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Maternal Education and Its Association with Dietary Diversity and Pregnancy and Breastfeeding Practices in Rural Madagascar

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Abstract

This study aimed to assess maternal health profiles related to diet, pregnancy, and breastfeeding practices among 437 mothers with children under 24 months in a rural village in Madagascar, and to examine their association with maternal educational attainment using interviews and anthropometric data. Bivariate statistical analyses were performed to explore associations between maternal education level and all studied variables. Multivariate analyses were also conducted but did not yield reliable results and are therefore not presented. The findings showed that higher maternal education was strongly associated with better socioeconomic conditions; improved access to essential resources like food, clean water, and healthcare facilities; and greater dietary diversity. More educated women reported consuming a wider range of foods, reflecting better nutritional quality and potential benefits for maternal health. In contrast, education level did not significantly affect pregnancy-related care or breastfeeding practices as recommended by the WHO. This suggests that while education enhances women's ability to access and choose nutritious diets, broader cultural or systemic factors may shape maternal care behaviors. Women with higher educational attainment had greater access to diverse and sufficient diets, which may contribute to improved maternal nutritional status. Sustainable interventions aimed at improving women's education and nutritional literacy are needed to support informed dietary choices and improve maternal and child health outcomes.

Keywords: maternal education; diet; pregnancy; breastfeeding; Madagascar

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1. Introduction

Most pregnancy-related complications and maternal deaths are preventable [1–3]. The main causes of these include inadequate access to quality maternal healthcare, delays in seeking care, and limited availability of emergency obstetric services [1–3]. These challenges

are particularly pronounced in low-income countries, where health system constraints intersect with poverty, malnutrition, and low educational attainment.

In Madagascar, maternal mortality has remained persistently high over the past decades [4–7], largely due to insufficient maternal care, limited emergency services, and widespread malnutrition. In 2018, the maternal mortality ratio was estimated at 426 deaths per 100,000 live births [8], far above the Sustainable Development Goal target of fewer than 70 deaths per 100,000 live births by 2030. Neonatal mortality also remains a major public health concern, especially in rural and underserved areas, with the highest rates seen in developing countries, particularly in Sub-Saharan Africa [9].

Maternal malnutrition is a key contributor to adverse maternal and neonatal outcomes and is exacerbated by food insecurity, poverty, and high physical workloads [10–12]. Poor nutritional status before and during pregnancy increases the risk of complications for both mothers and infants, particularly among women who were stunted in childhood or who experience inadequate gestational weight gain [10].

Globally, 240 million women are underweight and 468 million suffer from anemia, with the burden disproportionately affecting women of reproductive age from low- and middle-income countries [13–15]. In Sub-Saharan Africa, anemia and underweight among women of reproductive age remain ubiquitous and persistent [16–18]. Studies indicate that anemia is the most significant maternal health issue in Madagascar, often linked to poor diet and low education levels [19,20]. The benefits of early initiation and/or exclusive breastfeeding resulting in reduced rates of neonatal and infant morbidity and mortality have been extensively reviewed [21–26]. Data from 35 African countries showed an approximately 20% reduction in infant mortality associated with the early initiation of breastfeeding and a 21% reduction for every additional month of continued breastfeeding [27]. However, in Sub-Saharan Africa, less than 40% of infants under six months are exclusively breastfed [28–30] and while Madagascar reports higher rates of early breastfeeding initiation (70%) than the regional average (55.1%), further improvement in breastfeeding practices is needed and could reduce the threat to the lives of African children [31,32]. The context of Sub-Saharan Africa, including Madagascar, where obstetric, neonatal, and pediatric services are generally inadequate and/or underutilized, which makes the promotion of optimal dietary-, pregnancy-, and breastfeeding-related practices key strategies. The results from previous studies in Madagascar revealed a range of socio-cultural barriers impacting women's health-seeking behaviors [33–36]. The available literature commonly cites low maternal education level as a factor associated with poor nutrition, inadequate healthcare practices, and the underutilization of health services, while as women's education levels increase, there is an apparent improvement in both maternal and infant health and nutrition [33,35,37–41]. However, evidence on how maternal education relates simultaneously to diet, pregnancy care, and breastfeeding practices in rural Malagasy settings remains limited. This information could help to influence the design and implementation of effective future interventions targeted towards the improvement of maternal and child health through the provision of health education and the promotion of behavioral change.

Therefore, this study aimed to evaluate the health profiles, especially regarding diet and pregnancy and breastfeeding-related practices, of mothers in Ampefy, a rural village in the Itasy region of Madagascar, and correlate them with their levels of educational attainment.

2. Results

2.1. Sociodemographic and Economic Characteristics

Among the 437 participants, 3.9% were illiterate, 41.4% had primary education, 44.2% had lower secondary education, and 10.5% had upper secondary education. The variable

regarding the general characteristics of the mothers and the household socioeconomic status are presented in Tables 1 and 2 respectively.

Table 1. General characteristics of the mothers by education level.

	Education Level					
	Total	**Illiterate**	**Primary**	**1st Cycle Secondary**	**2nd Cycle Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Age (years)	25.84 ± 6.30	31.29 ± 6.97	26.19 ± 6.91	24.96 ± 5.90	26.11 ± 3.65	**0.001**
14–20	99 (22.7)	1 (5.9)	46 (25.4)	48 (24.9)	4 (8.7)	
21–30	245 (56.1)	7 (41.2)	86 (47.5)	115 (59.6)	37 (80.4)	**<0.001**
31–50	93 (21.3)	9 (52.9)	49 (27.1)	30 (15.5)	5 (10.9)	
Weight (kg)	48.56 ± 8.15	47.44 ± 7.30	47.40 ± 7.31	48.13 ± 7.82	55.35 ± 9.83	**<0.001**
Height (cm)	152.4 ± 7.02	153.12 ± 5.29	151.85 ± 5.82	152.25 ± 8.25	155.15 ± 5.71	**0.037**
BMI	20.62 ± 3.46	20.19 ± 2.87	20.28 ± 3.01	20.38 ± 3.59	23.09 ± 3.84	**0.001**
<18.5	285 (65.2)	12 (70.6)	127 (70.2)	118 (61.1)	28 (60.9)	
18.5–24.9	112 (25.6)	4 (23.5)	46 (25.4)	58 (30.1)	4 (8.7)	**<0.001**
25.0–29.9	34 (7.8)	1 (5.9)	8 (4.4)	14 (7.3)	11 (23.9)	
≥30	6 (1.4)	0 (0.0)	0 (0.0)	3 (1.6)	3 (6.5)	
Pathologies						**0.021**
Unspecified	11 (2.5)	0 (0.0)	4 (2.2)	6 (3.1)	1 (2.2)	
Asthma	1 (0.2)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	
Stomach pain	1 (0.2)	1 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	
Cardiac issues	1 (0.2)	0 (0.0)	1 (0.6)	0 (0.0)	0 (0.0)	
Sinusitis	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	
Epilepsy	1 (1.0)	0 (0.0)	0 (0.0)	2 (1.0)	0 (0.0)	
Type of pathology						**0.030**
Chronic	1 (14.3)	1 (100.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Acute	6 (85.7)	0 (0.0)	3 (100.0)	3 (100.0)	0 (0.0)	
Employment						**<0.001**
Farmer	318 (73.1)	11 (64.7)	140 (77.3)	152 (78.8)	15 (34.1)	
Seller	52 (12.0)	2 (11.8)	14 (7.7)	23 (11.9)	13 (29.5)	
Housewife	15 (3.4)	1 (5.9)	4 (2.2)	9 (4.7)	1 (2.3)	
Daily work	5 (1.1)	1 (5.9)	3 (1.7)	1 (0.5)	0 (0.0)	
Artisan	2 (0.5)	0 (0.0)	1 (0.6)	1 (0.5)	0 (0.0)	
Fisher	25 (5.7)	1 (5.9)	14 (7.7)	3 (1.6)	7 (15.9)	
Other	18 (4.1)	1 (5.9)	5 (2.8)	4 (2.1)	8 (18.2)	
Workplace						**0.018**
Home	31 (7.1)	1 (5.9)	14 (7.7)	8 (4.1)	8 (17.4)	
Outside	406 (92.9)	16 (94.1)	167 (92.3)	185 (95.9)	38 (82.6)	
Parity						**<0.001**
1	161 (38.6)	2 (11.8)	63 (38.4)	76 (39.4)	20 (43.5)	
2–3	203 (46.3)	3 (17.6)	79 (43.6)	97 (50.3)	24 (52.2)	
≥4	73 (16.7)	12 (70.6)	39 (21.5)	20 (10.4)	2 (4.3)	

Continuous variables are presented as mean and SD; categorical variables are presented as number and percentages.

Table 2. Socioeconomic characteristics of the household by mother's education level.

	Education Level					
	Total	**Illiterate**	**Primary**	**Lower Secondary**	**Upper Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Average monthly income (Malagasy Ariary)						**<0.001**
<200,000	328 (74.6)	15 (88.2)	152 (84.0)	144 (74.6)	17 (37.0)	
≥200,000	49 (25.4)	2 (11.8)	29 (16.0)	49 (25.4)	29 (63.0)	

Table 2. *Cont.*

	Education Level					
	Total	**Illiterate**	**Primary**	**Lower Secondary**	**Upper Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Number of sources of income						0.255
One	340 (77.8)	15 (88.2)	143 (79.0)	143 (74.1)	39 (84.8)	
More than one	97 (22.2)	2 (11.8)	38 (21.0)	50 (25.9)	7 (15.2)	
Person responsible for the major source of income						**0.015**
Father	238 (54.5)	8 (47.1)	106 (58.6)	102 (52.8)	22 (47.8)	
Mother	38 (8.7)	3 (17.6)	19 (10.5)	11 (5.7)	5 (10.9)	
Grandfather	9 (2.1)	1 (5.9)	3 (1.7)	4 (2.1)	1 (2.2)	
Grandmother	1 (0.2)	1 (5.9)	0 (0.0)	0 (0.0)	0 (0.0)	
Mother/father	137 (31.4)	4 (23.5)	50 (27.6)	65 (33.7)	18 (39.1)	
Grandmother/grandfather	6 (1.4)	0 (0.0)	1 (0.6)	5 (2.6)	0 (0.0)	
Grandfather/father	3 (0.7)	0 (0.0)	2 (1.1)	1 (0.5)	0 (0.0)	
Mother/grandmother	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	
Mother/grandfather	3 (0.7)	0 (0.0)	0 (0.0)	3 (1.6)	0 (0.0)	
Other	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	
Land ownership	226 (51.7)	4 (23.5)	94 (51.9)	103 (53.4)	25 (54.3)	0.124
House dimensions (m^2)	28.78 ± 24.17	19.88 ± 13.30	24.89 ± 15.30	30.99 ± 26.60	38.27 ± 38.11	**0.001**
People in the house	4.59 ± 1.7	5.53 ± 1.50	4.69 ± 1.80	4.46 ± 1.64	4.39 ± 1.47	0.051
Space per person (m^2)	6.27 ± 14.22	3.59 ± 8.87	5.31 ± 8.50	6.95 ± 16.22	8.72 ± 25.93	0.396
Source of water						0.432
Protected well	285 (65.2)	13 (76.5)	120 (66.3)	122 (63.2)	30 (65.2)	
Public standpipe	149 (34.1)	4 (23.5)	58 (32.0)	71 (36.8)	16 (34.8)	
Unprotected spring	3 (0.7)	0 (0.0)	3 (1.7)	0 (0.0)	0 (0.0)	
Walking distance to water source (min)						**0.011**
	9.29 ± 11.25	16.06 ± 19.26	9.46 ± 10.47	9.39 ± 11.27	5.67 ± 9.04	
Toilet in the house	398 (91.1)	12 (70.6)	164 (90.6)	177 (91.7)	45 (97.8)	**0.009**
Walking distance to health center (min)						**<0.001**
	47.67 ± 33.04	52.00 ± 42.86	50.27 ± 33.23	49.41 ± 32.31	28.54 ± 25.08	
Transport availability	113 (25.9)	2 (11.8)	34 (18.8)	56 (29.0)	21 (45.7)	**<0.001**

Continuous variables are presented as mean and SD; categorical variables are presented as number and percentages.

Participants' ages ranged from 18 to 50 years, with a mean of 25.84 (6.30) years. Significant differences between groups were observed, with the mean age of illiterate mothers being noticeably higher than those of the other educational attainment groups.

Regarding body mass index (BMI), a significant decrease in the percentage of underweight (BMI < 18.5) participants is observed between illiterate/primary-educated participants and mothers with lower or higher secondary education. Conversely, the percentage of overweight or obese (BMI $\geq$ 25.0) participants increased significantly when comparing illiterate/primary-educated mothers and mothers with lower or higher secondary education. Furthermore, no illiterate or primary-educated mothers had a BMI > 30.

In terms of health conditions, 2.5% of participants reported having a health issue, without specifying the type. The most common conditions included epilepsy, asthma, stomach pain, heart disease, and sinusitis, with significant differences observed across education groups.

Most participants reported working outside the home, with agriculture being the most common occupation, accounting for 73.1% of the total and significant differences depending on education level, with most notably only 34.1% of women with upper secondary education employed in agriculture. Trade employment was the second most common,

with the highest proportion in the upper secondary education group. Only 3.4% of women viewed their work at home as a proper job.

Significant differences in parity were also observed, with less-educated women presenting higher parity than those more highly educated.

Three quarters of participants reported a monthly income of less than 200,000 Malagasy Ariary (the national minimum wage) or ~40€. Income differed significantly between groups and was positively associated with education. About half of women reported that the father contributed most to the family finances, with statistically significant differences observed between groups.

Land ownership was reported by about half of participants, with ownership increasing with education, although this was not statistically significant. The average house size was 28.78 (24.17) m^2, with an average of 4.59 (1.7) people per household. House size increased with education level, while the number of household members decreased. The average floor area per person was 6.27 (14.22) m^2, which is lower than the WHO recommendation of 9–10 m^2 per person.

No significant differences were found in the main source of drinking water but distance to source increased as education level decreased. Significant differences were also found in the presence of a toilet inside the home, average walking distance to the nearest health center, and access to reliable transportation, with all improving with education level and significant differences observed between groups.

2.2. Nutritional Status and Dietary Diversity

The results of the analysis of maternal dietary habits are presented in Table 3 and the 24h dietary recall is presented in Table 4. Significant differences were observed between the groups regarding changes in maternal dietary practices during pregnancy and breastfeeding, with those more highly educated presenting higher rates of change in both cases.

Table 3. Dietary habits by mother's education level.

		Education Level				
	Total	**Illiterate**	**Primary**	**Lower Secondary**	**Upper Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Changes in mother's diet during pregnancy						**0.002**
	235 (53.8)	7 (41.2)	80 (44.2)	117 (60.6)	31 (67.4)	
Changes in mother's diet during breastfeeding						**0.008**
	182 (41.6)	6 (35.3)	61 (33.7)	88 (45.6)	27 (58.7)	
Person responsible for meal preparation at home						**0.031**
Mother	342 (78.3)	13 (76.5)	143 (79.0)	158 (81.9)	28 (60.9)	
Father	19 (4.3)	3 (17.6)	6 (3.3)	6 (3.1)	4 (8.7)	
Grandmother	7 (1.6)	0 (0.0)	4 (2.2)	2 (1.0)	1 (2.2)	
Grandfather	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	
Mother/father	44 (10.1)	1 (5.9)	18 (9.9)	19 (9.8)	6 (13.0)	
Mother/father/other	3 (0.7)	0 (0.0)	0 (0.0)	2 (1.0)	1 (2.2)	
Grandmother/other	2 (0.5)	0 (0.0)	1 (0.6)	1 (0.5)	0 (0.0)	
Mother/other	5 (1.1)	0 (0.0)	4 (2.2)	0 (0.0)	1 (2.2)	
Mother/grandmother	4 (0.9)	0 (0.0)	3 (1.7)	1 (0.5)	0 (0.0)	
Other	10 (2.3)	0 (0.0)	2 (1.1)	3 (1.6)	5 (10.9)	
Rice availability						**<0.001**
<6 months	140 (32.0)	12 (70.6)	78 (43.1)	48 (24.9)	2 (4.3)	
≥6 months	297 (68.0)	5 (29.4)	103 (56.9)	145 (75.1)	44 (95.7)	

Table 3. *Cont.*

	Education Level					
	Total	**Illiterate**	**Primary**	**Lower Secondary**	**Upper Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Use of iodized salt	333 (75.5%)	10 (58.8)	124 (68.5)	155 (80.3)	41 (89.1)	**0.002**
Dietary diversity						**0.002**
Insufficient (<5 groups)	144 (33.0)	9 (52.9)	74 (40.9)	48 (24.9)	13 (28.3)	
Sufficient (≥5 groups)	293 (67.0)	8 (47.1)	107 (59.1)	145 (75.1)	33 (71.7)	

Continuous variables are presented as mean and SD; categorical variables are presented as number and percentages.

Table 4. Results of 24 h dietary recall by mother's education level.

	Education Level					
	Total	**Illiterate**	**Primary**	**Lower Secondary**	**Upper Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Grain, white roots, and tubers	437 (100.0)	17 (100.0)	181 (100.0)	193 (100.0)	46 (100.0)	
Pulses (beans, peas, and other)	150 (34.3)	5 (29.4)	55 (30.4)	75 (38.9)	15 (32.6)	0.355
Nuts and seeds	86 (19.7)	3 (17.6)	32 (17.7)	39 (20.2)	12 (26.1)	0.630
Dairy products	128 (29.3)	3 (17.6)	35 (19.3)	67 (34.7)	23 (50.0)	**<0.001**
Meats, poultry, fish	301 (68.9)	6 (35.3)	114 (63.0)	142 (73.6)	39 (84.8)	**<0.001**
Eggs	44 (10.1)	0 (0.0)	15 (8.3)	21 (10.9)	8 (17.4)	0.145
Dark green leafy vegetables	322 (73.7)	16 (94.1)	142 (78.5)	135 (69.9)	29 (63.0)	**0.020**
Vitamin A-rich fruits, vegetables, and tubers	250 (57.2)	8 (47.1)	96 (53.0)	118 (61.1)	28 (60.9)	0.325
Other vegetables	328 (75.1)	9 (52.9)	122 (67.4)	160 (82.9)	37 (80.4)	**<0.001**
Other fruits	230 (52.6)	6 (35.3)	88 (48.6)	110 (57.0)	26 (56.5)	0.174

Continuous variables are presented as mean and SD; categorical variables are presented as number and percentages.

In 78.3% of cases, the mother was responsible for meal preparation. The percentage of households with limited access (<6 months) to rice, the staple food of the Malagasy diet, significantly decreased with higher education levels. Three-quarters of women reported using iodized salt in meal preparation, and this percentage significantly increased with education level.

Following the 24 h dietary recall, one-third of participants had an inadequate diet (<5 food groups) and this percentage decreased with education level.

Dietary diversity was assessed based on the foods consumed in the 24 h prior to the interview. All respondents consumed the food group 'cereals, white roots, and tubers'. 'Dark leafy green vegetables' and 'other vegetables', along with 'vitamin A-rich fruits, vegetables, and tubers', were among the most consumed food groups. The consumption of 'other vegetables' showed statistically significant differences between the groups.

'Meat, poultry, and fish' was the fourth most consumed food group, with significant differences in consumption across the four education groups. The consumption of animal products was limited in groups with higher economic constraints, primarily due to low purchasing power and the prohibitive cost of these products. This was also evident in the consumption of 'dairy products', where the percentage of consumption increased with education level, showing a statistically significant difference between the groups.

'Pulses', especially beans, played a vital role in a balanced diet, as they are a source of plant-based protein, available almost year-round, and relatively affordable. They were consumed by all mothers surveyed.

'Eggs' were the least consumed food group, especially by women with less than secondary education, as were other animal-derived products.

2.3. Pregnancy and Breastfeeding Practices

The results from the analysis of the variables related to pregnancy and breastfeeding practices are shown in Table 5. Among the multiparous women interviewed, the interval between pregnancies was typically 24 months or more, with a higher percentage of women in the lower education groups having shorter intervals between pregnancies.

Table 5. Habits and practices during pregnancy and breastfeeding by mother's educational level.

		Education Level				
	Total	**Illiterate**	**Primary**	**Lower Secondary**	**Upper Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Interval between pregnancies						
1st–2nd pregnancy						0.318
<24 months	56 (19.9)	5 (35.7)	26 (22.0)	21 (17.2)	4 (14.8)	
≥24 months	225 (80.1)	9 (64.3)	92 (78.0)	101 (82.8)	23 (85.2)	
2nd–3rd pregnancy						0.540
<24 months	19 (12.4)	3 (21.4)	9 (13.0)	7 (11.1)	0 (0.0)	
≥24 months	134 (87.6)	11 (78.6)	60 (87.0)	56 (88.9)	7 (100)	
3rd–4th pregnancy						0.446
<24 months	15 (21.7)	4 (40.0)	8 (20.5)	3 (15.8)	0 (0.0)	
≥24 months	54 (78.3)	6 (60.0)	31 (79.5)	16 (84.2)	1 (100)	
4th–5th pregnancy						0.355
<24 months	10 (20.8)	1 (33.3)	2 (12.5)	2 (40.0)	5 (20.8)	
≥24 months	38 (79.2)	2 (66.7)	14 (87.5)	3 (60.0)	19 (79.2)	
Antenatal visits						**0.003**
0	3 (0.7)	0 (0.0)	1 (0.6)	2 (1.0)	0 (0.0)	
1	7 (1.6)	0 (0.0)	6 (3.3)	1 (0.5)	0 (0.0)	
2–3	31 (7.1)	5 (29.4)	17 (9.4)	8 (4.1)	1 (2.2)	
≥4	396 (90.6)	12 (70.6)	157 (86.7)	182 (94.3)	45 (97.8)	
Information about signs of danger during pregnancy						**0.004**
	276 (63.2)	9 (52.9)	108 (59.7)	138 (71.5)	21 (45.7)	
Iron and folic acid supplementation	366 (83.8)	11 (64.7)	153 (84.5)	162 (83.9)	40 (87.0)	0.174
Delivery place						**0.029**
Home	157 (35.9)	5 (29.4)	78 (43.1)	64 (33.2)	10 (21.7)	
Health center	280 (64.1)	12 (70.6)	103 (56.9)	129 (66.8)	36 (78.3)	
Reason for home delivery						**<0.001**
Imminent birth	72 (45.0)	1 (20.0)	39 (48.8)	26 (40.0)	6 (60.0)	
Transport issues	19 (11.9)	0 (0.0)	14 (17.5)	4 (6.2)	1 (10.0)	
Absence of medical staff	1 (0.6)	0 (0.0)	0 (0.0)	1 (1.5)	0 (0.0)	
Personal choice	60 (37.5)	2 (40.0)	25 (31.2)	30 (46.2)	3 (30.0)	
Preference for 'reninjaza'	4 (2.5)	0 (0.0)	1 (1.3)	3 (4.6)	0 (0.0)	
Financial	4 (2.5)	2 (40.0)	1 (1.3)	1 (1.5)	0 (0.0)	
2nd reason for home delivery						0.572
Imminent birth	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	
Transport issues	8 (36.4)	0 (0.0)	3 (21.4)	4 (57.1)	1 (100.0)	
Absence of medical staff	2 (9.1)	0 (0.0)	2 (14.3)	0 (0.0)	0 (0.0)	
Personal choice	8 (36.4)	0 (0.0)	5 (35.7)	3 (42.9)	0 (0.0)	
Preference for 'reninjaza'	2 (9.1)	0 (0.0)	2 (14.3)	0 (0.0)	0 (0.0)	
Financial	2 (9.1)	0 (0.0)	2 (14.3)	0 (0.0)	0 (0.0)	

Table 5. *Cont.*

	Education Level					
	Total	**Illiterate**	**Primary**	**Lower Secondary**	**Upper Secondary**	
	n = 437 100.0%	**n = 17 3.89%**	**n = 181 41.41%**	**n = 193 44.16%**	**n = 46 10.52%**	***p*-Value**
Delivery type						**<0.001**
Vaginal	402 (92.0)	16 (94.1)	172 (95.0)	180 (93.3)	34 (73.9)	
Instrumental vaginal birth	23 (5.3)	1 (5.9)	7 (3.9)	8 (4.1)	7 (15.2)	
Cesarean section	12 (2.7)	0 (0.0)	2 (1.1)	5 (2.6)	5 (10.9)	
Breastfeeding initiation						0.248
During the first hour after birth	251 (57.4)	12 (70.6)	98 (54.1)	118 (61.1)	23 (50.0)	
After the first hour after birth	186 (42.6)	5 (29.4)	83 (45.9)	75 (38.9)	23 (50)	
EBF for the first 6 months	170 (44.2)	5 (33.3)	73 (44.2)	73 (43.2)	19 (52.8)	0.602
BF after 12 months	292 (96.1)	12 (85.7)	135 (96.4)	117 (95.9)	28 (100)	0.161
Currently breastfeeding	419 (95.9)	16 (94.1)	173 (95.6)	186 (96.4)	44 (95.7)	0.960
Weaning before 6 months	224 (60.9)	8 (57.1)	100 (63.7)	95 (59.9)	21 (58.3)	0.816

Continuous variables are presented as mean and SD; categorical variables are presented as number and percentages. BF: breastfeeding, EBF: exclusive breastfeeding.

The percentage of women who did not receive antenatal care during their last pregnancy was incredibly low (0.7%), with only one woman with primary education and two with lower secondary education reporting no antenatal visits. A small percentage (1.6%) had only one antenatal consultation, mostly from the primary and lower secondary education groups. A larger proportion (7.1%) had between two and three antenatal visits, with a higher percentage of illiterate women in this group. The majority (90.6%) of women had four or more antenatal care consultations during their last pregnancy, with the percentage increasing with the level of education: from 70.6% in illiterate women to 97.8% in those with upper secondary education.

Regarding the intake of iron/folic acid supplements during pregnancy, 83.8% of women reported taking these supplements, with the percentage increasing as education level increased (from 64.7% in illiterate women to 87% in those with upper secondary education). Around two-thirds (63.2%) of women received information about danger signs during pregnancy during their antenatal consultations.

Home births were common, with 35.9% of the participants giving birth at home. The percentage of women giving birth at home decreased as education level increased, with the main reason being imminent birth. Illiterate women (20%) had the lowest percentage of home births due to imminent birth, while upper secondary-educated women had the highest (60%). Another reason for home births was personal choice, which was more common among illiterate women (40%) compared with other groups. A small percentage of women (11.9%) had home births due to the lack of transport to a health center, and a few (2.5%) cited financial reasons. Only 2.5% of women who did not give birth at a health center received assistance from a traditional midwife, and this percentage was higher in the lower secondary and upper secondary education groups.

Regarding the type of delivery, 92.0% of the women had a vaginal birth, with the percentage decreasing as education level increased (94.1% in illiterate women to 73.9% in upper secondary-educated women). Instrumental vaginal births occurred in 5.3% of the women, with a higher percentage of women in the upper secondary group (15.2%) having an instrumental vaginal birth. Cesarean sections were performed in 2.7% of the women, and this percentage was higher in the upper secondary group (10.9%). Significant differences were observed in the type of delivery based on education level.

Breastfeeding practices were also examined. Fifty-seven percent (57.4%) of the participants initiated breastfeeding in the first hour after delivery, with no significant differences

between education groups. Exclusive breastfeeding for the first six months was practiced by 44.2% of the participants, with higher education groups tending to follow this practice more frequently, although no statistically significant differences were found. Most women (96.1%) continued breastfeeding until their child reached the age of one, and 95.9% were breastfeeding at the time of the interview. There were no significant differences in breastfeeding duration or rates of breastfeeding at the time of the interview. Early weaning, before six months, was practiced by 60.9% of the women, with no significant differences between the groups.

3. Discussion

The findings of this study reveal a positive association between a higher level of maternal education and advantageous socioeconomic status, improved access to essential resources like food and water, and greater proximity to health facilities. Maternal educational level was shown to influence all dietary habits studied, with significant differences observed for all studied variables. Conversely, no statistically significant differences were observed across education levels concerning optimal breastfeeding practices, as defined by WHO guidelines in this rural Malagasy context. It must also be noted that the lack of statistically significant results from the multivariate analyses weakens the conclusions that can be drawn from the results and the findings may not provide clear policy implications. The lack of significant results from the multivariate analyses is most likely due to the number of response options for some of the variables studied, which appear to require a larger sample size in order to find statistical significance. However, the results from the bivariate analysis still provide valuable information that may be helpful for future studies and/or interventions.

Higher educational attainment was associated with higher income, improved housing conditions, greater access to sanitation facilities, shorter distances to healthcare facilities, and more reliable transportation. Women with lower education levels were more likely to be engaged in subsistence agriculture and reported greater economic vulnerability. A dual burden of malnutrition was observed. Underweight prevalence was higher among women with lower education levels, whereas overweight and obesity were more common among women with secondary education. Dietary diversity was significantly associated with education level, with more educated women consuming a wider variety of food groups, including animal-sourced foods and dairy products. Antenatal care attendance was high overall, with most women attending four or more visits, particularly among those with higher education. Iron and folic acid supplementation during pregnancy increased with education level. These findings suggest that education may influence nutrition primarily because it is a reflection of improved access to resources, i.e., better socioeconomic status, rather than through behavioral change because women are aware of this need. In summary, it could simply be that women with a higher educational level have a better household socioeconomic status and can afford better nutrition.

Evidence indicates correlation but incomplete overlap between maternal education and household socioeconomic status, so one is not a full proxy for the other in Madagascar [42–44]. Empirical analyses often find independent, sometimes nonredundant effects of each measure. Studies that adjusted for both variables found that each retained statistically significant associations with outcomes, demonstrating no redundancy [45–47].

One empirical estimate concluded that wealth accounts for roughly one-third of the effect of maternal education on child survival, implying that education captures additional pathways (knowledge, practices, decision-making) not captured by wealth measures [34]. Additionally, where caregiver knowledge or practices are central, maternal education may show relatively larger associations [34,46]. On the other hand, where material or envi-

ronmental constraints drive outcomes (e.g., exposure-related disease or water/sanitation effects on maternal nutrition), household socioeconomic status can exert stronger effects than education [45,48]. Where studies examine survival, intervention heterogeneity, or mechanisms, evidence shows that both variables carry distinct information and both should be measured and modeled [34,45]. In conclusion, maternal education and household socioeconomic status are correlated but not interchangeable; using one as the sole proxy risks bias or missed mechanisms depending on the outcome of interest [34,45,47].

Regarding breastfeeding practices, however, no statistically significant differences were observed across education groups regarding the early initiation of breastfeeding, exclusive breastfeeding for six months, or breastfeeding duration. The absence of differences in breastfeeding practices across education levels indicates that these practices may be shaped predominantly by shared cultural norms and community-level influences rather than formal education and/or socioeconomic status. This underscores the importance of culturally sensitive, community-based interventions to promote optimal infant feeding practices.

Although the cross-sectional design limits causal inference and the reliance on self-reported data may introduce bias, this study's large sample size, high participation rate, and use of validated dietary indicators strengthen its validity.

A rising trend in poor maternal nutritional status has been seen in Madagascar for the past several years [6] and Madagascar is among the countries most heavily affected by maternal malnutrition [49]. Dietary diversity in the household is a domestic environment variable known to influence children's diets. The diet in Madagascar is very undiversified due to strict dietary habits and limited food availability. One factor that must be taken into account when interpreting the data is that the questionnaire was carried out close to 'la période de soudure', or the period before the first harvest, when stocks are limited and at the same time one has to cultivate one's field in order to have a good harvest afterwards. This is the most challenging time of the year for most families and the time when it is most necessary to formulate interventions aimed at making families aware of the importance of food diversification.

Within the four delineated groups, a dual burden of malnutrition is observable, characterized by undernutrition in lower-educated cohorts and overnutrition in those with higher educational attainment. However, the focus should remain in addressing undernutrition as it is vastly more prevalent and maternal underweight can negatively impact not only maternal health but also the health of their children. In 2009, the prevalence of undernutrition in women of reproductive age was reported at 26.7% and the prevalence of anemia in pregnant women at 38.3% [6]. In low- and middle-income countries, iron deficiency anemia among women is pervasive and affects maternal mortality rates [50]. Another issue affecting maternal and neonatal health is poor nutritional status before conception which can in turn affect gestational weight gain, which is inadequate in 76% to 100% of women in Madagascar [51,52].

Maternal undernutrition increases the risk of maternal death during childbirth [5]. Maternal undernutrition, particularly a low body mass index, which can cause fetal growth retardation, and non-optimal infant and young child feeding are the main causes of faltering growth and undernutrition in children under 2 years old. These conditions can have a lifelong negative impact on brain structure and function [5].

It has been shown that undernutrition can be reduced through the delivery of simple interventions at key stages of life and if effectively scaled up, these interventions can improve maternal nutrition and the rates of optimal breastfeeding practices [5]. One such intervention could be iron and folic acid supplementation which has been shown to reduce micronutrient deficiency, pregnancy complications, maternal mortality, and low birthweight [5]. Other interventions such as the use of iodized salt have been shown to improve fetal development, cognition, and intelligence in infants and reduce risks

of complications during pregnancy and delivery [5]. The use of food supplements and fortified foods can not only help prevent maternal undernutrition but also help to maintain breastfeeding and higher-quality breastmilk [5]. Among the underlying factors that need to be taken into consideration and addressed in order to effectively reduce undernutrition are poverty, inequity, low maternal education, and women's social status [5].

Furthermore, suboptimal breastfeeding practices are linked to severe malnutrition and stunting [53], affecting a child's cognitive development and hindering their potential future career. The Itasy region had a stunting rate of 52% in the 0–5 age group in the national Demographic Health Survey 2021 [54], one of the highest nationally, while Madagascar incurs an estimated annual loss of US$ 125 million due to these cognitive deficits.

Ensuring optimal growth and development requires providing infants and children with adequate energy and nutrients which includes having access to nutritionally dense breastmilk. The nutritional composition of breastmilk is dynamic, being influenced by factors such as lactation stage, time of day, and maternal nutritional status [55]. The nutritional status of breastfeeding mothers may affect energy density and contents of individual nutrients and therefore efforts to improve maternal status will contribute toward achieving optimum health and development in infants [55].

According to WHO and UNICEF recommendations, infants should initiate breastfeeding within the first hour of life and continue exclusive breastfeeding for the first six months, with the introduction of complementary foods thereafter while maintaining breastfeeding until at least two years of age [56,57]. National data for Madagascar from the Demographic Health Survey 2021 [54] indicate that almost all children under two years (98%) are breastfed, but only 60% initiate breastfeeding within the first hour after birth and 54% of children under 6 months are exclusively breastfed. However, other studies have reported lower rates of continued breastfeeding (58.9%), early initiation (45.2%), and exclusive breastfeeding (50.6%) in Madagascar [58,59]. In the present study, the prevalence of continued breastfeeding up to two years (95.9%), early breastfeeding initiation of breastfeeding (57.4%), and exclusive breastfeeding (44.2%) in the studied area fell between the estimated national averages.

A previous study predicted that at the lowest estimated rates for optimal breastfeeding practices for Madagascar, not supporting breastfeeding is estimated to result in over one million cases of childhood diarrhea and 20,000 cases of acute respiratory illness in children each year, with an estimated death toll of 5000 children annually just from these two outcomes [58,59]. At the rates found for the studied area, the number of preventable cases of childhood diarrhea and acute respiratory illness that could be related to suboptimal breastfeeding practices would be estimated to be around 350,000 and 16,000, respectively, each year with an estimated death toll of around 4250 children annually [58,59].

Another study that used UNICEF data on breastfeeding in Sub-Saharan African countries found an increased pooled relative mortality risk for non-exclusive breastfeeding (5.71, 95%CI: 2.14, 15.23) and delayed breastfeeding initiation (3.3, 95%CI: 2.49, 4.46) [60]. With an estimated population attributable fraction of 75.7% and 55.3%, respectively, this means that at least part of under-five deaths could be potentially prevented with interventions that promote optimal breastfeeding practices [60]. Furthermore, the early initiation of breastfeeding also reduces a mother's risk of post-partum hemorrhage, one of the leading causes of maternal mortality [5].

Previous studies have determined that the primary barriers to optimal breastfeeding practices are the poor understanding and cultural perceptions of mothers [61–64]. The conflict between optimal breastfeeding practices and those practices associated with traditional beliefs is the cause of a lack of acceptance and credibility of the former throughout Africa [65,66].

Along these lines, the utilization of traditional medicine during childbirth is also commonplace, often complementing professional healthcare. 'Reninjazas,' traditional birth attendants without biomedical training who provide maternal and infant care, are prevalent in Madagascar and attend hundreds of births annually. Estimates for the past twenty years show that skilled health workers (doctors, nurses, midwives, and other cadres of health workers) attend only around 40% of total births in Madagascar, meaning that over half of births took place without the help of a professionally trained obstetrician or hospital midwife [67,68]. Those births must have been assisted by a traditional birth attendant, the reninjaza. This aligns with this study's findings, where most surveyed women had at least four antenatal consultations, but a considerable number still resorted to traditional midwives and over a third had had homebirths.

In Madagascar, many women still use traditional caregivers, but the use of healthcare services is improving. The likelihood of using maternal healthcare services is positively associated with educational level even when the use of traditional caregivers, perceived as complementary, remains predominant. The 2018 Multiple Indicator Cluster Survey (MICS) showed that the majority of births took place at home, only 30.3% of pregnant women attended the four WHO-recommended antenatal visits, and that only 49% of births were assisted by a skilled birth attendant [8]. The remaining 51% of births were assisted by a reninjaza, a traditional birth attendant who does not receive any medical training but provides care and advice to women during pregnancy, delivery, and the postnatal period [69,70]. However, the Ministry of Health of Madagascar, in line with WHO recommendations, promotes that antenatal care should be provided by skilled attendants in order to prevent, detect, and treat any possible complications [71].

4. Materials and Methods

4.1. Study Design and Ethical Considerations

This exploratory, descriptive, cross-sectional study was conducted in collaboration with a non-governmental organization (Change Onlus Madagascar) involved in health and social development initiatives. This study followed the ethical principles of the Declaration of Helsinki and its latest amendment by the World Medical Association and received ethical approval from the Ethics Committee of the Universitat de Valencia (Spain) (register code: 2089516, dated 7 July 2022) and the Ethics Committee of the St. Paul Medical-Surgical Center from Soavinandriana (Madagascar) (register code: 20220197, dated 27 October 2022). Reporting followed the STROBE guidelines for observational studies [72].

4.2. Study Setting

Ampefy is a rural commune in the Soavinandriana District of the Itasy region of Madagascar comprising 13 fokontany, each comprising several small settlements with a total population of 25,078 (2021) and a population density of 67.8 inhabitants per km^2. The population is ethnically diverse, with various Malagasy cultural groups represented, though the Merina ethnic group predominates. The region has a subtropical climate influenced by monsoons that often bring severe flooding, damaging crops and exacerbating food insecurity.

4.3. Participants

Eligible participants were women residing in the study area who had a living child younger than 24 months. Participants were identified through health center records and community outreach activities conducted by local staff. Participants were informed about the study's objectives and data confidentiality, receiving an oral translation of the informed consent document from a local health worker. Each participant was assigned an identification number, and all data were anonymized. All eligible women approached (n = 437) agreed

to participate and provided informed consent. No participants met exclusion criteria (not providing informed consent, giving unreliable responses, or not completing the questionnaire).

4.4. Data Collection

Data were collected between October 2022 and March 2023 through face-to-face interviews conducted by trained health workers using tablet-based questionnaires. A semi-structured, ad hoc, non-pre-tested questionnaire was specifically designed for this study. It was developed based on a review of local staff experiences, the relevant literature, and the potential relationship between maternal education and pregnancy and breastfeeding practices. The questionnaire was initially prepared in English, translated into Malagasy by a bilingual translator, and back-translated into English to ensure accuracy. It was piloted with 10 mothers working at the health center to verify clarity and allow for modifications. A seven-day training course on data collection techniques was conducted to familiarize the research team with the study procedures and tools, which were tested on a separate group not included in the study.

The questionnaire assessed the following:

- General characteristics, including age, education level, employment type, and pregnancy history.
- Pregnancy and lactation practices, covering antenatal care, place of delivery, breastfeeding, and supplementation.
- Living conditions, assessing health status, access to clean water, distance to healthcare facilities, and transportation availability.
- Dietary diversity assessment based on the Minimum Dietary Diversity for Women of Reproductive Age (MDD-W) questionnaire [73].

Anthropometric measurements were taken to calculate body mass index (BMI).

4.5. Data Analysis

Maternal education was categorized into four levels: illiterate, primary education, lower secondary education, and upper secondary education. Descriptive statistics were used to summarize the general characteristics of the mothers (Table 1), household socioeconomic status (Table 2), maternal dietary habits (Table 3), 24 h dietary recall (Table 4), and pregnancy and breastfeeding practices (Table 5). Frequencies and percentages were used for categorical variables, while means and standard deviations were reported for continuous variables. The Shapiro–Wilk test was applied to assess the normality of data distribution. Associations between educational levels and categorical variables were examined using Pearson's chi-squared test or Student's t-test, while comparisons across education groups were conducted using ANOVA. A significance level of 5% ($p < 0.05$) and a 95% confidence interval were applied. Multivariate analyses were conducted but did not yield reliable results, possibly due to the numerous options for some of the variables studied which may require a larger sample size, and the results were therefore not included. Statistical analyses were performed using IBM SPSS Statistics version 26 (IBM Corp., Armonk, NY, USA).

5. Conclusions

Disparities in maternal and neonatal outcomes may stem from socio-cultural factors, such as the reliance on traditional birth attendants, variations in women's educational and economic statuses, and differences in the quality of antenatal care services. Understanding the familial decision-making process around finances, health, and nutrition may help to design targeted intervention programs promoting positive behavioral changes in these domains that could improve maternal and neonatal health status. Additionally, the extent of government and non-governmental organizations' involvement in promoting safe

motherhood and ability to uphold women's rights may vary across different regions, with rural regions being the most disadvantaged. Maternal education is one of the factors that are widely accepted to influence health outcomes, and in this study, it is most strongly associated with dietary habits while being apparently irrelevant in relation to pregnancy and breastfeeding practices.

Women with higher levels of education are more likely to have access to a more abundant and diverse diet which should in turn translate to a better maternal nutritional status. Educated women, benefiting from improved access to information and elevated household status, wield greater decision-making power regarding their diet. Therefore, it is crucial to initiate sustainable interventions that empower women to make informed decisions at both national and regional levels, which aim to improve women's nutritional status through educational interventions to improve nutritional literacy, helping to reduce food taboos and increase dietary diversity, while also promoting nutritional counseling and highlighting the importance of adequate maternal nutrition.

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

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