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Quantifying the Adequacy of Prenatal Care: A Comparison of Indices

SYNOPSIS

Objectives. In spite of the widespread use of prenatal care utilization indices in the scientific literature, little attention has been given to the extent to which these indices are comparable. This investigation contrasts the way five indices classified cases into categories of prenatal care use.

Methods. From the 1989–1991 South Carolina Public Use data files, single live births to resident mothers were selected for analysis (N=169,082). Five prenatal care indices were compared: *(a)* the modified Institute of Medicine (Kessner) index, *(b)* a variation of the IOM index using the full American College of Obstetrics and Gynecology visit recommendation, *(c)* an index derived from the recommendations of the U.S. Public Health Service Expert Panel on Prenatal Care, *(d)* the GINDEX, and *(e)* the APNCU index.

Results. The proportion of cases assigned to prenatal care utilization categories by each index varied markedly, ranging from 33.6% to 58.1% for adequate care, 9.2% to 20.3% for inadequate care, and 7.4% to 22.6% for intensive utilization.

Conclusions. The selection of a prenatal care utilization index for research and policy development purposes requires a careful consideration of the intent, criteria for defining adequacy, and coding assumptions of each index. As these indices are conceptually distinct in their measurement approach, they are likely to yield different patterns of prenatal care use in a population and cannot be used interchangeably. Recommendations for their use are provided.

State and national policy initiatives to improve pregnancy outcomes have focused on increasing the availability of and access to prenatal care services.[1] Much of the evidence indicating an association between insufficient prenatal care and poor pregnancy outcomes such as low birth weight stems from studies that employ indices of prenatal care utilization.[2–15] These indices, which measure the adequacy of prenatal care use, take into consideration the month prenatal care began, the number of prenatal care visits, and the gestational age at delivery.[2,4,12,16,17] These data items are recorded in state Certificate of Live Birth data files, which are widely available to researchers. In the last two decades, a variety of prenatal care utilization indices have been proposed.[2,4,12,16,17] Despite widespread use of some of these indices in research and policy development,[2–23] their comparability has not been fully explored.

In 1972, Kessner et al. reported the results of an Institute of Medicine (IOM) study that employed an original index of prenatal care utilization.[2] This index, initially labeled the Three Factor Health Services Index and commonly called the IOM or Kessner index, suggested a means to consider simultaneously, while adjusting for gestational age at delivery: *(a)* the month in which care is initiated, *(b)* the number of prenatal care visits, and *(c)* the type of obstetric service. A classification of "adequate" utilization of prenatal care required: *(a)* a first trimester initiation of care, *(b)* a specified number of prenatal care visits for the gestational age at delivery, and *(c)* delivery by a private obstetric service. Progressively later initiation of care or fewer visits for the gestational age at delivery resulted in a classification of either "intermediate" or "inadequate" prenatal care use.

The requirement of delivery on a private obstetric ward has since been largely ignored by researchers using the IOM index. This is due in part to this information being unavailable in most vital record databases and disagreement with the implication that only private patients get adequate care. Nearly all prenatal care utilization studies that use and reference the IOM index are actually employing the index with this modification.

The IOM index selected recommendations of the American College of Obstetrics and Gynecology (ACOG) to define the standard for an adequate number of prenatal care visits.[24] In general, the index's criterion for "adequate" use of prenatal care was a number of visits for gestational age at delivery that met or exceeded the ACOG recommendation. An inadequate number of visits was defined as less than 50% of the adequate visit criterion. However, the IOM index deviated from these recommendations for term and post-term births. For pregnancies of 36 or more weeks' gestation, the IOM index used only nine visits to delineate adequate care use, even though the ACOG recommendation clearly indicated more than nine visits.[24]

The developers of the IOM index did not adhere to the complete ACOG recommendations because of a computer data coding convention. The New York City vital record data file that was employed for the IOM study contained a single digit field for the coding of prenatal care visits; hence, a single code of "9" was used for all cases with nine or more prenatal care visits.[17] Current state vital records datasets code prenatal care visits beyond nine visits, and the IOM index can now be modified to reflect the full ACOG recommendation for the number of prenatal care visits for term and post-term births.[16,17] Nevertheless, the original IOM index coding strategy has been widely perpetuated in studies using indices of prenatal care utilization; as a result the full ACOG recommendation has rarely been used by researchers as a standard to assess the adequacy of prenatal care use.[17]

> The lack of an established convention for the quantitative measurement of adequacy of prenatal care utilization and the paucity of research data addressing the comparability of available indices have hindered the ability of researchers and policy makers to draw conclusions from the prenatal care literature.

Over the years, a number of other weaknesses in the IOM index have been identified and have resulted in proposals for several alternate indices of prenatal care use.[2–4,16,17] In the original IOM index, cases for which gestational age at delivery was not recorded were excluded from the study and cases with missing prenatal care visit or initiation data were assigned to the inadequate category.[2] In 1987, Alexander and Cornely proposed that the cases with missing data be treated separately instead of being included in the IOM's "inadequate" group or excluded entirely.[4] Alexander and Cornely argued that it was inappropriate to assume that cases with missing data had inadequate prenatal care use. They pointed out that variations in the completeness of data reporting would result in biased comparisons of inadequate prenatal care use over time and among geographic areas.[4,10,25] Further, these authors proposed that women receiving *no* prenatal care be disaggregated from the IOM index's inadequate care group because some of the women in the "no care" category may have delivered prematurely before having a chance to initiate prenatal care.[4,26]

Another step in the development of utilization indices was the conceptualization of a category of intensive use of prenatal care services. Alexander and Cornely proposed a graduated index, called the GINDEX, which expanded the three levels of the IOM index (adequate, intermediate, and inadequate) to six categories.[4] In addition to separate categories for "no care" and "missing," the GINDEX classified

as "intensive" those women who had an unexpectedly large number of prenatal care visits given their gestational age at delivery and the month their prenatal care began.[4] The intent of the intensive category was not to increase the number of *ordinal* levels of the adequacy of utilization scale. Rather, its purpose was to delineate a *nominal* category of cases with a utilization pattern suggesting a high risk morbid condition requiring more than the standard recommended number of prenatal care visits. Failing to separate these cases from those with more routine profiles of prenatal care participation could confound investigations of the impact of prenatal care utilization on birth outcomes. Diabetic mothers, for example, may receive more than the recommended number of visits and deliver heavier birth weight infants. Conversely, women threatening preterm delivery may receive an intensive number of visits and still deliver a preterm, low birth weight infant.

Kotelchuck's Adequacy of Prenatal Care Utilization (APNCU) index also proposed a category of intensive prenatal care use, but one based on a very different approach.[17] The APNCU index was not a modification of the IOM index but was developed independently. It proposed separate assessments of the adequacy of care based on: (*a*) the month in which prenatal care is initiated and (*b*) the number of visits from initiation of care until delivery. For the period between the initiation of care and delivery, the APNCU index compares the number of actual prenatal care visits to the number of expected visits, which is derived from the full ACOG prenatal care visit recommendation. A ratio of observed to expected visits greater than 110% of the ACOG recommendation is defined as "adequate plus," another term for intensive or greater than expected use of care. The observed-to-expected visit ratio and the separate assessment based on the timing of the first prenatal care visit are combined to form the summary APNCU index, although each component of the APNCU index can be assessed separately. The APNCU index can also isolate cases with missing data and can be modified to include a no care category.

Most recently, the U.S. Public Health Service Expert Panel on Prenatal Care (PHS/EPPC) proposed an alternate prenatal care visit schedule, which emphasizes earlier initiation of prenatal care and a number of visits that varies according to the number of children previously born to a women (parity), an indicator of pregnancy risk.[27,28] While promoting more comprehensive prenatal care, the report recommends fewer visits than the ACOG recommendation and even fewer visits for women who have already had a child. This is the first proposed prenatal care visit standard to suggest that a timetable of prenatal care use should be based on risk; the ACOG recommendation was established for low risk women. These PHS/EPPC recommendations suggest yet another possible index of prenatal care utilization, although a proposed computer coding algorithm has not appeared in the literature.

Although the IOM index (as typically modified to ignore delivery in a private obstetric service), the GINDEX, and the APNCU index are frequently cited in the scientific literature,[2–23] it remains unclear to what extent these indices and the two other indices that can be derived from the PHS/EPPC and full ACOG recommendations give comparable results in terms of classifying prenatal care utilization and assessing the impact of prenatal care on pregnancy outcomes. After developing the indices based on the PHS/EPPC and full ACOG recommendations, we used the same data to compare the extent to which these two and the other three commonly used indices (i.e., the modified IOM, GINDEX, and APNCU indices) agreed in assigning women to categories of prenatal care utilization.

Methods

From the South Carolina Public Use data files for the years 1989 to 1991, we selected single live births to mothers residing in the state (N=169,082). South Carolina vital records have been cited for their completeness and quality.[25]

Gestational age in completed weeks was calculated from

Table 1. Comparison of prenatal care indices by attributes

	Indices					
Attributes	*M-IOM*	*OB-REC*	*PHS-REC*	*GINDEX*	*GINDEX Revised*	*APNCU*
Basis for standard	ACOG[a]	ACOG	PHS	ACOG[a]	ACOG	ACOG
Adequate start of care	1–3 mos	1–3 mos	1–2 mos	1–3 mos	1–3 mos	1–4 mos
Adequate number of visits at 40 weeks	9	13	7 (multi-para) 9 (primi-para)	9	13	11
Intensive visit category	No	No	No	Yes	Yes	Yes
Missing category	No	No	No	Yes	Yes	Yes
No care category	No	No	No	Yes	Yes	No
Standard computer program	No	No[b]	No	Yes	Yes	Yes
Risk modified	No	No	Yes (parity)	No	No	No

[a]Does not follow full ACOG prenatal care visit recommendation for term and post-term births.

[b]Can be derived from Revised-GINDEX program provided on page 417.

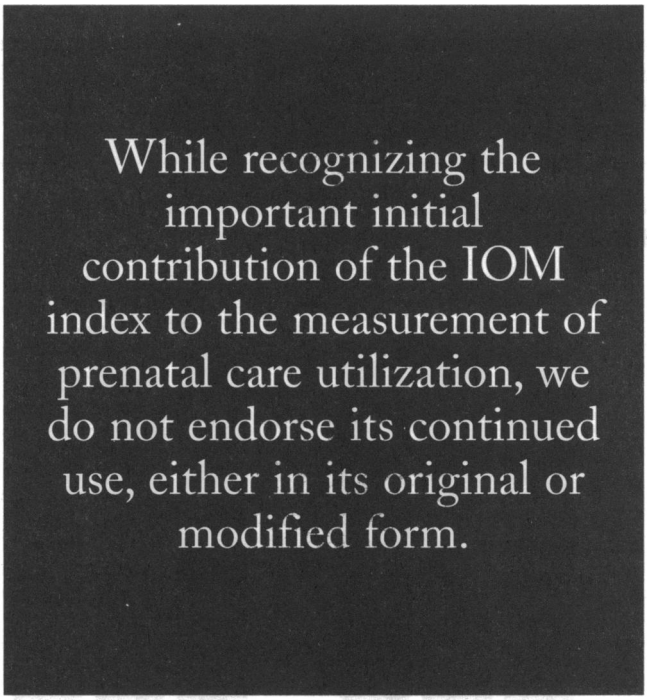
Table 2. Comparison of five prenatal care utilization indices: percent of cases assigned to each utilization category

Index	Intensive	Adequate	Intermediate	Inadequate	No care/ missing data
M-IOM	—	58.1	28.7	9.4	3.7
OB-Rec	—	33.6	46.2	16.4	3.7
PHS-Rec	—	44.8	42.3	9.2	3.7
GINDEX	7.4	52.4	27.1	9.3	3.7
APNCU	22.6	37.0	16.4	20.3	3.7

NOTE: *N* = 169,082 single live births to women residing in South Carolina, 1989–1991

the date of last normal menses to the date of birth. The gestational age for cases missing only the day of last normal menses was imputed using a standard imputation method.[29,30]

We compared five prenatal care indices: (*a*) the commonly used modified IOM index, which ignores the type of obstetric delivery service (M-IOM index),[2,3] (*b*) a variation of the M-IOM index using the full ACOG visit recommendation (OB-Rec index),[24] (*c*) an index suggested by the U.S. Public Health Service Expert Panel on Prenatal Care recommendation (PHS-Rec index),[27] (*d*) the GINDEX,[4] and (*e*) the APNCU index.[17] (In the interest of full disclosure, it should be noted that the authors of this article are the developers of two of these indices: Dr. Alexander of the GINDEX and Dr. Kotelchuck of the APNCU index.)



These five indices varied markedly in several ways (Table 1). The M-IOM, OB-Rec, and GINDEX indices require a first trimester (months one through three) initiation of care for a classification of adequate utilization, while the adequate care category of the PHS-Rec index requires initiation of care in months one or two and the APNCU index in months one through four. For most indices, the ACOG recommendation is the basis for defining an adequate number of prenatal care visits; yet, the full ACOG standard is only strictly followed by the OB-Rec and the APNCU indices. The GINDEX follows the M-IOM index in using the nine-visit coding limit. The PHS-Rec index applies the PHS/EPPC visit recommendation. The GINDEX and the APNCU indices include an intensive utilization category and call for a separate missing category. Finally, the GINDEX is unique for having a formal "no care" group.

For each index, we used the procedure employed in the GINDEX to create separate categories of cases with no prenatal care and missing prenatal care data. This modification of the other four indices was done to simplify our comparisons. The procedure for defining cases with no care or missing data is detailed on page 417. More details regarding the coding of these and the other indices can be obtained from the authors or the National Technical Information Service.

Using each of the five indices, we assigned each case to a prenatal care utilization category. We then compared the proportion of cases assigned to each category by each of the indices. Similarly, for each gestational age grouping (20–32, 33–36, 37–41 and 42+ weeks), we calculated the proportion of cases assigned to each utilization category for each index. This was done to evaluate the impact of using the full ACOG recommendation for term and post-term births and to more thoroughly explore the different intensive prenatal care coding strategies of the GINDEX and the APNCU index.

Results

After imputation of gestational age, a prenatal care utilization category could not be determined for 1.6% of cases due to missing data. No prenatal care was reported for 2.1% of the cases. In all, 3.7% of cases were either missing data or reported no prenatal care.

Table 2 provides the distribution of cases into prenatal care utilization categories for each index. The OB-Rec index assigned a smaller percentage of women (33.6%) to

the adequate prenatal care use category than the M-IOM index (58.1%) and assigned a higher percentage of women (16.2%) to the inadequate care use category than the M-IOM index (9.4%).

These percentages portray dramatically different pictures of prenatal care utilization in South Carolina and in particular reveal a substantial difference in the proportion of women assigned to the adequate category when the M-IOM's nine-visit coding limitation is removed. The percent adequate derived with the PHS-Rec index (44.8%) fell between the percent adequate indicated by the M-IOM and OB-Rec indices. The stricter criteria for adequacy in the PHS-Rec index, calling for the initiating of care in the first two months of pregnancy rather than in the first trimester, resulted in fewer cases being assigned to the adequate category than assigned by the M-IOM index. However, the PHS-Rec index's recommendation of fewer visits for a classification of adequate care resulted in the PHS-Rec index designating fewer cases with inadequate prenatal care use than the indices based on the ACOG recommendations.

Figure 1 shows the distribution of prenatal care utilization by gestational age category for the M-IOM, OB-Rec, and PHS-Rec indices. A comparison between the M-IOM and OB-Rec indices for term (37 to 41 weeks) and post-term (42+ weeks) births more fully reveals the marked impact of changing the nine-visit ceiling of the M-IOM index to the full ACOG recommendation. The OB-Rec index classified a much lower proportion of cases as adequate than the modified M-IOM index for later gestational ages and assigned higher proportions to the intermediate and inadequate categories.

A comparison of the GINDEX and the APNCU index, the two indices that incorporate intensive prenatal care use categories, also reveals conspicuous differences (Table 2). Of the two, the GINDEX classified cases in a manner closer to that of the M-IOM index, with the exception that the GINDEX's intensive group largely came from the M-IOM's adequate care group. The APNCU index revealed a much more somber picture of prenatal care utilization than the GINDEX, with the highest proportion (20.3%) of cases classified as inadequate. This in part reflects the APNCU index's stricter visit criteria for adequate prenatal care use. Combining the intensive and adequate categories yielded similar figures for the two indices (59.8% for the GINDEX and 59.6% for the APNCU). However, the APNCU index assigned more than three times as many cases to the intensive utilization category (22.6% APNCU and 7.4% GINDEX).

As evident in the Figure 2, in the very preterm (20 to 32

Figure 1. Percent of cases within each gestational age group assigned to each utilization category by M-IOM, OB-Rec, and PHS-Rec indices

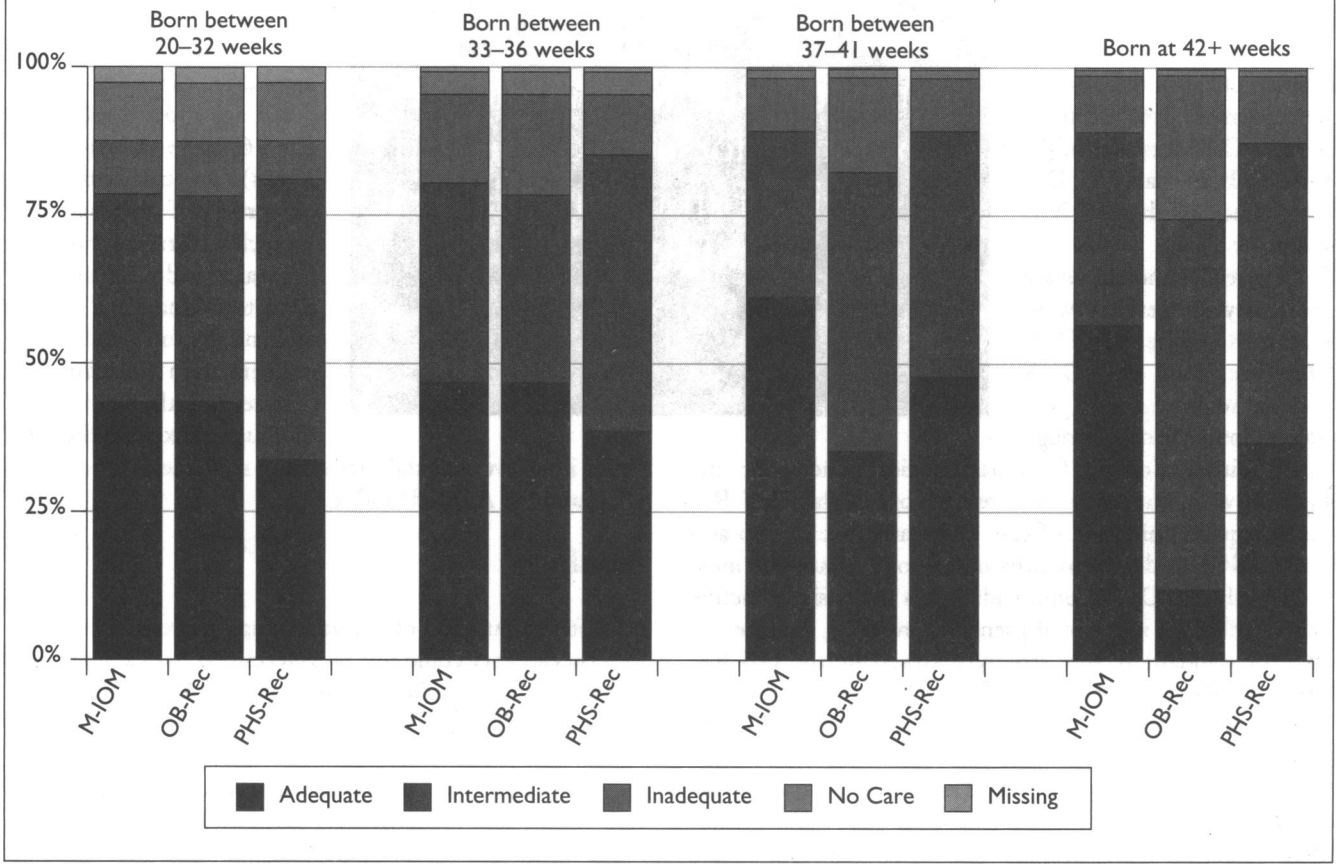
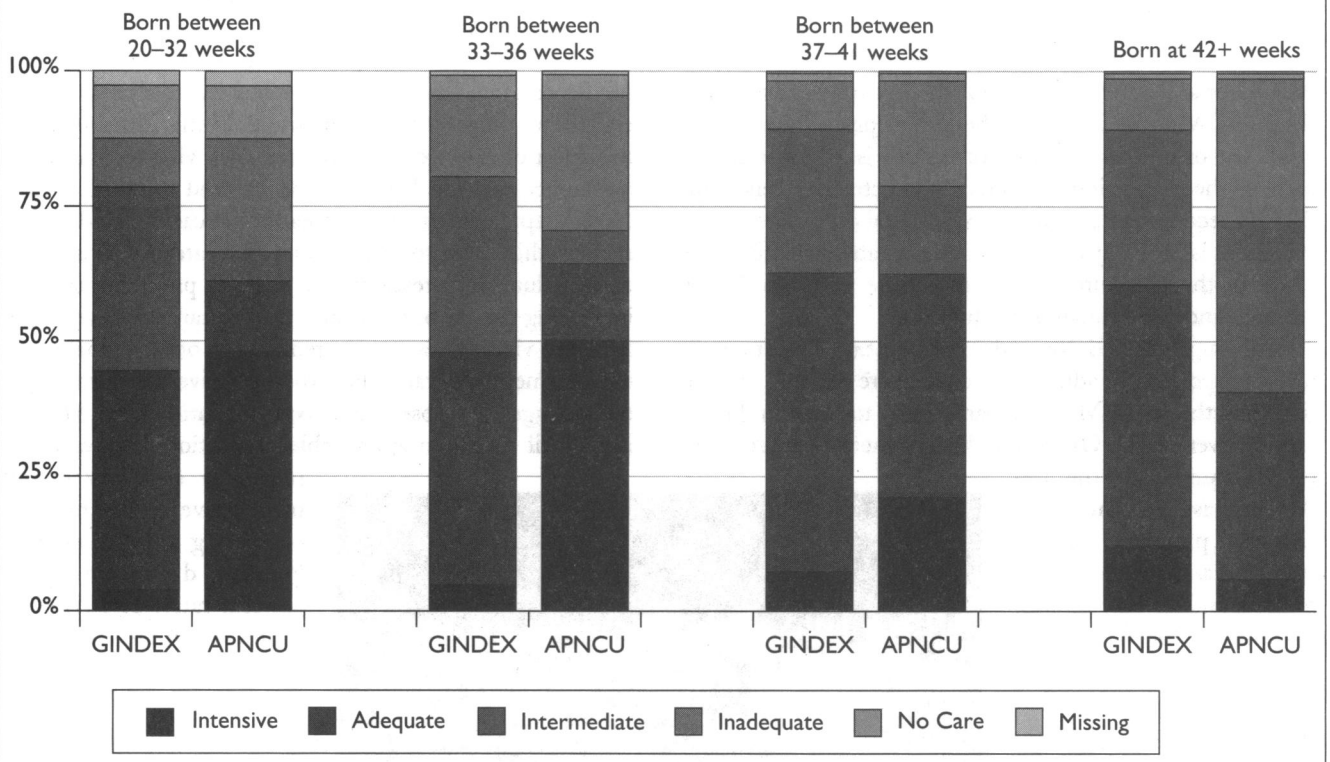


Figure 2. Percent of cases within each gestational age group assigned to each utilization category by APNCU index and GINDEX



weeks) and moderately preterm (33 to 36 weeks) categories, the APNCU index classified over 40% of the cases as intensive, in contrast to fewer than 5% for the GINDEX. The proportion of cases categorized as intensive by the APNCU index was markedly lower for term and post-term births than for preterm births, while more cases were assigned to the intensive group for these gestational ages by the GINDEX. For post-term births, the GINDEX placed a greater proportion of cases in the combined adequate and intensive groups (60.5%) than the APNCU index (40.6%). For each gestational age category, marked differences are also evident in the way these two indices distributed cases to the intermediate and inadequate prenatal care use categories.

Discussion

There has been substantial progress in the last 20 years toward improving the measurement of prenatal care utilization. The lack of an established convention for the quantitative measurement of adequacy of prenatal care utilization and the paucity of research data addressing the comparability of available indices continues to hinder the ability of researchers and policy makers to draw conclusions from the prenatal care literature. The present analysis shows that the five indices we examined produced markedly different utilization patterns. Because these indices are likely to generate distinctly different statistics on adequate prenatal care utilization in a population they cannot be used interchangeably.

While the overall intent of each of these indices is to provide a measure of access to and use of prenatal care services based on established clinical recommendations, each index employs distinct approaches to define utilization. The inconsistencies among these indices partially reflect different clinical recommendations for an "adequate" schedule of prenatal care visits and the extent to which those recommendations are strictly followed in constructing the index. In order to correct apparent weaknesses in previous indices, some indices provide additional categories—such as no care, missing data, and intensive utilization—which delineate special cases that should be treated separately. As the ongoing development of measures to assess prenatal care use continues, our findings indicate that the selection of a prenatal care utilization index for research, program evaluation, or policy development entails a careful consideration of the methodological underpinnings of the chosen index.

Based on our assessment, we propose the following guidance for the use of these indices. While recognizing the important initial contribution of the IOM index to the measurement of prenatal care utilization, we do not endorse its continued use, either in its original or modified (M-IOM index) form. The restricted nine-visit coding limitation of this index is not acceptable because it inaccurately classifies

the prenatal care utilization of term and post-term pregnancies and as a result may substantially misrepresent the relationship between prenatal care participation and pregnancy outcomes. Moreover, the original IOM index fails to distinguish missing and no care categories and, even when modified to delineate these groups, does not accurately reflect the ACOG or any other standard. Of the five indices examined, the M-IOM index indicated the largest proportion of adequate use of prenatal care; however, this is an inflated estimate of the proportion of women who actually received the ACOG recommended number of prenatal care visits. While this index is probably the most cited prenatal care utilization index in the literature, its continued use will only hinder research and policy analysis in this area.

Although the OB-Rec index will indicate a substantially lower proportion of adequate prenatal care use in a population than the M-IOM index, particularly for term and post-term deliveries, the OB-Rec index represents a more faithful assessment of the full ACOG visit recommendation. As presented in this study, it can further identify missing and no care groups. It is suitable for the longitudinal monitoring of prenatal care use in populations but is less useful for research on the relationship between prenatal care and birth outcomes since it does not include an intensive category. (A procedure for deriving the OB-Rec index from the computer coding algorithm of the revised GINDEX is on page 417.)

The five indices we examined described markedly different utilization patterns.

The incorporation of risk into the criteria for classifying prenatal care utilization is an innovation of the PHS-Rec index. However, it is unclear to what, if any, extent U.S. obstetricians have adopted the PHS/EPPC recommendation over those offered by the ACOG. Therefore, the PHS-Rec index as employed in this study would not be an appropriate index to assess adequacy of prenatal care use in the United States given that it measures adherence to a proposed pattern of visits that may not be widely recommended to patients. This index may only be useful in comparative studies of the impact of proposed prenatal care practice standards.

The GINDEX does differentiate missing, no care, and intensive groups, but its value is undermined by its reliance on the original and flawed IOM index nine-visit coding strategy for term births. While in this analysis we used the original GINDEX, we present on page 417 an alternative, the Revised GINDEX, using the full ACOG recommendation. With this revision, the GINDEX is useful for research focusing on birth outcomes and for monitoring trends in the proportion of cases with intensive use of prenatal care. It will also allow for an assessment of the adequacy of prenatal care use by the trimester in which care began. The intensive category is best suited for gestational age-specific research. The Revised GINDEX will produce a more negative view of adequacy of care than the original GINDEX, assigning a lower proportion of cases to the adequate group.

The APNCU index provides an appropriate index for use in assessing the extent of prenatal care utilization, especially after prenatal care is initiated. As this index separates initiation of care from compliance with visit recommendations once care has begun, it can be used to monitor these factors separately or in combination. It can be modified, as done in this study, to include a no care category. It is particularly valuable for research that assesses programs aimed at improving the use of prenatal care after care has begun, such as home visiting, case management, or other prenatal care enhancement programs. For women delivering at early gestational ages, the observed to expected ratio of the APNCU index will assign an appreciable proportion of cases to the intensive category, which may prove undesirable in comparing populations with known differences in preterm rates. The APNCU index provided the most somber picture of prenatal care utilization of any of the indices used in this study. The coding algorithm for the APNCU index is provided on page 417.

Notwithstanding our endorsement of the selected use of some of the available indices, all have limitations and there are several areas in need of further research to enhance their interpretation and further development. Affecting all are the inherent errors in accurately recording gestational age at delivery. These errors are a concern for those indices with intensive use categories because an apparent excessive number of visits may simply reflect an underestimated gestational age. Further, an invalid report overestimating gestational age may result in a less than adequate classification of prenatal care. Particularly when indices that employ the full ACOG recommendation are used, the overestimation of gestational age is a concern for the assessment of prenatal care use for post-term births.

Since the spacing of visits is not considered by any of these indices, the adequate categories may conceal intensive medical surveillance and intervention following a period of lack of regular prenatal care. Moreover, none of these indices incorporates indicators of the content of prenatal care. A recent study has revealed that content of care is a significant predictor of birth outcome.[31] More refined future indices should incorporate parameters that reflect the qualitative aspects of prenatal care in addition to measuring number of visits.

The two indices with categories of intensive utilization

(the GINDEX and APNCU index) produced markedly different results. The intensive category of the GINDEX includes cases with very high utilization patterns, that is, more than one standard deviation from the mean number of visits for each trimester of initiation and gestational age at delivery. The gestational age-specific intensive criteria of the GINDEX results in term births making up the majority of the intensive cases, reflecting the fact that term births comprise the majority of total births. In contrast, the APNCU index focuses on identifying cases with 110% or more of the expected number of visits. As the expected number of visits is much fewer for preterm births than for term births, one additional visit is proportionately more important and may mean the difference between adequate use (80% to 109.9% of expected visits) and intensive use (110% or more of expected visits). Therefore, this approach results in a relatively greater likelihood in the APNCU index than in the GINDEX of the classification of preterm births as intensive. Since prior research has indicated that intensive use of prenatal care is associated with poorer birth outcomes,[11] it is critical that these contrasting measurement approaches be explored more fully.

Both the ACOG and PHS/EPPC recommendations are based on expert opinions and traditional clinical practices. The effectiveness of neither standard has been assessed through rigorous scientific testing because of the ethical issues related to undertaking randomized, controlled trials in this area of clinical practice. Several European countries with birth outcome statistics that are comparable to or better than those of the United States prescribe a schedule of visits that differs conspicuously from both the ACOG and the PHS/EPPC guidelines.[32,33] The impact of different prenatal care visit schedules on pregnancy outcome needs to be systematically assessed.

Prenatal care indices, with the exception of the PHS-Rec index, are based on visit recommendations for average or low risk pregnancies and do not establish a recommended visit pattern for high risk women or for women with specific medical conditions. This may result in underestimating the prenatal care needs of high risk women and overestimating adequate utilization of prenatal care in the total population. The PHS/EPPC recommendation addresses the issue of risk, but only for parity. The intensive categories of the GINDEX and the APNCU index also suggest the importance of focusing on potentially high risk pregnancies. Further efforts to include maternal risk parameters in prenatal care utilization indices are needed in order to more thoroughly assess the adequacy of prenatal care use in populations with a full range of high and low risk pregnancies.

The ongoing development of more refined measures of prenatal care utilization is crucial to the accurate assessment of its impact on birth outcomes. Our ability to reach consensus on effective policy initiatives to improve prenatal care participation and reduce low birth weight and infant mortality rates will be hampered by the indiscriminate use of the currently available prenatal care utilization indices. An understanding of the conceptual basis and limitations of each index is a prerequisite for the valid interpretation of the patterns of prenatal care utilization revealed by each index and for the effective use of that information to develop sound policies to further improve pregnancy outcomes.

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CODING ALGORITHMS FOR REVISED GINDEX AND APNCU INDEX

REVISED GINDEX (Graduated Prenatal Care Utilization Index):

INTENSIVE PRENATAL CARE UTILIZATION:

```
IF (TPCB=1) & ( ((18<=GEST<=21) & (11=<PCV)) | ((22<=GEST<=25) & (13=<PCV))
   | ((26<=GEST<=29) & (14=<PCV)) | ((30<=GEST<=31) & (15=<PCV))
   | ((32<=GEST<=36) & (16=<PCV)) | ((37<=GEST<=40) & (17<=PCV))
   | ((41<=GEST<=42) & (18=<PCV)) | ((43<=GEST<=45) & (19<=PCV)) )
  THEN GINDEX=INTENSIVE (1st Trimester);
IF (TPCB=2) & ( ((18<=GEST<=21) & (10=<PCV)) | ((22<=GEST<=25) & (11=<PCV))
   | ((26<=GEST<=31) & (12=<PCV)) | ((32<=GEST<=35) & (13=<PCV))
   | ((36<=GEST<=37) & (14=<PCV)) | ((38<=GEST<=40) & (15=<PCV))
   | ((41<=GEST<=42) & (16=<PCV)) | ((43<=GEST<=45) & (17<=PCV)) )
  THEN GINDEX=INTENSIVE (2nd Trimester);
IF (TPCB=3) & ( ((GEST =25) & (9=<PCV)) | ((26<=GEST<=31) & (10=<PCV))
   | ((32<=GEST<=35) & (11=<PCV)) | ((36<=GEST<=37) & (12=<PCV))
   | ((38<=GEST<=40) & (13=<PCV)) | ((41<=GEST<=42) & (14=<PCV)) )
   | ((43<=GEST<=45) & (15=<PCV)) )
  THEN GINDEX=INTENSIVE (3rd Trimester);
```

ADEQUATE PRENATAL CARE UTILIZATION CRITERIA:

```
IF (TPCB=1) & ( ((18<=GEST<=21) & (3=<PCV<=10)) | ((22<=GEST<=25) & (4=<PCV<=12))
   | ((26<=GEST<=29) & (5=<PCV<=13))  | ((30<=GEST<=31) & (6=<PCV<=14))
   | ((32<=GEST<=33) & (7=<PCV<=15))  | ((34<=GEST<=35) & (8=<PCV<=15))
   | ((    GEST  =36) & (9=<PCV<=15))  | ((   GEST =37) & (10<=PCV<=16))
   | ((    GEST  =38) & (11=<PCV<=16)) | ((   GEST =39) & (12<=PCV<=16))
   | ((    GEST  =40) & (13=<PCV<=16)) | ((   GEST =41) & (14<=PCV<=17))
   | ((    GEST  =42) & (15=<PCV<=17)) | ((43<=GEST<=45) & (16<=PCV<=18)) )
  THEN GINDEX=ADEQUATE (1st Trimester);
```

INTERMEDIATE PRENATAL CARE UTILIZATION CRITERIA:

```
IF (TPCB=1) & ( ((18<=GEST<=21) & (1<=PCV<=2)) | ((22<=GEST<=25) & (2=<PCV<=3))
   | ((26<=GEST<=29) & (2=<PCV<=4))  | ((30<=GEST<=31) & (3=<PCV<=5))
   | ((32<=GEST<=33) & (4=<PCV<=6))  | ((34<=GEST<=35) & (5=<PCV<=7))
   | ((    GEST =36)  & (5=<PCV<=8))  | ((   GEST =37) & (6=<PCV<=9))
   | ((    GEST =38)  & (7=<PCV<=10)) | ((   GEST =39) & (7=<PCV<=11))
   | ((    GEST =40)  & (8=<PCV<=12)) | ((   GEST =41) & (8=<PCV<=13))
   | ((    GEST =42)  & (9=<PCV<=14)) | ((43<=GEST<=45) & (9=<PCV<=15)) )
  THEN GINDEX=INTERMEDIATE (1st Trimester);
IF (TPCB=2) & ( ((18<=GEST<=21) & (1=<PCV<=9)) | ((22<=GEST<=25) & (2=<PCV<=10))
   | ((26<=GEST<=29) & (2=<PCV<=11)) | ((30<=GEST<=31) & (3=<PCV<=11))
   | ((32<=GEST<=33) & (4=<PCV<=12)) | ((34<=GEST<=35) & (5=<PCV<=12))
   | ((36<=GEST<=37) & (6=<PCV<=13)) | ((38<=GEST<=39) & (7=<PCV<=14))
   | ((    GEST =40)  & (8=<PCV<=14)) | ((   GEST =41) & (8=<PCV<=15))
   | ((    GEST =42)  & (9=<PCV<=15)) | ((43<=GEST<=45) & (9=<PCV<=16)) )
  THEN GINDEX=INTERMEDIATE (2nd Trimester);
```

INADEQUATE PRENATAL CARE UTILIZATION CRITERIA:

```
IF (TPCB=1) &  ( ((22<=GEST<=29) & (PCV=1)) | ((30<=GEST<=31) & (1<=PCV<=2))
   | ((32<=GEST<=33) & (1<=PCV<=3))  | ((34<=GEST<=36) & (1<=PCV<=4))
   | ((    GEST =37)  & (1<=PCV<=5))  | ((38<=GEST<=39) & (1<=PCV<=6))
   | ((40<=GEST<=41) & (1<=PCV<=7))  | ((42<=GEST<=45) & (1<=PCV<=8)) )
  THEN GINDEX=INADEQUATE (1st Trimester);
   | ((40<=GEST<=41) & (1<=PCV<=7))  | ((42<=GEST<=45) & (1<=PCV<=8)) )
IF (TPCB=2) & ( ((22<=GEST<=29)  & (PCV=1)) | ((30<=GEST<=31) & (1<=PCV<=2))
   | ((32<=GEST<=33) & (1<=PCV<=3))  | ((34<=GEST<=35) & (1<=PCV<=4))
   | ((36<=GEST<=37) & (1<=PCV<=5))  | ((38<=GEST<=39) & (1<=PCV<=6))
   | ((40<=GEST<=41) & (1<=PCV<=7))  | ((42<=GEST<=45) & (1<=PCV<=8)) )
  THEN GINDEX=INADEQUATE (2nd Trimester);
IF (TPCB=3) & ( ((GEST =25) & (1<=PCV<=8) | ((26<=GEST<=31) & (1<=PCV<=9))
   | ((32<=GEST<=35) & (1<=PCV<=10)  | ((36<=GEST<=37) & (1<=PCV<=11))
   | ((38<=GEST<=40) & (1<=PCV<=12)  | ((41<=GEST<=42) & (1<=PCV<=13))
   | ((43<=GEST<=45) & (1<=PCV<=14)) )
  THEN GINDEX=INADEQUATE (3rd Trimester);
```

MISSING PRENATAL CARE CRITERIA:

```
IF   ( ((PCV=.)  & (TPCB^=0))       | ((TPCB=3) & (1<=GEST<=24))
     | ((TPCB=2) & (1<=GEST<=11)) | ((GEST=.) & (PCV^=0))
```

```
    | ((TPCB=.) & (PCV^=0))          | ((TPCB=0) & (PCV>0)) )
 THEN INDEX = MISSING;
```

NO PRENATAL CARE UTILIZATION:

```
IF (PCV=0) | (TPCB=0 & PCV=.) THEN INDEX = NOCARE;
```

Note: The OB-REC index can be created from the Revised Gindex by the following method: (1) Adequate: combine the first trimester intensive category with the adequate category. (2) Intermediate: combine the second trimester intensive with the two intermediate categories. (3) Inadequate: combine the third trimester intensive category and the three inadequate categories. (4) Although the no care group could also be combined into the inadequate category, we recommend that the no care and missing categories be treated separately.

APNCU (ADEQUACY OF PRENATAL CARE UTILIZATION) INDEX[6]:

CALCULATES ADEQUACY OF INITIATION OF PRENATAL CARE:

```
IF (PCV > 0) & (1<=MPCB<=2) THEN MOINDEX = 4;
IF (PCV > 0) & (3<=MPCB<=4) THEN MOINDEX = 3;
IF (PCV > 0) & (5<=MPCB<=6) THEN MOINDEX = 2;
IF (PCV > 0) & (7<=MPCB<=9) THEN MOINDEX = 1;
ELSE MOINDEX = .;
```

CALCULATES ADEQUACY OF RECEIVED PRENATAL CARE:

```
IF GEST GE 35 THEN UEXPVIS = (GEST - 35) + 9;
IF GEST EQ 34 THEN UEXPVIS =  9; IF GEST GE 32 THEN UEXPVIS =  8;
IF GEST GE 30 THEN UEXPVIS =  7; IF GEST GE 26 THEN UEXPVIS =  6;
IF GEST GE 22 THEN UEXPVIS =  5; IF GEST GE 18 THEN UEXPVIS =  4;
IF GEST GE 14 THEN UEXPVIS =  3; IF GEST GE 10 THEN UEXPVIS =  2;
IF GEST GE  6 THEN UEXPVIS =  1; IF GEST GE  0 THEN UEXPVIS =  0;
ELSE UEXPVIS = .;
IF MPCB = .| MPCB = 0 THEN EXPVIS = UEXPVIS;
IF MPCB =  9 THEN EXPVIS  =  UEXPVIS - 13;
IF MPCB =  8 THEN EXPVIS  =  UEXPVIS -  9;
IF MPCB =  7 THEN EXPVIS  =  UEXPVIS -  7;
IF MPCB =  6 THEN EXPVIS  =  UEXPVIS -  6;
IF MPCB =  5 THEN EXPVIS  =  UEXPVIS -  5;
IF MPCB =  4 THEN EXPVIS  =  UEXPVIS -  3;
IF MPCB =  3 THEN EXPVIS  =  UEXPVIS -  2;
IF MPCB =  2 THEN EXPVIS  =  UEXPVIS -  1;
IF MPCB =  1 THEN EXPVIS  =  UEXPVIS;
IF EXPVIS LE 0 THEN EXPVIS = 1;
ELSE EXPVIS = .;
EVRATIO = (PCV/EXPVIS) * 100;
IF EVRATIO =. THEN EVINDEX = 0;
IF EVRATIO > 109.99 THEN EVINDEX = 4;
IF (80<=EVRATIO<=109.99) THEN EVINDEX = 3;
IF (50<=EVRATIO<=79.99) THEN EVINDEX = 2;
IF (1<=EVRATIO<=49.99) THEN EVINDEX = 1;
```

CALCULATES COMBINED APNCU INDEX:

```
IF EVINDEX=4 & (1<=MPCB<=4) THEN APNCU=INTENSIVE;
IF (3<=EVINDEX<=4) & (3<=MOINDEX<=4) THEN APNCU = ADEQUATE;
IF EVINDEX EQ 1 | (1<=MOINDEX<=2) THEN APNCU = INADEQUATE;
ELSE APNCU = INTERMEDIATE;
```

Note: The original APNCU index differs slightly from the GINDEX in the assignment of cases to its missing category.

VARIABLE AND SYMBOL DEFINITIONS:

APNCU	= APNCU SUMMARY INDEX
EVINDEX	= APNCU EXPECTED VISIT INDEX
EVRATIO	= APNCU EXPECTED/OBSERVED VISIT RATIO
EXPVIS	= APNCU EXPECTED VISITS
GEST	= GESTATIONAL AGE (18–45 weeks based on LMP)
GINDEX	= GRADUATED PRENATAL CARE UTILIZATION INDEX
MOINDEX	= APNCU MONTH OF INITIATION INDEX
MPCB	= MONTH PRENATAL CARE BEGAN (0=none, 1–9 mos)
PCV	= NUMBER OF PRENATAL CARE VISITS (0=none, 1–49 visits)
TPCB	= TRIMESTER PRENATAL CARE BEGAN (0=none, 1–3 trimesters)
UEXPVIS	= APNCU UNADJUSTED EXPECTED VISITS
(|)	= or
(&)	= and
(.)	= missing data
NE (^=)	= not equal to