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Prevalence of group B *Streptococcus* colonization in pregnant women and serotype specific immunity among mother-newborns dyads in Ghana and Zimbabwe

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ABSTRACT

Background: Rectovaginal colonization with *Streptococcus agalactiae* (Group B *Streptococcus*; GBS) during pregnancy is a major risk factor for neonatal invasive GBS disease and adverse birth outcomes. We investigated the prevalence of maternal GBS colonization, serotype-specific immunoglobulin G (IgG) immunity in mother-newborn dyads, and GBS associated stillbirths in Ghana and Zimbabwe.

Methods: A prospective cohort of 1238 pregnant women and their infants was enrolled (2018–2020). Rectovaginal swabs collected at ≥36 weeks gestation or prior to delivery and chest aspirates from stillbirths were cultured for GBS. Isolates were serotyped using latex agglutination. Maternal and cord blood samples were analysed for GBS serotype-specific IgG using a multiplex bead-based immunoassay.

Results: The prevalence of recto-vaginal GBS colonization was 15.6% (68/437) in Ghana and 15.2% (50/329) in Zimbabwe. GBS was detected in 33.3% (3/9) of stillbirths. Dominant colonizing serotypes were Ia (25%), III (32%), and V (27%). Maternal IgG concentrations were significantly higher in Ghana than in Zimbabwe for serotypes Ib (0.11 vs 0.02 μg/mL; $p = 0.0001$), II (0.24 vs 0.06 μg/mL; $p = 0.0001$), and IV (0.03 vs 0.006 μg/mL; $p < 0.0001$). Transplacental IgG transfer ratios ranged from 0.81 to 1.08; highest for serotype II and lowest for Ia. Newborns with IgG above the serological thresholds for risk reduction for serotype Ia and III were 25.6% (Ia) and 38.4% (III) in Ghana; and 34.1% (Ia) and 26.8% (III) in Zimbabwe.

Conclusions: The predominant GBS serotypes distribution in Ghana and Zimbabwe aligns with global epidemiological patterns. Despite evidence of natural maternal IgG immunity and efficient transplacental transfer, most newborns lacked protective antibody levels against GBS. A maternal GBS vaccine targeting dominant serotypes may reduce the risk of GBS neonatal invasive disease and GBS-associated stillbirths.

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1. Introduction

Rectal or vaginal colonization with *Streptococcus agalactiae* (Group B *Streptococcus*; GBS) during pregnancy is a major risk factor for invasive GBS disease in infants, which manifests as early onset disease (EOD; 0–6 days of life) or late-onset disease (LOD; 7–89 days of life). Globally, GBS is estimated to cause approximately 394,000 invasive cases in infants under 90 days of life, resulting in nearly 90,000 deaths [1]. Beyond neonatal infections, maternal GBS colonization has been associated with adverse pregnancy outcomes, including stillbirths and preterm births [2,3]. In 2020, GBS was implicated in an estimated 46, 200 stillbirths worldwide, with sub-Saharan Africa accounting for approximately 50% of these cases (~20,300 stillbirths) [1].

Vertical transmission of GBS can occur via ascending infection during pregnancy or intrapartum exposure as the neonate passes through the birth canal [4]. The global prevalence of maternal GBS colonization is approximately 18%, with higher rates reported in sub-Saharan Africa (25.8%) and the highest prevalence documented in Mali (41.1%) [5,6]. Approximately 50% of infants born to colonized mothers acquire GBS, and 1–2% of those develop invasive disease [7]. In many high-income countries, screening for GBS is performed at 35–37 weeks and intrapartum antibiotic prophylaxis (IAP) is administered during labour to those who screen positive or meet clinical risk criteria [8]. However, implementation of IAP in low and middle-income countries is constrained by logistical and financial limitations [9]. Furthermore, IAP does not prevent GBS-associated LOD, stillbirths [10] or preterm births [9].

Maternal immunization represents a promising alternative strategy to protect newborns through transplacental transfer of GBS-specific immunoglobulin G (IgG) antibodies [11]. A hexavalent capsular polysaccharide-based vaccine (GBS6) and a protein-based vaccine candidate (N-terminal domains of the alpha-like proteins AlphaCN, RibN, Alp1N, and Alp2/3 N) is currently under development and has demonstrated immunogenicity in phase 2 clinical trial in pregnant women [12–14]. Nevertheless, data on GBS serotype distribution and naturally acquired immunity in African populations remain limited, which is critical for informing vaccine design and implementation strategies. Additionally, assessing maternally derived immunity in newborns at birth is essential for guiding maternal immunization programs.

This study aimed to characterize regional differences in GBS serotype prevalence and naturally acquired immunity. The primary objective was to determine the prevalence and serotype distribution of GBS colonization among pregnant women in Ghana and Zimbabwe. The secondary objective was to quantify serotype-specific IgG levels in maternal and cord blood samples to evaluate natural immunity in pregnant women and transplacental antibody transfer to newborns. Furthermore, we investigated GBS-associated stillbirths to better understand its contribution to perinatal mortality in these populations.

2. Methods

2.1. Study design and population

This prospective cohort study was conducted among pregnant women and their newborns at the Kintampo Health Research Centre (KHRC) in Kintampo, Ghana and the Centre for Sexual Health and HIV/AIDS Research (CSHHAR) in Harare, Zimbabwe from October 2018 to October 2020. Inclusion criteria were pregnant women between 13 and 27 weeks gestational age who resided in the catchment areas of the two study sites, intended to deliver within the study area, and were willing to participate in the study. Additionally, infants with potentially lethal congenital abnormalities identified at birth were excluded from follow-up although data and biological samples were collected at birth if the mothers provided consent.

2.2. Fieldwork

Pregnant women were identified through household visits by the study staff. Monthly follow-up visits were conducted during pregnancy, increasing to every 1–2 weeks after 36 weeks gestation. Infants were followed during predefined intervals for the first year of life (Fig. 1) via home visits or phone calls. Participant enrollment commenced on 31st October 2018 in Ghana and 9th October 2018 in Zimbabwe and concluded on 25th and 29th March 2019, respectively. Infant follow-up continued until October 2020 in both countries. In Ghana, study staff maintained a 24-h shift at two participating hospitals and a private maternity home with high numbers of deliveries to collect specimens and required data. In Zimbabwe, enrolment was conducted through community mapping in two high-density suburbs surrounding the City of Harare clinic (Mabvuku clinic). The study activities were centrally coordinated by the Liverpool School of Tropical Medicine (LSTM). Data on sociodemographic characteristics, medical and obstetric history were collected at baseline.

Harmonized protocols, standard operating procedures, and centralized procurement of reagents and kits were implemented across both sites. Structured questionnaires were administered electronically in real-time. A data management system was established at LSTM, incorporating built-in validation and consistency checks using RedCap (KHRC) and SurveyCTO (CeSHHAR).

Data collected at KHRC were hosted locally and de-identified before periodic sharing with LSTM. Data from CeSHHAR were transmitted directly to LSTM. Data managers at both sites conducted regular reviews to ensure accuracy and consistency.

2.3. Specimen collection

Recto-vaginal swabs and blood samples from pregnant women were collected from 36 weeks gestation or prior to delivery, preferably before the rupture of membranes. For participants who were not available for collection of samples before onset of labour, samples were collected as soon as possible during delivery. Recto-vaginal swabs were collected using Rayon-tipped swabs that were placed into Amies transport medium (TRANSWAB® MW170). Cord blood samples were collected after delivery at health facilities or at home in the case of home deliveries. Blood samples and recto-vaginal swabs were transported within 4 h of collection to the Seth Owusu-Agyei's Medical Laboratory at KHRC and the National Microbiology Reference Laboratory in Zimbabwe, where the specimens were immediately processed and stored. Serum samples and GBS isolates were subsequently shipped to the Vaccines and Infectious Diseases Analytics (WITS-VIDA) research unit at the University of the Witwatersrand, South Africa, for further serotyping and antibody analysis.

2.4. Laboratory investigations

2.4.1. GBS Culture and serotyping

Between 3 and 5 mL of blood was aspirated from the chest of stillborn infants within 24 h of birth and inoculated into paediatric blood culture bottles (Peds Plus). Cultures were incubated using the BACTEC 9050 system for up to five days. Positive cultures were typically detected within 24–48 h. Positive blood cultures and recto-vaginal swabs were inoculated onto GBS CHROMagar selective media and incubated aerobically at 35–37 °C. Plates were examined after 18–24 h for suspected GBS colonies, identified by their characteristic mauve coloration. Plates without mauve-like colonies were re-incubated for an additional 24 h. If no mauve-like colonies were observed after 48 h, the samples were considered negative for GBS. Suspected colonies were identified based on colonial morphology and colour and further confirmed by Gram staining, CAMP test, bile esculin, and latex agglutination test with specific Group B antisera (Strep B latex kit, Prolab Diagnostics, USA). All confirmed GBS isolates were stored in skimmed-milk tryptone glucose

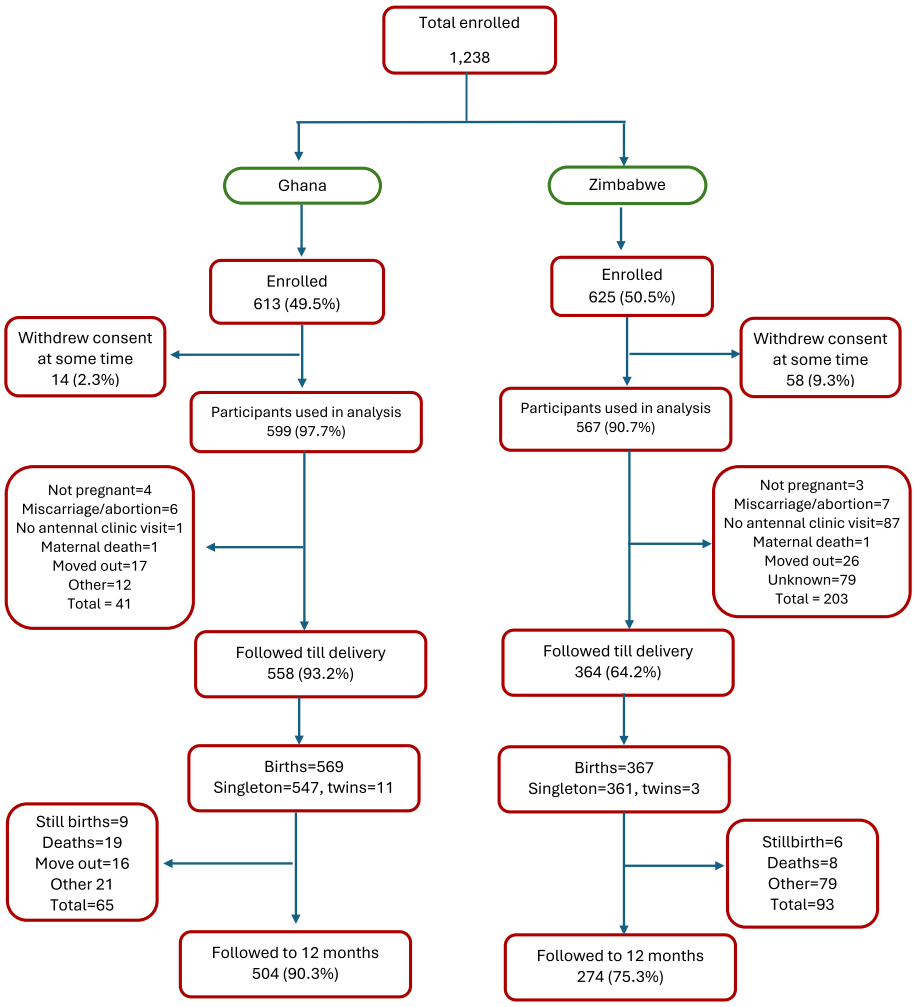


Fig. 1. Study profile.

and glycerol (STGG) medium and shipped to Wits-VIDA, in South Africa for serotyping. Serotyping was performed by the latex agglutination method with specific antisera against types Ia, Ib and II to IX capsular polysaccharides (CPS) antigens (SSI Diagnostica, Denmark) as described [15]. Serologically non typeable isolates were further typed by a polymerase chain reaction (PCR) method [16].

2.4.2. *Serotype-specific antibodies analysis*

GBS capsular polysaccharide (CPS) specific-IgG in serum samples were measured at Wits-VIDA using a multiplex immunoassay. Briefly, Magnetic microsphere beads (Biorad, USA) were coated with CPS-poly-L-lysine conjugates for GBS serotypes Ia, Ib, II, III, IV and V (provided by Pfizer) using a two-step carbodiimide reaction. Samples were diluted in assay buffer (0.5% bovine serum albumin on 1× phosphate-buffered saline (PBS), 0.05% Tween-20, 0.02% sodium azide, pH 7.2). An in-house serum composed of purified pooled human IgG (Polygam; National Bioproducts, South Africa) was calibrated with the standard serotype specific GBS reference serum [17]; and was used as reference serum. Samples and beads were incubated overnight at 4 °C. After washing (1× PBS, 0.05% Tween-20), samples were incubated for 1.5 h, with a 1:500 dilution of R-Phycoerythrin-conjugated goat anti human IgG Fcγ specific (Jackson immune research Cat. #109–115-098). Assays were performed in true duplicate and each plate included in-house high and low control sera. The results for serum IgG are given in μg/mL with lower detection limits of 0.0012, 0.0018, 0.0030, 0.0016, 0.005 and 0.0070 for serotype Ia, Ib, II, III, IV and V, respectively. For statistical analysis, samples with values below these limits were assigned values of half of the lower limit of detection. Bead fluorescence was read with the Bio-Plex 200 instrument (Bio-Rad) using Bio-Plex manager 6.0 software (Bio-Rad).

2.4.3. *Sample size estimation*

Based on an anticipated prevalence range of 15–30%, a sample size of approximately 400 pregnant women per site was determined to achieve a precision of ±4.5%. To account for potential loss to follow-up, missed biological sample collection, and participant dropout, the target enrollment was increased to 600 women per site, allowing for up to 33% attrition. Consequently, the total planned sample size for the study across both sites was 1200 pregnant women.

2.5. *Statistical analysis*

Data were analysed using Stata version 14.2 statistical software. Baseline demographic and clinical characteristics were summarised using descriptive statistics only, presented as counts with percentages for categorical variables and medians with interquartile ranges for continuous variables. The Prevalence of GBS colonization among pregnant women was defined as the proportion of mothers with GBS-positive recto-vaginal swab results among those with available swab data. Maternal and cord blood GBS serotype-specific anti-capsular IgG concentrations were summarised as geometric mean concentrations (GMCs) with 95% confidence intervals (CIs). Comparisons of GMCs between predefined groups were performed using unpaired *t*-tests.

For analyses of transplacental antibody transfer, inclusion was

restricted to maternal-cord blood dyads with samples collected within ±2 days of each other. When more than one maternal serum sample was available, the sample collected closest to delivery was used. Transplacental transfer ratios were calculated as the ratio of cord blood IgG GMCs to maternal serum IgG GMCs. In Ghana, 115 maternal serum samples and 125 cord blood samples were available for serological testing, of which 57 maternal–cord blood dyads met the predefined ±2-day collection criterion and included in transplacental transfer analyses. In Zimbabwe, 42 maternal serum samples and 41 cord blood samples were available for testing; however, only 8 maternal–cord blood dyads met the ±2-day criterion. Given the small number of paired samples, transplacental transfer ratio analyses were not performed for Zimbabwe.

The cord anti-CPS IgG concentrations associated with serological thresholds of risk reduction (SToRR) of invasive GBS disease by 80% was suggested to be 0.302 μg/mL and 0.198 μg/mL for serotype Ia and III, respectively, based on estimates from a maternal GBS6 vaccine clinical trial [13].

2.6. Ethics

Ethical approvals for the study were obtained from the Kintampo Health Research Centre's Institutional Ethics Committee (KHRCIEC/2018–8), the Ghana Health Service Ethics Review Committee (GHS-ERC:001/06/18), the Medical Research Council of Zimbabwe (MRCZ/A/2317) and the Liverpool School of Tropical Medicine's Research Ethics Committee (LSTM/18–034). Written informed consent was obtained from all study participants.

3. Results

A total of 1238 pregnant women were enrolled in the study (Fig. 2). Of these, 72 (5.2%) participants withdrew consent at some point during the follow-up period and were excluded from the analysis. The final analytic cohort included 1166 women (Ghana, $n = 599$ and Zimbabwe, $n = 567$), whose socio-demographic characteristics, medical history, and obstetric profiles are presented in Table 1. The median age of participants was 26 years [Interquartile Range (IQR): 22–31] and 25 years (IQR: 21–32) in Ghana and Zimbabwe, respectively. Of the 1166 enrolled women, 922 (558 in Ghana and 364 in Zimbabwe) were successfully followed through to delivery, 244 (41 in Ghana and 203 in Zimbabwe) were lost to follow up prior to delivery for various reasons (Fig. 1).

3.1. Prevalence of GBS colonization and serotypes distribution

Of the 922 women followed to delivery, rectovaginal swabs were available for 766 women participants (Ghana, $n = 437$ and Zimbabwe, $n = 329$). Rectovaginal swabs were not collected for 156 participants due to delivery outside the study area. The prevalence of maternal GBS colonization was 15.6%; (68/437) in Ghana and 15.2% (50/329) in Zimbabwe. Baseline socio-demographic characteristics between colonized and not colonized women were similar in both the countries (Supplementary table 1). The majority of GBS isolates in both countries were either serotypes Ia, III, or V, identified from 19%, 32%, and 29% of isolates in Ghana; and 34%, 32%, and 24% of isolates in Zimbabwe, respectively (Table 2). Serotypes Ib, II, and IV were each detected in <10% of isolates in both countries. Notably, serotype VII was found exclusively in Ghana (2%), while serotype VIII was detected only in Zimbabwe (4%).

3.2. Incidence of GBS among stillbirths

A total of 936 births were recorded, 569 from Ghana and 367 from Zimbabwe. During the study period, a total of 15 cases of stillbirth were identified with 9 cases from Ghana and 6 from Zimbabwe. The overall incidence of stillbirth was estimated at 16.0 per 1000 births (95% CI: 9.7–22.6). Site-specific incidence rates were 15.8 per 1000 births (95% CI: 8.2–30.4) in Ghana and 16.3 per 1000 births (95% CI: 7.3–36.4) in Zimbabwe. Chest aspirates were successfully collected from 9 of the 15 stillbirth cases (Ghana: $n = 5$; Zimbabwe: $n = 4$). Among these, GBS was isolated from 3 cases, one from Ghana and two from Zimbabwe corresponding to a detected proportion of GBS-associated stillbirths of 33% (3/9); 95% CI: 7–70 among the tested stillbirths.

Table 1
Baseline socio-demographic and medical characteristics of participants.

Characteristics	Ghana (N = 599) Number (%)	Zimbabwe (N = 567) Number (%)
Age in years		
<20	98 (16.4)	105(18.5)
20–29	326 (54.4)	287(50.6)
>30	175 (29.2)	175 (30.6)
Median age (IQR)	26 (22–31)	25 (21–32)
Highest educational level		
None or primary	279 (46.6)	46 (8.1)
Secondary and above	319 (53.3)	521(91.9)
Missing	1 (0.2)	
Marital status		
Never married	34 (5.7)	19 (3.6)
Married/cohabitating	559 (93.3)	526 (92.8)
Divorced/widowed	6 (1.0)	22 (3.8)
Occupation		
Unemployed	179 (29.9)	450 (79.4)
Employed	420 (70.1)	117 (20.6)
HIV infected		
Prior diagnosis	11 (1.8)	36 (6.3)
Diagnosed during ANC	4(1.2)	8 (1.4)
Infant received PMTCT	10 (1.7)	14 (2.5)
Pre-existing diagnoses		
Any of diabetes, cardiac disease, hypertension, epilepsy, asthma, chronic bronchitis, chronic cough	39 (6.5)	68 (12.0)
Diagnosis / treatment in the month before pregnancy		
Any of UTI, malaria, TB, mental illness, hep B, dental problems	178 (29.7)	65 (11.5)
Obstetric history (Median (IQR)		
Parity	1 (0–3)	2 (1–2)
Gravidity	3 (2–4)	2 (1–3)
Gestational age at enrolment (weeks)	22 (18–26)	22 (18–26)

Table 2
Serotype distribution of Group B Streptococcus isolates from pregnant women, by country.

Serotype	Ghana ($N = 68$) Number (%)	Zimbabwe ($N = 50$) Number (%)	All ($N = 118$) Number (%)
Ia	13 (19)	17 (34)	30 (25)
Ib	2 (3)	1 (2)	3 (3)
II	6 (9)	1 (2)	7 (6)
III	22 (32)	16 (32)	38 (32)
IV	4 (6)	1 (2)	5 (4)
V	20 (29)	12 (24)	32 (27)
VII	1 (2)	0 (0)	1 (1)
VIII	0 (0)	2 (4)	2 (2)

3.3. Maternal serotype-specific IgG antibodies

Of the 922 women followed to delivery, maternal blood samples were available for serological analysis from 115 women in Ghana and 42 women in Zimbabwe. Seroprevalence of IgG antibodies varied by serotypes and country. Geometric mean concentrations of serotype-specific IgG were significantly higher in Ghana compared to Zimbabwe for serotype Ib (0.11 vs 0.02 μg/mL, $p = 0.0001$), serotype II (0.24 vs 0.06 μg/mL, $p = 0.0001$), and serotype IV (0.03 vs 0.006 μg/mL, $p < 0.0001$);

Table 3
Comparison of Group B Streptococcus serotype specific IgG in maternal blood between countries.

Serotype	Ghana (*N* = 115)	Zimbabwe (*N* = 42)	Comparison
	GMC (95% CI)	GMC (95% CI)	*p*-value
Ia	0.04 (0.02–0.06)	0.04 (0.01–0.13)	0.75
Ib	0.11 (0.06–0.17)	0.02 (0.01–0.03)	0.0001
II	0.24 (0.17–0.33)	0.06 (0.03–0.12)	0.0001
III	0.13 (0.08–0.21)	0.06 (0.03–0.12)	0.06
IV	0.03 (0.02–0.05)	0.006 (0.004–0.011)	<0.0001
V	0.16 (0.11–0.26)	0.14 (0.07–0.29)	0.76

Table 3. In Ghana, women colonized with serotype Ia had higher homotypic IgG GMC's compared to non-colonized (0.51 vs 0.03 μg/mL, $p = 0.002$); Table 4. For serotypes III and V, no significant differences in IgG titres were observed between colonized and non-colonized. In Zimbabwe, colonization with serotypes Ia, III, or V did not result in differences in homotypic IgG titres (Table 4).

3.4. Transplacental ratio of GBS serum IgG antibodies in mother-newborn dyads

Among the 57 maternal-cord paired samples analysed in Ghana, maternal IgG GMCs varied by serotype, ranging from 0.023 μg/mL (serotype IV) to 0.219 μg/mL (serotype II). The cord-to-maternal IgG ratio for serotype-specific antibodies exceeded 0.8 across all serotypes, indicating efficient transplacental transfer (Table 5).

Among the available cord blood samples analysed (Ghana, $n = 125$; Zimbabwe, $n = 41$), the proportions of newborns with serotype-specific IgG concentrations above the SToRR associated with an estimated 80% reduction in invasive GBS disease were 25.6% (95% CI: 18.2–34.2) for serotype Ia and 38.4% (95% CI: 29.5–47.5) for serotype III in Ghana (Table 6). In Zimbabwe, corresponding proportions were 34.1% (95% CI: 20.1–50.1) for serotype Ia and 26.8% (95% CI: 14.2–42.9) for serotype III.

4. Discussion

We observed a comparable prevalence of maternal GBS colonization (~15%) in Ghana and Zimbabwe, with most isolates belonging to globally dominant serotypes Ia, III, and V. Notably, serotype VIII was detected in Zimbabwe for the first time, suggesting potential shifts in regional serotype epidemiology. Our findings confirm substantial heterogeneity in maternal colonization prevalence and serotype profiles across African settings [6,18–20]. The observed prevalence is comparable with GBS colonization rates of 19% reported in earlier studies in Ghana [21,22]; whilst being lower than the prevalence documented in another study (25.5–28%) [23]. In Zimbabwe, previously reported prevalence has ranged from 10% to as high as 60% [24,25]. Overall, the prevalence observed in both countries aligns with the recent estimates for sub-Saharan Africa (19.3%) [20] and West Africa (18.7%) [18], but is slightly lower than rates reported for the Southern Africa (23.7%) [18] and the African continent overall (22.4%) [18,19]. Although, the reasons for geographical variations remain uncertain, differences in sampling strategies, culture methods, circulating strains, and host immune factors are known to influence GBS colonization frequency [19].

Table 4
Comparison of maternal Group B Streptococcus serotype specific IgG among colonized and uncolonized participants.

Serotype	Colonized GMC (95% CI)	Un-colonized GMC (95% CI)	p-value
Ghana[a]			
Ia	0.61 (0.17–2.23), n = 12	0.03 (0.01–0.04), *n* = 103	0.003
III	0.10 (0.03–0.32), *n* = 17	0.14 (0.08–0.23), *n* = 98	0.61
V	0.48 (0.08–2.86), *n* = 13	0.14 (0.09–0.23), *n* = 102	0.09
Zimbabwe [b]			
Ia	0.11 (0.01–1.92), *n* = 10	0.03 (0.01–0.11), n = 32	0.35
III	0.08 (0.01–0.57), n = 10	0.05 (0.02–0.12), *n* = 32	0.60
V	0.20 (0.04–1.02), n = 10	0.13 (0.06–0.30), n = 32	0.62

[a] One mother was HIV-infected (un-colonized by any GBS serotype) and was included in the un-colonized group.

[b] Five mothers were HIV-infected, all were colonized with GBS (serotype III = 1, serotype V = 3 and VIII = 1).

The potential effectiveness of a multivalent GBS vaccine will depend on regional serotype distribution. In this study, dominant serotypes Ia, III, and V, accounted for over 80% of isolates, consistent with previous reports from Ghana, Zimbabwe [21], and global data [26]. In contrast, the low prevalence of serotype VII (2%) in Ghana differs markedly from a prior study in Ghana reporting a prevalence of 42.9% [23]. The identification of serotype VIII in Zimbabwe further suggests dynamic shifts in serotype epidemiology [27,28]. Serotype VIII is more commonly reported in East Asia, accounting for 35.6% and 20% of isolates among pregnant women in Japan and South Korea, respectively [29,30]. Emerging serotypes VI-IX are increasingly reported in Asia and Africa; colonizing up to 16% of pregnant women and contributing to up to 8% of early-onset neonatal GBS cases [26,31]. A meta-analysis by Gizachew et al, estimated pooled proportions of 16–30% of serotypes VI–IX in Africa, emphasizing the need for multivalent vaccine formulations that account for regional and temporal variability [18].

We observed significant inter-country differences in maternal serotype-specific IgG concentrations. Women in Ghana exhibited higher IgG levels than those in Zimbabwe for serotypes II and IV, likely reflecting higher carriage rates of these serotypes (9% vs 2% for II; 6% vs 2% for IV). However, discordance between carriage prevalence and antibody concentrations was also observed, such as higher IgG titers for serotype Ib in Ghana despite comparable carriage prevalence in Zimbabwe. These findings suggest that factors beyond serotype burden alone influence humoral immunity to GBS. Similar regional heterogeneity in naturally acquired GBS-specific IgG responses has been documented previously, including higher IgG titers among women in Bangladesh compared to Malawi [32]. Such variability implies that multivalent GBS vaccines may elicit variable immune responses across populations.

Despite efficient transplacental transfer of GBS serotype-specific IgG antibodies (cord-to-maternal ratios >0.8 for all serotypes in Ghana), most newborns had antibody concentrations below published SToRR for invasive GBS disease. Over 60% of newborns in Ghana and >65% in Zimbabwe had IgG concentrations below the SToRR for serotypes Ia and III. This gap in neonatal immunity reinforces the need for maternal immunization strategies capable of inducing robust serotype-specific antibody responses during pregnancy.

An exploratory finding of this study was the relatively high proportion of GBS-associated stillbirths (33%), exceeding pooled estimates of approximately 4% reported for sub-Saharan Africa (Kenya, Mozambique, and South Africa) [33]. Within our cohort, GBS was detected in 50% of stillbirths in Zimbabwe and 20% in Ghana, suggesting a potential contribution of in-utero GBS infection to perinatal mortality in countries with high stillbirth rates, including Ghana (22.7 per 1000 births) and Zimbabwe (20.6 per 1000 births) [34–36]. Given that case ascertainment relied solely on chest aspirates in this study, the true burden is likely underestimated. Broader specimen types investigated in Mozambique and South Africa have reported higher detection rates (17% [95% CI, 4%–41%] and 9.8%, respectively) compared to restricted sample types [35,36]. Modelling studies suggest that a maternal GBS vaccine with 80% efficacy and 90% coverage (assuming

Table 5
Transplacental ratio of Group B Streptococcus serotype specific IgG for paired mother and cord blood samples in Ghana.

	Serotype					
	Ia	Ib	II	III	IV	V
Maternal GMC (95% CI)	0.031	0.098	0.219	0.174	0.023	0.103
N = 57	(0.011–0.082)	(0.039–0.25)	(0.123–0.391)	(0.081–0.373)	(0.010–0.050)	(0.046–0.227)
Cord GMC (95% CI)	0.025	0.095	0.237	0.151	0.020	0.091
N = 57	(0.009–0.068)	(0.038–0.236)	(0.133–0.419)	(0.068–0.336)	(0.010–0.043)	(0.041–0.203)
Cord-Maternal GMC Ratio	0.81	0.97	1.08	0.87	0.87	0.88
(95% CI)	(0.62–1.11)	(0.74–1.26)	(0.88–1.33)	(0.70–1.087)	(0.74–1.10)	(0.64–1.22)

Table 6
Proportion of newborns with cord blood IgG concentrations above the serological threshold of risk reduction (SToRR) for an estimated 80% reduction in invasive Group B Streptococcus disease risk with serotype Ia and III.

Serotype	Ghana	Zimbabwe
Ia (≥0.302 μg/ml)	25.6% (95% CI 18.2–34.2; N = 32/125)	34.1% (95% CI 20.1–50.1; *N* = 14/41)
III (≥0.198 μg/ml)	38.4% (95% CI 29.8–47.5; *N* = 48/125)	26.83% (95%CI 14.2–42.9; N = 11/41)

no IAP) could prevent approximately 41,000 stillbirths globally [37], underscoring the urgency for strengthened surveillance to better define the contribution of GBS to stillbirths in low- and middle-income countries.

Several limitations should be considered when interpreting these findings. First, although the original study was powered to estimate maternal colonization prevalence, there was substantial attrition between enrollment and delivery, and rectovaginal swabs were available for only a subset of women followed to delivery. This attrition, largely due to delivery outside the study catchment areas, reduced the effective sample size for colonization analyses and may have introduced selection bias if women with missing samples differed systematically from those with complete data. Second, serological analyses were constrained by limited serum volumes and sample availability, resulting in a relatively small number of maternal–cord blood dyads eligible for transplacental transfer analyses, particularly in Zimbabwe where paired analyses could not be performed. Third, reliance on direct plating without selective enrichment may have reduced sensitivity for GBS detection, potentially leading to underestimation of GBS colonization prevalence. Finally, the SToRR applied (0.302 μg/mL for serotype Ia and 0.198 μg/mL for serotype III) were derived from a study using a different multiplex assay (the Gaston assay). To assess comparability, 30 serum samples using both the Gaston assay and the multiplex immunoassay used in this study were analysed. Correlation coefficients varied by serotype, with high concordance observed for serotype Ia ($r = 0.9915$) and serotype III ($r = 0.9642$), supporting the validity of the thresholds applied.

5. Conclusion

Maternal GBS colonization prevalence in Ghana and Zimbabwe is consistent with the reported sub-Saharan African estimates, dominated by serotypes Ia, III, and V. Although naturally acquired serotype-specific IgG immunity is present in pregnant women and efficiently transferred to newborns, most infants are born with antibody concentrations below the threshold associated with reduced risk of invasive GBS disease. These findings indicate that natural immunity alone is insufficient for neonatal protection and reinforce the rationale for multivalent maternal GBS vaccines targeting dominant serotypes in these settings.

CRediT authorship contribution statement

Irene Apewe Adjei: Writing – review & editing, Writing – original draft, Methodology, Investigation, Data curation. **Zivai Mupambireyi:** Writing – review & editing, Methodology, Investigation, Data curation. **Sarah A. White:** Writing – review & editing, Writing – original draft, Formal analysis. **Edward Matsikire:** Writing – review & editing, Validation, Data curation. **Alex Manu:** Writing – review & editing, Validation, Supervision, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Nisha Dhar:** Writing – review & editing, Writing – original draft. **Louisa Iddrisu:** Writing – review & editing, Methodology, Investigation. **Elizabeth Mathai:** Supervision, Project administration, Funding acquisition, Conceptualization. **Sam Newton:** Writing – review & editing. **Luis Cuevas:** Writing – original draft. **Oscar Agyei:** Writing – review & editing, Validation, Data curation. **Andrew Carey:** Writing – review & editing. **Yeetey Akpe Enuameh:** Writing – review & editing. **Jones Opoku-Mensah:** Writing – review & editing, Methodology, Investigation. **Matthews Mathai:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Frances Cowan:** Writing – review & editing, Writing – original draft, Supervision, Funding acquisition, Conceptualization. **Kwaku Poku Asante:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Gaurav Kwatra:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Funding acquisition, Formal analysis, Conceptualization.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2026.128626.

Data availability

Data will be made available on request.

References

[1] Gonçalves BP, Procter SR, Paul P, Chandna J, Lewin A, Seedat F, et al. Group B Streptococcus infection during pregnancy and infancy: estimates of regional and global burden. Lancet Glob Health 2022;10:e807–19.

[2] Seale AC, Blencowe H, Bianchi-Jassir F, Embleton N, Bassat Q, Ordi J, et al. Stillbirth with Group B Streptococcus disease worldwide: systematic review and meta-analyses. Clin Infect Dis 2017;65:S125–s32.

[3] Bianchi-Jassir F, Seale AC, Kohli-Lynch M, Lawn JE, Baker CJ, Bartlett L, et al. Preterm birth associated with Group B Streptococcus maternal colonization worldwide: systematic review and meta-analyses. Clin Infect Dis 2017;65:S133–42.

[4] Manuel G, Twentyman J, Noble K, Eastman AJ, Aronoff DM, Seepersaud R, et al. Group B Streptococcal infections in pregnancy and early life. Clin Microbiol Rev 2025;38:e0015422.

[5] Russell NJ, Seale AC, O'Driscoll M, O'Sullivan C, Bianchi-Jassir F, Gonzalez-Guarin J, et al. Maternal colonization with Group B Streptococcus and serotype distribution worldwide: systematic review and meta-analyses. Clin Infect Dis 2017;65:S100–s11.

[6] Kwatra G, Izu A, Cutland C, Akaba G, Ali MM, Ahmed Z, et al. Prevalence of group b streptococcus colonisation in mother-newborn dyads in low-income and middle-income south asian and african countries: a prospective, observational study. Lancet Microbe 2024;5:100897.

[7] Russell NJ, Seale AC, O'Sullivan C, Le Doare K, Heath PT, Lawn JE, et al. Risk of early-onset neonatal Group B Streptococcal disease with maternal colonization worldwide: systematic review and meta-analyses. Clin Infect Dis 2017;65:S152–s9.

[8] Le Doare K, O'Driscoll M, Turner K, Seedat F, Russell NJ, Seale AC, et al. Intrapartum antibiotic chemoprophylaxis policies for the prevention of Group B Streptococcal disease worldwide: systematic review. Clin Infect Dis 2017;65:S143–51.

[9] Nishihara Y, Dangor Z, French N, Madhi S, Heyderman R. Challenges in reducing group b streptococcus disease in african settings. Arch Dis Child 2017;102:72–7.

[10] Verani JR, McGee L, Schrag SJ. Prevention of perinatal group B streptococcal disease–revised guidelines from CDC, 2010. MMWR Recomm Rep 2010;59:1–36.

[11] Madhi SA, Dangor Z, Heath PT, Schrag S, Izu A, Sobanjo-Ter Meulen A, et al. Considerations for a phase-III trial to evaluate a Group B Streptococcus polysaccharide-protein conjugate vaccine in pregnant women for the prevention of early- and late-onset invasive disease in young-infants. Vaccine 2013;31(Suppl. 4):D52–7.

[12] Carreras-Abad C, Ramkhelawon L, Heath PT, Le Doare K. A vaccine against group b streptococcus: recent advances. Infect Drug Resist 2020;13:1263–72.

[13] Madhi SA, Anderson AS, Absalon J, Radley D, Simon R, Jongihlati B, et al. Potential for maternally administered vaccine for infant group b streptococcus. N Engl J Med 2023;389:215–27.

[14] Heath P.T., Zuma-Gwala N., Helmig R.B., Horne E., Kjærbye-Thygesen A., Crusell M.K.W., Nchabeleng M., Strehlau R., Khalil M.R., Jones C.E., Biccler J., Dimsits J., Johansson-Lindbom B., Fischer P.B., Oostvogels L., Madhi S.A., MVX0004 study group. Immunogenicity and safety of a group B Streptococcus vaccine (GBS-AlpN) in pregnant women and their infants: a phase 2, multicentre, observer-blind, randomised, placebo-controlled study. Lancet Infect Dis. 2025 Dec 9:S1473-3099(25)00659-0. doi: 10.1016/S1473-3099(25)00659-0. Epub ahead of print. Erratum in: Lancet Infect Dis. 2026 Mar;26(3):e146. doi: 10.1016/S1473-3099(26)00048-4. PMID: 41386262.

[15] Afshar B, Broughton K, Creti R, Decheva A, Hufnagel M, Kriz P, et al. International external quality assurance for laboratory identification and typing of streptococcus agalactiae (group b streptococci). J Clin Microbiol 2011;49:1475–82.

[16] Poyart C, Tazi A, Réglier-Poupet H, Billoët A, Tavares N, Raymond J, et al. Multiplex PCR assay for rapid and accurate capsular typing of group B *streptococci*. J Clin Microbiol 2007;45:1985–8.

[17] Kwatra G, Adrian PV, Shiri T, Buchmann EJ, Cutland CL, Madhi SA. Natural acquired humoral immunity against serotype-specific group b streptococcus rectovaginal colonization acquisition in pregnant women. Clin Microbiol Infect 2015;21(568):e13–21.

[18] Gizachew M, Tiruneh M, Moges F, Tessema B. Streptococcus agalactiae maternal colonization, antibiotic resistance and serotype profiles in africa: a meta-analysis. Ann Clin Microbiol Antimicrob 2019;18:14.

[19] Kwatra G, Cunnington MC, Merrall E, Adrian PV, Ip M, Klugman KP, et al. Prevalence of maternal colonisation with group b streptococcus: a systematic review and meta-analysis. Lancet Infect Dis 2016;16:1076–84.

[20] Wadilo F, Hailemeskel E, Kedir K, El-Khatib Z, Asogba PC, Seyoum T, et al. Prevalence of group B streptococcus maternal colonization, serotype distribution, and antimicrobial resistance in sub-Saharan Africa: a systematic review and meta-analysis. J Glob Antimicrob Resist 2023;32:134–44. https://doi.org/10.1016/j.jgar.2023.02.004.

[21] Vinnemeier CD, Brust P, Owusu-Dabo E, Sarpong N, Sarfo EY, Bio Y, et al. Group b streptococci serotype distribution in pregnant women in Ghana: assessment of potential coverage through future vaccines. Trop Med Int Health 2015;20:1516–24.

[22] Enweronu-Laryea CC, Damale N, Newman MJ. Prevalence of group B streptococcus in pregnant women attending a tertiary hospital in Ghana in 2001. Parity 2011;4:0.476.

[23] Slotved HC, Dayie N, Banini JAN, Frimodt-Moller N. Carriage and serotype distribution of streptococcus agalactiae in third trimester pregnancy in southern Ghana. BMC Pregnancy Childbirth 2017;17:238.

[24] 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;89:250–5.

[25] Mudzana R, Mavenyengwa RT, Gudza-Mugabe M. Analysis of virulence factors and antibiotic resistance genes in group b streptococcus from clinical samples. BMC Infect Dis 2021;21:125.

[26] Bianchi-Jassir F, Paul P, To KN, Carreras-Abad C, Seale AC, Jauneikaite E, et al. Systematic review of group B streptococcal capsular types, sequence types and surface proteins as potential vaccine candidates. Vaccine 2020;38:6682–94.

[27] Mavenyengwa RT, Maeland JA, Moyo SR. Serotype markers in a streptococcus agalactiae strain collection from Zimbabwe. Indian J Med Microbiol 2010;28:313–9.

[28] Moyo SR, Mudzori J, Tswana SA, Maeland JA. Prevalence, capsular type distribution, anthropometric and obstetric factors of group b streptococcus (streptococcus agalactiae) colonization in pregnancy. Cent Afr J Med 2000;46:115–20.

[29] Choi SJ, Kang J, Uh Y. Recent epidemiological changes in group b streptococcus among pregnant korean women. Ann Lab Med 2021;41:380–5.

[30] Lachenauer CS, Kasper DL, Shimada J, Ichiman Y, Ohtsuka H, Kaku M, et al. Serotypes VI and VIII predominate among group b streptococci isolated from pregnant japanese women. J Infect Dis 1999;179:1030–3.

[31] Elangovan D, Neeravi A, Sahni RD, Santhanam S, Beck MM, Adhiya R, et al. Serotype distribution and antimicrobial susceptibility profile of invasive group b streptococcal disease-in south indian population. Indian J Med Microbiol 2023;45:100392.

[32] Khandaker S, Sharma S, Hall T, Lim S, Lehtonen J, Leung S, et al. Diversity in naturally acquired immunity to group B *Streptococcus*: a comparative study of women from Bangladesh, Malawi, and the United Kingdom. J Infect Dis 2024;231:e456–67.

[33] Seale AC, Blencowe H, Bianchi-Jassir F, Embleton N, Bassat Q, Ordi J, et al. Stillbirth with group b streptococcus disease worldwide: systematic review and meta-analyses. Clin Infect Dis 2017;65:S125–32.

[34] Lawn JE, Blencowe H, Waiswa P, Amouzou A, Mathers C, Hogan D, et al. Stillbirths: rates, risk factors, and acceleration towards 2030. The Lancet 2016;387:587–603.

[35] Mahtab S, Madewell ZJ, Madhi SA, Wise A, Swart PJ, Velaphi S, et al. Stillbirths and neonatal deaths caused by group b streptococcus in Africa and South Asia identified through Child Health and Mortality Prevention Surveillance (CHAMPS). Open Forum Infect Dis 2023;10:ofad356.

[36] Menendez C, Castillo P, Martínez MJ, Jordao D, Lovane L, Ismail MR, et al. Validity of a minimally invasive autopsy for cause of death determination in stillborn babies and neonates in Mozambique: an observational study. PLoS Med 2017;14:e1002318.

[37] Seale AC, Bianchi-Jassir F, Russell NJ, Kohli-Lynch M, Tann CJ, Hall J, et al. Estimates of the burden of group b streptococcal disease worldwide for pregnant women, stillbirths, and children. Clin Infect Dis 2017;65:S200–s19.