Health Affairs Scholar, 2023, **1(2)**, 1–11
https://doi.org/10.1093/haschl/qxad020
Advance access publication: June 20, 2023
Research Article

Health Affairs Scholar
EMERGING & GLOBAL HEALTH POLICY
OXFORD

Understanding categories of postpartum care use among privately insured patients in the United States: a cluster-analytic approach

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Abstract

The postpartum period is critical for the health and well-being of birthing people, yet little is known about the range of health care services and supports needed during this time. Maternity care patients are often targeted for clinical interventions based on "low risk" or "high risk" designations, but dichotomized measures can be imprecise and may not reflect meaningful groups for understanding needed postpartum care. Using claims data from privately insured patients with childbirths between 2016 and 2018, this study identifies categories and predictors of postpartum care utilization, including the use of maternal care and other, nonmaternal, care (eg, respiratory, digestive). We then compare identified utilization-based categories with typical high- and low-risk designations. Among 269 992 patients, 5 categories were identified: (1) low use (55% of births); (2) moderate maternal care use, low other care use (25%); (3) moderate maternal, high other (8%); (4) high maternal, moderate other (7%); and (5) high maternal, high other (5%). Utilization-based categories were better at differentiating postpartum care use and were more consistent across patient profiles, compared with high- and low-risk dichotomies. Identifying categories of postpartum care need beyond a simple risk dichotomy is warranted and can assist in maternal health services research, policymaking, and clinical practice.

Lay summary

The time after childbirth is important for the health of a parent who has just given birth, and postpartum experiences and needs vary widely. We studied health care data for privately insured people who gave birth and identified 5 categories of health care use in the postpartum period. None of the categories we uncovered fit the common model of a single visit at 6 weeks postpartum as the sole care needed or used postpartum. Typically, patients are divided into high-risk and low-risk groups, but our research shows that this is insufficient and masks important differences among patients within these dichotomous groups. Using advanced statistical methods to identify categories of health care use after childbirth may improve postpartum health by better targeting resources to those who need them the most.

Key words: maternal health; postpartum health; postpartum care.

Introduction

Postpartum care in the United States is often inadequate and mistimed with postpartum patients' needs.[1] Despite three-quarters of birthing people reporting physical or emotional problems after childbirth, common care consists of a single visit 6 weeks after childbirth.[2–4] Recommendations to enhance postpartum care (more comprehensive, begin earlier, more frequent) were released by the American College of Obstetricians and Gynecologists (ACOG) in 2018.[5] While some limited evidence to support the ACOG recommendations is available from studies outside of the United States,[6–12] evidence on postpartum care patterns within the United States is lacking. This paucity of evidence is an important constraint on policy decisions and policy implementation given the United States' uniquely fragmented health care system.[13–15]

Maternal deaths in the United States recently increased by 40%, from 16.7 per 100 000 live births in 2010 to 23.8 in 2020.[16,17] Half of maternal deaths occur postpartum, in the year following birth, and often occur due to missed or delayed diagnosis, inappropriate or delayed treatment, and inadequate care.[5,18–21] Evidence is needed to better understand the needs of heterogeneous postpartum patients and to target clinical care and resources to those who need it most in order to prevent adverse outcomes.[22–25]

In maternity care settings, patients are often targeted for perinatal care interventions or determined to be eligible for additional treatment based on a risk profile designated prior to the postpartum period. Risk determinations can involve diagnosis of health complications or birth characteristics, and patients are often designated into dichotomous groups, either high or low risk, depending on these factors.[5,26,27] Although pregnancy-related diagnoses and birth complications provide

Received: March 28, 2023; Revised: May 24, 2023; Accepted: May 30, 2023

some indication of care needs, dichotomized measures (high vs low risk) may be imprecise, are based on oversimplified categories, and do not reflect the full range of needs or social determinants of health during the postpartum period.[28,29] Patients without measured risk indicators are left without further differentiation in recommended care. Further, there is no standard definition of a high-risk pregnancy; existing measures are inconsistently applied in research and clinical care,[5,26,27] lack attention to structural inequities and intersectional patient identities, and may be associated with adverse outcomes in current care management paradigms.[30]

Clustering techniques (data-mining procedures used to identify discrete categories) are gaining traction as a way to identify different types of patients, predict outcomes based on identified patient categories, and ultimately prevent future adverse outcomes.[31–34] Clustering methods work retrospectively, exploiting data from patient health care usage profiles; once clusters are identified, they can be used prospectively to better identify patients for future policy action and more targeted interventions.[35] Clustering methods have been applied to the prenatal care setting to compare common methods of measuring prenatal risk with actual utilization patterns,[36] but have not been applied to the postpartum period. The purpose of this study is to identify categories and predictors of postpartum care utilization and compare identified categories with typical high- and low-risk designations.

Data and methods

Data and study population

Data come from the IBM MarketScan® Commercial Database (2016–2019). MarketScan data include enrollees in employer health plans and large, self-insured health plans (~350 payers). MarketScan data include health care claims as well as encounters, generally hidden under global or bundled billing in other claims-based data. The data include enrollee identifiers, which allow tracking of patients across settings. However, MarketScan data do not include information on mortality or on patient race or ethnicity.[37]

Patients with childbirths were identified using International Classification of Diseases, Tenth Revision (ICD-10), and Diagnosis Related Group (DRG) codes.[38–40] Eligible patients included those who gave birth from November 2016 through December 2018, allowing 10 months of observation prior to childbirth and 1 year of postpartum follow-up. Patients with ages less than 10 years or more than 55 years were excluded, as were patients without continuous enrollment from 9 months prior to 1 year after childbirth; this latter restriction allowed assessment of health care use during the entire perinatal episode.

Variables

We constructed postpartum visit utilization variables, including the timing and frequency of visits from childbirth discharge to 90 days postpartum, as well as the reason for those visits. The 90-day time frame aligns with the end of the ACOG-recommended window for postpartum care and transition to well-woman care.[5,39,41] Visit reason was classified as either maternal ACOG-recommended postpartum care (eg, routine postpartum care, counseling and consultations, immunizations, screenings) or other outpatient care (eg, respiratory procedures, gastroenterology services, chiropractic services).[5,39,40] Emergency department visits and hospitalizations in the first 90 days postpartum were also separately examined. Visit reasons were identified using ICD-10, Current Procedural Terminology (CPT®, American Medical Association (AMA)), and revenue codes, as listed in Table S1.

We also examined events that occurred during pregnancy, calculating the date of last menstrual period using a published algorithm,[40] and during childbirth. We showed demographic characteristics for each patient, including region, rural or urban residence based on Office of Management and Budget definitions of metropolitan statistical areas,[42] maternal age (<20, 20–24, 25–34, 35+ y), and primary enrollee relation (employee, spouse, child/other dependent). Prenatal care utilization variables examined included the following:

- Adequacy of Prenatal Care Utilization (APNCU) Index (Note: The APNCU index, also called the Kotelchuck Index, is a summary measure that combines the month of prenatal care initiation and the number of prenatal care visits. The measure is based on the ACOG prenatal care standards for uncomplicated pregnancies. The summary score is categorized into 4 levels: inadequate [starting care after the fourth month or receiving <50% of expected visits], intermediate [care beginning by month 4 with 50%–79% of expected visits], adequate [care beginning by month 4 with 80%–109% of expected visits], and adequate plus [care beginning by month 4 with ≥110% of expected visits])[43];
- Proportion of recommended prenatal care components received[40]; and
- Number of emergency department visits or hospitalizations.

Clinical characteristics included the following:

- California Maternal Quality Care Collaborative (CMQCC) Comorbidity Index (Note: The CMQCC index is an obstetric comorbidity scoring system aimed at facilitating improved comparisons of severe maternal morbidity [potentially life-threatening complications of pregnancy and childbirth] rates between groups of patients by measuring differences in their underlying health status])[44];
- Severe maternal morbidity[45];
- Gestational age (very preterm: <32 wk; preterm: 32–37 wk; full-term: 38–42 wk; post-term: >42 wk);
- Cesarean birth;
- Extended length of stay (≥3 d following vaginal, ≥5 d following cesarean);
- Type of clinician providing the majority of prenatal care (obstetrician, family physician, midwife, other) (Note: The type of clinician providing the majority of prenatal care was the same type for >75% of visits for 76.8% of patients; the type of clinician providing the majority of care during the postpartum period was the same type for >75% of visits for 82.4% of patients. Other clinician types included other physicians, internists, multispecialty, neonatologists, nursing, physician assistant, and home health providers); and
- Birth location (hospital, birth center, home, other).

We measured insurance plan type and clinician type for all care during the postpartum period. Plan type is provided as enrollment information in the MarketScan data and available

for each month of enrollment. Patients can change plan types but still be tracked via their employer. Plan type included health maintenance organizations (HMOs), preferred provider organizations (PPOs), high-deductible and consumer-driven health plans (HDHPs), and other plans (basic, comprehensive, exclusive provider organizations, point-of-service) (Note: If patients switched plan types during their pregnancy, we measured the plan type that accounted for the majority of the perinatal period. The majority postpartum insurance plan type was the same type for >75% of visits for 99.7% of patients).[37]

There is not 1 universally agreed-upon definition of high-risk pregnancy, so we examined 4 measures: (1) a research-based measure encompassing a combination of preexisting or pregnancy-related conditions or complications during childbirth that can cause harm to the mother or fetus[26,29,46–48]; (2) ICD-10 coding for high-risk pregnancy that includes prior pregnancy and birth experiences, maternal age and prenatal care, unspecified "social problems," and other unspecified high risks as determined by the attending clinician; (3) a high-risk measure developed by the Society for Maternal-Fetal Medicine (SMFM) focusing on indications for cesarean delivery stemming from maternal or fetal complications[48]; and (4) a CMQCC comorbidity index, which examines the risk of severe maternal morbidity, score in the highest quartile (≥12) for these data.[44] Each measure has a different goal and focus, with the research-based definition largely encompassing factors included in the SMFM and CMQCC definitions. ICD-10 coding involves the least overlap with the other definitions. These measures are further described in Table S1.

Finally, in order to measure associations with longer-term postpartum outcomes, we examined (1) any emergency department visits or (2) any hospitalizations that occurred between 91 days and 1 year postpartum.

Analysis

We used a cluster-analytic approach to categorize patients with similar postpartum visit utilization patterns, including visit timing, frequency, and reason (Figure S1). Cluster input variables included 11 measures involving the overall number of visits, the visit frequency in various postpartum periods (1–8, 9–23, 24–34, 35–51, 52–71, and 72–90 d), and frequency by visits in the following categories: maternal recommended, other outpatient, emergency department, and hospitalization.

We used a partitioning k-means clustering method with Euclidean distance (distance between points).[49] This method requires the number of clusters be preselected and determines cluster membership by grouping the most similar patients according to cluster input variables selected (described above) with the goal of minimizing within-cluster differences in utilization patterns. The number of preselected clusters and combination and measurement of cluster input variables was varied in order to determine the best clustering solution (ie, the best combination of the number of clusters and cluster input variables).[49] We varied the preselected number of clusters from 2 to 10 clusters and varied the cluster input variables using continuous measures, standardized measures, dropping outliers with values greater than the 99th percentile, and grouped by time periods used in clinical recommendations: days 1–7 (first week), 8–21 (window for recommended early visit), 22–63 (window for recommended comprehensive visit), and 64–90 (window for extended follow-up).[5]

To determine the best number of clusters and cluster input variables to distinguish patient utilization categories, potential cluster solutions were evaluated and compared statistically (using pseudo F, R^2, cubic clustering criterion, and silhouette width) (Note: Pseudo F: ratio of between-cluster to within-cluster variation, observing when this starts to decrease; R^2: proportion of the variance explained by the cluster solution, with higher preferred; cubic clustering criterion: measure of minimizing within-cluster sum of squares, observing when this starts to decrease; silhouette width: measure of within-cluster to between-cluster dissimilarity, with higher positive values showing more substantial cluster structure),[50] visually (using the elbow method and canonical discriminant analysis) (Note: Elbow method: average within-cluster distance, looking for the largest drop while increasing cluster size; canonical discriminant analysis: visualization of linear combinations of input variables that provide maximal separation between clusters, with more defined visual separation between groups preferred), and for practical and clinically meaningful purposes.[51] The goal is to minimize within-cluster variation and maximize between-cluster differences in utilization patterns, so that utilization categories are distinct within clusters, while also balancing the number of clusters for practical purposes and ensuring that there are clinically meaningful differences between but not within categories. A 5-cluster solution using the main input variables measured categorically was determined as the optimal clustering solution because it had relatively high values for all statistical measures, visually provided clear separation between clusters upon canonical discriminant analysis, and created clinically meaningful differences in utilization patterns between categories.

In assessment of the robustness of the clustering solution, none of the alternative cluster input variables and cluster sizes further maximized these comparative dimensions. These results are provided in Figures S2 and S3. Further sensitivity analyses examined the impact of excluding patients with uncertain childbirth date or date of last menstrual period and using less restrictive continuous enrollment criteria ranging from 6 months prior to 6 months after childbirth (Figure S4).

After final cluster solutions were selected, we described postpartum care utilization categories, evaluated differences across categories using descriptive statistics, and examined predictors of category assignment (described above) using stratified multivariable logistic regression to calculate adjusted odds ratios (ORs) and 95% confidence intervals (CIs). Finally, we compared the utilization-based categories with high- and low-risk designations in order to examine distributional differences in patients, as well as differences in longer-term postpartum outcomes (91 d–1 y). We used SAS version 9.4 (SAS Institute, Cary, NC) for all analyses. This analysis used de-identified data and was exempted from review by the University of Minnesota Institutional Review Board.

Results

From November 2016 through December 2018, there were 269 992 patients with childbirths who met the sample criteria.

Postpartum utilization-based cluster profiles

Among the 269 992 patients, 5 clusters were identified that categorized patients by use of maternal recommended and

other care during the postpartum period. Figure 1 displays visit frequency at different points in the postpartum period and the reasons for those visits, showing the distributions for each utilization-based category. The first cluster had low health care use: these patients (n = 149 438; 55%) had an average of 0.7 visits overall (0.5 visits maternal visits, 0.1 other outpatient visits); 42% of these patients had no visits, 4% had an emergency department visit, and 0.6% were hospitalized during the postpartum period. On the other end of the spectrum, patients in the fifth cluster (n = 12 598; 5%) had high use of both maternal and other care: patients in cluster 5 had an average of 10.9 visits overall (5.0 maternal visits, 5.6 other outpatient visits); 19% had an emergency department visit and 8% were hospitalized. The remaining 3 clusters had moderate use of maternal and other care: cluster 2 had moderate maternal, low other use (n = 67 249; 25%); cluster 3 had moderate maternal, high other use (n = 20 502; 8%); and cluster 4 had high maternal, moderate other use (n = 20 205; 7%). In sensitivity analyses, we found no meaningful differences in identified categories when excluding those with unclear childbirth dates or shorter continuous enrollment criteria (Figure S4).

Figure 2 shows the visit frequency for patients in each category at different points in the postpartum period (1–8 d, 9–23 d, 24–34 d, 35–51 d, 52–71 d, and 72–90 d), normalized per 10 days to better compare visit trends across the postpartum period (since time periods vary in the number of days that they include). Patients with low use (cluster 1) consistently had fewer visits throughout the postpartum period. Patients with high maternal, high other use (cluster 5), on the other hand, had consistently elevated visit frequencies and increasing rates of other (nonmaternal) visits as the postpartum period progressed. Patients with high maternal care use but moderate other care use (cluster 4) had the highest rates of maternal visits in the first week postpartum. A spike in visits for all clusters occurred during days 35–51, which was largely driven by maternal care use and aligns with the common care model of a 6-week postpartum visit. Emergency department visits and hospitalizations through the first 90 days postpartum were highest for all clusters during the first week postpartum, with the highest rates for both maternal and other reasons occurring among patients with high maternal, high other use (cluster 5).

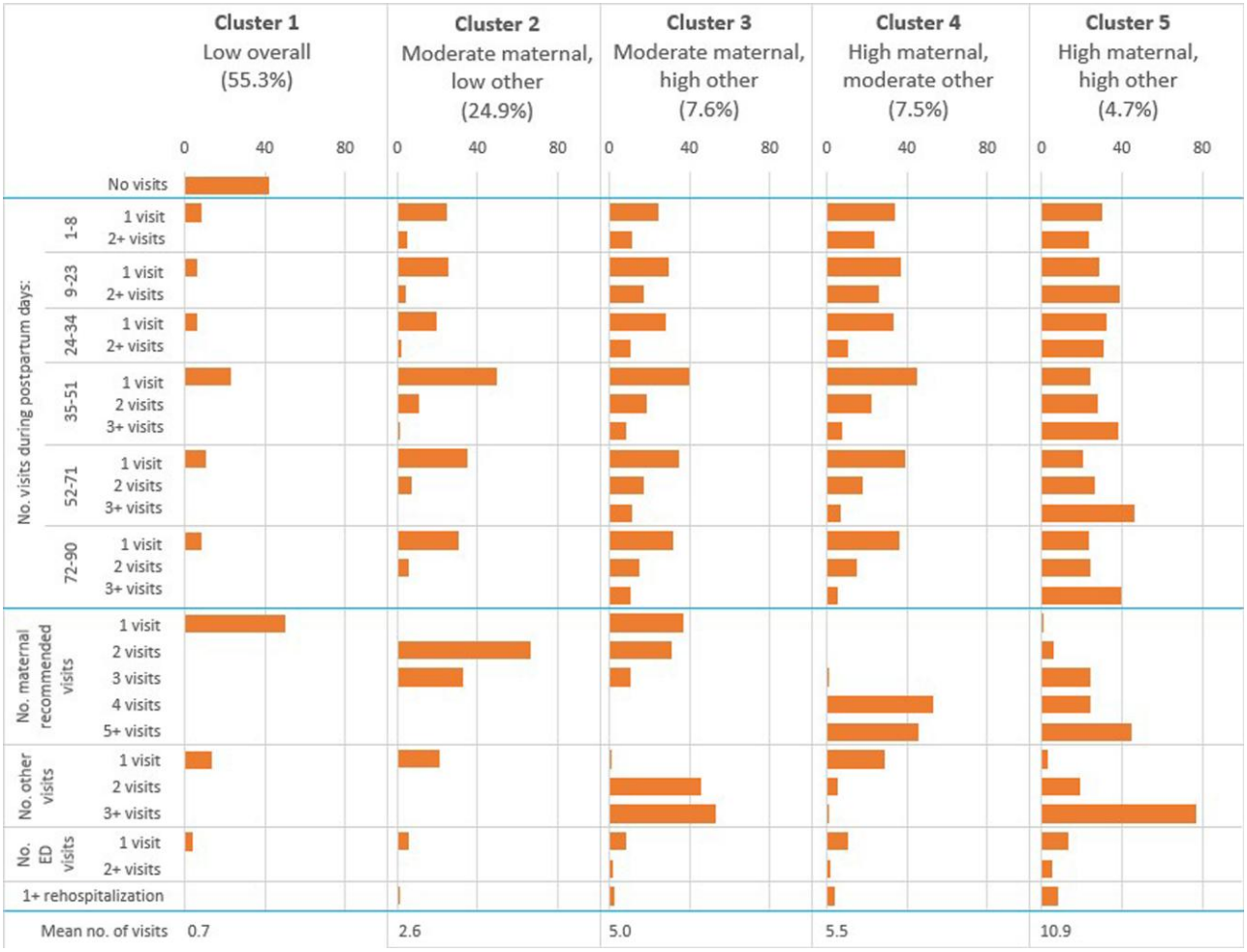

Figure 1. Distribution of cluster input variables by identified cluster categories. Maternal recommended visits include postpartum care components recommended by the American College of Obstetricians and Gynecologists (ie, routine postpartum care, individual postpartum services, counseling and consultations, immunizations, screenings). Other visits include care for all other reasons not included in maternal recommended (eg, respiratory procedures, digestive evaluations, gastroenterology services, eye exams, allergy testing/therapy, chiropractic services, dental services). Abbreviation: ED, emergency department.

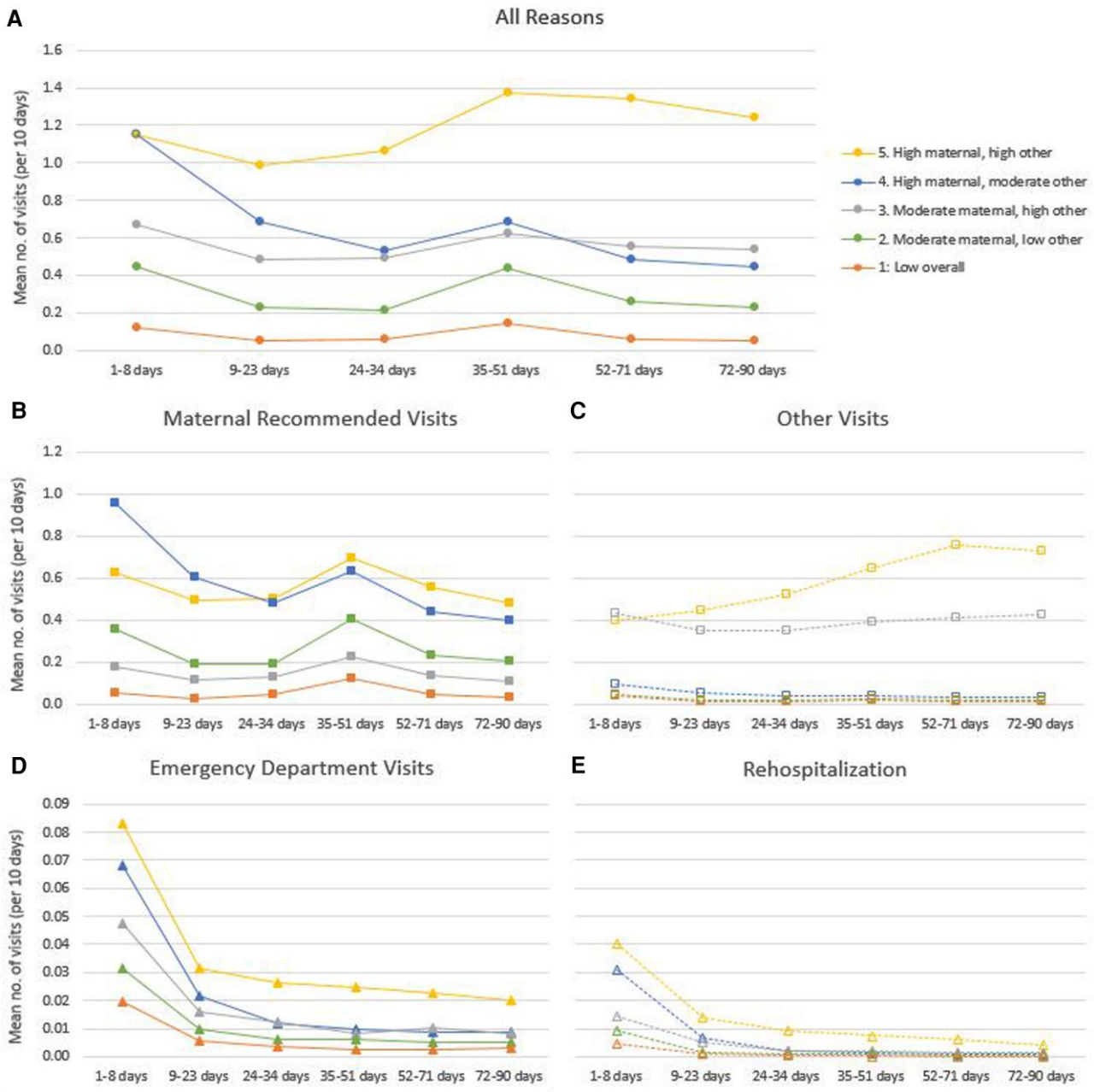

Figure 2. Normalized rates of postpartum visits by timing, reason, and utilization-based category. A: All visit reasons. B: Maternal recommended visits. C: Other outpatient visits. D: Emergency department visits. E: Rehospitalization. Orange indicates cluster 1 (low overall use), green indicates cluster 2 (moderate maternal, low other use), gray indicates cluster 3 (moderate maternal, high other use), blue indicates cluster 4 (high maternal, moderate other use), and yellow indicates cluster 5 (high maternal, high other use). Maternal recommended visits include postpartum care components recommended by the American College of Obstetricians and Gynecologists (ie, routine postpartum care, individual postpartum services, counseling and consultations, immunizations, screenings). Other visits include outpatient care for all other reasons not included in maternal recommended (eg, respiratory procedures, digestive evaluations, gastroenterology services, eye exams, allergy testing/therapy, chiropractic services, dental services).

Predictors of utilization-based cluster categories

The distribution of characteristics across utilization-based categories is presented in Table S2. The largest between-cluster differences were by region of residence, age at birth, adequacy of prenatal care utilization, and comorbidity index. Table 1 shows predictors of cluster assignment based on stratified logistic regression analyses. Patients with low overall use (cluster 1) were more likely to reside in the South (OR: 1.21; 95% CI: 1.18–1.24) and have inadequate prenatal care (OR: 1.57; 95% CI: 1.52–1.62). The strongest predictor of moderate maternal and low other use (cluster 2) was receiving prenatal care from a clinician other than a midwife or family physician (a highly varied category including physician assistants and nursing staff) compared with an obstetrician (OR: 1.24; 95% CI: 1.20–1.28). The strongest predictors of moderate maternal, high other use (cluster 3) were residing in the North Central region (OR: 1.25; 95% CI: 1.19–1.31) and having a very preterm birth (OR: 1.38; 95% CI: 1.25–1.52). For high maternal, moderate other use (cluster 4), the strongest predictors were adequate plus prenatal care (OR: 1.37; 95% CI: 1.32–1.43), higher comorbidity indices (≥12; OR: 1.52; 95% CI: 1.44–1.60), extended length of childbirth stay (OR: 1.27; 95%

Table 1. Prenatal and childbirth predictors of postpartum cluster assignment.

Characteristics	Low use overall: cluster 1 (n = 149 438; 55.3%)	Moderate maternal, low other use: cluster 2 (n = 67 249; 24.9%)	Moderate maternal, high other use: cluster 3 (n = 20 502; 7.6%)	High maternal, moderate other use: cluster 4 (n = 20 205; 7.5%)	High maternal, high other use: cluster 5 (n = 12 598; 4.7%)
Region at childbirth					
Northeast	Ref.	Ref.	Ref.	Ref.	Ref.
North Central	1.01 (0.98–1.04)	**0.93 (0.90–0.95)**	**1.25 (1.19–1.31)**	**0.90 (0.86–0.94)**	**1.08 (1.02–1.14)**
South	**1.21 (1.18–1.24)**	0.98 (0.95–1.01)	**0.92 (0.88–0.96)**	**0.84 (0.81–0.88)**	**0.73 (0.69–0.77)**
West	**1.06 (1.02–1.09)**	**0.95 (0.92–0.98)**	1.01 (0.96–1.06)	1.01 (0.96–1.06)	0.95 (0.89–1.01)
Unknown	**0.64 (0.45–0.89)**	1.01 (0.73–1.40)	1.25 (0.80–1.96)	**1.86 (1.26–2.75)**	0.98 (0.56–1.71)
Geography at childbirth					
Urban	Ref.	Ref.	Ref.	Ref.	Ref.
Rural	**1.06 (1.03–1.09)**	1.01 (0.97–1.04)	1.01 (0.96–1.06)	**0.90 (0.85–0.95)**	**0.87 (0.81–0.93)**
Unknown	**0.89 (0.86–0.93)**	0.99 (0.95–1.04)	**1.08 (1.02–1.15)**	**1.11 (1.04–1.18)**	**1.20 (1.12–1.30)**
Age at childbirth					
<20 y	1.05 (0.97–1.15)	1.06 (0.98–1.16)	**0.82 (0.71–0.95)**	0.99 (0.86–1.15)	**0.81 (0.67–0.98)**
20–24 y	**1.18 (1.13–1.24)**	1.04 (0.99–1.09)	**0.75 (0.69–0.82)**	**0.91 (0.84–0.99)**	**0.64 (0.57–0.73)**
25–34 y	Ref.	Ref.	Ref.	Ref.	Ref.
35+ y	1.02 (0.99–1.04)	**0.92 (0.90–0.94)**	**1.13 (1.09–1.17)**	**0.94 (0.91–0.98)**	**1.08 (1.03–1.13)**
Relationship to plan holder					
Employee	Ref.	Ref.	Ref.	Ref.	Ref.
Spouse	**1.07 (1.05–1.09)**	**0.93 (0.91–0.95)**	**1.08 (1.04–1.11)**	**0.95 (0.92–0.98)**	0.96 (0.92–1.00)
Child/other	**1.08 (1.03–1.15)**	**0.93 (0.88–0.99)**	1.03 (0.94–1.14)	**0.89 (0.81–0.98)**	1.12 (0.98–1.28)
Adequacy of prenatal care (APNCU)					
Adequate plus	**0.72 (0.71–0.74)**	1.00 (0.98–1.03)	1.03 (0.99–1.07)	**1.37 (1.32–1.43)**	**1.62 (1.55–1.70)**
Adequate	Ref.	Ref.	Ref.	Ref.	Ref.
Intermediate	**1.22 (1.19–1.25)**	**0.97 (0.94–0.99)**	0.96 (0.92–1.00)	**0.76 (0.73–0.79)**	**0.71 (0.67–0.75)**
Inadequate	**1.57 (1.52–1.62)**	**0.87 (0.84–0.90)**	**0.86 (0.82–0.91)**	**0.54 (0.51–0.58)**	**0.48 (0.44–0.52)**
No care	1.01 (0.54–1.90)	1.28 (0.59–2.75)	0.72 (0.29–1.80)	1.00 (0.23–4.38)	NA
CMQCC comorbidity index					
0	Ref.	Ref.	Ref.	Ref.	Ref.
1–4	**0.89 (0.87–0.91)**	**1.04 (1.01–1.08)**	**1.06 (1.01–1.11)**	**1.11 (1.05–1.16)**	**1.32 (1.23–1.40)**
5–11	**0.84 (0.82–0.87)**	**1.03 (1.01–1.06)**	**1.07 (1.02–1.12)**	**1.21 (1.15–1.26)**	**1.47 (1.38–1.57)**
≥12	**0.68 (0.66–0.71)**	**1.03 (1.00–1.07)**	**1.13 (1.07–1.19)**	**1.52 (1.44–1.60)**	**1.93 (1.80–2.06)**
Gestational age					
Very preterm (<32 wk)	1.05 (0.98–1.14)	**0.84 (0.78–0.90)**	**1.38 (1.25–1.52)**	**0.82 (0.74–0.91)**	1.02 (0.92–1.14)
Preterm (32–37 wk)	**1.18 (1.15–1.21)**	0.97 (0.94–1.00)	0.97 (0.92–1.01)	**0.89 (0.85–0.93)**	**0.77 (0.73–0.81)**
Full-term (38–42 wk)	Ref.	Ref.	Ref.	Ref.	Ref.
Post-term (>42 wk)	1.01 (0.71–1.45)	1.05 (0.72–1.53)	1.24 (0.73–2.11)	**0.25 (0.08–0.78)**	1.57 (0.84–2.95)
Childbirth mode					
Cesarean	0.98 (0.96–1.00)	1.00 (0.98–1.02)	**0.96 (0.93–0.99)**	**1.12 (1.09–1.16)**	0.99 (0.95–1.03)
Extended LOS					
Vaginal ≥3 d, cesarean ≥5 d	**0.86 (0.84–0.88)**	1.00 (0.97–1.02)	1.01 (0.98–1.05)	**1.27 (1.23–1.31)**	**1.23 (1.18–1.28)**
Clinician during majority of prenatal care					
No care	1.50 (0.83–2.73)	0.57 (0.27–1.17)	1.45 (0.61–3.43)	0.82 (0.20–3.40)	NA
Obstetrician	Ref.	Ref.	Ref.	Ref.	Ref.
Family physician	0.96 (0.92–1.00)	1.00 (0.96–1.05)	**1.07 (1.00–1.15)**	**1.08 (1.01–1.16)**	0.97 (0.9.0–1.06)
Midwife	**0.83 (0.77–0.89)**	1.02 (0.95–1.10)	**1.27 (1.14–1.40)**	1.10 (0.99–1.24)	**1.21 (1.05–1.38)**
Other	**0.78 (0.76–0.80)**	**1.24 (1.20–1.28)**	**0.86 (0.82–0.90)**	**1.26 (1.20–1.32)**	**1.20 (1.13–1.28)**
Clinician during majority of postpartum period					
Obstetrician	Ref.	Ref.	Ref.	Ref.	Ref.
Family physician	**0.72 (0.70–0.74)**	0.98 (0.95–1.00)	**1.24 (1.18–1.30)**	**1.31 (1.26–1.37)**	**1.70 (1.61–1.79)**
Midwife	**0.85 (0.79–0.90)**	0.94 (0.88–1.01)	1.07 (0.96–1.19)	**1.37 (1.25–1.51)**	**1.37 (1.21–1.54)**
Other	**1.56 (1.53–1.59)**	**0.54 (0.52–0.55)**	**1.78 (1.72–1.84)**	**0.72 (0.70–0.75)**	1.01 (0.97–1.05)

(*continued*)

Table 1. Continued

Characteristics	Low use overall: cluster 1 (n = 149 438; 55.3%)	Moderate maternal, low other use: cluster 2 (n = 67 249; 24.9%)	Moderate maternal, high other use: cluster 3 (n = 20 502; 7.6%)	High maternal, moderate other use: cluster 4 (n = 20 205; 7.5%)	High maternal, high other use: cluster 5 (n = 12 598; 4.7%)
Postpartum insurance plan type					
HMO	**0.93 (0.90–0.95)**	**1.11 (1.08–1.15)**	**0.83 (0.79–0.87)**	**1.20 (1.15–1.25)**	**0.88 (0.83–0.93)**
PPO	Ref.	Ref.	Ref.	Ref.	Ref.
HDHP	1.00 (0.98–1.02)	1.01 (0.98–1.03)	0.97 (0.94–1.01)	1.01 (0.97–1.05)	1.00 (0.95–1.04)
Other	**1.06 (1.03–1.09)**	**1.04 (1.01–1.08)**	**0.85 (0.80–0.89)**	1.03 (0.98–1.08)	**0.85 (0.80–0.91)**

Abbreviations: aOR, adjusted odds ratio; APNCU, Adequacy of Prenatal Care Utilization Index; CI, confidence interval; CMQCC, California Maternal Quality Care Collaborative; HDHP, high-deductible health plan (includes consumer-driven health plans); HMO, health maintenance organization; LOS, length of stay; PPO, preferred provider organization; Ref., reference.
Data are given as aORs (95% CI). Bolded values indicate statistically significant estimates (95% CI's that do not contain 1). Other health plans include basic, comprehensive, exclusive provider organizations, and point-of-service. Other clinicians include other physicians, internists, multispecialty, neonatologists, nursing, physician assistant, and home health.

CI: 1.23–1.31), and enrollment in an HMO rather than a PPO (OR: 1.20; 95% CI: 1.15–1.25). Predictors for high maternal, high other use (cluster 5) were similar to cluster 4 across prenatal care, comorbidity, and extended length of childbirth stay, but with higher odds across most categories.

Comparison to currently used risk profiles

The proportion of the study population deemed high risk was dependent on the definition applied (Figure 3). Twenty-eight percent of patients were considered high risk using the research-based definition, 11% using ICD-10 coding, 33% using SMFM, and 24% using CMQCC. The ICD-10 definition had the lowest overlap with other high-risk definitions (all <45%). Of the other definitions, the highest congruence was between the CMQCC and research-based definitions (76%) and between the research-based and SMFM definitions (70%) (data not shown).

The distribution of postpartum utilization-based categories across low- and high-risk dichotomies was fairly consistent. Of patients designated as low risk under the research-based, ICD-10, SMFM, and CMQCC definitions, 17%–19% were in a high-use cluster (3–5). Of patients designated as high risk under each definition, 73%–77% were in a lower-use cluster (1–2). Overall, these results indicate that misclassification for high-risk and low-risk patients exists, and that there is misalignment between dichotomized risk definitions and actual utilization of care in the postpartum period.

In examination of longer-term postpartum outcomes (days 91–365), emergency department visits were experienced by 9.9%–10.6% of patients classified as low risk and 12.5%–15.7% of those classified as high risk, and hospitalizations were experienced by 1.2%–1.3% of low-risk and 2.0%–2.5% of high-risk patients using the research-based, SMFM, and CMQCC definitions. Alternatively, the ICD-10 definitions resulted in a lower prevalence of these outcomes for high- compared with low-risk patients (emergency department: 11.5% low-risk/9.3% high risk; hospitalization: 1.5% low-risk/1.4% high-risk). The utilization-based categories we defined showed distinct, increasing trends in the prevalence of longer-term postpartum emergency department visits and hospitalizations across clusters, ranging from 9.9% to 17.2% and 1.3% to 4.0%, respectively.

Discussion

In this study of privately insured patients, cluster analysis of health care utilization postpartum resulted in 5 categories: (1) low use, (2) moderate maternal and low other care use, (3) moderate maternal and high other use, (4) high maternal and moderate other use, and (5) high maternal and high other use. The largest differences in patient characteristics among categories included region of residence, age at birth, adequacy of prenatal care, comorbidity index, gestational age, and extended length of childbirth stay. Comparing the 5 utilization-based categories with high- and low-risk dichotomies reveals incongruent identification of at-risk patients depending on the definition used, misalignment between definitions of risk and actual care utilization after childbirth, and better prediction of longer-term postpartum outcomes using the 5 utilization-based clusters.

Clinical implications

None of the utilization-based categories we identified fit the common model of a single visit at 6 weeks postpartum as the sole care needed or used during the postpartum period.[5] Several factors were strong independent predictors of postpartum care categories (maternal age, prenatal care use, comorbidities, and birth complications). These characteristics could be used to better identify which patients might need specific kinds of postpartum care, support, and clinical attention beyond binary designations that provide 1 level of care for patients deemed high risk and another level for all other patients.

Utilization-based categories of postpartum care may more effectively differentiate types of patients. Clinicians could use these categories to provide tailored support for certain types of patients (eg, coordination of care for those with high maternal and nonmaternal health care use, tailored maternal support for those with high maternal use and poor longer-term postpartum outcomes, and potentially more social support for those who have low use but have high nonclinical needs in the postpartum period). Which patients are designated as high risk and deemed eligible for additional care is highly variable depending on the risk definition used by different states, practices, and clinicians. Further, currently used high- and low-risk definitions do not align with care patterns that patients actually experience after childbirth. This could be because dichotomous risk categories are not adequate and/or that identifying overall risk based on prenatal and childbirth complications is not sufficient for determining postpartum risk. Identifying postpartum needs requires nuance beyond high- or low-risk dichotomies, which

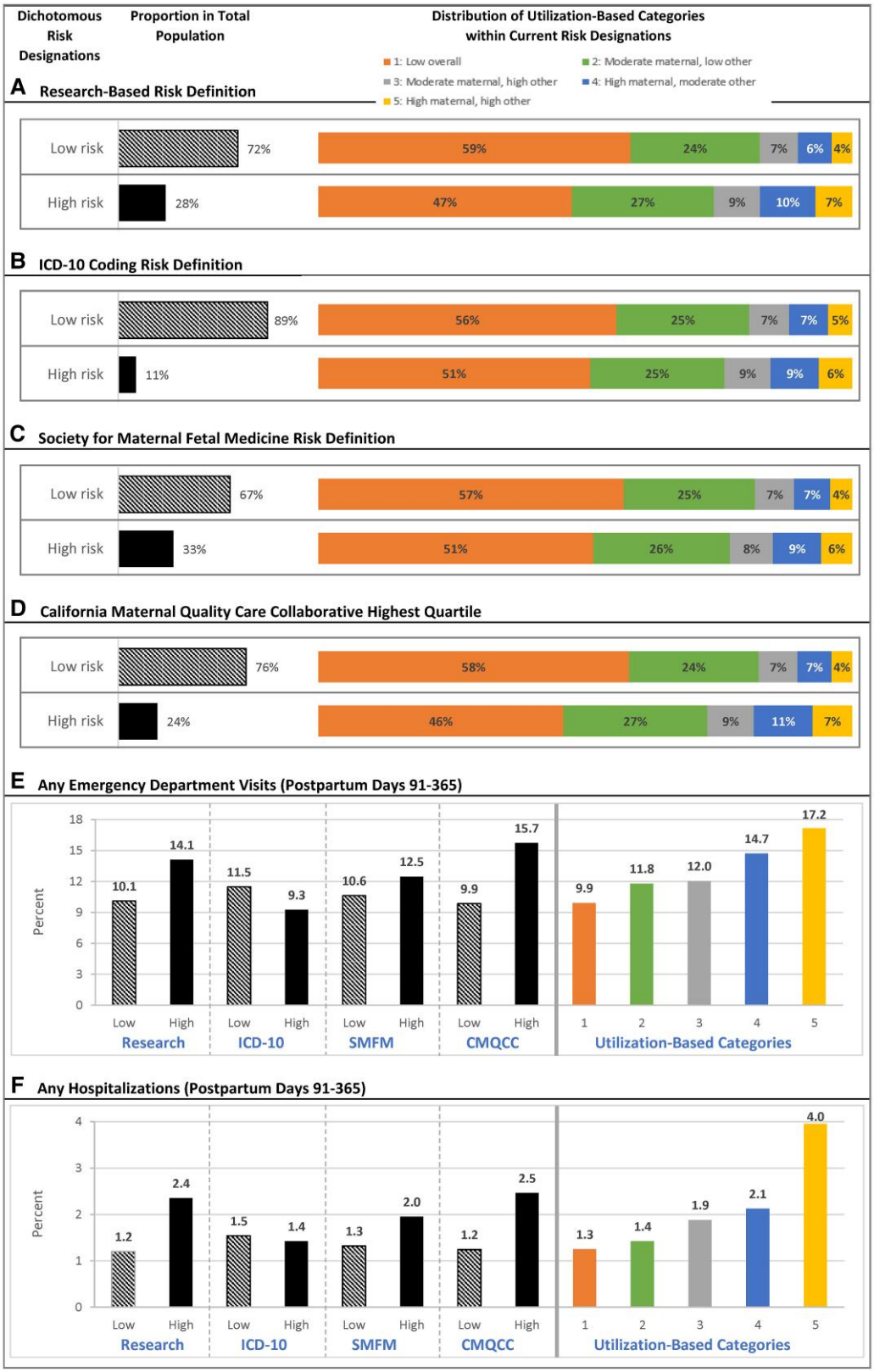

Figure 3. Comparison of high- vs. low-risk designations with utilization-based categories. A: Research-based risk definition. B: International Classification of Diseases, Tenth Revision (ICD-10), coding risk definition. C: Society for Maternal-Fetal Medicine (SMFM) risk definition. D: California Maternal Quality Care Collaborative (CMQCC) highest quartile. E: Any emergency department visits (postpartum days 91–365). F: Any hospitalizations (postpartum days 91–365). Utilization categories: Orange indicates cluster 1 (low overall use), green indicates cluster 2 (moderate maternal, low other use), gray indicates cluster 3 (moderate maternal, high other use), blue indicates cluster 4 (high maternal, moderate other use), and yellow indicates cluster 5 (high maternal, high other use). Risk designations: Patterned black and white indicates low risk and solid black indicates high risk. The research-based risk definition uses a combination of preexisting or pregnancy-related conditions or complications during childbirth that can cause harm to the mother or fetus.

oversimplify postpartum patient needs, yet are often used to determine access to additional care.[29,52]

These findings are important in the context of increased attention to clinical and professional postpartum care recommendations and postpartum health insurance coverage policies. For example, insurance often covers an additional postpartum visit only for cesarean birth; this rule is inconsistent with study findings that show prenatal care adequacy and other comorbidities also predict additional use of care in the postpartum period.[53]

Policy implications

This study highlights the potential usefulness of clustering methods to better target resources to meet the wide-ranging needs of postpartum patients, better aligning care recommendations and resources, including reimbursement policies that support such realignment.[5] However, clustering should not be used alone in policymaking without understanding the limitations of its application.

A major challenge for clinical and policy interpretation of these findings is ascertaining whether utilization-based categories indicate appropriate utilization of care when needed. The low use cluster (cluster 1), for example, might pool clinically appropriate low use (for people who do not need additional care) and clinically inappropriate low use (among patients who experience access barriers due to lack of insurance, transportation, distance from care, or other factors). The higher prevalence of assignment to this cluster in the South and in rural areas may reflect declining access to maternity services for such patients.[54,55] This could also reflect prior negative experiences with the health care system that discourage patients from seeking needed care.[56] In addition, these data do not allow for interpretation of the underlying quality of care received, which may affect health outcomes. Thus, this analysis should be replicated in datasets that include Medicaid beneficiaries, uninsured people, race and ethnicity data, and data related to other social determinants of health and health care access so that representation, appropriateness, and quality of care can be evaluated. Additional application of these clustering models using a variety of data sources and by health systems with access to richer data may help improve accuracy in decision making and help reduce biased results that stem from the data-generating process.[57]

Limitations

There are limitations to the current study; many relate to the data used in this analysis. Importantly, systemic racism in health care delivery and data informatics might exacerbate racial disparities,[57] and data on patient race were not available in MarketScan. The dataset used in this analysis did not include Medicaid beneficiaries or uninsured patients. Future applications of clustering techniques for postpartum health could use datasets that contain data on structural inequities and maternal health disparities (eg, low income, rurality, race and ethnicity) and people who do not have private health insurance. MarketScan data do not include all private insurance plans nor does the dataset distinguish between specific plan provider, specific practice or practice-level policies, or specific clinicians; thus, external generalizability may be limited. This is an important limitation as we were not able to discern the role of the clinician or practice in generating the clusters using these data (ie, whether the clusters reflect differences in patients or differences in practice and clinician decision making). Because the MarketScan data are derived from administrative claims, patients who did not attend visits or for whom claims were not made do not appear in the dataset. Further, patients with no or low use of care means that data for the evaluation of risk factors prior to and after childbirth are necessarily less available for these patients when claims data, generated by visits, are used for the analysis. Maternal deaths, which are hidden in the MarketScan data to protect patient privacy, could not be examined. Patients can be followed across years and plan types in these data; however, if a patient switches employers, they can no longer be followed even if the new employer also contributes data to MarketScan (each employer encrypts data and shares the data with MarketScan using employer-specific methods). Despite these limitations, this is a novel application of clustering methods to the postpartum period, which provides a first step toward generating a stronger evidence base to improve postpartum care.

Conclusion

This analysis identified 5 distinct categories of care utilization in the postpartum period associated with unique health care needs among people who gave birth, providing a new analytic tool for informing maternal health services research, health care policymaking, and clinical practice.

Acknowledgments

The authors gratefully acknowledge Carrie Henning-Smith and Hannah Neprash, from the University of Minnesota and Lindsay K. Admon from the University of Michigan for their feedback on drafts of this manuscript.

Supplementary material

Supplementary material is available at *Health Affairs Scholar* online.

Funding

This research was supported by the National Institutes of Health's (NIH's) National Center for Advancing Translational Sciences, grant UL1TR002494. The content is solely the responsibility of the authors and does not necessarily represent the official views of the NIH.

Conflicts of interest

Please see ICMJE form(s) for author conflicts of interest. These have been provided as supplementary materials.

Notes

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