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Dietary Patterns of Preschool Children (Aged 3–6) in Public Primary Schools of Avaradrano District in Antananarivo Madagascar: A Descriptive Cross-Sectional 24-Hour Dietary Recall Study

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Abstract

Background

Malnutrition remains a major public health challenge in Madagascar, affecting nearly two out of five children under five years of age. Research on child nutrition provides nationally representative data on child health, anthropometry, dietary diversity, and feeding practices. This study provides updated, quantitative assessments of total energy and nutrient intake among preschool children, with a detailed analysis of daily dietary composition. In addition, particular attention has been given to the contribution of snacks to children's daily diets.

Methods

Cross-sectional dietary data were collected from 253 children aged 3 to 6 years via the 24-hour dietary recall method. This approach allowed for the estimation of the types and quantities of foods consumed by participants during the 24 hours preceding the survey. The nutritional value of foods was estimated via data from the CIQUAL food composition table (French Agency for Food, Environmental and Occupational Health & Safety), which is supported by relevant literature. Data processing was conducted via R statistical software version 4.5.1 (2025-06-13, UCRT).

Results

The median energy intake was 1061 kcal (95% CI: 1003—1122). On average, carbohydrates provided 69% of the total energy, with protein and fat contributing 12% and 15%, respectively. The mean dietary diversity score was 4.49 ± 1.20, reflecting a high consumption of cereals and starchy foods (99.6%) and a low intake of dairy products (4.7%). Nearly all the children (98%) consumed three meals per day—breakfast, lunch, and dinner—while 2% skipped dinner. Snacking was common, with 98% of the children consuming at least one snack daily. Among those who snack, 25% did so only in the morning, whereas 4% had snacks exclusively in the afternoon.

Conclusions

Despite the consumption of meals and snacks, the nutritional and energy intake of the children aged 3–6 years remains below the recommended requirements for this age group, indicating a risk of nutrient deficiencies. Snacks play a significant role in children's diets and represent a valuable opportunity to increase the nutritional quality of their diet by contributing to energy intake and supplementing essential nutrient requirements.

INTRODUCTION

In 2025, the population of Madagascar is estimated to be more than 32 million [1]. The country is characterized by a young and rapidly growing population. The demographic structure is dominated by children and adolescents, who represent nearly 40% of the total population [2]. Children under the age of five make up approximately 15% of the population. This highlights the importance of issues related to health, nutrition, and early childhood development. One of the major challenges in child health is malnutrition. In Madagascar, it remains a serious problem and a persistent threat to children's health [3].

Chronic malnutrition develops in children exposed to recurrent and long-term nutritional deficiencies. As a result, their growth is compromised, preventing them from reaching their full potential. This results in stunted growth, characterized by insufficient weight and height for their age [4]. Chronic malnutrition affects approximately 37.8% of children under five years of age in Madagascar [5, 6]. This prevalence exceeds the 30% threshold set by the WHO and UNICEF in 2019 [7]. Acute malnutrition, on the other hand, arises from sudden and severe nutritional deficits. It leads to rapid weight loss, compromising health and increasing the risk of serious complications and even death [8]. The national average rate of acute malnutrition is 7.5%. However, there are significant regional disparities [9].

There is clear evidence that malnutrition in children results from inadequate food intake, both quantitatively and qualitatively. This explains the direct link between inadequate nutrition and malnutrition in children [10]. Within households, nutrition data reveal an insufficient, almost monotonous, and poorly varied diet. Seventy-six percent of the population does not reach the minimum calorie intake of 2133 kcal per day [11]. Under these conditions, the nutritional status of children depends largely on the food available in the home, both in terms of quantity and quality, which exposes young children to an increased risk of malnutrition and nutritional deficiencies [9].

In Madagascar, research on preschool’s children dietary intake and practices has primarily focused on global nutrition indicators to assess children’s nutritional status. The latter generally refers to anthropometric measurements such as stunting, the prevalence of specific micronutrient deficiencies and overall malnutrition rate which are often the subject of national surveys on nutrition. Real data on foods consumed, dietary diversity, meal frequency, and snack consumption among preschool-aged children remain limited. This knowledge gap represents a constraint in identifying levers for dietary improvements. It therefore highlights the need to provide updated data on the actual dietary intakes of preschool-aged children in Madagascar.

The early childhood period is crucial for physical and cognitive development. Nutritional deficiencies have lasting consequences for health, growth, and school performance [12]. This study aims to better understand children's eating habits, particularly the foods they consume and the composition of their daily meals. The main objective was to characterize what children consume each day, identify the number of meals and snacks eaten daily, and determine the composition and diversity of their food intake. This approach highlights not only caloric and nutrient intake but also local eating practices. A survey was conducted to identify the foods consumed and analyse the composition of children's daily food intake.

METHODS

The study population consisted of 253 children aged 3 to 6 years. The study has taken into account the ethical principles for research involving human participants. The children's parents were informed in advance about the objectives and procedures of the study. Prior to the data collection, their free and informed consent was obtained.

To select the participants, a simple random sampling method was used. The sample size was determined using Cochran's formula adapted for finite populations, considering a 95% confidence level and a 6% margin of error. The recruited children were preschool-aged pupils enrolled in public primary schools (EPP). The selection of schools was conducted using a purposive sampling based on predefined criteria. Among them, the presence of preschool classes was required, the availability and willingness of the school administrator to let the study be conducted there, and fieldwork logistical constraints. The needed sample was achieved through recruitment formed by nine EPPs in the district of Avaradrano. The parents of pupils are reliable sources of information on their children's diet [13]. They were invited to individual interviews. The interviews were conducted via a face—to—face questionnaire. They provided details of all the food and drink consumed by their children on the day before the survey. The surveys were conducted in schools.

Investigators were trained to collect dietary data via the 24-hour dietary recall tool. This tool provides an accurate description of the foods consumed and the quantities ingested during the 24 hours preceding the survey, thus providing a reliable estimate of recent dietary intake [13]. This method is widely used in nutritional epidemiology [14, 15]. Nevertheless, the 24-hour food recall only provides estimate of the recent dietary consumption. Children's food consumption patterns cannot be precisely captured from it. interviewer collects data on the foods consumed by the child, as well as the corresponding quantities, during their different meals (breakfast, lunch, dinner, and snacks). The parents reported the child's food consumption for the entire day preceding the survey. To limit bias due to forgetfulness, the recall covers the day immediately preceding the survey. The interviewer also verified that it was a normal day for the child, excluding holidays or other special occasions.

Parents report the quantities consumed by their children using previously identified household utensils. Questions about the quantity and volume consumed are asked for each food item to reduce possible errors in portion sizes [16]. Other types of food were counted by the number of items, for example, fruit and eggs. Purchased snacks were described by their packaging and price to determine their equivalence on the market and to determine their characteristics. The quantities expressed were subsequently converted into grams [17].

The nutritional value of the foods consumed was estimated via the CIQUAL nutritional composition table developed by the French Agency for Food, Environmental and Occupational Health & Safety (ANSES) [18]. It provides value for energy, macronutrients (proteins, lipids, carbohydrates), vitamins, and minerals for several thousand foods. The data are in g/100 g and can be related to the quantities collected. In CIQUAL, foods are representative of French consumption. The conversion of foods consumed into

nutritional intakes via the CIQUAL table was used in a study on food purchases at home in France [19]. The calculation takes this context into account. The use of the CIQUAL database was based on its content of diversified food list but also by the inexistence of a national database which contains the composition of Malagasy foods. Furthermore, CIQUAL has the advantage to be an open and free online resource. To ensure the reliability of the data, comparisons were made via bibliography. For typical Malagasy foods and cooked dishes, the calculation was performed by summing the constituent ingredients.

The energy value of foods is calculated via the Atwater formula: Energy (kcal) = (Protein (g) × 4) + (Carbohydrates (g) × 4) + (Lipids (g) × 9). Energy intake was calculated on the basis of the quantities of food reported in the 24-hour dietary recall and then aggregated by individual. Quantitative variables were described using the mean and standard deviation when their distribution was approximately normal. The means are also presented with their 95% confidence intervals to assess the accuracy of the estimates.

The foods consumed were classified into ten food groups to calculate the dietary diversity score. The food groups are: cereals and starchy foods, sweets and beverages, vegetables, meat and eggs, legumes and seeds, tuber, fish and seafood, fruit, oils and fats, milk and dairy products. The score ranges from 0 to 10. This score corresponds to the simple count of food groups consumed by the individual during the day preceding the survey [20]. The definition of food groups was established taking into account the context of the study. The groups proposed in the FAO guide were used as a reference for the categorization of foods consumed [21]. The methodological process followed in this study is illustrated in Fig. 1.

RESULTS

The population consisted of 253 children divided into four age groups. As shown in Table 1, five-year-olds were the majority, followed by six-year-olds, four-year-olds, and finally three-year-olds. The proportions of boys and girls in the sample were similar, with 48% boys and 52% girls.

Table 1
Demographic characteristics of the study population

AGE	n	%	% Boys	% Girls
3	10	4%	2%	2%
4	58	23%	11%	12%
5	118	47%	21%	25%
6	67	26%	14%	13%
Total	**253**	**100%**	**48%**	**52%**

The average energy intake is 1102 kcal/day (95% CI: 1063—1141). The median energy intake is 1061 kcal (95% CI = 1003–1122). The diet consisted of approximately 11% protein, 14% fat, and 72% carbohydrates. Energy and nutrient intake indicators are presented in Table 2.

The diet is based mainly on rice, which is the main dish at every meal. The high consumption of cereals and starchy, especially rice, represents a key finding and a fundamental characteristic of the Malagasy diet. The food consumption majority of the population highly depends on rice. The latter serves as the primary source of energy intake. Diverse food, including meat, eggs, fish, and vegetables, is provided in side dishes. Rice is eaten at least twice a day, at lunch and dinner. At breakfast, it is often replaced by bread and tea. Snacks mainly include doughnuts (mofogasy, mofobaolina), cookies, and wafers, as well as fried wheat flour snacks and pasta. This dietary structure centered on carbohydrates indicates a low food diversity which can lead to lack of micronutrients.

Table 2
Energy and nutrient intake indicators

Nutrients	Indicators	Reference Values
Energy	kcal/day (Mean ± Standard Deviation)	1102 ± 315
	kcal/day (Median ± Standard Deviation)	1061 ± 314
Protein	Average protein intake (g/day)	31 ± 20
	% energy from protein	11
Lipids	Average lipid intake (g/day)	17 ± 12
	% of energy from lipids	14
Carbohydrates	Average carbohydrate intake (g/day)	195 ± 57
	% of energy from carbohydrates	71

Almost all the children ate three meals a day (98%), with a small proportion (2%) not eating in the evening (dinner). Snacking is a common practice in the morning and afternoon.

The dietary diversity score reveals the nutritional quality of the diet [22]. The observed score was 4.5 out of 10, indicating moderate dietary diversity. As illustrated in Fig. 2, the most frequently consumed food groups are cereals and starchy foods, which form the basis of the diet. They occupy a majority position, mainly through the consumption of rice, bread, doughnuts, and pasta. Sweets and beverages come next, linked to the frequent consumption of tea and biscuits. Vegetables also play an important role in dishes accompanying rice, as do meat and eggs. The different source of proteins found in the list of food consumed by the participants includes: zebu meat (in the format of meatballs and minced meat), pork meat (sausages), chicken meat, eggs and fishery products such as dried fish and crayfish. Goat meat was mentioned only once. The consumption of legumes and seeds has also been reported, although it remains less common. Overall, this dietary profile highlights a predominance of energy-dense foods,

combined with a partial diversification of protein and vegetable sources. Dairy product consumption was very low, and when consumed, it consisted primarily of yogurt and milk. The distribution of participants by food group consumption and dietary diversity score is presented in Table 3.

Table 3
Participant percentage by food group and dietary diversity score

Foods groups	Food Included	Percentage (%)
Cereals and starchy foods	Rice, corn, and food made from cereals (bread, pasta, noodles, or others) – mofogasy, ramanonaka, menakely, mofobaolina doughnuts	99.6
Sweets and beverages	Candy, chocolate, cookies, wafers, pastries (madeleines, cakes, ice cream), sweet tea, sweet coffee, soft drinks	90.5
Vegetables	All types of vegetables: carrot, cucumber, pumpkin, squash, green bean, leafy vegetables, sweet potato leaves, cassava leaf, greens, watercress	79.4
Meat and eggs	Beef, pork, goat, chicken, offal (guts, liver)	39.9
Legumes and seeds	Beans, peas, amber peas, pigeon peas, black eyed peas, fresh or dried soybeans and their derived products Peanuts	35.2
Tuber	Potato, cassava, sweet potatoes	30.8
Fish and seafood	Fresh or dried fish, crayfish, bichique	24.1
Fruit	All types of fruit: banana, mango, orange, medlar	22.1
Oils and fats	Margarine	22.1
Milk and dairy products	Milk, yogurt	4.7
DDS (±SD Mean)		**4.49 ± 1.20**

DISCUSSION

Nutritional references vary depending on the author, country, and time. The terminology used depends on each country [23]. It is also necessary to know nutritional requirements on the basis of sex and age group [24]. In our context, the recommended dietary intake (RDI) was chosen to take into account dietary habits and the specificities of the African context [25]. Thus, for energy intake, the recommendation of 1300 kcal/day is taken as a reference because it corresponds to the limiting factor for 3-year-old children [26]. Under these conditions, only a quarter (26%) of the children surveyed meet this requirement. Energy and nutrient intake values compared with RDI references are presented in Table 4.

Current recommendations advocate a balanced distribution of total energy intake, with approximately 50% of energy derived from carbohydrates, 30–40% from fat, and 10% from protein [27]. Carbohydrates are largely predominant in meals, accounting for 71% of total energy intake. Conversely, fats contribute only 14%, or approximately half of the recommended intake, whereas protein intake is more or less in line with recommendations. This distribution reflects an imbalance in macronutrients, marked by an overconsumption of carbohydrates at the expense of fats, which are essential for children's growth and development. A healthy diet requires adequate energy and nutrient intake. This is necessary for children's physical, cognitive, and mental development and for their long-term health [28].

In terms of the number of meals per day, the WHO recommends that children aged 2 to 5 eat five times a day, with three meals and two nutritious snacks per day [29]. This recommendation was largely satisfactory, as the majority of participants consumed three meals and at least one to two snacks per day.

Children’s meals are characterized by a high carbohydrate density and are derived mainly from cereals and starchy foods, which primarily serve to promote satiety. These widely available and culturally embedded foods provide immediate energy at a relatively low cost, making them practical dietary staples in this context. On the other hand, this predominance of carbohydrates is accompanied by an insufficient intake of protein and fat. Protein-rich foods, which are often more expensive or less accessible, are consumed in limited quantities. Dietary fats are infrequently included in meals; when present, they are most commonly derived from margarine, which is typically used as a spread on bread at breakfast or during snacks. However, adequate fat intake is crucial in childhood, particularly for growth, energy density, and the absorption of fat-soluble vitamins [30]. This unbalanced distribution of macronutrients may therefore compromise the overall nutritional quality of the diet, particularly for children's growth, muscle development, and proper immune system function. A healthy diet is achieved through a variety of foods, including fruits, vegetables, legumes, whole grains, and lean protein sources [31].

The results of this study are in accordance with the national report from the National Micronutrient Deficiency Survey (ENCM) conducted in Madagascar. This survey provides an in-depth assessment of the nutritional status of the Malagasy population [5]. The high consumption of rice was reported among 98% of the surveyed households. The quantities consumed were particularly high. The median daily rice consumption for children aged 2 to 5 years old was estimated at 155 g/jour (IC 95%: 127–182 g). The national survey also highlighted the high consumption of sweet food items among children which is consistent with our findings. Concerning the dietary diversity, an adequate dietary diversity score was observed in only approximately 20–25% of the target populations included in the ENCM. These findings indicate relatively low dietary diversity. The present study observed that milk and dairy products ranked last among the food groups consumed by children. This observation is in line with the prevalence of calcium deficiency affecting more than 90% of the population, as reported by the ENCM.

Table 4
Energy and nutrient intake, indicators, and RDI references

Nutrients	Indicators	Reference Values	RDI	% above RDI
Energy	kcal/day (Mean ± Standard Deviation)	1102±315	1300	26%
	kcal/day (Median ± Standard Deviation)	1061±314		
Protein	Average protein intake (g/day)	31 ± 20	46–50	16%
	% energy from protein	11	10–20	
Lipids	Average lipid intake (g/day)	17 ± 12	30–40	11%
	% of energy from lipids	14	30–35	
Carbohydrates	Average carbohydrate intake (g/day)	195 ± 57	100–185	2% less than 100 56% between 100 and 200 42% more than 200
	% of energy from carbohydrates	71	50–55	

LIMITATIONS OF THE STUDY

The study was conducted during a specific period of the year and is based on a cross-sectional design. This type of survey provides a snapshot of the food situation at a given moment but does not consider seasonal variations that may influence food availability and consumption habits [32]. The survey was carried out during a period of food availability, outside the lean season. The observed dietary intake therefore reflects a situation of relative food abundance. Conducting the survey at several times of the year would make it possible to analyse the impact of the seasons on diet, particularly in terms of dietary diversity, frequency of consumption of certain food groups, and nutritional intake. Taking one day to record food intake provides only a partial view of participants' usual dietary intake [33]. For a more complete and representative view, a repeated or longitudinal approach would provide information on children's dietary practices throughout the year. Furthermore, the possibility of conducting an in-depth analysis is been limited by the cross-sectional design of the study. It also restricts from exploring temporal relationship and establishing causal inferences.

The geographical scope of the study limits the representativeness of the findings, as nine EPPs were selected, located within a single district in the country. Therefore, the conclusions drawn cannot be applied to all preschool-aged children in Madagascar.

The reliance on the CIQUAL food composition database also represents another potential limitation of the study. Indeed, this database represents its specific context and does not provide and exhaustive list of all the foods consumed by the participants. Estimation bias may exist for certain foods and traditional

dishes commonly consumed in Madagascar. Although it is a valuable tool providing data for individual ingredients, composite dishes are generally estimated through recipe reconstruction based on the contribution of each ingredient. This highlights the need for a database of standardized local recipes, particularly for cooked dishes [16].

The study of micronutrients has proven more difficult to carry out due to the limitations of the available resources, both in terms of data from the literature and the CIQUAL database. These constraints limit access to detailed information adapted to the local context, making accurate assessment of micronutrient intake more complex.

CONCLUSION

This study provides a better understanding of the daily dietary habits of preschool children in the Avaradrano district. This highlights what they actually consume, as well as the quality and quantity of their dietary intake. These observations are important since nutrition is largely shaped by everyday eating habits. Only a quarter of the study population met the recommended energy intake of 1300 kcal per day. Their diets were dominated by cereals and starchy foods. The children consumed three meals per day, with at least one snack consumed daily. Given the important role of snacks, improving their nutritional quality represents an appropriate strategy to increase the overall nutritional quality of their diet.

Abbreviations

ANSES: Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail (French Agency for Food, Environmental and Occupational Health & Safety)

CIQUAL: Centre d'Information sur la Qualité des Aliments (French Food Composition Database)

DDS: Dietary Diversity Score

EPP: École Primaire Publique (Public Primary School)

FAO: Food and Agriculture Organization of the United Nations

RDI: Recommended Dietary Intake

SD: Standard Deviation

UNICEF: United Nations Children's Fund

WHO: World Health Organization

Declarations

Ethics approval and consent to participate: The research protocol was approved by the internal Ethics Committee of the Doctoral School of Process Engineering and Agricultural and Food Industrial Systems, University of Antananarivo. Administrative approval for the study was obtained from the head of each participating primary school. Participation was entirely voluntary, and verbal informed consent was obtained from the parents of all participating children prior to data collection. To ensure participant privacy, all data were anonymized and the identities of parents and children were kept strictly confidential. As a token of appreciation for their time, parents were provided with a ballpoint pen upon completion of the interview.

Consent for publication: Not applicable.

Availability of data and materials: Data are contained within the article. The datasets supporting the conclusions of this article are included within the article. The raw individual-level dietary recall data are not publicly available but anonymized data may be made available by the corresponding author upon reasonable request.

Competing interests: The authors declare no conflicts of interest.

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Authors' contributions: M.N.R. conceived and designed the study; conducted the study and wrote the paper. G.R. and F.H.R. verified the accuracy of the nutritional intake calculation; critically reviewed the paper. All authors have read and agreed to the published version of the manuscript.

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Figures

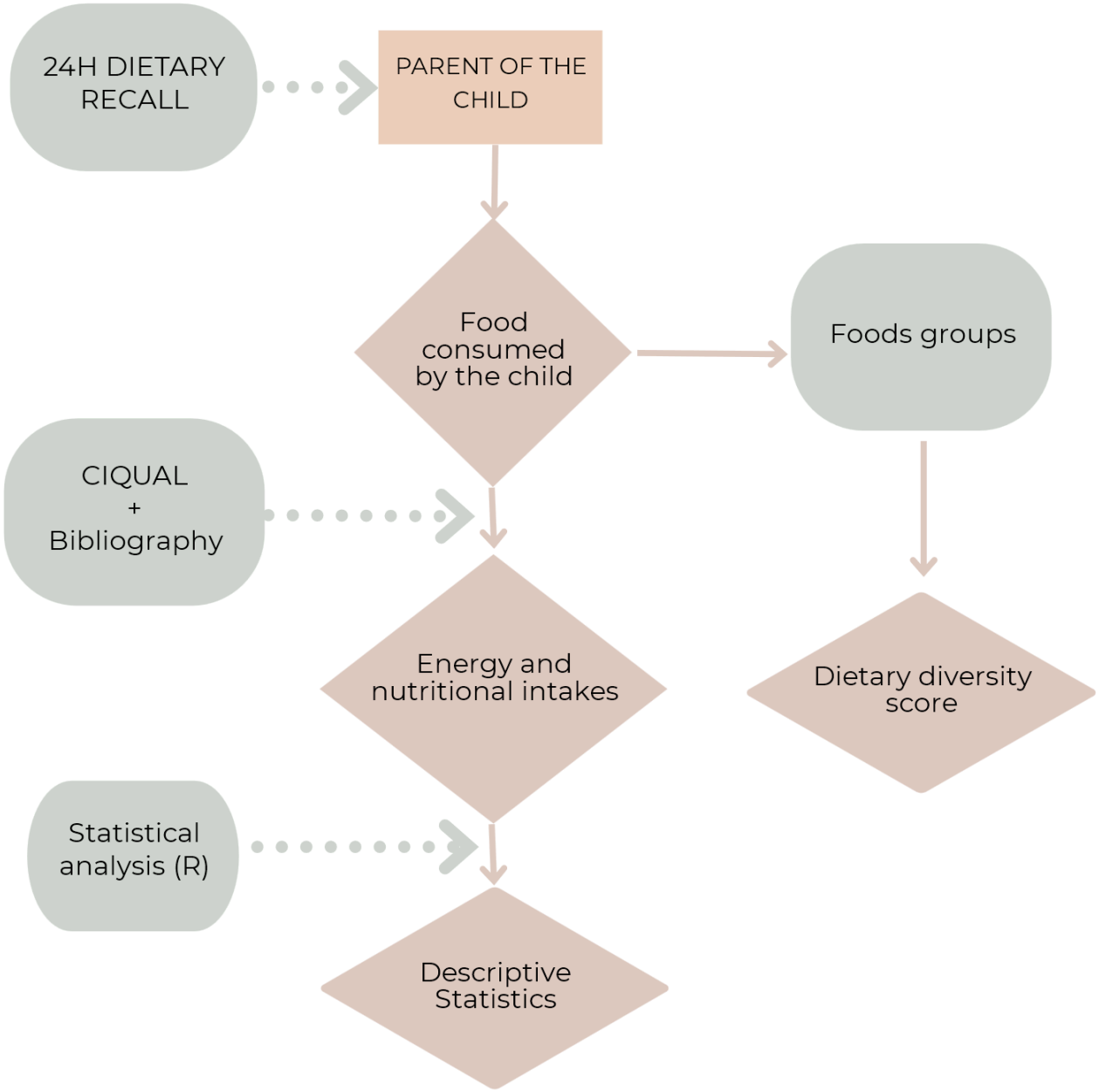


Figure 1

Methodology Flowchart

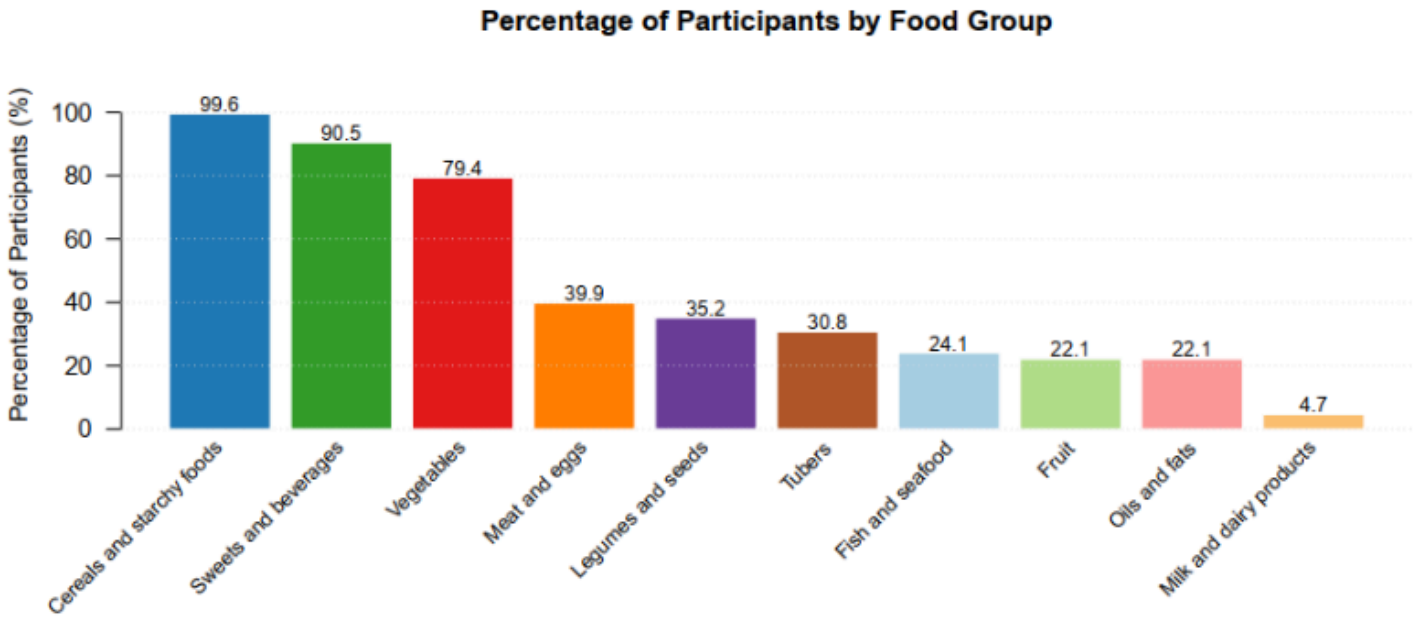


Figure 2

Percentages of participants by food group