**Supplemental Material**

**Temporal trends in pregnancy-associated stroke and its outcomes among women with hypertensive disorders of pregnancy**

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**Supplemental Methods**

**Study design and variables**

All eligible discharges with an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnosis codes of 650 (*Normal delivery),*V27 (*Outcome of delivery)*, selected delivery related procedures and diagnosis-related group (DRG) delivery codes were used to identify the delivery population. As each pregnancy will result in only one delivery hospitalisation per year, the discharge record is linked to each pregnancy. However, many women have more than one pregnancy, and therefore one woman can have multiple delivery hospitalisation episodes over the study period. Codes for hypertensive disorders of pregnancy (HDP) (Supplemental Table IA) were then applied to the delivery population in order to identified the HDP population in this study.

Patient demographics that were extracted include: age, race and ethnicity, median household income according to ZIP code, admission day (weekday or weekend), hospital region, and patient comorbidity conditions. As each discharge record included information on up to 30 diagnoses that the patient had (15 between 2004 and 2008, 25 between 2009 and 2013 and 30 in 2014), we used these diagnosis codes to identify the comorbidity conditions recorded during the delivery hospitalisation.

To account for the complex survey design of the NIS database, the survey estimation commands were used (svy prefix in Stata) for all analyses. As the discharge records were not sampled individually but by hospitals, the survey estimation accounted for the clustering of records within hospitals by defining each hospital to be the primary sampling unit. In order to calculate national estimates and variances, we used sampling weights for each individual discharge provided by the AHRQ. The sampling weights are needed because of the study design where different observations may have different probabilities of selection.

There has been a change in sampling strategy over time to generate more generalizable estimates by reducing sampling bias. Before 2012 the NIS retained all discharges from a sample of hospitals, but since then the NIS samples discharges from all hospitals participating in HUCP, which approximates a 20% stratified sample of all discharges from U.S. hospitals. In order to ensure the data were comparable across all years of the study period, two sets of weights (pre-2012 and 2012 onwards) were used as there was a redesign of the NIS dataset in 2012.

As the total charge recorded in the NIS database is the amount of the hospital bill and not representative of the actual cost of hospital services, we used a charge to cost conversion ratio provided by AHRQ to convert the reported charge into actual cost for the payer.

**Supplemental Table I. Search codes.**

**A. For hypertensive disorders of pregnancy.**

|  |  |
| --- | --- |
| **Hypertensive disorders of pregnancy** | **ICD-9-CM codes** |
| Preeclampsia/eclampsia | 6424x, 6425x, 6426x |
| Gestational hypertension | 6423x |
| Chronic hypertension | 6420x, 6421x, 6422x, 6429x or Elixhauser comorbidity hypertension variable =1 in NIS dataset  |
| Superimposed preeclampsia on chronic hypertension | 6427x or a combination of chronic hypertension and preeclampsia as defined above |

**B. For exposure of stroke.**

|  |  |
| --- | --- |
| **Type of stroke** | **ICD-9-CM codes** |
| Acute ischaemic stroke | 433.01, 433.11, 433.21, 433.31, 433.81, 433.91, 434.01, 434.11, 434.91, 435.x, 435.8-9, 436, 671.5, 325 |
| Acute haemorrhagic stroke (subarachnoid, intracerebral haemorrhage) | 430, 431, 432.x |
| Cerebral venous thrombosis | 437.6, 671.5, 325 |
| Transient ischaemic attack | 435.x |
| Stroke, unspecified  | 674.0x, 997.02 |

**C. For treatments and delivery complications.**

|  |  |
| --- | --- |
| **Treatments / Complications** | **ICD-9-CM or ICD-9-CM PR codes** |
| Angiography | PR 98841 |
| Thrombolysis | PR 9910 |
| Thrombectomy | PR 3974 |
| Mortality | 7616 or DIED variable =1 in NIS dataset |
| Preterm birth | 644x |
| Stillbirth | 6564x, v271x, v273x, v274x, v276x, v277x, 7680, 7681 |
| Postpartum haemorrhage | 666x |
| Caesarean section | PR 740 741 742 744 7499 |

**D. For cardiovascular risk factors and other comorbidities.**

|  |  |
| --- | --- |
| **Comorbidities**  | **ICD-9-CM or DXCCS codes** |
| Smoker | V1582, 3051x, 6490x, 98984 |
| Congenital heart disease | 6485, 745x, 746x, 747x, DXCCS 213 |
| Dyslipidaemia | DXCCS 53 |
| Ischaemic heart disease | 410x, 411x, 412, 413x, 4140x, 4142, 4143, 4144, 4148, 4149 |
| Peripartum cardiomyopathy | 425x, 6745x |
| Arrhythmia | 426x, 427x |
| Previous stroke | V1254 |
| Sickle cell disease | 2826x |
| Gestational diabetes | 6488x |
| Fetal growth restriction | 6565x |
| Placenta praevia | 6410x, 6411x |
| Multiple pregnancy | V272x, v273x, v274x, v275x, v276x, v277x, 651x |
| Selected Elixhauser comorbidities (obesity, heart failure, diabetes, valvular disease, pulmonary circulation disorders, peripheral vascular disorders, other neurological disorders, chronic pulmonary disease, hypothyroidism, renal failure, liver disease, HIV and AIDS, rheumatoid arthritis/collagen vascular diseases, fluid and electrolyte disorders, deficiency anaemia, alcohol abuse, drug abuse, depression, psychosis, coagulopathy, paralysis, peptic ulcer abuse, depression) | List of comorbidities and associated ICD-9-CM code can be found (Quan 2005 et al.) at: http://czresearch.com/dropbox/Quan\_MedCare\_2005v43p1130.pdf |

ICD-9-CM, International Classification of Diseases, 9th Revision, Clinical Modification. PR, procedural. DXCCS, Diagnosis Clinical Classification Software.

**Supplemental Table II. The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Item No.** | **STROBE items** | **Location in manuscript where items are reported** (page) | **RECORD items** | **Location in manuscript where items are reported** (page) |
| **Title and abstract** |
|  | 1 | (a) Indicate the study’s design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found | 4 | RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included.RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract.RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract. | 4 |
| **Introduction** |
| Background rationale | 2 | Explain the scientific background and rationale for the investigation being reported | 6 |  |  |
| Objectives | 3 | State specific objectives, including any prespecified hypotheses | 7 |  |  |
| **Methods** |
| Study Design | 4 | Present key elements of study design early in the paper | 7 |  |  |
| Setting | 5 | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 7 |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Variables | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable. | 7-8Supplemental table I | RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided. | Supplemental table I |
| Data sources/ measurement | 8 | For each variable of interest, give sources of data and details of methods of assessment (measurement).Describe comparability of assessment methods if there is more than one group | 7-8 |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Bias | 9 | Describe any efforts to address potential sources of bias | 9 |  |  |
| Study size | 10 | Explain how the study size was arrived at | 7 |  |  |
| Quantitative variables | 11 | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why | NA |  |  |
| Statistical methods | 12 | 1. Describe all statistical methods, including those used to control for confounding
2. Describe any methods used to examine subgroups and interactions
3. Explain how missing data were addressed
4. *Cohort study* - If applicable, explain how loss to follow-up was addressed

*Case-control study* - If applicable, explain how matching of cases and controls was addressed*Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy1. Describe any sensitivity analyses
 | 9 |  |  |
| Data access and cleaning methods |  | .. |  | RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. | 7 |
|  |  |  |  | RECORD 12.2: Authors should provide information on the data cleaning methods used in the study. | 8 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Linkage |  | .. |  | RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided. | NA |
| **Results** |
| Participants | 13 | 1. Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed)
2. Give reasons for non- participation at each stage.
3. Consider use of a flow diagram
 | Figure 1 | RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram. | Figure 1 |
| Descriptive data | 14 | 1. Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders
2. Indicate the number of participants with missing data for each variable of interest
3. *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)
 | Supplemental Table IVFigure 17 |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  Outcome data |  15 | *Cohort study* - Report numbers of outcome events or summary measures over time*Case-control study* - Report numbers in each exposure category, or summary measures of exposure*Cross-sectional study* - Report numbers of outcome events or summary measures | SupplementalTable VI |  |  |
| Main results | 16 | 1. Give unadjusted estimates and, if applicable, confounder- adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included
2. Report category boundaries when continuous variables were categorized
3. If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
 | Table 2NANA |  |  |
| Other analyses | 17 | Report other analyses done— e.g., analyses of subgroups and interactions, and sensitivity analyses | Supplemental Table VII |  |  |
| **Discussion** |
| Key results | 18 | Summarise key results with reference to study objectives | 13 |  |  |
| Limitations | 19 | Discuss limitations of the study, taking into account sources of potential bias or imprecision.Discuss both direction and magnitude of any potential bias | 17 | RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported. | 17 |
| Interpretation | 20 | Give a cautious overall interpretation of results considering objectives,limitations, multiplicity of analyses, results from similar studies, and other relevant evidence | 13-18 |  |  |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results | 17 |  |  |
| **Other Information** |
| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 18 |  |  |
| Accessibility of protocol, raw data, and programming code |  | .. |  | RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code. | In supplementalmaterials |

Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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**Supplemental Table III. Temporal trends of median age in (A) HDP stroke population and (B) HDP population; and race and ethnicity groups in (C) HDP stroke population and (D) HDP population, between 2004-2014. HDP, hypertensive disorders of pregnancy.**

**A.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| All stroke | 29 | 32 | 29 | 29.5 | 32 | 31 | 30 | 30 | 30 | 31 | 30 |
| Ischaemic stroke | 28 | 30 | 29 | 27 | 34 | 31 | 30 | 27 | 32 | 32.5 | 28 |
| Haemorrhagic stroke | 30 | 34 | 31 | 30 | 30 | 24 | 29 | 34 | 29 | 31 | 32 |
| Unspecified | 30 | 32 | 29 | 31 | 34 | 33 | 31 | 34 | 30 | 27 | 31 |

B.

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| HDP | 28 | 28 | 27 | 28 | 28 | 28 | 28 | 28 | 29 | 29 | 29 |

**C.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| White | 23.15% | 36.08% | 28.41% | 24.96% | 31.69% | 35.12% | 48.17% | 35.89% | 27.27% | 33.33% | 27.27% |
| Black | 31.81% | 15.56% | 18.64% | 18.41% | 17.89% | 22.40% | 21.96% | 29.18% | 28.79% | 31.67% | 29.09% |
| Hispanic | 18.64% | 15.89% | 22.91% | 21.48% | 23.97% | 19.91% | 13.39% | 18.89% | 19.70% | 26.67% | 25.45% |
| Asian/Pacific Islander | 5.88% | 0% | 2.53% | 6.45% | 4.58% | 0% | 5.21% | 4.99% | 4.55% | 3.33% | 5.45% |
| Native American | 0% | 1.55% | 1.43% | 1.21% | 0% | 1.43% | 1.48% | 0% | 1.52% | 0% | 0% |
| Other | 3.39% | 2.58% | 4.22% | 2.59% | 2.24% | 4.87% | 1.76% | 3.44% | 12.12% | 1.67% | 3.64% |
| Missing | 17.12% | 28.34% | 21.85% | 24.91% | 19.63% | 16.27% | 8.03% | 7.62% | 6.06% | 3.33% | 9.09% |

**D.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| White | 40.07% | 39.37% | 36.59% | 35.33% | 44.29% | 43.64% | 46.74% | 45.84% | 50.23% | 50.09% | 50.15% |
| Black | 14.90% | 12.02% | 12.94% | 15.63% | 14.83% | 17.60% | 20.59% | 19.61% | 20.50% | 20.38% | 20.35% |
| Hispanic | 14.21% | 14.25% | 16.31% | 14.93% | 14.74% | 15.61% | 15.11% | 18.04% | 15.87% | 16.27% | 16.23% |
| Asian/Pacific Islander | 2.45% | 2.37% | 1.54% | 2.22% | 2.58% | 2.38% | 3.31% | 2.58% | 3.01% | 3.10% | 3.16% |
| Native American | 0.38% | 0.65% | 0.75% | 0.79% | 0.75% | 0.90% | 0.82% | 0.80% | 0.99% | 0.78% | 0.71% |
| Other | 2.52% | 3.37% | 2.95% | 2.94% | 2.84% | 3.76% | 3.03% | 3.80% | 4.21% | 3.44% | 3.65% |
| Missing | 25.47% | 27.98% | 28.92% | 28.17% | 19.97% | 16.10% | 10.40% | 9.33% | 5.18% | 5.94% | 5.74% |

**Supplemental Table IV. Patient characteristics stratified by subgroups of stroke.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | No stroke | All stroke | Stroke |
| **Ischaemic** | **Haemorrhagic** | **Unspecified** |
| HDP delivery hospitalisation | 99.92% | 0.08% | 0.029% | 0.028% | 0.023% |
| Number of deliveries, weighted  | 4,236,893 | 3,391 | 1,229 | 1,187 | 975 |
| Demographics |
| Age,median (IQR) | 28(23-33) | 30(24-35) | 29(24-35) | 31(24-35) | 31 (25-35) |
| Race and ethnicity: 1. White | 44.1% | 31.6% | 31.0% | 27.7% | 37.1% |
| 2. Black | 17.3% | 24.2% | 27.0% | 24.1% | 20.7% |
| 3. Hispanic | 15.6% | 20.5% | 16.9% | 25.1% | 19.3% |
| 4. Asian / Pacific Islander | 2.6% | 3.9% |  4.0% | 3.9% | 3.9% |
| 5. Native American | 0.8% | 0.8% | 0.4% | 1.2% | 0.9% |
| 6. Other | 3.3% | 0.4% | 3.9% | 5.8% | 1.8% |
| 7. Missing | 16.3% | 15.0% | 16.8% | 12.2% | 16.3% |
| Median ZIP code income:1. 1st quartile | 25.0% | 25.0% | 26.6% | 23.2% | 24.9% |
| 2. 2nd quartile | 20.9% | 20.7% | 19.6% | 23.3% | 18.9% |
| 3. 3rd quartile | 19.7% | 18.9% | 18.3% | 19.4% | 19.1% |
| 4. 4th quartile | 15.9% | 13.3% | 15.3% | 13.1% | 11.0% |
| 5. Missing income | 18.5% | 22.1% | 20.2% | 21.0% | 26.1% |
| Weekday admission | 85.9% | 79.9% | 77.7% | 78.9% | 83.9% |
|  Hospital region:1. Northeast | 14.7% | 15.4% | 11.2% | 18.0% | 17.6% |
| 2. Midwest | 20.8% | 16.8% | 16.9% | 17.1% | 16.2% |
| 3. South  | 43.9% | 42.4% | 47.8% | 38.6% | 40.3% |
| 4. West | 20.6% | 25.4% | 24.1% | 26.3% | 25.9% |
| Discharge location:1. Routine | 96.46% | 62.39% | 67.25% | 42.88% | 80.45% |
| 2. Short-term hospital | 0.48% | 10.27% | 9.00% | 17.31% | 3.11% |
| 3.Other facilities  | 0.09% | 11.08% | 8.66% | 18.09% | 5.46% |
| 4. Home health care | 2.63% | 6.63% | 8.78% | 5.43% | 5.37% |
| 5. Against medical advice | 0.31% | 0.84% | 1.53% | 0% | 1.00% |
| 6. Died | 0.02% | 8.79% | 4.78% | 16.29% | 4.61% |
| 7. Unknown, alive | 0.01% | 0% | 0% | 0% | 0% |
| Risk factors and comorbidities |
| Alcohol abuse | 0.15% | 0.14% | 0% | 0% | 0.48% |
| Arrhythmia | 0.71% | 5.97% | 6.28% | 5.65% | 6.10% |
| Coagulopathy | 3.05% | 18.89% | 17.10% | 25.24% | 13.27% |
| Congenital heart disease | 0.16% | 2.38% | 2.36% | 1.17% | 3.90% |
| Depression | 2.77% | 4.31% | 2.81% | 4.53% | 5.98% |
| Diabetes | 3.90% | 4.46% | 4.78% | 2.87% | 6.04% |
| Drug abuse | 1.71% | 5.09% | 5.10% | 4.77% | 5.48% |
| Dyslipidaemia | 0.34% | 3.02% | 4.85% | 1.23% | 2.89% |
| Fluid and electrolyte disorders | 1.72% | 19.52% | 21.88% | 24.48% | 10.33% |
| Gestational diabetes | 10.53% | 5.68% | 5.94% | 4.42% | 6.92% |
| Heart failure | 0.29% | 2.70% | 4.02% | 0.77% | 3.41% |
| Ischaemic heart disease | 0.09%  | 1.60% | 2.40% | 0.80% | 1.57% |
| Neurological disorders | 0.81% | 21.52% | 20.73% | 23.26% | 20.38% |
| Obesity | 11.07% | 10.09% | 12.41% | 8.27% | 9.36% |
| Peripartum cardiomyopathy | 0.26% | 2.43% | 3.58% | 0.79% | 2.98% |
| Peripheral vascular disease | 0.04% | 1.60% | 3.22% | 0.83% | 0.46% |
| Previous stroke | 0.00086% | 1.59% | 1.61% | 0% | 3.54% |
| Renal Failure | 0.32% | 1.92% | 1.63% | 1.27% | 3.09% |
| Rheumatoid arthritis / collagen vascular diseases | 0.49% | 1.60% | 0.39% | 1.22% | 3.65% |
| Sickle cell disease | 0.10% | 0.69% | 1.90% | 0% | 0% |
| Smoking | 6.77% | 7.65% | 9.03% | 6.36% | 7.49% |
| Valvular disease | 0.62% | 2.02% | 1.18% | 2.16% | 2.92% |
| Cost outcomes |
| Length of stay, median (IQR) | 3(2-4) | 6(3-10) | 6(4-11) | 7(3-12) | 5(3-7) |
|  Total charge, $, median (IQR) | 4,762(3,278-7,036) | 14,655(8,494-27,895) | 15,738(9,613-27,007) | 20,532 (10,256-41,042) | $10,651 ($5,358-$17,193) |

**Supplemental Table V. Patient characteristics, risk factors, comorbidities, treatments, and delivery complications from 2004 to 2014.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | No stroke | All stroke | Stroke |
| **Ischaemic** | **Haemorrhagic** | **Unspecified** |
| **2004-2007** | **2008-2011** | **2012-2014** | **2004-2007** | **2008-2011** | **2012-2014** | **2004-2007** | **2008-2011** | **2012-2014** | **2004-2007** | **2008-2011** | **2012-2014** | **2004-2007** | **2008-2011** | **2012-2014** |
| Demographics |
| Age,median (IQR) | 28(22-33) | 28(23-33) | 29(24-33) | 30(24-35) | 31(25-36) | 30(25-35) | 28 (22-33) | 30(25-36) | 31 (24-36) | 31(23-36) | 31(24-35) | 31(26-35) | 31(25-35) | 33(27-37) | 28(24-33) |
| Race and ethnicity:1. White | 37.77% | 45.14% | 50.17% | 27.86% | 38.02% | 29.28% | 19.59% | 40.34% | 34.29% | 24.22% | 33.28% | 26.32% | 39.01% | 40.55% | 25.71% |
| 2. Black | 13.90% | 18.16% | 20.40% | 21.32% | 23.20% | 29.83% | 24.05% | 28.84% | 28.57% | 23.08% | 17.73% | 31.58% | 17.12% | 21.91% | 28.57% |
| 3. Hispanic | 14.93% | 15.88% | 16.12% | 19.78% | 18.74% | 23.76% | 22.56% | 10.91% | 17.14% | 24.39% | 28.86% | 22.37% | 12.92% | 17.43% | 40.00% |
| 4. Asian / Pacific Islander | 2.14% | 2.71% | 3.09% | 3.89% | 3.53% | 4.42% | 4.14% | 1.20% | 7.14% | 4.02% | 4.97% | 2.63% | 3.54% | 5.06% | 2.86% |
| 5. Native American | 0.64% | 0.82% | 0.82% | 1.02% | 0.79% | 0.55% | 0% | 1.06% | 0% | 2.08% | 0% | 1.32% | 1.03% | 1.38% | 0% |
| 6. Other | 2.94% | 3.36% | 3.76% | 3.18% | 3.19% | 6.08% | 3.93% | 3.57% | 4.29% | 3.12% | 5.35% | 9.21% | 2.53% | 0% | 2.86% |
| 7. Missing | 27.66% | 13.93% | 5.63% | 22.94% | 12.53% | 6.08% | 25.73% | 14.07% | 8.57% | 19.10% | 9.81% | 6.58% | 23.85% | 13.67% | 0% |
| Median ZIP code income:1. 1st quartile | 15.37% | 29.55% | 30.96% | 18.91% | 25.69% | 33.15% | 22.01% | 25.27% | 34.29% | 18.01% | 20.87% | 31.58% | 16.83% | 32.17% | 34.29% |
| 2. 2nd quartile | 12.68% | 25.10% | 25.39% | 12.93% | 26.53% | 25.41% | 11.43% | 26.79% | 21.43% | 14.87% | 28.93% | 27.63% | 12.56% | 23.22% | 28.57% |
| 3. 3rd quartile | 11.99% | 24.01% | 23.49% | 12.31% | 23.53% | 23.20% | 12.45% | 19.44% | 24.29% | 9.79% | 29.16% | 21.05% | 14.49% | 22.41% | 25.71% |
| 4. 4th quartile | 10.37% | 19.25% | 18.41% | 5.55% | 21.59% | 14.92% | 5.64% | 23.94% | 17.14% | 7.32% | 18.37% | 14.47% | 3.84% | 22.20% | 11.43% |
| 5. Missing income | 49.58% | 2.08% | 1.76% | 50.30% | 2.67% | 3.31% | 48.46% | 4.56% | 2.86% | 50.01% | 2.66% | 5.26% | 52.28% | 0% | 0% |
| Weekday admission | 86.3% | 86.0% | 85.2% | 78.03% | 83.30% | 78.45% | 75.7% | 81.5% | 75.7% | 77.7% | 81.6% | 77.6% | 80.6% | 88.0% | 85.7% |
| Length of stay, median (IQR) | 3(2-4) | 3(2-4) | 3(2-4) | 6(3-10) | 5(3-11) | 6(3-10) | 6(4-10) | 6(3-11) | 5(4-10) | 7(2-12) | 6(3-11) | 7(3-16) | 4(3-7) | 5(3-9) | 5(3-7) |
| Total charge, $, median (IQR) | 4,368 (3,007-6,479) | 4,976 (3,419-7,395) | 4.962 (3,469-7,228) | 12,822(6,860-24165) | 16,531(9,092-35771) | 14,455(9,338-31,745) | 14,593 (9,613-26,213) | 16,384 (9,764-32,042) | 15,166 (9,464-26,879) | 19,769 (9,986-32,085) | 21,179 (9,856-41,042) | 20,051 (10,925-58,351) | 8,658 (4,839-15,327) | 14,526 (5,942-31,703) | 11,194 (7,460-14,306) |
| Hospital region:1. Northeast | 15.2% | 14.3% | 14.7% | 16.8% | 11.9% | 17.7% | 13.3% | 10.0% | 10.0% | 21.3% | 13.8% | 18.4% | 16.0% | 12.0% | 31.4% |
| 2. Midwest | 20.7% | 20.9% | 20.8% | 16.5% | 15.4% | 18.8% | 15.6% | 14.6% | 21.4% | 12.2% | 20.1% | 19.7% | 21.4% | 10.9% | 11.4% |
| 3. South | 43.5% | 43.9% | 44.3% | 43.9% | 43.9% | 41.4% | 45.7% | 52.9% | 44.3% | 40.8% | 33.7% | 40.8% | 39.3% | 43.5% | 37.2% |
| 4. West | 20.6% | 20.9% | 20.2% | 24.8% | 28.9% | 22.1% | 25.4% | 22.5% | 24.3% | 25.7% | 32.4% | 21.1% | 23.3% | 33.6% | 20.0% |
| Discharge location:1. Routine | 96.27% | 96.44% | 96.73% | 63.91% | 61.38% | 61.33% | 68.86%  | 63.29% | 70.00% | 41.12% | 45.75% | 42.11% | 80.18% | 77.80% | 85.71% |
| 2. Short term hospital | 0.47% | 0.50% | 0.47 % | 10.88% | 9.77% | 9.94% | 10.52% | 8.93% | 7.14% | 19.80% | 15.94% | 15.79% | 3.02% | 3.41% | 2.86% |
| 3.Other facilities | 0.10% | 0.08% | 0.10% | 10.14% | 9.54% | 14.36% | 7.36% | 6.60% | 12.86% | 14.43% | 20.73% | 19.74% | 8.83% | 0% | 5.71% |
| 4. Home health care | 2.85% | 2.63% | 2.35% | 7.63% | 6.30% | 5.52% | 10.19% | 10.97% | 4.29% | 6.84% | 1.22% | 7.89% | 5.95% | 5.91% | 2.86% |
| 5. Against medical advice | 0.29% | 0.32% | 0.34% | 1.35% | 0.45% | 0.55% | 3.07% | 1.15% | 0% | 0% | 0% | 0% | 0.96% | 0% | 2.86% |
| 6. Died | 0.02% | 0.02% | 0.01% | 6.09% | 12.57% | 8.29% | 0% | 9.06% | 5.71% | 17.82% | 16.35% | 14.47% | 1.06% | 12.88% | 0% |
| 7. Unknown, alive | 0.005% | 0.002% | 0.001% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0%  | 0% | 0% | 0% |
| Risk factors and comorbidities |
| Alcohol abuse | 0.13% | 0.15% | 0.20% | 0% | 0.42% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 1.51% | 0% |
| Arrhythmia | 0.53% | 0.72% | 0.91% | 2.40% | 10.39% | 6.08% | 2.10% | 11.14% | 5.71% | 1.08% | 7.41% | 9.21% | 3.97% | 13.01% | 0% |
| Coagulopathy | 2.11% | 3.22% | 3.96% | 11.49% | 25.88% | 21.55% | 10.14% | 19.73% | 22.86% | 19.88% | 33.19% | 23.68% | 5.08% | 25.62% | 14.29% |
| Congenital heart disease | 0.11% | 0.16% | 0.21% | 1.98% | 2.55% | 2.76% | 3.11% | 1.17% | 2.86% | 0% | 2.40% | 1.32% | 2.74% | 4.67% | 5.71% |
| Depression | 2.01% | 2.88% | 3.54% | 2.04% | 7.05% | 4.42% | 0% | 4.55% | 4.29% | 2.06% | 9.42% | 2.63% | 3.96% | 7.67% | 8.57% |
| Diabetes | 3.44% | 3.97% | 4.38% | 3.45% | 4.85% | 5.52% | 3.15% | 5.72% | 5.71% | 2.22% | 3.90% | 2.63% | 4.85% | 4.81% | 11.43% |
| Drug abuse | 1.38% | 1.58% | 2.25% | 4.42% | 4.66% | 6.63% | 7.28% | 2.28% | 5.71% | 4.06% | 3.74% | 6.58% | 2.04% | 9.13% | 8.57% |
| Dyslipidaemia | 1.57% | 3.59% | 5.36% | 0.99% | 2.56% | 6.63% | 0% | 4.56% | 11.43% | 1.06% | 0% | 2.63% | 1.87% | 2.87% | 5.71% |
| Fluid and electrolyte disorders | 1.48% | 1.77% | 1.94% | 12.23% | 24.19% | 24.86% | 14.42% | 25.41% | 27.14% | 15.70% | 28.95% | 30.26% | 0.70% | 16.63% | 8.57% |
| Gestational diabetes | 9.36% | 10.57% | 11.87% | 5.09% | 4.73% | 7.73% | 4.28% | 7.89% | 5.71% | 4.14% | 2.53% | 6.58% | 6.73% | 2.96% | 14.29% |
| Heart failure | 0.31% | 0.30% | 0.27% | 2.03% | 3.93% | 2.21% | 3.23% | 3.46% | 5.71% | 0% | 2.47% | 0% | 2.77% | 6.39% | 0% |
| Ischaemic heart disease | 0.07% | 0.10% | 0.11% | 1.40% | 2.26% | 1.10% | 2.04% | 3.59% | 1.43% | 0% | 1.21% | 1.32% | 2.07% | 1.69% | 0% |
| Neurological disorders | 0.69% | 0.80% | 0.94% | 22.09% | 17.15% | 25.97% | 22.01% | 16.45% | 24.29% | 20.26% | 20.97% | 28.95% | 23.85% | 13.47% | 22.86% |
| Obesity | 5.82% | 11.50% | 16.79% | 4.64% | 15.15% | 12.15% | 6.07% | 21.08% | 10.00% | 2.10% | 11.90% | 11.84% | 5.61% | 10.76% | 17.14% |
| Peripartum cardiomyopathy | 0.24% | 0.28% | 0.27% | 1.40% | 3.42% | 2.76% | 1.00% | 4.53% | 5.71%  | 0% | 1.19% | 1.32% | 3.07% | 4.58% | 0% |
| Peripheral vascular disease | 0.026% | 0.037% | 0.049% | 0.36% | 1.27% | 3.87% | 0% | 2.23% | 8.57% | 1.11% | 0% | 1.32% | 0% | 1.46% | 0% |
| Previous stroke | 0.004% | 0.104% | 0.161% | 0.34% | 1.25% | 3.87% | 1.040% | 0% | 4.286% | 0% | 0% | 0% | 0% | 4.559% | 11.429% |
| Renal failure | 0.25% | 0.34% | 0.40% | 1.82% | 2.25% | 1.66% | 1.13% | 2.33% | 1.43% | 2.31% | 0% | 1.32% | 2.03% | 4.90% | 2.86% |
| Rheumatoid arthritis / collagen vascular diseases | 1.02% | 1.21% | 1.29% | 1.41% | 2.25% | 1.10% | 0.22% | 0.27% | 0.33% | 0.60% | 0.83% | 0.85% | 0.16% | 0.21% | 0.26% |
| Sickle cell | 0.10% | 0.10% | 0.10% | 0.35% | 1.24% | 0.55% | 1.05% | 3.19% | 1.43% | 0% | 0% | 0% | 0% | 0% | 0% |
| Smoking | 4.65% | 6.94% | 9.10% | 3.93% | 9.47% | 11.05% | 4.18% | 9.82% | 14.29% | 2.25% | 8.29% | 9.21% | 5.24% | 10.41% | 8.57% |
| Valvular disease | 0.87% | 0.55% | 0.41% | 2.03% | 2.75% | 1.10% | 2.15% | 1.14% | 0% | 0.96% | 3.09% | 2.63% | 2.92% | 4.62% | 0% |
| Treatments (per 10,000 hospitalizations) |
| Angiography | 1.89 | 1.10 | 0.65 | 706 | 692 | 1326 | 9.44 | 651 | 1142 | 794 | 924 | 1974 | 401 | 464 | 286 |
| Thrombectomy | 0 | 0 | 0 | 0 | 45 | 110 | 0 | 0 | 143 | NA | NA | NA | 0 | 0 | 0 |
| Thrombolysis | 0.262 | 0.598 | 1184 | 35 | 0 | 221 | 1.07 | 0 | 4.29 | NA | NA | NA | 0 | 0 | 0 |
| Delivery complications (per 10,000 hospitalizations) |
| Caesarean section | 4565 | 4698 | 4619 | 6374 | 5775 | 6243 | 6768 | 5984 | 5714 | 6173 | 5352 | 6316 | 6187 | 5998 | 7143 |
| Maternal mortality | 22 | 24 | 14 | 609 | 1257 | 828 | 0 | 9057 | 5714 | 178158 | 163542 | 144737 | 1063 | 12881 | 0 |
| Preterm birth | 1690 | 1591 | 1173 | 2569 | 2322 | 2044 | 3146 | 2238 | 1857 | 2331 | 2587 | 2237 | 2244 | 2116 | 2000 |
| Postpartum haemorrhage | 474 | 477 | 512 | 1486 | 2101 | 1050 | 1660 | 1736 | 1286 | 1635 | 2880 | 1184 | 1184 | 167 | 286 |
| Stillbirth | 89 | 87 | 89 | 256 | 300 | 301 | 0 | 252 | 303 | 135 | 312 | 462 | 594 | 358 | 0 |

**Supplemental Table VI. Treatments and delivery complications (per 10,000 hospitalisations) stratified by subgroups of stroke.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | No stroke | All stroke | Stroke |
| **Ischaemic** | **Haemorrhagic** | **Unspecified** |
| Treatments |
| Angiography | 1.2 | 868 | 899 | 1212 | 4 |
| Thrombectomy | 0 | 45 | 41 | NA | 0 |
| Thrombolysis | 0.39 | 74 | 162 | NA | 0 |
| Delivery complications |
| Caesarean section | 4629 | 6144 | 6195 | 5963 | 6303 |
| Maternal mortality | 2 | 879 | 478 | 1629 | 461 |
| Postpartum haemorrhage | 486 | 1569 | 1580 | 1878 | 1172 |
| Preterm birth | 1504 | 2347 | 2462 | 2381 | 2159 |
| Stillbirth | 88 | 282 | 169 | 297 | 411 |

**Supplemental Table VII. Sensitivity analysis of association between subgroups of stroke and delivery complications and cost outcomes, comparing the fully adjusted model with complete case analysis which excluded hospitalisation episodes with missing information on race and ethnicity and median ZIP code income variables.**

|  |  |  |
| --- | --- | --- |
|  | All stroke | Stroke |
| **Ischaemic** | **Haemorrhagic** | **Unspecified** |
| Caesarean section |
| Fully adjusted model | 1.58(1.33, 1.86) | 1.62(1.22, 2.16) | 1.44(1.08, 1.91) | 1.71(1.26, 2.30) |
| Excluded missing records on race and ethnicity and median ZIP code income variables | 1.64(1.32, 2.03) | 1.68(1.18, 2.39) | 1.43(1.02, 2.01) | 1.91(1.26, 2.91) |
| Maternal Mortality |
| Fully adjusted model | 99.78(59.15, 168.31) | 30.34(12.32, 74.73) | 260.80(138.10, 492.51) | 40.34(14.16, 114.87) |
| Excluded missing records on race and ethnicity and median ZIP code income variables | 109.37(60.48, 197.80) | 30.82(10.01, 94.91) | 271.34(132.25, 556.71) | 42.96(14.07, 131.17) |
| Postpartum haemorrhage |
| Fully adjusted model | 1.91(1.54, 2.37) | 1.98(1.38, 2.83) | 2.03(1.46, 2.82) | 1.98(1.50, 2.61) |
| Excluded missing records on race and ethnicity and median ZIP code income variables | 1.62(1.23, 2.13) | 1.70(1.07, 2.70)  | 1.93(1.30, 2.84) | 1.04(0.52, 2.09) |
| Preterm birth |
| Fully adjusted model | 1.22(0.99, 1.49) | 1.34(0.98, 1.82) | 1.25(0.91, 1.73) | 1.02(0.68, 1.54) |
| Excluded missing records on race and ethnicity and median ZIP code income variables | 1.29(1.00, 1.65) | 1.45(0.99, 2.12) | 1.45(1.00, 2.11)  | 0.90(0.54, 1.49) |
| Stillbirth |
| Fully adjusted model | 1.68(1.00, 2.82) | 0.93(0.34, 2.69) | 1.67(0.70, 4.00) | 2.84(1.33, 6.07) |
| Excluded missing records on race and ethnicity and median ZIP code income variables | 1.56(0.84, 2.89) | 0.98(0.30, 3.18) | 1.81(0.69, 4.70) | 2.08(0.74, 5.91) |
| Length of stay |
| Fully adjusted model | 3.99(3.06, 4.92) | 3.72(2.41, 5.02) | 5.74(3.67, 7.81) | 2.18(1.05, 3.31) |
| Excluded missing records on race and ethnicity and median ZIP code income variables | 3.74(2.59, 4.89) | 3.50(2.11, 4.90) | 5.08(2.54, 7.62) | 2.28(0.73, 3.83) |
| Total charge |
| Fully adjusted model | 19806.53(16048.09, 23564.97) | 20479.98(13422.27, 27537.70) | 28272.45(20881.17, 35663.74) | 8722.65(5013.95, 12431) |
| Excluded missing records on race and ethnicity and median ZIP code income variables | 19056.83(14721.76, 23391.91) | 20972.16(12140.99, 29803.32) | 25025.00(17521.54, 32528.47) | 8308.50(4293.06, 12323.95) |

Data expressed as odds ratios and 95% confidence intervals for categorical variables or beta coefficients and 95% confidence intervals for continuous variables.

**Supplemental Table VIII. Study population stratified by hypertensive disorders of pregnancy subgroups.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Superimposed pre-eclampsia | Preeclampsia | Gestational hypertension | Chronic hypertension |
| HDP delivery hospitalisation | 6.1% | 38.1% | 34.0% | 21.8% |
| Number of deliveries, weighted | 257,385 | 1,615,972 | 1,443,817 | 923,110 |
|  | **No stroke** | **All stroke** | **No stroke** | **All stroke** | **No stroke** | **All stroke** | **No stroke** | **All stroke** |
| HDP delivery hospitalisation with stroke | --- | 18.8% | --- | 52.5% | --- | 8.7% | --- | 20.0% |
| Number of deliveries, weighted | 256,749 | 636 | 1,614,191 | 1,781 | 1,443,521 | 296 | 922,432 | 678 |

**Supplemental Table IX.** Association of stroke with risk factors, comorbidities and delivery complications, stratified by hypertensive disorders of pregnancy subgroups.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Superimposed preeclampsia | Preeclampsia | Gestational hypertension | Chronic hypertension |
| Risk factors and comorbidities |  |
| Alcohol abuse | 1.17(0.17, 7.92) | \* | \* | \* |
| Arrhythmia | 5.80(3.13, 10.76) | 2.03(0.98, 4.18) | 5.59(1.64, 19.07) | 1.80(0.79, 4.13) |
| Coagulopathy | 3.57(2.07, 6.18) | \* | 3.57(1.50, 8.49) | 1.74(0.76, 3.99) |
| Congenital heart disease | 2.31(0.39, 13.55) | 6.23(2.33, 16.66) | 12.52(1.94, 80.83) | 14.42(4.99, 41.69) |
| Depression | 0.87(0.38, 2.01) | 0.95(0.49, 1.84) | 0.45(0.06, 3.58) | 1.27(0.62, 2.58) |
| Diabetes | 0.56(0.29, 1.09) | 0.35(0.14, 0.90) | \* | 0.67(0.35, 1.27) |
| Drug abuse | 2.16(1.08, 4.34) | 1.96(1.10, 3.51) | 1.46(0.22, 9.67) | 1.50(0.66, 3.40) |
| Dyslipidaemia | 1.40(0.26, 7.70) | 4.43(1.67, 11.76) | 32.83(8.64, 124.75) | 4.22(1.98, 9.02) |
| Fluid and electrolyte disorders | 5.32(3.27, 8.65) | 4.73(3.42, 6.55) | 11.91(4.72, 30.03) | 4.87(2.66, 8.94) |
| Gestational diabetes | 0.53(0.27, 1.03) | 0.43(0.26, 0.73) | 0.38(0.12, 1.22) | 0.58(0.32, 1.06) |
| Heart failure | 0.34(0.06, 1.83) | 2.87(0.93, 8.91) | \* | 3.69(1.32, 10.33) |
| Ischaemic heart disease | 2.69(0.59, 12.20) | 2.08(0.40, 10.77) | \* | 3.73(1.07, 12.98) |
| Neurological disorders | 11.81(6.07, 22.99) | 22.64(16.76, 30.59) | 20.66(8.58, 49.76) | 8.82(4.77, 16.32) |
| Obesity | 0.94(0.58, 1.51) | 0.83(0.53, 1.30) | 1.24(0.53, 2.90) | 0.68(0.40, 1.16) |
| Peripartum cardiomyopathy | 4.58(1.11, 18.83) | 0.76(0.13, 4.51) | 6.25(1.96, 19.91) | 0.73(0.13, 4.21) |
| Peripheral vascular disease | 7.81(1.86, 32.76) | 9.59(0.99, 93.19) | 16.31(2.11, 126.02) | 10.58(2.67, 41.85) |
| Previous stroke | 3.62(0.61, 21.55) | 6.92(1.84, 25.94) | 30.00(3.40, 264.62) | 3.12(0.57, 17.06) |
| Renal failure | 0.38(0.11, 1.32) | 4.45(0.96, 20.63) | \* | 1.92(0.69, 5.33) |
| Rheumatoid arthritis / Collagen vascular diseases | 1.31(0.46, 3.76) | 0.47(0.11, 2.02) | \* | 2.31(0.77, 6.87) |
| Sickle cell disease | \* | 2.89(0.88, 9.44) | \* | 2.63(0.34, 20.45) |
| Smoking | 0.76(0.38, 1.52) | 0.67(0.39, 1.16) | 1.43(0.52, 3.97) | 1.26(0.71, 2.24) |
| Valvular disease | 2.34(0.89, 6.16) | 1.41(0.45, 4.38) | \* | 0.25(0.02, 3.02) |
| Delivery complications |
| Caesarean section | 1.20(0.81, 1.79) | 1.68(1.32, 2.13) | 1.58(0.88, 2.81) | 0.92(0.65, 1.32) |
| Maternal mortality | 87.92(31.38, 246.30) | 91.96(47.75, 177.08) | 340.94(25.94, 4480.86) | 54.54(7.67, 387.92) |
| Postpartum haemorrhage | 1.32(0.74, 2.35) | 2.08(1.61, 2.70) | 0.84(0.29, 2.47) | 2.06(1.06, 4.00) |
| Preterm birth | 0.58(0.37, 0.91) | 1.16(0.92, 1.47) | 2.50(1.22, 5.14) | 0.70(0.39, 1.24) |
| Stillbirth | 2.32(0.89, 6.02) | 1.35(0.65, 2.82) | \* | 1.17(0.35, 3.91) |



**Supplementary Figure I.** Comparison of median income quartile (Qrtl) between (A) hypertensive disorders of pregnancy (HDP) population in the delivery hospitalizations and (B) the stroke subpopulation in the HDP delivery hospitalizations over one decade.

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**Supplementary Figure II.** Risk of delivery complications in women with hypertensive disorders of pregnancy and stroke between 2004 and 2014. (A) Mortality (B) Preterm birth (C) Stillbirth (D) Postpartum haemorrhage and (E) Caesarean section.