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Prevalence and risk factors of food insecurity during pregnancy: a multicenter survey in French Guiana

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Abstract

Background The post-COVID international situation, wars and food price inflation are hampering access to food for the most vulnerable households who have no safety net against unforeseen events. While pregnant women are particularly vulnerable to food shortages and nutritional imbalances, data on food insecurity during pregnancy and associated risk factors are scarce.

Methods A 2023 multicenter, cross-sectional study was conducted among a representative sample of 730 women during the third trimester of pregnancy in French Guiana. Food insecurity (USDA Food Security Survey Module), diet quality indicators derived from a qualitative 24-h recall (Minimum Dietary Diversity for Women MDD-W, All-5 indicator, NCD risk foods), pre-conceptional nutritional status (body mass index – BMI) and gestational weight gain (GWG), and women's self-esteem were collected. Data were weighted to ensure sample representativeness, and modified Poisson regression was used to identify risk factors for FI during pregnancy.

Results Overall, 32.3% [95% CI: 28.8–35.9] of the women lived in a food-insecure household during pregnancy and only 45.6% [95% CI: 42.0–49.2] of the women had reached the MDD-W set at 5 food groups. More than 80% of the women had consumed sweetened beverages and 25.1% were obese before conception. According to the multivariate model, the factors positively associated with food insecurity included living in substandard housing, living alone with children, having low self-esteem and being born abroad (with or without a residence permit). On the other hand, having a stable and declared income and social support were protective factors against food insecurity after adjusting for the other variables.

Conclusions This study highlights a frequently overlooked situation in French Guiana that is likely to affect the health of children at the very beginning of their lives. Peer-based programs or government financial assistance programs could help strengthen the ability of the poorest households with pregnant women to cope with food insecurity.

Keywords Food insecurity, Pregnancy, French Guiana, Dietary diversity, Obesity

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Background

Food insecurity (FI) is a complex concept that cuts across disciplines. The Food and Agriculture Organization of the United Nations (FAO) defines it as a situation in which people do not always have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life [1]. To achieve this, four conditions must be met: food availability, access to available food, appropriate use of available and accessible food and stability of these three dimensions over time [1].

Since the COVID19 pandemic, the concept of FI has become a matter of increasing concern to the international community, and not only in low- and middle-income countries (LICs and MICs). The prevalence of undernourishment has increased from 7.9% of the global population in 2019 to 9.2% in 2022 [2]. In the post-COVID19 period, the war in Ukraine has added an additional international shock by rising food prices. In 2022, according to the FAO, 58% of countries had a prevalence of undernourishment that remained above pre-pandemic levels [2]. Although the situation is more critical in LICs and MICs, deteriorating food security is also observed in high-income countries [3]. In Italy, for example, the risk of food insecurity increased from 8% before the pandemic to 16.2% after [4]. In the United States, a multisite survey conducted before and during the COVID crisis showed that food insecurity had increased from 23 to 55% depending on the state [5].

In France, FI has been most often associated with recipients of food aid [6]. Since the COVID19 crisis, the profile of those affected by FI has broadened, revealing hidden food inequalities [7, 8]. With a GDP per capita that is among the lowest in France and the highest in South America, more than half of the population lives below the poverty line [9]. Foreign-born Guianese (i.e. 1 in 3 people in French Guiana) had higher poverty rates than those born in France (36.6% versus 12%). In this context, a large informal economy has developed.

Preliminary studies conducted in 2020 and 2021 in precarious urban neighborhoods in French Guiana revealed a high prevalence of FI, particularly among households with low financial resources, limited social capital, and whose foreign-born members do not have residence permits [8]. During the recent health crisis, for this vulnerable population with no safety net against the unexpected, the concern was more to develop daily strategies to feed themselves than strategies to protect themselves from the coronavirus [8].

With the highest fertility rate in France and South America the impact of inequalities in access to food on maternal and child health in French Guiana is a pressing issue [10]. At the household level, FI can lead to an unbalanced distribution of food quantity and quality among household members, to the detriment of women and children. This can put pregnant women at risk of poor health due to their increased and specific nutritional needs during pregnancy [11, 12]. Difficulties in pregnant women's access to food may also be related to reduced mobility or work interruptions at the end of pregnancy [13]. Given the direct and indirect impact of FI on undernutrition and malnutrition, and the central role of maternal nutrition and well-being during the critical first 1,000 days of a child's life, this issue is becoming a matter of serious concern [14, 15] In addition, the issue of maternal obesity and its relationship to FI deserves special attention given the adverse perinatal outcomes associated with it [16].

No data have been published on FI and dietary diversity during pregnancy in French Guiana. Therefore, in the current political and economic context, the main objective of this study was to estimate the prevalence of food insecurity during pregnancy in French Guiana. Secondly, this study aimed to investigate the factors associated with this food insecurity. Specifically, socioeconomic factors of pregnant women and their households, maternal psychological factors, maternal dietary diversity during pregnancy, and anthropometric measurements of pregnant women (pre-pregnancy body mass index (BMI) and gestational weight gain (GWG)) were examined. By providing new, up-to-date data on this topic, we hope to pave the way for better care of pregnant women and their children from the very beginning of their lives.

Methods

Study design

The Nutri Pou Ti'moun survey (NPTM) was a multicenter, cross-sectional study of pregnant women in French Guiana.

Participant recruitment and enrollment

In French Guiana, an average of 8,000 live births are registered each year. All deliveries take place in the 3 hospitals of French Guiana. On the coast, the maternity hospital in Cayenne registered about 50% of deliveries in 2021, and the maternity hospital in Kourou, 10%. In the west, at the border with Suriname, the Saint Laurent du Maroni maternity hospital recorded 40% of deliveries.

Study participants were recruited during prenatal visits between January and September 2023. The eligibility criteria for the study were as follows: be at least 29 weeks pregnant and attend a prenatal visit at one of the three maternity hospitals in French Guiana.

To be included, women had to give their consent to participate in the study (as well as the consent of legal representatives for minors). Women under guardianship

or trusteeship were excluded, as were women who were unable to give their consent at the time of enrollment (for medical, moral, physical, linguistic or comprehension reasons…).

Sample size calculations were based on an estimated prevalence of FI of 28%, a margin of error of 4.2 and a confidence level of 99%, and resulted in a required sample size of at least 700 women. Given the number of deliveries per maternity hospital, we estimated that a 9-month recruitment phase would be sufficient to meet this target.

Proportional stratified random sampling (by maternity hospital) was used. Thus, the study was offered successively to all eligible women attending any of the 3 maternity hospitals between 8am and 2 pm. The number of planned recruitments was proportional to the number of deliveries per center (i.e. at least 4 per day for Cayenne, at least 1 for Kourou, at least 3 for Saint Laurent du Maroni).

Data collection

Each woman was interviewed twice by health mediators, during prenatal visits (third trimester of pregnancy) and postnatal (2–5 days after delivery) hospitalization.

At the prenatal inclusion visit, health mediators collected non-opposition to study participation from participants (and from legal representatives for women under 18) and administered dietary diversity and self-esteem questionnaires to participants.

After delivery and before discharge, health mediators collected socioeconomic and household FI data from participants. Pre-pregnancy and pre-delivery weights and height were obtained from the pregnancy follow-up medical record.

All questionnaires were administered face-to-face in the participant's language with the help of health mediators (French, Haitian Creole, Brazilian Portuguese, Spanish, English or languages of the Maroni River region—Djuka, Saramaka, Sranan Tongo). Mediators were previously trained in questionnaire administration by nutritionists and the NPTM study team. A 15-day pilot study was carried out before the start of enrolment.

Measures

Outcome variables

Household food insecurity (FI) was measured using the USDA Food Security Survey Module [17]. The scale consists of 10 questions and includes the pregnancy period. The measurement tool provides a score between 0 and 10. The outcome variable (i.e., household food insecurity during pregnancy) was defined as 1 for a USDA score ≥ 3 (food insecurity) and 0 for a score < 3 (food security). For descriptive purpose the proportion of households being severely food insecure, as defined by a USDA score ≥ 6, were also calculated.

Maternal covariables

The socioeconomic profile of the mothers was assessed using the following data:

1) administrative data: age (< 20 years; 20–34.9 and ≥ 35 years), place of birth, administrative status (French citizen; foreigner national with or without residence permit), French mother tongue, length of stay in French Guiana in terciles (< 8 years, between 8 and 21.9 years and ≥ 22 years).
2) socio-professional data: educational level started but not necessarily validated (before and after high school), occupation (housewife)
3) data on social support. Based on 2 items of the EPICES scale (in French, Échelle d'évaluation de la Précarité et des Inégalités de santé dans les Centres d'Examens de Santé), which is a validated French indicator of precariousness [18], a variable is created: material or financial help from social network in case of need.
4) whether or not the woman was covered by the universal health insurance; The universal health insurance (PUMa in French) covers health care costs for anyone who works or lives in France on a stable and regular basis. If the person does not have open rights under the PUMa, he or she can, under certain conditions and on a temporary basis, benefit from the State Medical Aid (AME in French).
5) and whether or not she was living with the father of the child at the end of the pregnancy.

Mothers'self-esteem was assessed using the Rosenberg self-esteem scale [19]. The questionnaire consists of 10 questions scored on a Likert scale from 1 to 4. The 5 positive questions were scored as follows: 1 strongly disagree, 2 disagree, 3 agree and 4 strongly agree. For the 5 negative questions, the scoring was reversed. The sum of the scores for the 10 questions gives a total score of 40. The score is presented here as a mean ± standard deviation (SD) and in terciles. The variable"self-esteem"is presented in 2 categories:"low self-esteem"(first tercile; score < 30) and"medium to high self-esteem"(second and last tercile: 30–40).

To assess the diversity of the diet during pregnancy, we collected individual data on the qualitative consumption of different food groups over a 24-h period from a list of 24 pre-defined food groups and using an open recall. The project team's nutritionists and facilitators adapted the measurement tool to the local context (language, food terms, lists for each group, composition of local dishes).

On the basis of this recall, several dietary indicators were calculated.

1) Dietary diversity score: For each woman, we calculated the Women's Dietary Diversity Score (WDDS-10), defined as the number of different food groups consumed in the previous 24-h using the 10 recommended food group classification: 1. Cereals, white roots and tubers and plantains 2. Pulses (beans, peas and lentils) 3. Nuts and seeds 4. Milk and dairy products 5. Meat, poultry and fish 6. Eggs 7. Dark green leafy vegetables 8. Other vitamin A-rich fruits and vegetables 9. Other vegetables 10. Other fruits [20].
2) Minimum dietary diversity indicator: We also calculated the Minimum Dietary Diversity for Women (MDD-W), a dichotomous indicator of whether or not women had consumed at least five of the ten food groups in the previous 24 h. Women who reach the threshold of five food groups are more likely to meet their nutrient requirements [20]. The threshold of 5 or more food groups for the MDD-W indicator can be extended to all women of childbearing age, regardless of their physiological state [21].
3) ALL-5 indicator: This indicator was defined as the proportion of pregnant women who consumed the five food groups recommended in the World Dietary Guidelines during the previous 24-h: at least one starch, at least one vegetable, at least one fruit, at least one legume, nut or seed, and at least one food of animal origin [22]
4) NCD risk score: This score was defined as the proportion of pregnant women who consumed foods which are related to the risk of non-communicable diseases (derived from the WHO International Agency for Research on Cancer), namely: 1) Sweet beverages 2) Sweet foods 3) Salty or fried snacks [23].

Pre-pregnancy BMI was calculated by dividing the weight (in kg) of pregnant women at their first prenatal visit (≤ 12 weeks gestation) by their height (in meter squared). According to the WHO and NIH, BMI values were classified into 4 categories: underweight (BMI less than 18.5 kg/m^2), normal weight (BMI greater than or equal to 18.5 to 24.9 kg/m^2), overweight (BMI greater than or equal to 25 to 29.9 kg/m^2), obese (BMI greater than or equal to 30 kg/m^2) [24].

Gestational weight gain (GWG) is the difference between the weight measured at the last prenatal visit before delivery and the weight measured at the first prenatal visit. Gestational weight gain (GWG) was classified according to the 2009 guidelines of the Institute of Medicine. For a woman of normal pre-conception BMI, the total target GWG is 11.5 to 16 kg, according to the 2009 IOM definitions. For a woman who is underweight before conception, the total target GWG is 12.5 to 18 kg; for a woman who is overweight before conception, the total target GWG is 7 to 11.5 kg; and for a woman who is obese before conception, the total target GWG is 5 to 9 kg [25].

Household covariables

1) Household data included: composition: Single-parent family, number of people in the household (< 5; ≥ 5), number of children in the household (< 3; ≥ 3),
2) housing: electricity in the home or running drinking water from the tap (yes/non), access to farm land to grow fruits, vegetables, or tubers, and household financial resources: stable income from formal or informal work for at least one household member.

Statistical analysis

First, the NPTM survey data were weighted using reference data from the French Guiana birth registry. This calibration took into account age, place of birth, place of residence, and hospital of delivery to ensure the representativeness of the sample. Calibration weights were calculated in SAS version 9.4 using the CALMAR macro from the French National Institute for Statistics and Economic Studies (INSEE) [26].

The STATA software (STATA Corporation, College Station, TX, USA—version 16.0) was then used for the survey data analysis commands (svy), taking into account a calibration weight for all analyses.

Due to the weighting of the survey, all descriptive results are presented as weighted proportions rather than numbers per category.

The analysis was performed in three stages: descriptive, bivariate, and multivariate.

1. First, a descriptive analysis was performed to present the characteristics of the sample, as well as the weighted prevalence of food insecurity, dietary diversity indicators, and BMI categories. Continuous variables are presented as means ± SD, and categorical variables are presented with 95% CIs.
2. A bivariate analysis was then performed to examine the associations between the factors of interest (social, economic, psychological, food and anthropometric dimensions of the women and their household) and the outcome variable (food insecurity during pregnancy coded 1 and food security coded 0) using Pearson's Chi^2 test (comparison of weighted proportions).

3. A multivariate analysis was then performed to determine which covariates (of the pregnant woman or her household) were during pregnancy independently associated with food insecurity during pregnancy.

In cases where an outcome variable has a proportion greater than 10% in the study population, the overestimation of relative risk by odds ratios may be very significant. As an alternative to using logistic regression models in cross-sectional studies, the modified Poisson regression model has been proposed to calculate prevalence ratios [27].

The covariates included in the model were selected according to three criteria: relevance to the variable to be explained from the literature (i.e., food insecurity during pregnancy), the existence of an association in the bivariate analysis (up to a p-value of 0.2), and the absence of multicollinearity. Variance inflation factors (VIF) were examined, and the mean VIF for all variables included in the multivariate model was 1.7. Two dependent variables related to family composition were significantly associated with food insecurity, but only one was selected to avoid multicollinearity of the variables. Therefore, the variable"single-parent family"was chosen. The multivariate model with all selected variables corresponds to the saturated multivariate model. A backward method was then used to keep only the significant factors at the 0.05 threshold in the final multivariate model (corresponding to parsimonious model).

Regarding the categorization of the variables, it was decided to create a"non-response"category. The weighted percentages are therefore expressed from the total number of 730 women. The categorization of the variables remained the same from the descriptive analysis to the multivariate analysis, as specified in the methodological description of the variables above, except for the categorization of BMI; for the bivariate and multivariate analysis, a grouping of the " < 18.5 kg/m^2" category with the "18.5–24.9 kg/m^2" category was chosen so as not to unbalance the different categories.

An alpha threshold of 5% was selected.

Results

Out of 912 eligible pregnant women, 786 were included in the NPTM study (Fig. 1). Of the 786 women included in the study, 730 were included in the analysis (407 in Cayenne, 65 in Kourou and 258 in Saint Laurent du Maroni).

Description of the sample of pregnant women and their households

The mean age of the women was 28.6 years (± 0.3 years), with a minimum of 15 and a maximum of 47 years old. More than half of the women (52.4%) were born abroad, mainly in Haiti (22.0%), Suriname (18.1%) or Brazil (6.6%), and 19.5% did not have a French residence permit. In 55.3% of the cases, French was the mother tongue of the women included. Only 13.9% had started higher education and 50.1% considered themselves to be housewives. During pregnancy, 30.5% of the women did not have universal health insurance covering the cost of prenatal care. At the end of their pregnancy, 37.0% were not living with the father of their child (Table 1).

The mean score on the Rosenberg Self-Esteem Scale was 31.6 [95%CI: 31.2–32.0].

For 47.1% of the women in the study, pregnancy was intended at this stage in their lives.

The majority of pregnant women (78.4%) lived in urban areas. Households had at least 5 members in 34.0% of cases and at least 3 children in 27.8% of cases. Just under 2 in 3 households (62.1%) felt they had enough money to meet their pregnancy-related needs, and 18.3% received cash donations from relatives. Households without running water or electricity accounted for 16.2% of the sample and 22.4% had access to farm land for food supply (Table 2).

Regarding dietary diversity in the third trimester of pregnancy, 45.6% [95%CI: 42.0- 49.2] of pregnant women reported eating at least 5 food groups in the previous 24 h.

The mean WDDS was 4.9 food groups [95%CI: 4.7–5.1].

The food groups consumed by at least 90% of the women were grains, roots, tubers or plantains, and meat, poultry or fish. Next, the food groups consumed by 30–50% of women were milk or dairy products, vegetables (vitamin A-rich, dark green and other vegetables) and fruits (vitamin A-rich and other fruits). Finally, the food groups consumed by less than 30% of women were eggs, pulses and nuts, and seeds (Additional files 1).

Regarding the All-5 indicator, only 9.6% of women had eaten the five recommended daily food groups (vegetables, pulses, nuts or seeds, animal products and starchy foods). In addition,

a very large majority of women (> 80%) had consumed at least one sweetened beverage (fruit juice, fizzy drink or sweetened tea/coffee) in the previous 24 h. (Additional files 1).

With regard to anthropometric measurements, the mean preconception BMI was 26.9 kg/m^2 (± 0.3). In our sample, 21.8% [95%CI: 19.9–25.1] of women were

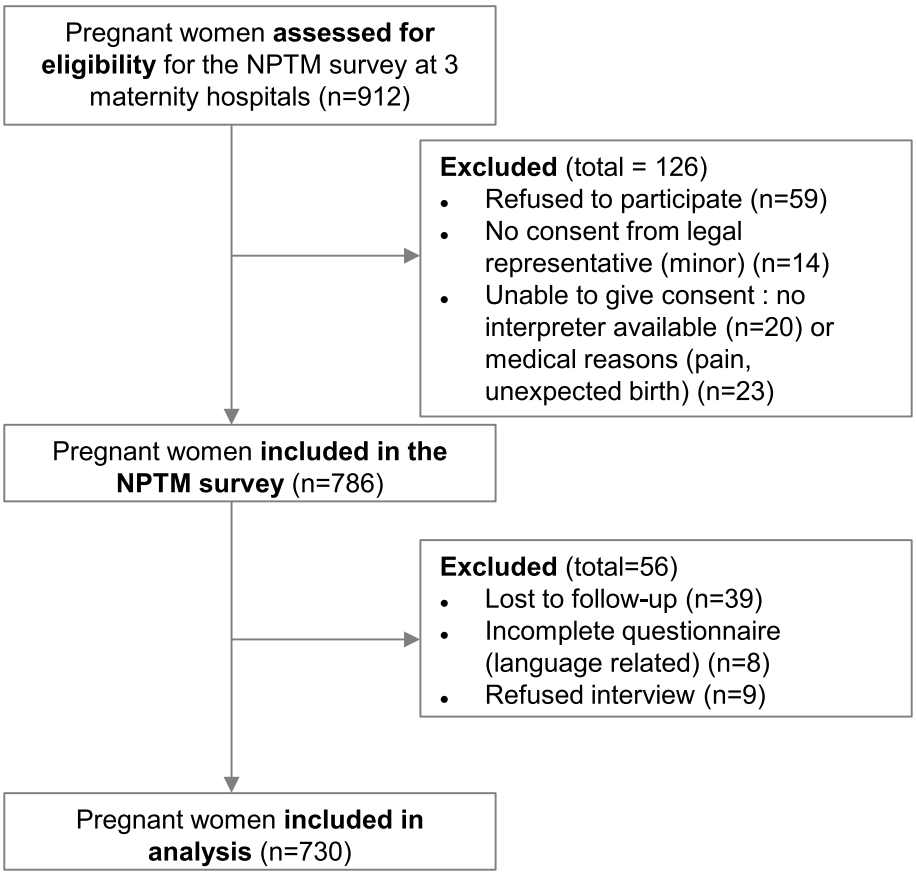

Fig.1 Nutri Pou Ti'Moun (NPTM) study flowchart, 2023

overweight and 25.1% [95%CI: 22.0–28.4] were obese before pregnancy (Table 1).

The mean GWG according to the IOM was 10.2 kg (± 0.3); 23.2% of the women had an excessive GWG while 32.6% had an insufficient GWG (Table 1). Specifically, according to the IOM recommendations, weight gain during pregnancy was excessive for 6.7% of underweight women, 24.3% of women with a normal BMI, 31.3% of overweight women, and 30.8% of obese women before pregnancy (Additional files 2).

Measure of household food insecurity during pregnancy

The prevalence of food insecurity during pregnancy among included women was 32.3% [95% CI: 28.8–35.9], including 16.3% [95% CI: 13.7–19.3] of severe food insecurity. Among food-insecure households, 16.1% of women had applied for food aid during their pregnancy. Among food-insecure households with children, 45% of women reported that one of the adults in the household had gone without food to feed the children in the household.

Factors associated with food insecurity during pregnancy

Table 3 shows the results of the bivariate analysis between the factors studied (mother and household) and the situation of food insecurity during pregnancy. Being born abroad (with or without a residence permit), dropping out of school before high school, living alone with children (single-parent family), having low self-esteem, or living in housing without electricity or running water were factors positively associated with food insecurity during pregnancy; conversely, living in French Guiana for at least 8 years, having an open right to universal health insurance, being able to count on social support in case of need, or having a declared and stable source of income were factors inversely associated with situations of food insecurity during pregnancy.

Although the difference was not statistically significant, women who were obese before pregnancy were more likely to be food insecure during pregnancy than women with a BMI of less than 25 kg/m^2.

The indicator of maternal dietary diversity in the third trimester of pregnancy was not significantly associated with household food insecurity. In fact, 45.4% of

Table 1 The characteristics of the pregnant women included in the NPTM study, 2023 (*n*=730)

Characteristics of women included (*n*=730)		**%**
Age	<20 yr.	12.3
	20 to 35 yr.	67.2
	>35 yr.	20.5
Administrative status	French citizen	46.1
	Foreign national with residence permit	24.8
	Foreign national without residence permit	19.5
	NK	9.6
Length of stay in French Guiana (in terciles)	<8 yr	32.5
	8–21.9 yr	29.3
	22 yr and +	35.3
	NK	2.9
Universal health insurance	Yes	64.9
	No	30.5
	NK	4.6
Education level (started but not necessarily validated)	Before high school	13.9
	Over high school	84.6
	NK	1.4
Social Support if needed	Yes	78.3
	No	21.7
Lives with child's father (at the end of pregnancy)	Yes	63.0
	No	37.0
Maternal self esteem (in tercile)	Low (score <30)	22.7
	Medium or high (31–40)	55.7
	NK	16.6
Antropometric measurements		
Preconception maternal BMI	Underweight (<18.5 kg/m^2)	4.5
	Normal weight (18.5–24.9 kg/m^2)	34.2
	Overweight (25.0–29.9 kg/m^2)	21.8
	Obese (more than 30.0 kg/m^2)	25.1
	NK	14.4
GWG according to IOM (depending on maternal BMI)	as recommended	25.1
	Excessive	23.2
	Insuffisient	32.6
	NK	19.2
Based on food recalls in the last 24 hours		
Minimum dietary diversity for women	<5 food groups	41.6
	5 or more food groups	45.6
	NK	12.8
All-5 indicator	Not all 5 food groups	77.6
	All 5 food groups	9.6
	NK	12.8

NK Not Known, *yr* years, %: weighted percentage; *BMI* Body Mass Index, *IOM* Institute Of Medecine

women in food secure households and 45.9% of women in food insecure households had reached the MDD (at least 5 food groups), with no significant difference between the groups. With regard to the All-5 indicator, food-insecure women were less likely than others to have consumed the five recommended food groups on the previous day (6.2% vs. 11.2%).

According to the parsimonious multivariate model adopted (Table 4), women born abroad were more likely than those born in France to live in a household with

Table 2 Household characteristics of pregnant women included in the NPTM study ($n = 730$), 2023

Household Characteristics		%
Household localisation	Urban	78.4
	Rural	21.6
Household Composition		
People in household	<5	59.0
	≥ 5	34.0
	NK	7.1
Single-parent family	Yes	14.3
	No	78.6
	NK	7.1
Children in Household	<3	65.1
	≥ 3	27.8
	NK	7.1
Housing		
Home without electricity or running water	yes	16.2
	No	83.8
With access to farm land (fruits, vegetables, tubers)	yes	22.4
	No	77.6
Financial Capital		
At least 1 member with a declared source of income	Yes	48.6
	No	51.4

NK Not Known; % weight percentages

food insecurity during pregnancy (controlling for other factors), with an aPR of 1.4 (p = 0.03) if they had a residence permit and 1.9 ($p < 0.01$) if they did not. Similarly, low maternal self-esteem (aPR = 1.5, $p < 0.01$), a single-parent family (aPR = 1.4, $p < 0.01$)), and a home without running water or electricity (aPR = 1.3, p = 0.04) were factors positively associated with food insecurity during pregnancy. Conversely, having a stable and declared household income (aPR = 0.7, $p < 0.01$) and being able to count on social support in case of need (aPR = 0.7, $p < 0.01$) were factors negatively associated with food insecurity during pregnancy.

Preconceptional BMI, the all-5 indicator, level of education, length of stay in French Guiana and open right to universal health insurance were no longer significantly associated with food insecurity during pregnancy after adjustment for the other factors (Table 4).

Discussion

In summary, our findings revealed worrying levels of food insecurity during pregnancy, with almost one in three women (32.3%) experiencing food insecurity during pregnancy and one in six (16.3%) experiencing severe food insecurity. The study identified factors that were significantly associated with food insecurity during pregnancy. Women who were born abroad, with low self-esteem, living alone with children and in housing without water or electricity were more likely to experience food insecurity during their pregnancy than others, while having a stable and declared family income and being able to count on social support in times of need were protective factors against food insecurity during pregnancy. The study also showed that women had low dietary diversity during pregnancy, with barely one in two reaching the MDD threshold in the third trimester (45.4%). Finally, pre-pregnancy obesity rates were very high in the study sample (25.1%), especially in food insecure households (29.2%).

Although French Guiana is a French territory—a wealthy country—the high prevalence of FI during pregnancy was closer to that observed in Latin America and the Caribbean (LAC) than in France. A recent systematic review reported a high prevalence of FI ranging from 28.2% in Brazil to 64.9% in Haiti [28], while another study estimated the prevalence of FI at 17.9% in socially deprived areas of Paris [29]. Our results illustrate the paradox of French Guiana, which is administratively French in terms of health infrastructure, but which in reality is similar to neighboring countries in terms of fertility, youthfulness of the population and magnitude of migratory flows. In our sample, the majority of pregnant women were of foreign origin, had a low level of education and were financially dependent. In French Guiana, even before the COVID-19 period, one person in two lived below the poverty line (compared to 14% in metropolitan France), with great inequalities in the distribution of wealth [30] and food prices being 34% higher than in France [31]. Only 15.6% of pregnant women in the survey received a university education, compared with 59.4% in metropolitan France [32]. In this context, migrants, single-parent families and people with no qualifications are more exposed to the risk of poverty than others [9]. Not surprisingly, household financial stability during pregnancy was a protective factor against household food insecurity. The current cost of living crisis, reflected in rising food and energy prices, could only exacerbate the situation of the most vulnerable households [33].

However, financial instability is not the only risk factor identified in this study. It is interesting to note the relative importance of other factors, such as inadequate housing [34, 35]. Indeed, water insecurity and lack of electricity at home (often associated with precarious installations) may not only lead to poor food hygiene, but may also limit food choices by making it difficult to prepare or preserve food and dishes (particularly in tropical areas). The immediate family environment may also play a role in the child's well-being and risk of stress [34].

In addition to this material vulnerability, the relationship between household FI and socio-psychological

Table 3 Crude prevalence ratios of factors associated with food insecurity during pregnancy (Bivariate analysis) in the NPTM study, 2023 ($n = 730$)

	Food security %	Food insecurity %	*p*	Not adjusted Crude PR	95%CI	*p*
Age (years)						
<20	12.8	11.1	0.30	0.9	[0.6–1.4]	0.76
20 to 35	68.4	64.8		1 (Ref.)		
>35	18.8	24.1		1.2	[0.9–1.5]	0.12
Administrative status						
French citizen	53.9	29.8	<0.01	1 (Ref.)		
Foreign national with residence permit	24.7	24.8		1.5	[1.1–2.1]	<0.01
Foreign national without residence permit	12.4	34.3		2.7	[2.1–3.5]	<0.01
NK	8.9	11.7		1.8	[1.2–2.7]	<0.01
Length of stay in French Guiana (years; in tercile)						
<8	27.1	43.9	<0.01	1 (Ref.)		
8.0–21.9	29.8	28.1		0.7	[0.5–0.9]	<0.01
≥ 22.0	40.7	23.9		0.5	[0.4–0.7]	<0.01
NK	2.4	4.0		1.1	[0.6–1.8]	0.96
Universal health insurance						
Yes	23.1	46.2	<0.01	0.5	[0.4–0.6]	<0.01
No	72.6	48.6		1 (Ref.)		
NK	4.3	5.2		0.7	[0.4–1.3]	0.29
Education level						
Before high school	88.4	76.6	<0.01	1.6	[1.3–2.1]	<0.01
Over high school	10.7	20.6		1 (Ref.)		
NK	0.8	2.7		2.1	[1.2–3.6]	<0.01
Social Support if needed						
Yes	84.8	64.7	<0.01	0.5	[0.4–0.6]	<0.01
No	15.2	35.3		1 (Ref.)		
Lives with child's father						
Yes	35.6	39.9	0.28	0.9	[0.7–1.1]	0.27
No	64.4	60.1		1 (Ref.)		
Maternal self esteem (score in tercile)						
Low (<30)	22.8	38.0	<0.01	1.8	[1.4–2.2]	<0.01
Mediumor high (31–40)	61.7	43.1		1 (Ref.)		
NK	15.5	18.9		1.5	[1.1–2.0]	0.01
Preconception BMI (kg/m²)						
<24.9	40.5	34.9	0.10	1 (Ref.)		
25.0–29.9	23.2	18.8		1.0	[0.7–1.3]	0.79
≥ 30.0	23.1	29.2		1.3	[1.0–1.7]	0.06
NK	13.2	17.0		1.3	[0.9–1.8]	0.10
GWG						
as recommended	26.2	22.8	0.59	1 (Ref.)		
Excessive	23.8	21.9		1.0	[0.7–1.4]	0.35
Insuffisient	31.9	34.0		1.1	[0.8–1.5]	0.82
NK	18.2	21.4		1.2	[0.9–1.7]	0.22
Minimum dietary diversity of Women						
<5 food groups	41.6	41.5	0.99	1 (Ref.)		
≥ 5 food groups	45.4	45.9		1.0	[0.8–1.3]	0.94
NK	12.9	12.6		1.0	[0.7–1.5]	0.91

Table 3 (continued)

	Food security %	Food insecurity %	*p*	Not adjusted Crude PR	95%CI	*p*
All-5 indicator						
Not all 5 food groups	75.9	81.2	0.11	1 (Ref.)		
All 5 food groups	11.2	6.2		0.6	[0.4–1.0]	<0.05
NK	12.9	12.6		0.9	[0.7–1.3]	0.70
Household localisation						
Urban	76.4	82.6	0.07	1 (Ref.)		
Rural	23.6	17.4		0.8	[0.5–1.0]	0.08
Number of people in the household						
<5	60.3	56.1	0.47	1 (Ref.)		
≥ 5	32.4	37.3		1.1	[0.1–1.4]	0.22
NK	7.3	6.5		1.1	[0.6–1.6]	0.90
Single-parent family						
Yes	11.8	19.6	0.03	1.4	[1.1–1.9]	<0.01
No	80.9	73.9		1 (Ref.)		
NK	7.3	6.5		1.0	[0.6–1.6]	0.95
Children in Household						
<3	67.7	59.7	0.07	1 (Ref.)		
≥ 3	25.0	33.8		1.3	[1.0–1.7]	0.02
NK	7.3	6.5		1.0	[0.6–1.6]	0.976
Electricity and running water at home						
Without	10.4	28.3	<0.01	2.0	[1.6–2.5]	<0.01
With	89.6	71.7		1 (Ref.)		
With access to farm land (fruits, vegetables, tubers)						
yes	23.3	20.4	0.41	0.9	[0.7–1.2]	0.42
No	76.7	79.5		1 (Ref.)		
At least 1 member with a declared source of income						
Yes	56.6	31.9	<0.01	0.5	[0.4–0.6]	<0.01
No	43.4	68.1		1 (Ref.)		

determinants in this study highlighted the importance of self-esteem during pregnancy, social capital and mutual support networks [36]. Indeed, the literature has highlighted the difficulty of coping with food stress for oneself and one's family when self-esteem is low. Similarly, the difficulty of empowerment women has been described when the woman feels isolated, unsupported, a migrant, alone with her children, and with a low level of education [37].

Some households adopt strategies to cope with food shortages that may be more or less effective or more or less harmful in the long run. In a British study, some parents experiencing food insecurity decided eating less to protect their child from hunger [38]. This parenting strategy was also observed in our study [39]. A study among South African households with children reported higher levels of stress and anxiety among food-insecure households that had resorted to begging for food [40]. On the other hand, it has been suggested that coping strategies based on social capital can reduce the impact of food insecurity and provide moral support to the household. Sharing experiences within a community and pooling goods or services can help reduce costs while providing moral support and combating social isolation [41]. Results from 330 low-income households in the United States showed that social capital was associated with a reduced risk of hunger, even after adjusting for household socioeconomic factors [42]. A household's resilience may have been strengthened by experiences such as community gardening, belonging to informal networks, sharing knowledge, sharing food in the event of a poor harvest, or building mutual trust with neighbors (to catalyze solidarity, cooperation and coordination in the community) [43].

The high prevalence of FI in these households raises the question of meeting nutritional needs during pregnancy. Although no association was found between dietary diversity in the past 24 h and food insecurity during

Table 4 Adjusted prevalence ratios of factors associated with food insecurity during pregnancy (Multivariate model) in the NPTM study, 2023 ($n = 730$)

Factors associated with FI	Saturated Model			Parsimonious Model		
	Adjusted PR	95%CI	*p*	Adjusted PR	95%CI	*p*
Administrative status						
French citizen	1 (Ref.)			1 (Ref.)		
Foreign national with residence permit	1.3	[1.0–1.8]	0.10	1.4	[1.0–1.9]	0.03
Foreign national without residence permit	1.9	[1.3–2.9]	<0.01	1.9	[1.4–2.6]	<0.01
NK	1.2	[0.7–2.2]	0.45	1.4	[0.9–2.2]	0.09
Length of stay in French Guiana (years in tercile)						
<8.0	1 (Ref.)					
8.0–21.9	1.0	[0.7–1.3]	0.80	-	-	-
≥ 22.0	0.9	[0.6–1.2]	0.43	-	-	-
NK	0.9	[0.5–1.8]	0.87	-	-	-
Household localisation						
Urban	0.8	[0.6–1.1]	0.12	-	-	-
Rural	1 (Ref.)					
Universal health insurance						
Yes	1.0	[0.7–1.4]	0.98	-	-	-
No	1 (Ref.)					
NK	1.0	[0.5–2.0]	0.95	-	-	-
Education level						
Before high school	0.9	[0.7–1.2]	0.38	-	-	-
Over high school	1 (Ref.)					
NK	2.1	[1.1–4.0]	0.03	-	-	-
Social Support if needed						
Yes	0.7	[0.6–0.9]	<0.01	0.7	[0.6–0.9]	<0.01
No	1 (Ref.)			1 (Ref.)		
Maternal self esteem (score in tercile)						
Low (<30)	1.5	[1.2–1.9]	<0.01	1.5	[1.2–1.9]	<0.01
Medium or high (31–40)	1 (Ref.)			1 (Ref.)		
NK	1.6	[1.1–2.4]	0.02	1.3	[0.9–1.7]	0.07
Preconception BMI (kg/m^2)						
<24.9	1 (Ref.)					
25.0–29.9	0.9	[0.6–1.2]	0.38	-	-	-
≥ 30.0	1.0	[0.8–1.4]	0.72	-	-	-
NK	1.1	[0.8–1.5]	0.60	-	-	-
All-5 indicator						
Not all 5 food groups	1 (Ref.)					
All 5 food groups	0.7	[0.5–1.1]	0.1	-	-	-
NK	0.7	[0.4–1.1]	0.13	-	-	-
Single-parent family						
Yes	1.4	[1.1–1.8]	<0.01	1.4	1.1–1.7	<0.01
No	1 (Ref.)			1 (Ref.)		
NK	0.9	[0.5–1.5]	0.61	0.9	0.5–1.5	0.70
Electricity and running water at home						
Without	1.3	[1.0–1.6]	0.03	1.3	1.0–1.6	0.04
With	1 (Ref.)			1 (Ref.)		
At least 1 member with a declared source of income						
Yes	0.7	[0.5–0.9]	<0.01	0.7	0.5–0.8	<0.01
No	1 (Ref.)			1 (Ref.)		

pregnancy (with and without adjustment for other factors of interest), this study provides interesting descriptive results [44]. While most pregnant women's meals included at least one starchy food and one animal food, only one in two had eaten fruit the previous day, two in three had eaten a vegetable and one in three had eaten pulses, nuts or seeds. These findings warn on the risk of micronutrient and fiber deficiencies [45] and potential adverse effects on fetal growth [46]. Preferring cheaper but more energy-dense foods (often sweeter and fatter) may be a strategy to cope with FI and lead to overweight [47]. In this study, the consumption of sugary drinks was extremely high and the prevalence of obesity very worrying. In fact, the levels of obesity observed were closer to those in Brazil and Mexico than to those in France [48]. Pre-pregnancy obesity appeared to be more common among pregnant women in food insecure situations than among others, although this study was unable to show a significant association, possibly due to a lack of statistical power.

The study has both strengths and limitations that need to be considered. One of the limitations of the WDDS and all-5 was that they did not take into account for differences in the nutritional quality of foods within the same food group. In addition, information on portion size, frequency of consumption of food groups, and consumption of ultra-processed foods would certainly have provided a better understanding of the diet of the study population, particularly those with a high BMI. Finally, in the absence of previous data, it was not possible to determine whether household food insecurity during pregnancy was chronic or acute. However, while recent data on FI in pregnant women are scarce, especially in the post-COVID-19 period, the NPTM study provided an update on the situation of this vulnerable group in French Guiana in 2023 (prevalence, severity and description) [49]. The methodology took care to control selection bias by weighting the sample using a calibration method, and used several standardized and validated measurement tools to best describe the problem (USDA Food Security Survey Module, Rosenberg Self-Esteem Scale, WDDS, MDD and All-5 indicators, preconception BMI and GWG).

Conclusion

This study is the first in French Guiana on this topic. It responds to the call to publish more literature on FI during pregnancy in order to increase the evidence base on the subject [49]. Finally, this study confirms concerns about the extent and severity of FI during pregnancy in French Guiana. It highlights a hidden, difficult to detect and potentially harmful situation in Europe that threatens the first days of life of children in a significant proportion of the population. Raising awareness to FI is an important first step. Some of the factors associated with food insecurity during pregnancy presented in this study should allow the design of targeted and effective interventions. These could include interventions to facilitate the sharing of knowledge and strategies among groups of pregnant women, but also interventions to reduce the price of micronutrient-rich foods (such as fruits, vegetables or nuts) for vulnerable households. Following the example of the USDA's Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in the United States, French government programs could help the most vulnerable households with pregnant women access better-quality foods tailored to their needs [50]. The financial and human investment in such interventions can only be beneficial for the health and future of children [51]. Unfortunately, this situation is certainly not limited to French Guiana. It is likely that widespread but unrecognized food insecurity exists in many other areas of the world.

Abbreviations

BMI	Body mass index
FAO	Food and Agriculture Organization of the United Nations
FI	Food insecurity
GWG	Gestational weight gain
INSEE	Institut National de la Statistique et des Etudes Economiques
LICs and MICs	Low- and middle-income countries
MDD-W	Minimum Dietary Diversity for Women
MVN	Multivariate normal distribution
NPTM	Nutri Pou Ti'moun survey
USDA	Food Security Survey Module
WDDS	Women's Dietary Diversity Score

Supplementary Information

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Additional file 1.

Additional file 2.

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Authors' contributions

CB and MS designed and conducted the research. CB, MS, MN, MSG, CG, AA and EL analyzed and interpreted the data. MP, GF, NH, JDH, NC, NPTM study team were involved in participant inclusion and data collection. CB, EL, MS, MN, MSG drafted the work. All authors made intellectual contributions and read and approved the final manuscript.

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Data availability
The data sets used and/or analyzed in this study are available from the corresponding author upon reasonable request, subject to the approval of the French ethics committees.

Declarations

Ethics approval and consent to participate
All subjects and their legal representatives (if they were under 18) provided informed consent before recruitment. The study was approved by the French ethics committee ("Comité de Protection des Personnes Sud-Est 1") on 3 October 2022 (ID-RCB number: 2022-A01772-41; clinicaltrials.gov number: NCT05653128; CNIL number: 2224668). This study adheres to the ethical guidelines of the World Medical Association Declaration of Helsinki—Ethical Principles for Medical Research Involving Human Subjects.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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