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Assessing the Quality of Prenatal Care: Use of the Kotelchuck Index Combined with Prenatal Care Data

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Abstract: The aim of the present study was to propose a quality prenatal (PN) care assessment model combining use and visit content (both adjusted for the weeks of gestation) to estimate inadequate PN care and associated factors in Rio Branco, Acre. A cross-sectional study was conducted using a population-based cohort of 1030 women in the city of Rio Branco in 2015. The use of PN care was classified according to the adapted Kotelchuck index by combining the performance of clinical-obstetric procedures adjusted for weeks of gestation. Levels of adequacy were built according to PN care use and content. Gross and adjusted odds ratios were estimated by using a logistic regression. The prevalence rates of inadequate prenatal care quality were 25.9% (Level-1), 54.8% (Level-2), 68.8% (Level-3), and 78.6% (Level-4). The factors associated with Level-1 were age $\leq$ 34 years (ORaj:3.74), not having a partner (ORaj:1.62), unplanned pregnancy (ORaj:1.73), and multiparity (ORaj:2.25); those for Level-2 comprised not having a partner (ORaj:1.82) and multiparity (ORaj:1.33); those for Level-3 were age $\leq$ 34 years (ORaj:3.31), not having a partner (Oraj:1.71), unplanned pregnancy (Oraj:1.45), PN in the private sector (Oraj:3.08), and multiparity (ORaj:2.17); those for Level 4 comprised not having a partner (ORaj:2.33), family income < 1 MW (ORaj:2.05), unplanned pregnancy (ORaj:1.41), PN in the private sector (ORaj:6.80), and multiparity (ORaj:1.49). The Kotelchuck index was proven efficient in assessing the combined effect of use and content in assessing PN care quality.

Keywords: prenatal care; health evaluation; health services

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1. Introduction

Maternal and child health indicators comprise an important reflection of health and development conditions. In this context, prenatal (PN) care indicators such as the Kessner and Kotelchuck indices were developed to assess the use of PN care (by combining the number of PN visits and timing of initiation of PN care) [1,2].

The indices were developed based on these indicators and are the most commonly applied in both the Brazilian and international literature. The former allows for assessments of the combination of the number of visits with the week when prenatal care began. The second index, also known as the Adequacy Prenatal Care Utilization Index (APNCUI), allows for the analysis of the number of visits and timing of initiation of PN care both independently and/or combined in addition to adjusting the number of visits for weeks of gestation [1,2].

Although most of the proposed evaluation indices are applied to assess PN access and use, the literature has demonstrated that such criteria are not sufficient to assess the quality of the PN care because the content of the assistance PN (clinical procedures and laboratory tests) performed in a timely manner is essential for high-quality PN care [3,4]. Studies have demonstrated that insufficient or absent PN care is associated with negative outcomes that include preterm births, low birth weights (LBWs), and neonatal mortality.

Thus, identifying PN care flaws and quality is paramount because high-quality PN care programs may contribute to decreasing complications during pregnancy and delivery, thereby positively affecting mother-and-child morbidity and mortality [5,6].

Prenatal care use effects on maternal, fetal, and infant outcomes have been investigated worldwide [7,8]. However, this does not necessarily reflect consultation procedures (content), which are essential in preventing hazard outcomes such as spontaneous preterm births, low birth weights, and vertical disease transmission [7,8]. In Brazil, Takeda and collaborators [3] and Anversa and collaborators [9] proposed a PN care program evaluation model that considers content criteria combined with use (PN care onset and number of appointments). However, the authors employed the Kessner index according to the Brazilian Ministry of Health recommendations [10], which does not adjust the number of visits according to weeks of gestation [3,9]. Therefore, the present study proposes a quality PN care assessment model combining use and visit content (both adjusted for weeks of gestation) to estimate the prevalence of inadequate PN care and associated factors in the city of Rio Branco, Acre. This city is located in the western Brazilian Amazon area and comprises 3.27% of Brazil's population [11]. Despite its high PN care coverage (97.5%), this region presents the highest percentage of women without PN care (60% higher than the national average) and experiences the worst neonatal results, including spontaneous preterm births (8.5%) and LBWs (7.9%) [12].

2. Results

A total of 129 (10.7%) women were lost, 6 lacked prenatal cards at hospitalization, and 123 lacked information on the prenatal card regarding the number of visits and timing of initiation of PN care. Thus, the study population encompassed 1030 women who answered a questionnaire containing information concerning sociodemographic, current pregnancy, and PN care procedures and exams.

From 1030 women included in the study, 20.3% were inadequate for Level-1 quality, 0.0% for Level-2, 12.0% for Level-3, and 0.0% for Level-4. On the other hand, 74.1% were more than adequate/adequate for Level-1, 45.2% for Level-2, 31.2% for Level-3, and 21.4% for Level-4 (Table 1).

According to Table 2, compared to women classified as receiving adequate PN care, those classified as receiving inadequate PN care at Level-1 were more frequently aged <20 years (34.4%); self-declared as multiethnic (32.4%); had an education level <elementary school (37.6%); had no partner (38.5%); had family income up to 1 MW (42.3%); belonged to class C, D, and E (28.4%); had an unplanned pregnancy (31.1%); had no previous abortion (31.2%); used the public health service (27.9%); and were multiparous (30.7%) with statistical significance. Regarding women classified as receiving inadequate PN care in Level-2, the majority had no partner (62.1%), used private health services (53.6%), and were multiparous (58.1%) with statistical significance. Among those classified as receiving inadequate PN care in Level-3, the most frequent characteristics were having no partner (77.0%), family income up to 1 MW (77.5%), unplanned pregnancy (72.2%), using private health care service (67.1%), no previous abortions (75.3%), and multiparity (63.0%) with statistical significance. Regarding those classified as inadequate in Level-4, a greater proportion had no partner (87.6%), had family income up to 1 MW (85.9%), had an unplanned pregnancy (80.9%), used private health care service (76.5%), had no previous abortions (83.1%), and was multiparous (74.5%) with statistical significance.

Table 1. Distribution of the inadequacy of PN care content according to the Kotelchuck index adapted to Brazilian Ministry of Health and WHO recommendations in a cohort of parturients in the city of Rio Branco, AC, 2015.

Levels [a] of PN Care	**Analysis Adjusted for Procedure IGs**	
	N	**%**
Level-1 (Adapted Kotelchuck)		
>Adequate	522	(50.7)
Adequate	241	(23.4)
Intermediate	58	(5.6)
Inadequate	209	(20.3)
Level-2 (Level 1 + clinical-obstetric procedures)		
>Adequate	361	(35.0)
Adequate	105	(10.2)
Intermediate	564	(54.8)
Inadequate	0	(0.0)
Level-3 (Level 1 + laboratory tests)		
>Adequate	243	(23.6)
Adequate	78	(7.6)
Intermediate	585	(56.8)
Inadequate	124	(12.0)
Level-4 (Level 1 + clinical-obstetric procedures + laboratory tests)		
>Adequate	184	(17.9)
Adequate	36	(3.5)
Intermediate	810	(78.6)
Inadequate	0	(0.0)
Total	1030	100

[a] Levels established by Silveira, Santos, and Costa (2001) and Anversa et al. (2012).

In the multivariate analysis (Table 3), when considering Level-1 of PN care quality, women aged $\leq$ 20 years old (OR = 3.74; CI: 95%: 1.90–7.35) or 20–34 years old (OR = 1.79; CI: 95%: 1.01–3.18) with elementary school II schooling (OR = 2.53; CI: 95%: 1.41–4.53) or a high school (OR = 1.60; CI: 95%: 0.94–2.70) education level, with no partner (OR = 1.62; CI: 95%: 1.07–2.46), with an unplanned pregnancy (OR = 1.73; CI: 95%: 1.22–2.47), and were multiparous (OR = 2.25; CI: 95%: 1.50–3.35) presented a statistically increased chance of inadequate PN care. Concerning Level-2 PN care quality, women with no partner (OR = 1.82; CI: 95%: 1.27–2.61) and multiparous women (OR = 1.33; CI: 95%: 1.03–1.71) presented statistically increased chances of inadequate PN care. When assessing Level-3 of PN care quality, women aged >20 years old (OR = 3.31; CI: 95%: 1.92–5.73) or 20–34 years old (OR = 1.99; CI: 95%: 1.27–3.12) with no partner (OR = 1.71; CI: 95%: 1.12–2.59); with an unplanned pregnancy (OR = 1.45; CI: 95%: 1.09–1.93), using private health care service (OR = 3.08; CI: 95%: 1.91–4.97), and who were multiparous (OR = 2.17; CI: 95%: 1.59–2.96) presented statistically increased chances of inadequate PN care. Regarding Level-4 of PN quality, women with no partner (OR = 2.33; CI: 95%: 1.30–4.17), with family income < 1 MW (OR = 2.05; CI: 95%: 1.07–3.92), with an unplanned pregnancy (OR = 1.41; CI: 95%: 1.01–2.00); using private health care service (OR = 6.80; CI: 95%: 2.84–16.28), and who were multiparous (OR = 1.49; CI: 95%:1.06–2.11) presented statistically increased chances of inadequate PN care.

Table 2. Sociodemographic characteristics, clinical history, and PN care according to [a] inadequacy of PN care in a cohort of parturients in the municipality of Rio Branco, AC, 2015.

Variable	Total	Level-1: Kotelchuck			Level-2: Level-1 + Clinical-Obstetric Exams			Level-3: Level-1 + Laboratory Tests			Level—4: Level-1 + Level-2 + Level-3		
	[d] N (%)	[b] Inadequate	[c] Adequate	*p*-Value	[b] Inadequate	[c] Adequate	*p*-Value	[b] Inadequate	[c] Adequate	*p*-Value	[b] Inadequate	[c] Adequate	*p*-Value
	1030 (100%)	267 (100%)	763 (100%)		564(100%)	466(100%)		709 (100%)	321 (100%)		810 (100%)	220 (100%)	
Age (years)													
<20	256 (24.8)	88 (34.4)	168 (65.6)		145 (56.6)	111 (43.4)		185 (72.3)	71 (27.7)		202 (78.9)	54 (21.1)	
20–34	664 (64.5)	160 (24.1)	504 (75.9)	0.001	362 (54.5)	302 (45.5)	0.682	456 (68.7)	208 (31.3)	0.140	527 (79.4)	137 (20.6)	0.395
≥35	110 (10.7)	19 (17.3)	91 (82.7)		57 (51.8)	53 (48.2)		68 (61.8)	42 (38.2)		81 (73.6)	29 (26.4)	
Skin color													
White	109 (10.6)	18 (16.5)	91 (83.5)		62 (56.9)	47 (43.1)		74 (67.9)	35 (32.1)		92 (84.4)	17 (15.6)	
Brown	853 (82.8)	227 (26.6)	626 (73.4)	0.035	462 (54.2)	391 (45.8)	0.679	594 (69.6)	259 (30.4)	0.271	666 (78.1)	187 (21.9)	0.286
Other	68 (6.6)	22 (32.4)	46 (67.6)		40 (58.8)	28 (41.2)		41 (60.3)	27 (39.7)		52 (76.5)	16 (23.5)	
Schooling													
Up to elementary school II	266 (25.9)	100 (37.6)	166 (62.4)		159 (59.8)	107 (40.2)		196 (73.7)	70 (26.3)		216 (81.2)	50 (18.8)	
High school	533 (51.8)	137 (25.7)	396 (74.3)	<0.001	288 (54.0)	245 (46.0)	0.111	357 (67.0)	176 (33.0)	0.138	409 (76.7)	124 (23.3)	0.290
University education	231 (22.3)	30 (13.0)	201 (87.0)		117 (50.6)	114 (49.4)		156 (67.5)	75 (32.5)		185 (80.1)	46 (19.9)	
Marital situation													
No partner	161 (15.6)	62 (38.5)	99 (61.5)	<0.001	100 (62.1)	61 (37.9)	0.025	124 (77.0)	37 (23.0)	0.015	141 (87.6)	20 (12.4)	0.003
With partner	869 (84.4)	205 (23.6)	664 (76.4)		464 (53.4)	405 (46.6)		585 (67.3)	284 (32.7)		669 (77.0)	200 (23.0)	
Family income													
Up to 1 MW [e]	142 (13.7)	60 (42.3)	82 (57.7)		86 (60.6)	56 (39.4)	0.354	110 (77.5)	32 (22.5)		122 (85.9)	20 (14.1)	
1 to 3 MW	506 (49.1)	141 (27.9)	365 (72.1)	<0.001	272 (53.8)	234 (46.2)		333 (65.8)	173 (34.2)	0.030	378 (74.7)	128 (25.3)	0.008
>3 MW	237 (22.2)	41 (17.3)	196 (82.7)		131 (55.3)	106 (44.7)		164 (69.2)	73 (30.8)		192 (81.0)	45 (19.0)	
ABEP class													
A and B	201 (19.7)	34 (16.9)	167 (83.1)	<0.001	105 (52.2)	96 (47.8)	0.244	136 (67.7)	65 (32.3)	0.690	160 (79.6)	41 (20.4)	0.662
C, D, and E	816 (80.3)	232 (28.4)	584 (71.6)		365 (44.7)	451 (55.3)		564 (69.1)	252 (30.9)		638 (78.2)	178 (21.8)	
Planned pregnancy													
No	643 (62.7)	200 (31.1)	443 (68.9)	<0.001	361 (56.1)	282 (43.9)	0.239	464 (72.2)	179 (27.8)	0.003	520 (80.9)	123 (19.1)	0.023
Yes	382 (37.3)	67 (17.5)	315 (82.5)		200 (52.4)	182 (47.6)		242 (63.4)	140 (36.6)		286 (74.9)	96 (25.1)	
Prenatal care													
Public	896 (87.0)	250 (27.9)	646 (72.1)	<0.001	480 (53.6)	416 (46.4)	0.048	601 (67.1)	295 (32.9)	0.002	685 (76.5)	211 (23.5)	<0.001
Private	134 (13.0)	17 (12.7)	117 (87.3)		84 (62.7)	50 (37.3)		108 (80.6)	26 (19.4)		125 (93.3)	9 (6.7)	
Abortion													
No	433 (67.6)	135 (31.2)	298 (68.8)	0.033	248 (57.3)	185 (42.7)	0.610	326 (75.3)	107 (24.7)	0.002	360 (83.1)	73 (16.9)	0.010
Yes	208 (32.4)	48 (23.1)	160 (76.9)		114 (54.8)	94 (45.2)		132 (63.5)	76 (36.5)		155 (74.5)	53 (25.5)	

Table 2. *Cont.*

Variable	Total	Level-1: Kotelchuck			Level-2: Level-1 + Clinical-Obstetric Exams			Level-3: Level-1 + Laboratory Tests			Level—4: Level-1 + Level-2 + Level-3		
	[d] N (%)	[b] Inadequate	[c] Adequate	*p*-Value	[b] Inadequate	[c] Adequate	*p*-Value	[b] Inadequate	[c] Adequate	*p*-Value	[b] Inadequate	[c] Adequate	*p*-Value
Number of births													
Primiparous	443 (43.0)	87 (19.6)	356 (80.4)	<0.001	223 (50.3)	220 (49.7)	0.013	279 (63.0)	164 (37.0)	<0.001	330 (74.5)	113 (25.5)	0.005
Multiparous	587 (57.0)	180 (30.7)	407 (69.3)		341 (58.1)	246 (41.9)		430 (73.3)	157 (26.7)		480 (81.8)	107 (18.2)	

[a] Criterion based on the Kotelchuck index (repetition of exams during the third trimester was not considered); [b] Inadequate: Intermediate + Inadequate; [c] Adequate: More than adequate + Adequate; [d] totals may change due to missing data; [e] MW = 788 reais or US$ 302.

Table 3. Factors associated with [a] inadequate PN care in Rio Branco, Acre, according to the adapted Kotelchuck index.

Variable	Levels of Quality of PN Care according to the Category of Use (Kotelchuck Index) Combined with Content							
	Level 1: Kotelchuck Adapted to the PHPN		Level-2: Level-1 + Clinical-Obstetric Exams		Level 3: Level-1 + Laboratory Tests		Level 4: Level-1 + Obstetric + Laboratory Exams	
	OR_{crude} (CI 95%)	$OR_{adjusted}$ (CI 95%)	OR_{crude} (CI 95%)	$OR_{adjusted}$ (CI 95%)	OR_{crude} (CI 95%)	$OR_{adjusted}$ (CI 95%)	OR_{crude} (CI 95%)	$OR_{adjusted}$ (CI 95%)
Age (years)								
<20	2.50 (1.43–4.38)	3.74 (1.90–7.35)	1.22 (0.78–1.90)		1.60 (1.00–2.58)	3.31 (1.92–5.73)	1.34 (0.80–2.25)	
20–34	1.52 (0.89–2.57)	1.79 (1.01–3.18)	1.12 (0.74–1.67)		1.35 (0.89–2.05)	1.99 (1.27–3.12)	1.38 (0.87–2.20)	
≥ 35	1	1	1		1	1	1	
Ethnicity								
White	1		1		1		1	
Brown	1.83 (1.08–3.10)		0.90 (0.60–1.33)		1.08 (0.70–1.66)		0.65 (0.38–1.13)	
Other	2.41 (1.18–4.95)		1.09 (0.59–2.00)		0.71 (0.38–1.34)		0.29 (0.29–1.29)	
Schooling								
≤Elementary school	4.03 (2.55–6.37)	2.53 (1.41–4.53)	1.45 (1.01–2.07)		1.34 (0.91–1.98)		1.07 (0.69–1.68)	
High school	2.31 (1.50–3.56)	1.60 (0.94–2.70)	1.15 (0.84–1.57)		0.97 (0.70–1.35)		0.82 (0.56–1.20)	
University education	1	1	1		1		1	
Marital Situation								
Without partner	2.02 (1.42–2.89)	1.62 (1.07–2.46)	1.43 (1.01–2.02)	1.82 (1.27–2.61)	1.62 (1.09–2.41)	1.71 (1.12–2.59)	2.10 (1.29–3.46)	2.33 (1.30–4.17)
With partner	1	1	1	1	1	1	1	1
Family Income								
Up to 1 MW	3.49 (2.17–5.61)	1.35 (0.77–2.36)	1.24 (0.81–1.90)		1.53 (0.94–2.47)		1.43 (0.80–2.53)	2.05 (1.07–3.92)
1 to 3 MW	1.84 (1.25–2.72)	0.98 (0.62–1.54)	0.94 (0.70–1.23)		0.85 (0.61–1.19)		0.69 (0.47–1.01)	0.89 (0.58–1.36)
>3 MW	1	1	1		1		1	1
ABEP class								
A and B	1		1		1		1	
C, D, and E	1.95 (1.30–2.90)		1.13 (0.83–1.53)		1.07 (0.76–1.48)		0.92 (0.63–1.35)	

Table 3. *Cont.*

Variable	Levels of Quality of PN Care according to the Category of Use (Kotelchuck Index) Combined with Content							
	Level 1: Kotelchuck Adapted to the PHPN		**Level-2: Level-1 + Clinical-Obstetric Exams**		**Level 3: Level-1 + Laboratory Tests**		**Level 4: Level-1 + Obstetric + Laboratory Exams**	
	OR_{crude} (CI 95%)	**$OR_{adjusted}$ (CI 95%)**	**OR_{crude} (CI 95%)**	**$OR_{adjusted}$ (CI 95%)**	**OR_{crude} (CI 95%)**	**$OR_{adjusted}$ (CI 95%)**	**OR_{crude} (CI 95%)**	**$OR_{adjusted}$ (CI 95%)**
				Planned Pregnancy				
No	2.12 (1.55–2.90)	1.73 (1.22–2.47)	1.16 (0.90–1.50)		1.50 (1.14–1.96)	1.45 (1.09–1.93)	1.42 (1.04–1.92)	1.41 (1.01–2.00)
Yes	1	1	1		1	1	1	1
PN care								
Public	1		1	1	1	1	1	1
Private	0.37 (0.22–0.63)		1.46 (1.00–2.12)	1.43 (0.98–2.09)	2.03 (1.30–2.03)	3.08 (1.91–4.97)	4.28 (2.13–8.56)	6.80 (2.84–16.28)
Abortion								
No	1.51 (1.03–2.21)		1.10 (0.79–1.54)		1.75 (1.22–2.50)		1.69 (1.13–2.52)	
Yes	1		1		1		1	
				Number of Births				
Primiparous	1	1	1	1	1	1	1	1
Multiparous	1.81 (1.35–2.42)	2.25 (1.50–3.35)	1.37 (1.07–1.76)	1.33 (1.03–1.71)	1.61(1.23–2.10)	2.17 (1.59–2.96)	1.53 (1.14–2.07)	1.49 (1.06–2.11)

3. Discussion

Although the Kotelchuck index has been consistently employed to assess PN care use quality in the literature [13,14], many studies conducted in Brazil still use limited indices such as the Kessner index [9,15,16] because preterm births may present an adequate number of visits for weeks of gestation. Therefore, an index combining the use and recommended contents adjusted according to weeks of gestation may adequately provide accurate PN care quality assessments.

Since its development, the Kotelchuck index has revealed that an increased number of women with more than adequate PN care translates into decreased unfavorable outcomes such as low birth weights and preterm births. Thus, Kotelchuck and colleagues conducted a cross-sectional study in 1997 to evaluate the content of PN care administered to women classified as low-income individuals [17] that demonstrated the limitations of this index in assessing the adequacy of PN care when content is not considered.

In this sense, the present study provides evidence that the Kotelchuck index combined with contents adjusted for weeks of gestation may comprise a complete and accurate PN care quality assessment strategy. The findings indicated very frequent inadequate PN care (78.6%) in Rio Branco, Acre. The contents presented higher weights on the adequacy drop compared to the Kotelchuck index alone: the Level-3 inadequacy when employing this index was 68.8%; for Level-2, it was 54.8%.

The observed Level-2 adequacy decreases corroborated other studies [9,18]. In one study, for example, the same trend was noted in the city of Santa Maria in southern Brazil [9] in 2010, where the adequacy frequency when combining clinical-obstetric procedures and the Kessner index was 46.0%. However, that study applied the Kessner index adapted by Takeda, which does not adjust the number of visits for weeks of gestation, which could have underestimated PN care adequacy. In another assessment, concerning use combined with laboratory tests (Level-3), in Santa Maria in 2012, the decrease was lowered from 59.0% (Level-1) to 8.0% (Level-3) [9]. This suggested that even after the creation of national policies and programs over the years, the performance of laboratory tests remains the greatest challenge with regard to the quality of PN care in different regions; this includes Acre, which is located in a region presenting high hepatitis B endemicity. These findings reinforce the need for awareness concerning screening and potentially early morbidity detection in addition to a greater number of children and lack of a partner, which often makes the woman a household keeper, which in turn makes it impossible for her to seek health care.

The literature demonstrates that failure to perform routine examinations can be associated with several factors such as failures in health service structuring; i.e., barriers and difficulties related to scheduling and performance, which depend on often insufficient inputs for the demands in place. In addition, test scheduling, realization, and results must be performed and obtained in a timely manner [18].

The difference between the inadequacy of Level-4 PN care (78.6%) when considering all content criteria and Level-1 (25,9%) was considerable, suggesting that although women from Acre have access and utilize PN care programs, they are not provided with the full recommended procedures and laboratory tests, which was similar to that observed other studies [9,19–21], demonstrating failures in accessing essential services for safe pregnancy and delivery in developing countries.

In another study carried out in Santa Maria [9], the PN care adequacy for all issues (use + laboratory tests + obstetric procedures) was evaluated between 2009 and 2010 according the Brazilian recommendations [10]. The factors associated with PN care inadequacy for all issues may reflect patient barriers, the healthcare system itself, and health professionals and services. Thus, the findings reported herein stress the need for a continuous individualized care monitoring system regarding PN care with a surveillance system for users who were not submitted to recommended clinical procedures and examinations in a timely manner. Additionally, the results reported herein were similar to those observed in a study carried out in São Tomé and Príncipe between 2008 and 2009, which showed

that adequate PN care was more frequent among married women who wished to become pregnant and exhibited a better economic well-being index [22].

Although the PN care provided in the private sector has often led to a higher frequency of adequacy compared to the public sector in both the international [23] and Brazilian [24] literature, performing PN care in the private sector in Rio Branco led to a 6.80-fold higher chance of inadequate care than patients who underwent PN care in the public sector. The apparent inadequacy in the private sector regarding obstetric procedures can be partly explained by the superiority of performing more expensive procedures such as ultrasounds in this sector instead of fetal heart rate and fetal movement tests, which are less expensive.

Additionally, a lack of pregnancy card standardization in the private Rio Branco system may lead professionals to miss report visits in gestational cards. Similarly, since the private system in Rio Branco usually covers long-term patients, private health professionals often skip the request of specific recommended tests such as those for syphilis, HIV, and hepatitis B and C due to the known patient health profiles; i.e., steady partners, sexually transmitted disease history, and so on. Another aspect is the difference between nurse and doctor PN care performances in each Rio Branco sector. In the private sector, PN care is performed exclusively by a medical doctor, while in the public sector, PN care for low-risk pregnancies is performed by nurses. In this sense, it is important to highlight that nurses in Brazil can only prescribe medications, requests, and perform clinical and laboratory tests officially recommended by the Ministry of Health in the scope of PN care programs. This may explain why the number of fetal movements and fetal heart rates are more frequently assessed in the public sector compared to the private sector because nurses cannot conduct ultrasounds according to Brazilian legislation [25].

Since nurses perform the PN care in low-risk pregnancies, another aspect for greater public sector PN adequacy concerns the holistic nursing care provided by these professionals and informing them of all aspects recommended in the Brazilian Ministry of Health protocols and manuals, which can contribute to compliance with established standards [14,26].

The present study contributes to the public health field by proposing a more accurate PN care quality index that allows for estimates of the frequency of PN care inadequacy according to the main components recommended by official agencies adjusted for weeks of gestation. Additionally, the proposed index may be customized to the official recommendations of any country. Finally, this analysis allows for the identification of factors associated with inadequacy, which should become targets for public health interventions, thereby prioritizing women at risk of poor PN care use and those receiving inadequate PN care content. This approach provides health managers with a standard for evaluating program quality and the main points deserving greater investment and/or strategic management interventions.

In sum, the findings reported herein demonstrate the importance of actions that contribute to timely access to obstetric and laboratory procedures during consultations responsible for identifying possible complications; such initiatives are paramount in reducing child and maternal morbidity and mortality in the western Amazon.

4. Materials and Methods

This article is an integral part of two major projects: "Use of medicine during pregnancy, childbirth and breastfeeding in pregnant women in the municipality of Rio Branco, Acre" and "Evolution of nutritional indicators of children from birth to the first year of life in Rio Branco, Acre", both of which were approved by the Research Ethics Committee of the Federal University of Acre. All participants provided informed consent. Detailed sampling procedures were previously published elsewhere [27].

A cross-sectional, population-based study analysis was carried out on a cohort of pregnant women residents of the Rio Branco urban area who delivered at only two maternities (one public and another private) in 2015. From 1205 mothers eligible for this study, 46 were excluded because either they had twins, performed PN care in another city, or had no PN care. A total of 1159 women were included in this study. Information on the

utilization and content of PN care was obtained through the records available on the PN care cards as follows: Place of PN care; last menstruation period (LMP) to define the weeks of gestation of the beginning PN care, preferably; or ultrasound (USG); number of visits, laboratory test records, weight, blood pressure, uterine height, and heartbeat and fetal movement assessments.

To assess the utilization of PN care programs (timing of initiation of PN care and number of visits), we used the Kotelchuck index adapted to the Brazilian recommendations [10], which includes six PN care visits until full-term birth, while adjusting the number of visits for preterm births. The Kotelchuck index categories were calculated while considering the weeks of gestation at PN care onset, which were categorized as 1 and 2 months, 3 and 4 months, 5 and 6 months, and 7 to 9 months; while the ratio of the number of visits was obtained by the ratio of the number of visits observed to those expected for weeks of gestation. The PN care content adequacy variable was obtained based on Brazilian [10,28] and WHO [29] recommendations and adjusted using the number of obstetric procedures according to weeks of gestation. Thus, the adequacy criteria of the PN care process used in the present study were adaptations of the proposals developed by Silveira, Santos, and Costa (2001) [30] and Anversa (2012) [9] and categorized into suitability levels as shown in Table 4.

Table 4. Quality of prenatal care classification and criteria according to the adapted Kotelchuck index combined with prenatal care content.

Levels of PN Care Quality Assessment			
Level	**Criteria**	**Quality**	**Description of Each Category Content**
1	# of visits Initial GA at the beginning of PN care	More than adequate	Beginning of PN care $\leq$ 4th month with $\geq$110.0% of expected visits
		Adequate	Beginning of PN care $\leq$ 4th month and with 80.0 to 109.9% of the expected visits
		Intermediate	Beginning of PN care $\leq$ 4th month and with 50.0 to 79.9% of the expected visits
		Inadequate	Start of follow-up > 4th month and/<50.0% of the expected visits
2	Level-1+Obstetric Procedures	More than adequate	More than adequate Level-1; and $\geq$5 records of arterial pressure (AP), weight, GA, uterine height (UH), or number of records equivalent to 100% of the number of visits; and $\geq$4 recordsof cardiofetal heartbeats (CFH) and fetal movement (FM).
		Adequate	More than adequate or Adequate Level-1; and $\geq$5 records of AP, weight, GA, UH, or number of records equivalent to 75.0% of the number of visits; and $\geq$4 records of CFH and MF.
		Intermediate	More than adequate, Adequate, or Intermediate Level-1; and 3–4 records of AP, weight, GA, UH, or number of records $\geq$50.0% of the number of visits (including for CFH and MF)
		Inadequate	More than adequate, Adequate, Intermediate, or Inadequate Level-1; and <2 records of UH, GA, AP, weight, CFH, and MF

Table 4. *Cont.*

Levels of PN Care Quality Assessment			
Level	**Criteria**	**Quality**	**Description of Each Category Content**
3	Level-1 + Laboratory tests	More than adequate	More than adequate Level-1; and 1 record of ABO/RH test, Hb/Ht, VDRL, QUE, fasting blood glucose, anti-HIV, HbsAg, and Toxop. (1st trimester)
		Adequate	Adequate Level-1; and 1 record of ABO/RH test, Hb/Ht, VDRL, QUE, fasting blood glucose, anti-HIV, HbsAg, and Toxop.(1st trimester)
		Intermediate	More than adequate, Adequate, or Intermediate Level-1; and at least one record of one of the exams
		Inadequate	More than adequate, Adequate, Intermediate; or Inadequate Level-1; and no record of exams
4	(Level-1 + Level-2 + Level-3)	More than adequate	More than adequate Level-1; and ≥5 records or number of records equivalent to 100% of the number of visits AP, weight, GA, UH; and ≥4 records of CFH and MF; and Exam registration: ABO/RH test, Hb/Ht, VDRL, QUE, fasting blood glucose, anti-HIV, and Toxop. (1st trimester)
		Adequate	More than adequate or Adequate Level-1; and ≥5 records of AP, weight, GA, UH, or number of records equivalent to 75.0% of the number of visits; and ≥4 records of CFH and MF; and exam records of ABO/RH test, Hb/Ht, VDRL, QUE, fasting blood glucose, anti-HIV, and Toxop. (1st trimester)
		Intermediate	More than adequate, Adequate, or Intermediate Level-1; and 3–4 records of AP, weight, GA, UH, or number of records ≥50% of the number of visits (including CFH and MF); and at least one record of one of the exams
		Inadequate	More than adequate, Adequate, Intermediate, or Inadequate Level-1; and/or <2 records of UH, GA, AP, weight, CFH, and MF; and/or no exam records.

The distributions of epidemiological and obstetrics characteristics according to adequacy levels were evaluated by using the absolute and relative frequencies of the categorical variables. Differences were assessed using the X^2-test and Fisher's exact test at a 5% significance level. Thus, the outcome (inadequacy) was classified based on the aforementioned adequacy levels (Square-1). Subsequently, adequacy levels were transformed into dichotomous variables as follows: intermediate + inadequate level in a single category (inadequate) and more than adequate + adequate in a single category (adequate).

Crude and adjusted odds ratios were obtained with their respective 95% confidence intervals. Multiple analyses were performed considering the input criteria for the model as a p-value < 0.20 of each variable in the crude analysis and their biological relevance in the causal process. The output criteria were set as a p-value < 0.05 or to maintain model parsimony. Thus, for the final model, we considered the variable significance level and biological plausibility. The goodness-of-fit model was assessed by a residual analysis. All analyses were performed using the SPSS 22.0 statistical package.

5. Conclusions

Although the literature has shown a high coverage of prenatal care in Rio Branco, the findings of this study suggest that almost 23 years after the implementation of the Human-

ization Program for Prenatal and Birth in the country, the established recommendations are still not widely implemented for the entire target population in the municipality of Rio Branco. Economically disadvantaged women with the lowest social support and the lowest educational level are at most risk of receiving low-quality prenatal care, pointing to the need for interventions aimed at the most vulnerable populations through a care network that takes into account the disadvantages that compromise the quality of this assistance in this municipality.

From a methodological point of view, this study proposed an accurate and sensitive approach to assess the quality of the prenatal process by combining the Kotelchuck index with prenatal care content adjusted for weeks of gestation. This strategy would allow for an adequate and accurate assessment that reveals the real process quality standard.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of the Federal University of Acre (protocol codes 760821 and 1074982).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

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