. 2007;25:7706–7710.

85. Lopez-Zambrano MA, Briceno G, Rodriguez-Morales AJ. Trends in the prevalence of HIV and syphilis among pregnant women under antenatal care in central Venezuela. Int J Infect Dis. 2009;13:e189–e191.

84. Lujan J, De Onate WA, Delva W, Claes P, Sambola F, Temmerman M, et al. Prevalence of sexually transmitted infections in women attending antenatal care in Tete province, Mozambique. S Afr Med J. 2008;8:e49.

83. Madzime S, Adem M, Mahomed K, Woelk GB, Mudzamiri S, Williams MA. Hepatitis B virus infection among pregnant women delivering at Harare Maternity Hospital, Harare Zimbabwe, 1996 to 1997. Central Afr J Med. 1999;45:195–198.

82. Madzime S, William MA, Mohamed K, October T, Adem M, Mudzamiri S, et al. Seroprevalence of hepatitis C virus infection among indigent urban pregnant women in Zimbabwe. Centr Afr J Med. 2000;46:1–4.

81. Majlessi F, Batebi A, Shariat M, Rahimi A, Azad TM. Rubella serology in pregnant women attending health centres of Tehran University of Medical Sciences. East Mediterran Health J. 2008;14:590–594.

80. Mansouri S, Ghasami E, Najad NS. Vaginal colonization of Group B streptococci during late pregnancy in Southeast of Iran: incidence, serotype distribution and susceptibility to antibiotics. J Med Sci. 2008;8:574–578.

79. Mathai E, Mathai M, Prakash MA, Bergstrom S. Audit of management of pregnant women with positive VDRL tests. Natl Med J India. 2001;14:202–204.

78. Mavenyengwa RT, Afset JE, Schei B, Berg S, Caspersen T, Bergseng H, et al. Group B Streptococcus colonization during pregnancy and maternal-fetal transmission in Zimbabwe. Acta Obstet Gynecol Scand. 2010;89:250–255.

77. Mayank S, Bahl R, Bhandari N. Reproductive tract infections in pregnant women in Delhi, India. Int J Gynaecol Obstet. 2001;75:81–82.

76. Kwiek JJ, Mwapasa V, Allker AP, Muula AS, Misiri HE, Molyneux ME, et al. Socio-demographic characteristics associated with HIV and syphilis seroreactivity among pregnant women in Blantyre, Malawi, 2000–2004. Malawi Med J. 2008;20:80–85.

75. Labbe A, Mendonca AP, Alves AC, Jaffar S, Dias F, Alvarenga IC, et al. The impact of syphilis, HIV-1, and HIV-2 on pregnancy outcome in Bissau, Guinea-Bissau. Sex Transmit Dis. 2002;29:157–167.

74. Larcher JS, Capellino F, De Giusto R, Travella C, Balangani FG, Kreiker G, et al. Group B streptococcal colonization during pregnancy and prevention of early onset of disease. Medicina. 2005;65:201–206.

73. Latif AS, Mason PR, Marowa E, Gwanzuru L, Chingono A, Mbengeranwa OL. Risk factors for gonococcal and chlamydial cervical infection in pregnant and non-pregnant women in Zimbabwe. Centr Afr J Med. 1999;45:252–258.

72. Kizito D, Woodburn PW, Kesande B, Ameke C, Nabolime J, Muwanga M, et al. Uptake of HIV and syphillis testing of pregnant women and their male partners in a programme for prevention of mother-to-child HIV transmission in Uganda. Trop Med Int Health. 2008;13:680–682.

71. Kumar A, Sharma KA, Gupta RK, Kar P, Chakravarti A. Prevalence and risk factors for hepatitis C virus among pregnant women. Indian J Med Res. 2007;126:211–215.

70. Kumar A, Sharma KA, Gupta RK, Kar P, Murthy NS. Hepatitis C virus infection during pregnancy in North India. Int J Gynaecol Obstet. 2005;88:55–56.

69. Kurewa NE, Mapingure MF, Munjoma MW, Chirenje MZ, Rusakaniko S, Stray-Pedersen B. The burden and risk factors of sexually transmitted infections and reproductive tract infections among pregnant women in Zimbabwe. BMC Infect Dis. 2010;10:e127.
REFERENCES

98. Meda N, Sangare L, Lankoande S, Sanou PT, Compaore PI, Catraye J, et al. Pattern of sexually transmitted diseases among pregnant women in Burkina Faso, west Africa: potential for a clinical management based on simple approaches. Genitourin Med. 1997;73:188–193.

99. Miyamoto SK, Bertolini DA. Study into the HBsAg seroprevalence in pregnant women from the 15th Health Regional and the immunoprophylaxia on the newborns of these HBsAg-positive women. Acta Scient.

100. Munkhuu B, Liabsuetrakul T, Chongsuvivatwong V, Geater A, Janchiv R. Coverage of antenatal syphilis screening and predictors for not being screened in Ulaanbaatar, Mongolia. Sex Transm Dis. 2006;33:284–288.

101. Mulanga-Kabeya C, Morel E, Patrei D, Delaporte E, Bouguoudogo F, Maiga YI, et al. Prevalence and risk assessment for sexually transmitted infections in pregnant women and female sex workers in Mali: is syndromic approach suitable for screening? Sex Transm Infect. 1999;75:358–360.

102. Munkhutu B, Liabsuetrakul T, Chongsuvivatwong V, Geater A, Janchiv R. Coverage of antenatal syphilis screening and predictors for not being screened in Ulaanbaatar, Mongolia. Sex Transm Dis. 2006;33:284–288.

103. Mwalagile D, Swai AB, Sandstrom E, Urassa E, Biberfeld G, Mhalu FS. High frequency of sexually transmitted diseases among pregnant women in Dar es Salaam, Tanzania: need for intervention. East Afr Med J. 1996;73:675–678.

104. Myer L, Karim SSA, Lombard C, Wilkinson D. Treatment of maternal syphilis in rural South Africa: effect of multiple doses of benzathine penicillin on pregnancy loss. Trop Med Int Health 2004;9:1216–1221.

105. Namavar Jahromi B, Poorarian S, Poorfarheee S. The prevalence and adverse effects of group B streptococcal colonization during pregnancy. Arch Iran Med. 2008;11:654–657.

106. Ndumbé PM, Andela A, Nkemmkgeng-Asong J, Watonsi E, Nyambi P. Prevalence of infections affecting the child among pregnant women in Yaoundé, Cameroon. Med Microbiol Immunol. 1992;181:127–130.

107. Ndumbe PM, Andela A, Nkemmkgeng-Asong J, Watonsi E, Nyambi P. Prevalence of infections affecting the child among pregnant women in Yaounde, Cameroon. Med Microbiol Immunol. 1992;181:127–130.

108. Myer L, Karim SSA, Lombard C, Wilkinson D. Treatment of maternal syphilis in rural South Africa: effect of multiple doses of benzathine penicillin on pregnancy loss. Trop Med Int Health 2004;9:1216–1221.

109. Obi SN, Onah HE, Ezugwu FO. Risk factors for hepatitis B infection during pregnancy in a Nigerian obstetric population. J Obstet Gynaecol. 2006;26:770–772.

110. Ocak S, Zeteroglu S, Ozer C, Dolapcioglu K, Gungoren A. Seroprevalence of Toxoplasma gondii, rubella and cytomegalovirus among pregnant women in southern Turkey. Scand. J. Infect. Dis. 2007;39:231–234.

111. Ocampo-Torres M, Sanchez-Perez HJ, Nazar-Beutelspacher A, Castro-Ramirez AE, Cordero-Ocampo B. Factors associated with Streptococcus group B colonization in pregnant women in Los Altos, Chiapas. Salud Publica Mex. 2000;42:413–421.

112. Olofth E, Mburthia J, Gatheru Z, Murila F, Kanyiyingi F, Mugo F, et al. Seroprevalence of hepatitis B markers in pregnant women in Kenya. East Afr Med J. 2006;83:485–493.

113. Olaniyi SB, Aderoniy J. Determination of asymptomatic carrier rate of beta-haemolytic group B Streptococcus in vaginas of pregnant women in Ibadan, Nigeria. Zentralbl Bakteriol Mikrobiol Hyg A. 1986;261:248–253.

114. Oshithani H, Kasolo F, Tembo C, Mpahalwani M, Mizuta K, Luo N, et al. Hepatitis B virus infection among pregnant women in Zambia. East Afr Med J. 1995;72:813–815.

115. Ozumba UC, Oshi DC, Nwokeji CM, Anya SE. Trends in seroreactivity for syphilis among pregnant Nigerian women. Sex Transm Infect. 1999;75:120–126.

116. Paihawadana P, Wickremasinghe AR, Perera J. Seroprevalence of rubella antibodies among pregnant females in Sri Lanka. South East Asian J Trop Med Public Health. 2003;34:398–404.

117. Panekrotav SC, Saluk YV, Klimova IV. Epidemiology of syphilis in pregnant women and congenital syphilis in Belarus. Acta Dermatovenerol Alpin Pannonica Adriat. 2006;15:33–38.

118. Parthiban R, Shanmugam S, Velu V, Nandakumar S, Dhevahi E, Thangaraj K, et al. Transmission of hepatitis C virus infection from asymptomatic mother to child in southern India. Int J Infect Dis. 2009;13:e394–e400.

119. Pehlivan E, Karaoglu L, Ozen M, Gunes G, Tekerekoglu MS, Genc MF, et al. Rubella seroprevalence in an unvaccinated pregnant population in Malatya, Turkey. Public Health. 2007;121:462–468.

120. Pham L, Woelk GB, Ning Y, Madzime S, Mudzamiri S, Mahomed K, et al. Seroprevalence and risk factors of syphilis infection in pregnant women delivering at Harare Maternity Hospital, Zimbabwe. Centr Afr J Med. 2005;51:24–30.

121. Plewes K, Lee T, Kajeechewa L, Thwin MM, Lee SJ, Carrara VI. Low seroprevalence of HIV and syphilis in pregnant women in refugee camps on the Thai-Burma border. Int J STD AIDS. 2008;19:833–837.

122. Prakash C, Sharma RS, Bhatai R, Verghese T, Datta KK. Prevalence of North India of hepatitis B carrier state amongst pregnant women. South East Asian J Trop Med Public Health 1998;29:80–84.

123. Revollo R, Tinajeros F, Hilari C, Garcia SG, Zegarra L, Diaz-Olavarrieta C, et al. Maternal and congenital syphilis in four provinces in Bolivia. Salud Publica Mex. 2007;49:422–428.

124. Rey JL, Coulibaly M, Noba V. Syphilis test proposed within the context of a programme to reduce mother/child HIV transmission: example of the Wassakara health care center in Abidjan. Bull Soc Pathol Exot. 2005;98:390–391.
REFERENCES

125. Rodrigues CS, Guimaraes MD. Syphilis positivity in puerperal women: still a challenge in Brazil. Rev Panam Salud Publica. 2004;16:168–175.

126. Romoren M, Sundby J, Velauthapillai M, Rahman M, Klouman E, Hjortdahl P, et al. Chlamydia and gonorrhoea in pregnant Batswana women: time to discard the syndromic approach? BMC Infect Dis. 2007;7:e27.

127. Romoren M, Velauthapillai M, Rahman M, Sundby J, Klouman E, Hjortdahl P, et al. Trichomoniasis and bacterial vaginosis in pregnancy: inadequately managed with the syndromic approach. Bull World Health Organ. 2007;85:297–304.

128. Rotchford K, Lombard C, Zuma K, Wilkinson D. Impact on perinatal mortality of missed opportunities to treat maternal syphilis in rural South Africa: baseline results from a clinic randomized controlled trial. Trop Med Int Health. 2000;5:800–804.

129. Rouet F, Chaix M, Inwoley A, Msellati P, Viho I, Combe P, et al. HBV and HCV prevalence and viremia in HIV-positive and HIV-negative pregnant women in Abidjan, Cote d’Ivoire: the ANRS 1236 study. J Med Virol 2004;74:34–40.

130. Rutgers S. Syphilis in pregnancy: a medical audit in a rural district. Cent Afr J Med. 1993; 39:248–253.

131. Sangare L, Meda N, Lankoaoue S, Dyck EV, Cartoux M, Compaore IP. HIV infection among pregnant women in Burkina Faso: a nationwide serosurvey. Int J STD AIDS. 1997;8:646–651.

132. Scale AC, Mwaniki M, Newton CR, Berkley JA. Maternal and early onset neonatal bacterial sepsis: burden and strategies for prevention in Sub-Saharan Africa. Lancet Infect Dis. 2009;9:428–238.

133. Sebastian VJ, Bhattacharya S, Ray S, Daud JH. Prevalence of hepatitis-B surface antigen in the pregnant women of Brunel Darussalam. South East Asian J Trop Med Public Health. 1990;21:123–127.

134. Seoud M, Nassar AH, Zalloua P, Boghossian N, Ezeddine J, Fakhoury H, et al. Prenatal and neonatal Group B Streptococcus screening and serotyping in Lebanon: incidence and implications. Acta Obstet Gynecol Scand. 2010;89:399–403.

135. Sethi S, Sharma K, Dhaliwal LK, Banga SS, Sharma M. Declining trends in syphilis prevalence among antenatal women in northern India: a 10-year analysis from a tertiary healthcare centre. Sex Transm Infect. 2007;83:592–598.

136. Shebl FM, El-Kamary SS, Saleh DA, Abdel-Hamid M, Mikhail N, Allam A, et al. Prospective cohort study of mother-to-infant infection and clearance of hepatitis C in rural Egyptian villages. J Med Virol. 2009;81:1024–1031.

137. Sheikh SM. Hepatitis B and C: value of universal antenatal screening. J Coll Physicians Surg Pakistan. 2009;19:179–182.

138. Shrestha P, Bhandari D, Sharma D, Bhandari BP A study of viral hepatitis during pregnancy in Nepal Medical College Teaching Hospital. Nepal Med Coll J. 2009;11:192–194.

139. Sidky I, Thomas M. Prevalence of Group B streptococcal infection colonisation in pregnant women and their offspring in the Middle East. J Obstet Gynaecol. 2002;22:179–180.

140. Simpore J, Ilboudo D, Samandoulougou A, Guardo P, Castronovo P, Musumeci S. HCV and HIV co-infection in pregnant women attending St. Camille Medical Centre in Ouagadougou (Burkina Faso). J Med Virol. 2005;75:209–212.

141. Singla N, Chander J. Seroprevalence of HBsAg in females in a North India tertiary care hospital, with special reference to pregnancy. New Zealand Med J. 2008;121:105–106.

142. Southwick KL, Blanco S, Santander A, Estenssoro M, Torrico F, Seoane G, et al. Maternal and congenital infections of mother-to-infant transmission. J AIDS Hum Retrovirol. 1999;20:52–59.

143. Taha TE, Gray RH, Kumwenda NI, Hoover DR, Mtimavalye LAR, Liomba GN. HIV infection and disturbances of vaginal flora during pregnancy. J AIDS Hum Retrovirol. 1999;22:517–521.

144. Tamer GS, Dundar D, Caliskan E. Seroprevalence of Toxoplasma gondii, rubella and cytomegalovirus among pregnant women in western region of Turkey. Clin Invest Med. 2007; 32:E43–47.

145. Taha TE, Gray RH, Kumwenda NI, Hoover DR, Mitmavalye LAR, Liomba GN. HIV infection and disturbances of vaginal flora during pregnancy. J AIDS Hum Retrovirol. 1999;22:517–521.
REFERENCES

153. Temmerman M, Ali FM, Ndinya-Achola J, Moses S, Plummer FA, Piot P. Rapid increase of both HIV-1 infection and syphilis among pregnant women in Nairobi, Kenya. AIDS. 1992;6:1181–1185.

154. Temmerman M, Fonck K, Bashir F, Inion I, Ndinya-Achola JO, Bwayo J, et al. Declining syphilis prevalence in pregnant women in Nairobi since 1995: another success story in the STD field? Int J STD AIDS. 1999;10:405–408.

155. Temmerman M, Gichangi P, Fonck K, Apers L, Claes P, Van Renterghem L, et al. Effect of a syphilis control programme on pregnancy outcome in Nairobi, Kenya. Sex Transm Infect. 2000;76:117–121.

156. Thammalangsy S, Sihavong A, Phouthavane T, Sayabounthavong K, Puapermpoonsiri S, Kitayaporn D, et al. The prevalence of lower genital tract infections among ante-natal care (ANC) clinic patients in two central hospitals, Vientiane, Lao People’s Democratic Republic. South East Asian J Trop Med Public Health. 2006;37:190–199.

157. Todd CS, Ahmadzai M, Atiqzai F, Miller S, Smith JM, Ghazanfar SA, et al. Seroprevalence and correlates of HIV, syphilis, and hepatitis B and C virus among intrapartum patients in Kabul, Afghanistan. BMC Infect Dis. 2008;8:e119.

158. Toresani I, Limansky A, Bogado I, Guardati MC, Viale A, Sutich EG, et al. Phenotypic and genotypic study of streptococcus agalactiae in vagina of pregnant women in Argentina. Medicina 2001; 61:295–300.

159. Tsegaye A, Rinke De Wit TF, Mekonnen Y, Beyene A, Aklilu M, Messele T, et al. Decline in prevalence of HIV-1 infection and syphilis among young women attending antenatal care clinics in Addis Ababa, Ethiopia: results from sentinel surveillance, 1995–2001. Ethiop Med J. 2003;41(Suppl 1):31–34.

160. Tseng H, Chang C, Tan H, Yang S, Chang H. Seroprevalence study of rubella antibodies among pregnant women from seven Asian countries: evaluation of the rubella vaccination program in Taiwan. Vaccine. 2006;24:5772–5777.

161. Vazquez-Martinez JL, Coreno-Juarez MO, Montano-Estrada LF, Attlan M, Gomez-Dantes H. Seroprevalence of hepatitis B in pregnant women in Mexico. Salud Publica Mex. 2003;45:165–170.

162. Watson-Jones D, Changalucha J, Gumodoka B, Weiss H, Rusizoka M, Ndeki L, et al. Syphilis in pregnancy in Tanzania. I. Impact of maternal syphilis on outcome of pregnancy. J Infect Dis. 2002;186:940–947.

163. Weerasekera DS, Fernando S, Weerasekera MM. Susceptibility to rubella among pregnant women and the serological evidence of congenital rubella in newborn babies at Colombo South Teaching Hospital. Ceylon Med J. 2003;48:51–53.

164. Werawatakul Y, Wilaluckana C, Taksaphan S, Thinkumrup J, Pragarasung M, Chouwajaroen P. Prevalence and risk factors of Streptococcus agalactiae (group B) colonization in mothers and neonatal contamination at Siriraj Hospital. J Med Assoc Thai 2001;84:1422–1429.

165. Woodruff BA, Popovici F, Beldescu N, Shapiro CN, Hersh BS. Hepatitis B virus infection among pregnant women in northeastern Romania. Int J Epidemiol. 1993;22:923–926.

166. Yahya-Malima K, Evjen-Olsen B, Matee MI, Fylkesnes K, Haarr L. HIV-1, HSV-2 and syphilis among pregnant women in a rural area of Tanzania: prevalence and risk factors. BMC Infect Dis. 2008;8:e75.

167. Zhang S, Li R, Wang Y, Liu Q, Zhou Y, Hu Y. Seroprevalence of hepatitis B surface antigen among pregnant women in Jiangsu, China, 17 years after introduction of hepatitis B vaccine. Int J Gynaecol Obstet. 2010;109:194–197.

168. Zusman AS, Baltimore RS, Fonseca SNS. Prevalence of maternal group B Streptococcal colonization and related risk factors in a Brazilian population. Braz J Infect Dis. 2006;10:242–246.

169. Moszynski P. UN summit launches new initiative for women and children’s health BMJ 2010;341:c5276.