

Prevalence and risk factors for micronutrient deficiencies in pregnant women at Cayenne maternity, French Guiana

Amandine Duclau (✉ amandine.duclau@gmail.com)

Centre Hospitalier Andree Rosemon <https://orcid.org/0000-0002-1637-3245>

Fanny Abad

Centre Hospitalier Andree Rosemon

Antoine Adenis

Centre Hospitalier Andree Rosemon

Malika Leneuve-Dorilas

Centre Hospitalier Andree Rosemon

Mathieu Nacher

Centre Hospitalier Andree Rosemon

Research article

Keywords: micronutrients, deficiencies, pregnancy, risks factors, social inequalities in health, French Guiana

Posted Date: November 14th, 2019

DOI: <https://doi.org/10.21203/rs.2.17318/v1>

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Abstract

Background Involved in physical and brain development, immune system functioning and various metabolic processes, micronutrients have profound health effects. The nutritional status of the pregnant woman is a major determinant of fetal health. French Guiana has the highest annual population growth rate. Social inequalities, cultural practices and parasitoses in French Guiana could affect the prevalence of these deficiencies. The main objective was to estimate the prevalence of micronutrient deficiency among pregnant women in French Guiana. The secondary objective was to identify socio-demographic, dietary, obstetric and neonatal risk factors associated with deficiencies.

Methods Pregnant woman over 22 weeks of pregnancy hospitalized for delivery at the Obstetrical Emergency Department of the Hospital Center in Cayenne from May 2018 to March 2019. A socio-demographic and food questionnaire was administered. Medical data were collected from the medical records. Blood and urine samples were taken. The descriptive analysis used the Student and Chi2 tests. Prevalence ratios were obtained a Poisson regression.

Results A total of 341 women were included. The majority were born in Haiti (39%) and French Guiana (34%). At least one micronutrient deficiency was documented in 81% of women. Women receiving State Medical Aid had a 35% greater risk of deficiency during pregnancy compared to those with both normal and complementary health insurance. (PR=1.35 95% CI (1.12;1.63) p-value=0.002)

Conclusions Micronutrient deficiencies in pregnant women in French Guiana are a real public health problem, a fact that was previously overlooked in a context of rising obesity. A varied and balanced diet remains the most effective solution to prevent these deficiencies. In French Guiana, a region where precariousness and obesity are widespread, nutritional care seems urgent.

Introduction

Micronutrients, also known as vitamins and minerals, are the essential components of a quality diet and have profound health effects. Although they are only needed in very small quantities, micronutrients are the essential building blocks for stimulating human growth and metabolism. They are involved in physical and brain development, the functioning of the immune system and various metabolic processes. (1–2)

Micronutrient malnutrition is widespread in industrialized countries, and even more in developing regions. It can affect all age groups, but young children and women of childbearing age tend to be the groups most at risk. (3)

Micronutrient deficiencies can even occur in communities where the food supply is sufficient to meet the population's energy needs. They are often referred to as "invisible hunger": the body, despite a satisfactory caloric intake, is always hungry for good nutrition. (4–5–6)

Pregnancy is a period of increased metabolic needs, due to the physiological changes of the pregnant woman and the needs of the fetus. Micronutrient malnutrition is harmful to women and their children because their nutritional status is a major determinant of fetal health. (7)

Micronutrient malnutrition has many effects on human health, not all of which are clinically apparent. Even moderate deficiencies (detectable by biochemical measurements) can seriously impair the functioning of the human body. Therefore, in addition to its direct effects on human health, micronutrient malnutrition has profound implications for economic development and productivity, particularly in terms of potentially high public health costs and losses in human capital formation.

According to a WHO study, the most common micronutrient deficiencies are iron, vitamin A and iodine deficiencies. Next come zinc, folic acid (vitamin B9), vitamin B12 and other B-group vitamins, vitamin C, vitamin D, calcium, selenium and fluoride. (4–8)

French Guiana's 240,000 inhabitants constitute a heterogeneous group, including (but not limited to) Creoles, Black Maroons, Metropolitans (French from mainland France), Amerindians, Hmong and migrants of all generations from South America, the Caribbean and Asia. A single road runs along the entire coastline from east to west. The rest of the territory is accessible by canoe, plane or helicopter.

Health coverage is uneven across the country and the entire health system suffers from a shortage of health professionals (INSEE 2014).

French Guiana is by far the French region with the highest average annual population growth (+3.1% between 2007 and 2030). This remains true for Latin America, where French Guiana is the country with the highest fertility rate, along with Guatemala.

The birth rate (birth rate 3.5 versus 2 in metropolitan France) is one of the drivers of this growth. In 2017, there were 4321 births at the maternity ward in Cayenne hospital.

The national perinatal survey estimated in 2010 that, in French overseas departments (Guadeloupe, French Guiana, Reunion Island), 12% of single live births occurred prematurely, whereas this frequency was only 5.5% in France mainland. (13)

Some authors estimate the preterm birth rate in French Guiana at 13.5% of live births.

In addition, in French Guiana, excess weight and obesity are a major public health problem that can mask a problem of malnutrition due to lack of intake or malabsorption. (10)

Indeed, if the population, due to lack of resources, cannot diversify their diet and consume adequate quantities of fruits, vegetables or foods of animal origin containing micronutrients, deficiencies are inevitable.

In addition, there are many patients in French Guiana who suffer from gastrointestinal parasitic infections or have problems accessing safe drinking water causing diarrhea. The above situations can

induce deficiencies through malabsorption.

Precariousness and social isolation are two of French Guiana's major problems. They are often responsible for the renunciation of rights and care, and lead to health inequalities. (10)

The main objective of the study was to estimate the prevalence of micronutrient deficiencies among women hospitalized for delivery.

The secondary objectives were to analyze the socio-demographic and dietary risk factors associated with micronutrient deficiencies and to analyze obstetric and neonatal pathologies associated with micronutrient deficiencies.

Methods

This study was a descriptive, cross-sectional, monocentric study.

Any woman who was pregnant for at least 22 weeks of pregnancy, hospitalized for delivery within the Gynaecological and Obstetrical Emergency Unit of the Cayenne General Hospital could participate in the study after giving written informed consent.

The criteria for non-inclusion were: refusal to participate in the study; being under guardianship; lack of representation of a legal guardian if under age of 18; having already been included in the study.

In French Guiana, three hospitals were able to accommodate women who were delivering.

We chose Cayenne as the center of inclusion knowing that more than half of the births on French Guiana territory took place at this hospital in 2017. (source INSEE)

Thus, only women from the Lower Maroni territory are not represented in our study sample because they delivered in Saint Laurent du Maroni.

The number of subjects required was calculated so that the deficiency rate for each of the micronutrients studied could be estimated. A number of 300 patients was considered sufficient.

Micronutrient deficiencies were investigated by blood and urine sampling. The results made it possible to determine a deficiency according to the World Health Organization (WHO) definition of the biological thresholds characterizing these deficiencies: urinary iodine $<100 \mu\text{g/L}$ at the individual level; median $<150 \mu\text{g/L}$ at the population of pregnant women; zinc blood level $< 700 \mu\text{g/L}$; magnesium $< 0.66 \text{ mmol/L}$; serum retinol $< 0.70 \mu\text{mol/L}$; erythrocyte folates $< 140 \text{ ng/mL}$; cobalamin blood level $< 150 \text{ pmol/L}$; martial assessment: ferritin $<15 \mu\text{g/L}$; serum iron $< 5.8 \mu\text{mol/L}$; transferrin iron saturation coefficient $<16\%$.

Socio-demographic and dietary risk factors associated with micronutrient deficiencies were investigated using a structured questionnaire with sociodemographic data (age, place of birth, mother language, place

of residence in the last 9 months, date of arrival in French Guiana, possession of a residence permit for foreign women, health coverage, education level, marital status, professional status before pregnancy); food data (food Diversity Score (qualitative) and national nutrition and health program nutritional benchmarks (quantitative)); obstetrical and neonatal pathologies associated with micronutrient deficiencies (patient's past medical history and review of patients' and newborns' medical records completed by patients face to face interviews).

Patient's medical data reviewed were weight before pregnancy and on the day of inclusion, height, gestational age, pregnancy follow-up, microcytic anemia (hemoglobinemia <110 g/L, GMV >80 fl), primary hypothyroidism (increased TSH), gynaecological-obstetrical history, personal history of goiter or dysthyroidism, history of night blindness, personal history of anemia, other chronic conditions, history of digestive disorder/parasitoses, malaria history, drug treatment before and during pregnancy, micronutrient supplementation before and during pregnancy, tobacco use during pregnancy, alcohol use during pregnancy). Newborns' medical data reviewed were: (gestational age at delivery, mode of delivery, weight, height, head circumference, APGAR, pathologies diagnosed on clinical examination before the 8th day of life).

The inclusions were performed by the investigator from Monday to Friday between 7am and 5pm, randomly i.e. according to the order of arrival of the patients in the obstetrical emergency unit of Cayenne General Hospital.

On the first day of hospitalization in the department, the investigator proposed to patients who met the inclusion criteria to be included in the study. The investigator collected the patient's data from the medical record and interviewed the patient to complete the nutritional questionnaire.

The biological, blood and urine samples required for our study were collected during routine blood sampling upon entry and hospitalization.

Concerning iron deficiency, ferritin, a recognized indicator for estimating iron deficiency, is decreased during pregnancy. In order not to overestimate an iron deficiency by hypoferritinemia ultimately due to pregnancy alone, it was decided to take into account the martial assessment in order to define an iron deficiency in the study.

Statistical analysis was performed with Stata13©(College Station, Texas, USA).

The descriptive analysis used Student's t-test for quantitative data, Chi2 test or Fischer's test for qualitative data. A p-value of less than 0. 05 was considered significant. The low percentage of missing data did not require any specific statistical intervention.

The explanatory analysis was based on a Poisson regression to obtain prevalence ratios, which, given the frequency of the study outcome are less biased than odds ratios. Unified models analyzed the risk factors associated with at least one deficiency.

Using an identical method, obstetrical and neonatal pathologies were analyzed to estimate the statistical association with at least one micronutrient deficiency.

The research was conducted in compliance with current French regulations, and ethical approval was given by the Comité de protection des personnes (N°2018-A00139–46).

Results

A total of 341 pregnant women admitted to the Obstetrical Emergency Department who gave birth at the hospital in Cayenne agreed to participate in the study between 29 May 2018 and 29 March 2019.

Sociodemographic characteristics

The average age was 28.6 years (range 15–45 years).

The majority of women were born in Haiti and French Guiana (39% and 34% respectively). 9% of them were born in Brazil, 6% in France Mainland, 4% in Suriname, 4% in the Dominican Republic.

The mother language was Haitian Creole for 37% of the women, French for 31%, Portuguese for 11%, Nengue Tongo for 7%, Spanish for 4% of them.

The women participating in the study had a “high school” level for 35% of them and a “middle school” level for 31% of them. 21% had completed higher education, 5% had vocational training. 8% of women had not attended school or had interrupted their primary education.

Over a third of women were single (39%), 43% lived in a couple, 16% were married or in a couple, and 2% were divorced.

The median length of stay in French Guiana at inclusion was 2.7 years (range 1 month - 41 years). 90% of the women participating in the study lived in French Guiana throughout their pregnancy.

Among foreign women, 68% did not have a residence permit.

Concerning social coverage, 160 women (47%) benefited from the universal medical coverage, 68 (20%) from regular health insurance and a complementary health insurance, 66 (19%) from the State Medical Aid for foreigners, 21 (6%) from regular health insurance without complementary insurance, and 26(8%) did not benefit from any social coverage.

The majority of women (59%) were housewives, 26% had a permanent job, 7% were in training, 5% were looking for work, 4% were temporary workers.

Nutritional characteristics

The majority of women drank tap water (65%); 30% drank bottled water; the remaining 5% drank water from the well, rain or creek. Water intake was insufficient, less than 1.5L of water per day for 22% of

women.

The 9-category food diversity score showed 52% of the women had a score of 4 or less.

The national nutrition and health program includes 4 items. 9% of women responded to the 4 items. 66% of women responded to 2 items or less.

Thirteen percent of women experienced eating disorders during pregnancy, 11% consumed “pemba”, which consists of aluminum-rich clay.

The body mass index before pregnancy averaged 26.7. At the beginning of pregnancy, one in four women was overweight and one in four was obese (in total half were overweight or obese).

The median weight gain during pregnancy was 10kg. A quarter of women gained 15kg or more during pregnancy, with a maximum of 37kg.

Obstetrical characteristics

The gestational age at inclusion ranged between 22 and 42 weeks of pregnancy.

Fifteen percent of women gave birth prematurely, 4.5% extremely prematurely.

Fifteen percent of the newborns in the study had a birth defect or required intensive care.

The first obstetrical consultation took place before the 14th week of amenorrhea for 75% of women. The average number of previous pregnancies was 3. Among the 10% of *primigravida* women, 18% received prenatal consultations and 27% birth preparation sessions. Among multiparous women, 81% of them had breastfed their previous child.

Twenty-three percent of the women participating in the study had a history of voluntary termination of pregnancy.

Nearly 1 woman in 4 (24%) had a history of miscarriage.

Night blindness during pregnancy was reported by 11% of the women participating in the study.

Biological characteristics

Microcytic anemia was reported in 21% of women.

Primary hypothyroidism was observed in 6.4% of women.

For urinary iodine, the median observed in our study sample is 104 ug/L.

Micronutrient deficiencies were documented in:

- 47% of women for iodine
- 28% of women for zinc
- 11% of women for magnesium
- 1.5% of women for folic acid
- 35% of women for vitamin A
- 39% of women for vitamin B12
- 7% of women for the martial check-up

At least one micronutrient deficiency was objectively detected in 81% of the women participating in the study; 46% of women had at least two deficiencies; 18% had at least three.

No drug treatments that could induce deficiency were reported among the women in the study.

Table 1 showed that place of birth, mother language, health insurance, maternal education level and APGAR at 10 minutes from the newborn were significantly associated with micronutrient deficiency.

Women with State Medical Aid and Universal Medical Coverage had a greater risk, respectively 35% and 31%, of micronutrient deficiency during pregnancy compared to those with both normal and complementary health insurance.

Women born in Haiti and in the Dominican Republic had an, respectively 17% and 21%, increase of the risk of micronutrient deficiency during pregnancy compared to those born in French Guiana.

An increased educational level is in favour of a decreased risk of micronutrient deficiency:

women with a Bachelor's degree had a 15% decrease in the risk of micronutrient deficiency during pregnancy; 38% for women with a master's degree and 99% for women with a doctorate compared to those at the "high school" level.

Women who had never gone to school had a 16% increased risk of micronutrient deficiency during pregnancy compared to those at the high school level.

Women whose mother language was Haitian Creole, Spanish and Nengue Tongo had a, respectively 24%, 29% and 33%, greater risk of micronutrient deficiency during pregnancy compared to those whose mother language was French.

Probability of increasing the APGAR score by one unit at 10 minutes of the newborn's life was significantly decreased by 2% in women with at least one micronutrient deficiency.

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Probability of increasing the APGAR score by one unit at 10 minutes of the newborn's life was significantly decreased by 2% in women with at least one micronutrient deficiency.

Discussion

Our study reveals for the first time that micronutrient deficiencies are a real public health problem for pregnant women in French Guiana. Indeed, at least one micronutrient deficiency was objectively identified in 81% of the women participating in the study.

The estimates in our study in relation to the literature indicate that French Guiana's population of pregnant women has a public health problem of iron deficiency and anaemia, vitamin A deficiency, and

iodine deficiency. (4) The lack of consensus for the other micronutrients analyzed does not allow us to define the observed deficiencies as public health problems. Nevertheless, our study also shows the substantial prevalence of vitamin B12 (39%), zinc (28%) and magnesium (37%) deficiencies. (8)

Our study found anemia in 41% of women. This prevalence thus highlights a severe public health problem for the population.

The decreased hemoglobin due to physiological hemodilution during pregnancy cannot be considered as a justification for anemia below the threshold of 11g/dl during the 3rd trimester of pregnancy.

The consumption of “pemba” clay is known to promote anemia. 11% of the women in our study sample reported using it during their pregnancy. (12) However, this consumption was discontinued beyond the first trimester of pregnancy.

Our study showed a 35% prevalence of vitamin A deficiency. The public health problem is therefore severe. In addition, night blindness was reported by 11% of the study participants. As this prevalence is higher than 5%, this is an additional criterion indicating a public health problem (8).

A public health problem of iodine deficiency is defined in pregnant women by a median urinary iodine concentration of less than 150 µg/L in the general population. (9) Our study sample has a median urinary iodine concentration of 104 µg/L and primary hypothyroidism was documented in 6.4% of participants.

Magnesium deficiency is difficult to define and there is still no consensus on a reliable biological indicator. (9) However, in the SU. VI. MAX study conducted in France under the supervision of INSERM, the analysis of the magnesium dietary intakes of about 5,500 people revealed that about 3/4 of them had insufficient intakes.

Only the prevalence of folic acid deficiency was found to be low (1.5%). This suggests good compliance with systematic supplementation during pregnancy.

The women most at risk of developing these deficiencies are women born in Haiti and the Dominican Republic, often living in precarious conditions. Given the context of intense immigration from Haiti to French Guiana, facilitating access to care soon after these women arrive should be a priority.

More than half of the women in the study were overweight (27%) or obese (27%) at the beginning of their pregnancy. This excess weight masks a diet that was found to be low in nutritional intake. Indeed, 52% of the women interviewed had a food diversity score of 4 or less. The consumption of 66% of the women participating in the study responded to only 2 nutritional categories out of 4, or less, which is not enough according to the recommendations of the French National Nutrition Health Programme. (13–14)

These results suggest it is important and urgent to set up nutritional support for all pregnant women in French Guiana. At the same time, nutritional education sessions during school could be an effective way to promote a varied and balanced diet, and to prevent overweight and morbidity in adulthood.

In French Guiana, in 2015, 12.8% of newborns had a low birth weight versus was 8.2% in metropolitan France.

The national perinatal survey estimated in 2010 that, in French overseas departments (Guadeloupe, French Guiana, Reunion Island), 12% of unique live births occurred prematurely versus 5.5% in metropolitan France. Some authors estimate the prematurity rate in French Guiana at 13.5% of live births. (11)

This confirms that the health problems in French Guiana cannot be compared to those in metropolitan France. Prevention and medical care for women and children must be designed and adapted to the particularities of this region.

The study sampled women arriving in the Obstetrical Emergency Unit at Cayenne Hospital. Although this sample does not represent all pregnant women in French Guiana, the majority of the population uses the hospital in Cayenne to deliver their babies.

Less than one percent of eligible women refused to participate in the study and none were lost to follow-up. Our sample size corresponded to the calculated optimal theoretical sample size.

Given these elements, we thus consider that the representativeness of the study sample was good.

However, there were possible study limitations: laboratory constraints, restrained inclusions during weekday working hours. Our sample represented 10% of the total number of births over the 10-month inclusion period. It is likely that women consulting during the day may present pregnancies at higher risk of delivery without the patient actually being in labor.

The inclusions were also found to be dependent on the on-call medical team. Some women already in labor presenting themselves in the unit for an imminent delivery were not offered to participate in the study due to lack of time.

Thus, the proportion of pathological pregnancies was probably slightly overestimated.

In addition, the sample probably underestimated the proportion of underage women. Although they were willing to participate in the study, some could not be included in the study because of the lack of representation of a legal guardian. These underage women came most often from isolated villages.

The collection method used was the 24-hour recall method. This is the most common and recommended method to limit memory bias. (15–16–17)

Three different investigators collected the data. The measurement bias that could be induced by the investigator's subjectivity was anticipated and limited by the introduction of a procedure for conducting the questionnaire and collecting medical data. Investigators were trained, in pairs, for the necessary time.

In addition, our study included a reporting bias due to the difficulty of communicating with women who do not speak French at all. However, this only affected a small percentage of our sample.

Conclusion

In a context where excess weight concerns over half the population of French Guiana's women we showed that micronutrient deficiencies in pregnant women in French Guiana are a real public health problem with 81% of women being concerned. A varied and balanced diet remains the most effective solution to prevent these deficiencies from occurring. (18)

However, poor populations often cannot afford, or do not know how to, to diversify their nutritional intake.

Although French Guiana has the highest gross domestic product (GDP) per capita, and the highest health expenditure per capita in Latin America, it is a region where precariousness is widespread. This segment of the population is particularly at risk of micronutrient deficiencies and should thus be the target of nutritional interventions and efforts to improve access to care.

Although the fight against obesity should still be of major public health importance we here show that the nutritional problems in French Guiana are complex with both excesses and deficiencies, a fact that was overlooked until now and is of great operational importance. Indeed, folate deficiency was rare which suggests that, when a micronutrient is specifically targeted, supplementation efforts may have an impact in our population. Thus targeting other micronutrients should also be possible in our population. The present results should surely raise awareness and guide specific efforts to rapidly compensate these deficiencies.

Declarations

Ethics approval and consent to participate

The CarMa study protocol was approved by the French Ethic Committee: Comité de Protection des Personnes Ile de France V, reference number: 2018-A00139-46

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was supported by the Agence Régionale de Santé Guyane.

Authors' contributions

AD: Substantial contribution to conception and design, fieldwork, literature review, analysis and interpretation of data, drafting and critically revising the article for important intellectual contribution and final approval of the version to be published. FA: Substantial contribution to fieldwork, drafting and critically revising the article for important intellectual contribution and final approval of the version to be published. AA: Substantial contribution to conception and design, drafting and critically revising the article for important intellectual contribution and final approval of the version to be published. MLD: Substantial contribution to conception and fieldwork, drafting and critically revising the article for important intellectual contribution and final approval of the version to be published. MN: Substantial contribution to conception and design, literature review, analysis and interpretation of data, drafting and critically revising the article for important intellectual contribution and final approval of the version to be published.

Acknowledgements

Not applicable.

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Table

Association between characteristics and at least one micronutrient deficiency

Characteristics	Univariate analysis		
	PR	IC 95%	p-value
Insurance			0.011
No health and supplementary health insurance	1		
State Medical Aid	1.35	1.12 ; 1.63	0.002
Universal Medical Coverage	1.31	1.10 ; 1.57	0.003
None	1.22	0.95 ; 1.57	0.123
Social insurance	1.01	0.71 ; 1.43	0.967
Yes	0.98	0.97 ; 0.99	0.011
Birth			0.026
French Guiana	1		
Brazil	0.94	0.74 ; 1.19	0.608
Guyana	0.98	0.55 ; 1.74	0.945
Haiti	1.17	1.04 ; 1.31	0.009
Metropolitan France	0.76	0.51 ; 1.13	0.169
Dominican Republic	1.21	1.00 ; 1.45	0.049
Surinam	1.13	0.91 ; 1.42	0.274
Educational status			0.001
High school	1		
Vocational school certificate	0.82	0.60 ; 1.12	0.208
Bachelor degree	0.85	0.71 ; 1.01	0.061
Non-response	0.58	0.14 ; 2.32	0.440
Secondary school	0.99	0.89 ; 1.10	0.898
Doctorate	0.01	0.01 ; 0.01	0.001
Master degree	0.62	0.37 ; 1.04	0.068
Never attended school	1.16	1.08 ; 1.24	0.001
Primary school	0.90	0.80 ; 0.93	0.421
Language			0.002
French	1		
Amerindian	0.79	0.41 ; 1.52	0.485
English	0.92	0.52 ; 1.65	0.790
French Guiana creole	1.13	0.84 ; 1.54	0.415
Haitian creole	1.24	1.09 ; 1.42	0.001
Spanish	1.29	1.07 ; 1.55	0.009
Portuguese	1.00	0.79 ; 1.27	0.990
Nengue Tongo	1.33	1.15 ; 1.54	0.001