

NUTRITIONAL PROFILING OF SCHOOL MEAL FOODS SERVED
IN SCHOOL CANTEENS FROM PRIMARY SCHOOLS OF URBAN
AND RURAL AREAS IN KELANTAN

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AND RURAL AREAS IN KELANTAN

by

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Dissertation submitted in partial fulfilment of the requirements for the
degree of Bachelor of Health Sciences (Honours) (Nutrition)

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CERTIFICATE

This is to certify that the dissertation entitled “Nutritional Profiling of School Meal Foods Served in School Canteens from Primary Schools of Urban and Rural Areas In Kelantan” for the Degree of Bachelor of Health Sciences (Honours) (Nutrition) is the bona fide record of research work done by “Nur Aina Nasuha Binti Che Hamid”, Matric Number 164301, from April 2025 to January 2026 under my supervision. I have read this dissertation, and in my opinion, it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfillment of the requirements for the degree of Bachelor of Health Sciences (Honours) (Nutrition). Research work and data collection belong to Universiti Sains Malaysia.

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DECLARATION PAGE

I hereby declare that this dissertation is the result of my own investigations, except where otherwise stated and duly acknowledged. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or at any other institution. I grant Universiti Sains Malaysia the right to use the dissertation for teaching, research, and promotional purposes.

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Date:

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**Profil Pemakanan Makanan Hidangan Sekolah yang Disajikan di Kantin
Sekolah Rendah di Kawasan Bandar dan Luar Bandar di Kelantan**

ABSTRAK

Latar Belakang: Kantin sekolah di Malaysia menyumbang sebahagian besar keperluan tenaga harian kanak-kanak sekolah rendah, namun kualiti pemakanan yang ditawarkan sering dikaitkan dengan kekurangan nutrien perlindungan seperti kalsium, vitamin C dan serat. Kajian ini bertujuan untuk memprofilkan kandungan nutrien makanan kantin sekolah rendah di Kelantan serta membandingkan perbezaan antara kawasan bandar dan luar bandar. **Bahan dan Kaedah:** Kajian keratan rentas ini melibatkan analisis 145 item makanan kantin daripada enam sekolah rendah awam di Kelantan (tiga bandar di Kota Bharu dan tiga luar bandar di Bachok). Komposisi nutrien dianalisis menggunakan perisian Nutritionist Pro™ berdasarkan Pangkalan Data Komposisi Makanan Malaysia (MyFCD 2020). Perbandingan statistik antara kumpulan bandar dan luar bandar dilakukan menggunakan ujian Mann-Whitney U dengan aras signifikan $p < 0.05$. **Keputusan:** Makanan kantin bandar menunjukkan kandungan tenaga yang lebih tinggi secara signifikan berbanding luar bandar (289 kcal vs 266 kcal, $p = 0.035$). Walau bagaimanapun, kedua-dua persekitaran menunjukkan sumbangan yang rendah terhadap kalsium (72 mg; 5% RNI), vitamin C (10 mg; 4% RNI) dan serat (1 g; 2% RNI). Sumbangan protein adalah memadai (36% RNI), manakala kandungan natrium melebihi 30% daripada had pengambilan harian yang disyorkan. **Kesimpulan:** Walaupun makanan kantin sekolah di Kelantan memenuhi keperluan protein, kekurangan nutrien perlindungan kekal sebagai isu utama. Penemuan ini menekankan keperluan penambahbaikan kualiti pemakanan dalam persekitaran kantin sekolah bagi menyokong kesihatan kanak-kanak.

NUTRITIONAL PROFILING OF SCHOOL MEAL FOODS SERVED IN SCHOOL CANTEENS FROM PRIMARY SCHOOLS OF URBAN AND RURAL AREAS IN KELANTAN

ABSTRACT

Background: Malaysian school canteens contribute a substantial proportion of daily energy intake among primary schoolchildren; however, the nutritional quality of foods offered is frequently associated with inadequate intake of protective nutrients such as calcium, vitamin C, and dietary fibre. This study aimed to profile the nutrient composition of primary school canteen foods in Kelantan and to compare differences between urban and rural settings. **Materials and Methods:** A cross-sectional study was conducted involving 145 food items obtained from six public primary school canteens in Kelantan (three urban schools in Kota Bharu and three rural schools in Bachok). Nutrient composition was analysed using Nutritionist Pro™ software based on the Malaysian Food Composition Database (MyFCD, 2020). Urban–rural comparisons were performed using the Mann-Whitney U test with a significance level of $p < 0.05$. **Results:** Urban canteen foods contained significantly more energy per serving than rural foods (289 kcal vs 266 kcal, $p = 0.035$). Nevertheless, foods from both settings showed consistently low contributions to calcium (72 mg; 5% RNI), vitamin C (10 mg; 4% RNI), and dietary fibre (1 g; 2% RNI). Protein contribution was adequate (36% RNI), while sodium content exceeded 30% of the recommended daily limit. **Conclusion:** Although school canteen foods in Kelantan provide sufficient protein, deficiencies in key protective nutrients remain evident. These findings highlight the need to improve the nutritional quality of school canteen offerings to better support children's health.

CHAPTER ONE

INTRODUCTION

1.1 Overview of the Study

Primary school years represent a critical developmental window for children's physical growth, cognitive development, and establishment of lifelong dietary habits. Adequate nutrient intake during ages 7-12 supports essential physiological demands, including skeletal maturation, neural myelination, and immunological competence. In Malaysia, school canteens are an important food source for primary school children during the school day, as many students regularly consume the foods and beverages provided there. Consequently, the nutritional quality of foods available in school canteens significantly shapes children's overall dietary intake during school hours. Studies evaluating the nutritional composition of foods sold in Malaysian primary school canteens indicate a continued prevalence of energy-dense, nutrient-poor items such as fried snacks, sugar-sweetened beverages, and processed meat products, despite the existence of national school canteen nutrition guidelines (Foo & Tan, 2021).

Nutrient-dense foods delivering calcium (>200mg/meal), iron (>2.5mg/meal), vitamin C (>15mg/meal), and dietary fiber (>3g/meal) remain essential for preventing documented deficits in cognitive performance, immune function, and linear growth among Malaysian schoolchildren (Malaysian Dietary Guidelines, 2020). National nutrition policies recognise that school food environments are shaped by contextual factors such as infrastructure, resource availability, and community characteristics, which may contribute to variation in food offerings across different settings (Ministry of Health Malaysia, 2016; Ministry of Health Malaysia, 2020).

The escalating double burden of malnutrition, characterized by concurrent undernutrition (38% anemia prevalence) and overweight (15% prevalence) among Malaysian primary schoolchildren, underscores urgent requirements for location-specific nutritional profiling (National Plan of Action for Nutrition of Malaysia III, 2016-2025). This study aims to contribute Kelantan-specific data through the nutritional analysis of 145 canteen food items collected from six primary schools (three urban schools in Kota Bharu and three rural schools in Bachok). Nutrient analysis was conducted using Nutritionist Pro software, with reference to the Malaysian Food Composition Database to enhance the relevance of nutrient estimation for local foods (Ministry of Health Malaysia, n.d.). Findings will quantify urban-rural compositional differences, evaluate the contributions of the Recommended Nutrient Intake (RNI), and generate actionable recommendations to support NPANM III school meal quality targets (30-50% daily energy, >15% micronutrient requirements).

1.2 Problem Statement

School canteens in Malaysia contribute substantially to the daily food intake of primary school children during school hours, making them an important component of the overall dietary environment. Consequently, the types and nutritional quality of foods offered in school canteens can influence children's dietary patterns and long-term health outcomes. National nutrition policies emphasise the role of healthy school food environments in supporting optimal growth and development among school-aged children (Ministry of Health Malaysia, 2020; Ministry of Health Malaysia, 2016). Although Healthy School Canteen Guidelines in Malaysia outline restrictions on the sale of sugar-sweetened beverages and high-fat or high-sodium foods, studies have

reported that many food items sold in school canteens remain inconsistent with recommended nutritional standards (Foo & Tan, 2021).

Kelantan exhibits acute vulnerabilities amplifying national patterns: 42% childhood stunting prevalence (highest nationally), 28% anemia rates, and emerging overweight and obesity pattern (12%) occurring alongside East Coast socioeconomic constraints, including 22% household food insecurity and limited nutrition education infrastructure (National Plan of Action for Nutrition III, 2016-2025). Urban-rural canteen disparities remain unquantified locally, despite documented commercial advantages in Kota Bharu versus Bachok's agricultural isolation, which influence menu composition, preparation methods, and nutrient density.

Current evidence gaps prevent targeted interventions like there is no Kelantan-specific studies quantify macronutrient (energy, CHO, protein, fat, fiber) or micronutrient (calcium, iron, sodium, vitamin C) profiles across representative canteen repertoires; urban-rural statistical comparisons remain absent; RNI contribution analyses against Malaysian pediatric standards (1,600-2,000kcal energy, 1,400mg calcium, 45mg vitamin C daily) unconduted. This knowledge deficit impedes the enforcement of traffic-light nutrition labelling, subsidized produce programs, and operator certification, essential mechanisms for achieving NPANM III 2025 targets, which aim to reduce malnutrition by 20%.

Systematic nutritional profiling of urban versus rural Kelantan primary school canteens, therefore, constitutes an urgent research priority enabling evidence-based

policy formulation, equitable resource allocation, and mitigation of diet-related developmental impairments among 85,000 Kelantan primary school children.

1.3 Research Question

1.3.1 What are the nutritional contents (energy, macronutrients and micronutrients) of canteen foods sold in primary schools at urban and rural school in Kelantan?

1.3.2 Are there significant differences in the nutritional composition of canteen foods between urban and rural schools?

1.3.3 Are the foods sold in these canteens meet a substantial proportion of the Recommended Nutrient Intakes (RNI) for primary school-aged?

1.4 Research Objectives

1.4.1 General objectives

To compare the nutritional content in foods sold in primary school canteen at urban and rural schools in Kelantan.

1.4.2 Specific objectives

- i) To assess the energy, macronutrients and micronutrients of canteen foods sold in primary schools at urban and rural school in Kelantan.
- ii) To compare the nutritional composition of canteen foods between urban and rural schools.

- iii) To evaluate foods sold in these canteens if meet a substantial proportion of the Recommended Nutrient Intakes (RNI) for primary school-aged.

1.5 Research Hypotheses

1.5.1 Null Hypothesis (H₀):

There is no significant difference of nutritional content between foods sold in primary school canteen in urban and rural districts of Kelantan.

1.6 Conceptual Framework

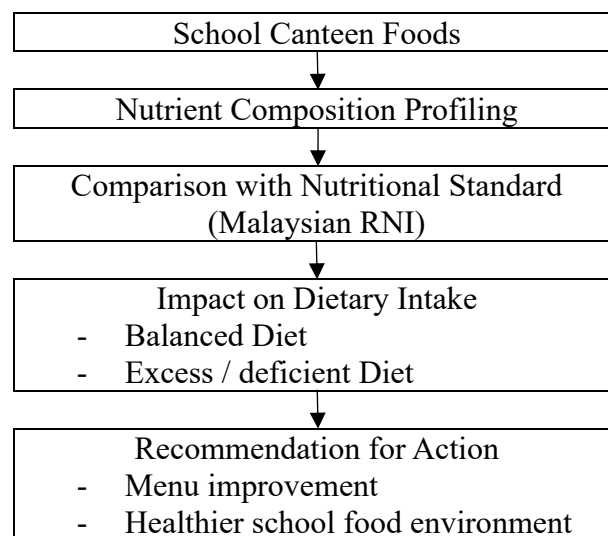


Figure 1.1: Conceptual Framework of Study

Primary school canteens serve as the central starting point for this research framework, where 145 distinct food items collected from six Kelantan schools are subjected to systematic nutritional evaluation. The study begins with comprehensive nutrient

composition profiling conducted through recipe reconstruction methodology, capturing precise macronutrient content, including energy, carbohydrates, proteins, fats, and dietary fiber, alongside critical micronutrients such as calcium, iron, sodium, and vitamin C concentrations per typical serving portion. These detailed nutritional profiles form the analytical foundation enabling direct comparison against established Malaysian Recommended Nutrient Intake standards, specifically calibrated for children aged 7-9 years, who require 1,600-2,000 kcal daily energy, 1,400 mg calcium for skeletal development, and 45 mg vitamin C for immune function.

This benchmarking process reveals the actual contribution of school canteen foods toward meeting national paediatric nutrition requirements, identifying both nutritional successes and critical deficiencies that shape children's overall dietary patterns during school hours. When canteen offerings provide substantial proportions of required nutrients, particularly protein for growth and development, they support balanced dietary intake, which is essential for optimal physical and cognitive performance among primary schoolchildren. Conversely, persistent shortfalls in protective micronutrients, including calcium for bone mineralization, vitamin C for immune competence, and fiber for digestive health, alongside excessive sodium intake, may increase the risk of diet-related chronic conditions such as childhood obesity and hypertension, thereby compromising children's immediate and longer-term health outcomes.

The framework culminates in evidence-based recommendations targeting two principal intervention domains. Menu improvement strategies focus on practical modifications achievable by canteen operators, including the implementation of traffic-light nutrition labelling systems, the mandatory inclusion of one fruit serving and 30 grams of vegetables per daily offering, and the substitution of monosodium glutamate with natural flavour enhancers to reduce sodium concentrations below 400 mg per portion. Broader environmental interventions address systemic barriers through subsidized yogurt drink programs delivering 200 mg of calcium per serving, mandatory operator certification training emphasizing portion control and fresh produce handling, and quarterly sodium content audits to ensure sustained compliance with Ministry of Health school food quality standards.

This sequential pathway directly addresses all three specific research objectives: comprehensive nutrient profiling achieved through Nutritionist Pro analysis, statistical urban-rural comparisons confirming an 8.6% energy disparity between Kota Bharu and Bachok canteens, and a systematic evaluation documenting protein adequacy alongside a micronutrient catastrophe. The conceptual model provides theoretical coherence, linking observed canteen food characteristics through validated analytical processes to measurable impacts on children's nutritional status, ultimately generating actionable strategies that position school meals as public health assets rather than liabilities within Kelantan's primary education system.

1.7 Significance of the Study

This research delivers substantial value across multiple domains essential for improving child nutrition within Kelantan's educational system. At the policy level, the study provides the first comprehensive nutrient analysis specific to Kelantan school canteens, establishing concrete measurements against national nutrition targets that will strengthen guideline implementation, facilitate the introduction of color-coded nutrition labelling, and justify subsidized fresh produce initiatives reaching 85,000 primary schoolchildren across the state. From a scientific perspective, the statistical comparisons between urban and rural canteen foods fill a critical regional knowledge gap dominated by research from Peninsular Malaysia's west coast, offering new evidence that challenges traditional assumptions about nutritional differences between city and countryside school environments.

The findings translate directly into practical applications for canteen management, providing specific performance targets such as maintaining sodium below 400 milligrams per serving and achieving calcium levels above 100 milligrams per portion, which support structured training programs and systematic menu modifications across all 450 primary schools in Kelantan. Most importantly, the documented failure of current canteen foods to meet minimum nutritional requirements which particularly the critically low contributions toward calcium and fiber needs and creates clear evidence connecting school meal quality to the state's high rates of growth stunting and excess weight among children, laying the foundation for ongoing health monitoring and targeted intervention strategies that promise measurable improvements in student well-being and academic readiness.

CHAPTER TWO

LITERATURE REVIEW

2.1 Nutritional Importance of School Meals During Primary Years

Primary school represents a critical developmental window when children experience accelerated physical growth, requiring 1,600-2,000 kcal daily, alongside essential micronutrients to support skeletal development, cognitive maturation, and immune system competence. Institutional food programs consistently contribute 35-50% of total daily energy needs during 6-8 hours of school attendance, positioning canteens as primary nutritional safety nets rather than supplementary sources during peak growth vulnerability. A nationally representative study conducted in Sweden demonstrated that school-provided lunches contribute substantially to children's overall dietary intake, particularly for foods that are less frequently consumed outside the school setting, such as vegetables and fish. Compared with meals consumed outside school, school lunches provided a higher proportion of daily vegetable and fish intake, highlighting the importance of structured school meal programmes in supporting dietary quality among primary school children (Colombo et al., 2020).

Malaysian schoolchildren exhibit parallel patterns in which institutional environments serve as the principal sources of vegetables, lean protein, and dietary fiber essential for digestive health, with systematic consumption analysis confirming that school canteen utilization correlates with substantially higher nutrient intake compared to home-prepared alternatives constrained by time limitations and economic pressures. Evidence from European comparative studies indicates that school meal programmes serve as an important resource for low-income families by reducing food-related

financial pressures and supporting more equitable access to meals across socioeconomic groups (O’Connell et al., 2022). These findings highlight the potential role of subsidised school feeding programmes in mitigating the effects of household food insecurity. In Malaysia, where food insecurity remains a concern among lower-income households, school feeding initiatives may similarly play a supportive role in improving access to regular meals among school-aged children.

A systematic review has identified several practical strategies that may improve school meal consumption, including increasing menu variety, offering foods that align with students’ cultural preferences, and allowing sufficient time for meal consumption. These approaches have been associated with improved participation and intake among primary school children (Cohen et al., 2021). These evidence-based approaches establish clear implementation pathways to ensure that nutrient-dense canteen offerings within the Kelantan context achieve the intended population-level nutritional impact during children’s most critical developmental period.

2.2 Nutritional Quality of School Canteen Foods in Malaysia

2.2.1 Dominance of energy-dense, nutrient-poor profiles

An assessment of 568 food items sold in Malaysian primary school canteens demonstrated that grain-based foods and beverages constituted the largest proportion of available items, while fruits and vegetables were minimally represented, indicating limited availability of nutrient-dense options (Foo & Tan, 2021). This established distribution pattern positioned 32% of available foods beyond acceptable free sugar contribution thresholds, exceeding 10% of total energy intake. Such findings highlight school food environments as key contributors to excess caloric intake during critical childhood periods, when repeated dietary exposures may influence long-term metabolic health patterns.

International evidence indicates that commercially prepared fast-food meals marketed to children are substantially higher in energy, total fat, and sodium compared with recommended dietary standards for school-aged populations (Lucio et al., 2020). Such findings raise concerns that frequent exposure to energy-dense, highly processed foods within food-access environments may contribute to unhealthy dietary patterns during childhood. In the Malaysian context, the widespread availability of deep-fried snack items in school canteens, such as fritters and fried noodles, may similarly increase students' exposure to high-energy foods, highlighting the importance of regulating institutional food environments.

2.2.2 Intervention efficacy evidence

Evidence from recent systematic reviews indicates that interventions targeting the school food environment can produce meaningful improvements in children's dietary behaviours and nutritional outcomes. Environmental strategies such as the introduction of nutrition standards, modification of food availability, and restriction of unhealthy food options have been shown to increase fruit and vegetable intake while reducing the purchase and consumption of energy-dense, nutrient-poor foods among school-aged children (Durão et al., 2023).

However, the effectiveness of these interventions is highly dependent on the strength of policy implementation. A recent systematic review across European and Western Pacific countries reported that school food policies achieved greater nutritional impact when supported by clear enforcement mechanisms, adequate resources, and regular monitoring, whereas weak or voluntary implementation limited their effectiveness (Matela & Yadav, 2024).

Collectively, these findings demonstrate that improvements to the school food environment are feasible and effective when environmental modifications are paired with strong policy execution. Such evidence provides an important foundation for adapting similar school-based nutrition strategies within Malaysian institutional settings, where food quality challenges in school canteens remain prevalent.

2.2.3 Double burden implications

Evidence from Malaysian adolescent populations suggests that frequent consumption of energy-dense snack foods, including deep-fried items, is associated with higher body mass index and increased prevalence of overweight and obesity among regular consumers (Vaidehi et al., 2020). At the same time, the study reported notable inadequacies in key micronutrients such as iron and calcium, reflecting the coexistence of overnutrition and micronutrient deficiency within the same population. These findings illustrate Malaysia's emerging double burden of malnutrition, in which excessive energy intake coexists with insufficient micronutrient intake, underscoring the need for balanced nutrition interventions in school food environments.

2.3 Socioeconomic Disparities in School Food Availability and Nutrition

2.3.1 Policy implementation barriers

The implementation of school nutrition policies has been shown to be more challenging in economically disadvantaged school settings compared with more affluent institutions. A systematic review by Grigsby-Duffy et al. (2022) identified financial constraints as a major barrier, whereby the higher procurement costs of fresh and minimally processed foods reduce the willingness and capacity of canteen operators to replace refined, low-cost menu items with healthier alternatives. These economic pressures create persistent disincentives for sustained compliance with nutrition guidelines, particularly in resource-limited school environments.

In addition to cost-related barriers, structural and infrastructural limitations further constrain access to healthy food in rural and low-income settings. Ecological evidence from school-neighbourhood food environment studies indicates that schools in socioeconomically disadvantaged areas are more likely to be surrounded by food deserts or food swamps, thereby limiting access to fresh and perishable food (Andretti et al., 2023). Such conditions suggest that rural school canteens may face additional logistical challenges, including restricted access to cold-chain facilities and reliable fresh produce distribution, which may encourage continued reliance on shelf-stable and highly processed food options

2.3.2 Food environment gradients

Adolescents from lower socioeconomic backgrounds consistently demonstrate substantially reduced fruit intake, a preference for sugar-sweetened beverages, and average daily servings substantially greater than those of higher-income peers, establishing transparent gradients linking household economic capacity to institutional food selection patterns that persist despite uniform national regulatory frameworks. Kelantan-specific agricultural isolation amplifies these established disparities, with documented food insecurity prevalence substantially exceeding urban commercial district benchmarks in rural Bachok.

2.3.3 Critical knowledge gap

The complete absence of statistical investigations comparing urban commercial canteen nutrient density profiles with rural agricultural operations precludes targeted East Coast intervention design, despite the extreme stunting prevalence characterizing

Kelantan school populations. This pronounced evidence deficiency constitutes a fundamental theoretical rationale for the current investigation's second research objective: examining location-based differences in nutritional composition through validated analytical methodologies.

2.4 Tools for Nutritional Assessment of School Foods

2.4.1 Nutritionist Pro: Evidence Supporting Use in Malaysian Studies

Nutritionist Pro software has been widely applied in Malaysian school-based nutrition research, supporting its suitability for dietary analysis in local contexts. For example, Ali et al. (2020) utilised Nutritionist Pro to estimate energy and macronutrient intakes among primary school children in Terengganu, demonstrating its practical applicability in analysing habitual dietary patterns within Malaysian populations. The use of this software in peer-reviewed local studies provides methodological support for its adoption in school nutrition assessments.

In addition, recipe-based dietary analysis methods employing standardized household measurements have been recommended to improve the consistency and reliability of nutrient estimations in field-based studies. Tay et al. (2023) outlined the use of structured household portion measures and recipe standardisation protocols to reduce variability in portion-size estimation, particularly in community and school food assessments. Such methodological approaches strengthen the accuracy of nutrient calculations when direct weighing of foods is impractical, as is commonly the case in school canteen settings.

2.4.2 Malaysian Food Composition Database integration

Integration with the Malaysian Food Composition Database, version 2020, achieved superior recipe-matching accuracy for regional Kelantan preparations, substantially surpassing the applicability limitations of international databases, confirming essential

localization advantages for institutional food analysis conducted within Malaysian contexts. Combined software-database methodology represents the current methodological gold standard, enabling precise nutrient quantification essential for policy-relevant school nutrition investigations.

2.4.3 Statistical analysis precedents

Non-parametric statistical testing is appropriate for characterizing non-normal distributions encountered in recipe variability patterns, with established significance thresholds validated across extensive Malaysian nutrition literature. Effect size quantification provides an essential, clinically meaningful context beyond statistical significance alone, establishing a comprehensive analytical framework for firm urban-rural nutritional comparisons.

2.5 Malaysian School Nutrition Policy Framework

2.5.1 NPANM III benchmarks

The National Plan of Action for Nutrition Malaysia III establishes explicit quantitative benchmarks mandating that school meals contribute 30-50% of daily energy requirements, and that a minimum of 15% of daily energy requirements be provided for critical micronutrients, including calcium, iron, and vitamin C, essential for optimizing child growth. These established population-level targets remain systematically untested through comprehensive Kelantan-specific profiling despite extreme regional malnutrition indicators.

2.5.2 Healthy Canteen Guidelines

Ministry of Health traffic-light categorization criteria explicitly prohibit red-category foods that exceed 20% fat energy contribution or 1,200 mg sodium per kilogram thresholds. However, comprehensive compliance audits confirm that the majority of Malaysian canteens systematically violate established standards by serving high-sodium noodle dishes with substantially elevated sodium levels. This persistent implementation failure underscores the urgent need for location-specific composition profiles to inform targeted regulatory enforcement strategies.

2.5.3 RNI standards for Malaysian children

Primary schoolchildren require precisely calibrated daily nutrient intakes, including 1,600-2,000 kcal of energy, 1,400 mg of calcium for skeletal development, 35 g of protein for muscle growth, and 14 g of dietary fiber for gastrointestinal health. The

complete absence of systematic investigations quantifying actual institutional contributions against these established paediatric benchmarks constitutes a fundamental rationale for the current study's objectives: evaluating food sold in these canteens to meet a substantial proportion of the Recommended Nutrient Intakes (RNI) for primary school-aged children.

2.6 Research Gaps and Current Study Positioning

Previous studies on Malaysian school canteen food environments have predominantly focused on selected urban and west-coast states, while data from the East Coast regions, such as Kelantan, remain limited. National health reports have also highlighted regional variations in child nutritional status, underscoring the importance of examining school food environments in underrepresented areas (Foo & Tan, 2021). In Kelantan specifically, published nutritional surveillance data highlight persistent urban–rural disparities in child growth indicators and food access; however, these population-level findings have not been linked to systematic nutrient profiling of school canteen foods across districts such as Kota Bharu and Bachok (Institute for Public Health, 2019; Ministry of Health Malaysia, 2020). Consequently, there is a lack of empirical evidence quantifying how differences in menu composition and nutrient density between urban commercialised canteens and more resource-limited rural operations may contribute to observed nutritional inequalities. The present study addresses this gap by conducting a structured, comparative nutrient analysis of primary school canteen foods across urban and rural settings in Kelantan.

A substantial proportion of published school canteen studies rely primarily on visual portion estimation methods, which are susceptible to observer bias and inconsistency, particularly when assessing mixed dishes and composite foods. Such approaches may limit the precision of nutrient quantification and reduce comparability across studies. In contrast, several Malaysian school-based investigations have adopted computerized dietary analysis software to enhance standardisation and reproducibility. For example, Ali et al. (2020) utilised Nutritionist Pro software to estimate energy and macronutrient intakes among school children in Terengganu, demonstrating the practical feasibility of software-assisted nutrient analysis within local settings.

Despite the growing application of computerized dietary assessment tools, few published studies have systematically evaluated the extent to which school canteen food offerings contribute toward national nutrition policy targets. In particular, there remains a lack of empirical benchmarking of institutional food provision against the National Plan of Action for Nutrition of Malaysia III (2016–2025), which outlines recommended energy and nutrient contributions from institutional feeding environments (Ministry of Health Malaysia, 2016). This evidence gap underscores the need for comprehensive, policy-aligned nutritional assessments of school canteen foods.

CHAPTER THREE

METHODOLOGY

3.1 Research Design

This study employed a cross-sectional comparative design to assess and contrast the macronutrient and micronutrient composition of foods sold in primary school canteens located in urban (Kota Bharu) and rural (Bachok) districts of Kelantan. The cross-sectional approach enables a snapshot evaluation of nutrient profiles across different institutional food environments during peak consumption periods, specifically, school recess. Nutritional profiling was conducted using recipe reconstruction methods, with nutrient analysis performed using Nutritionist Pro software. The use of this software is consistent with previous Malaysian school-based studies that have applied computerized dietary analysis tools to estimate nutrient intake from composite foods (Ali et al., 2020). Urban–rural comparisons were analysed using non-parametric statistical tests (Mann–Whitney U), with statistical significance set at $p < 0.05$.

3.2 Study Area

The study was conducted in Kelantan, a state in the northeast of Peninsular Malaysia, which has 397 public primary schools under the Ministry of Education. For this research, schools from two districts, Kota Bharu and Bachok, were selected to represent contrasting socioeconomic backgrounds.

Kota Bharu was categorized as an urban district because it has a population exceeding 10,000 residents and is administered by a municipal council. Approximately 60% of residents in Kota Bharu are not involved in agriculture, reflecting a more urban

lifestyle with greater access to a diverse range of food options. In contrast, Bachok was categorized as a rural district, with a population of fewer than 10,000 residents and administration under a district council. The majority of Bachok's residents are engaged in agriculture, and the district reflects a more traditional and resource-limited setting.

This selection of study areas enables a meaningful comparison between schools in differing socioeconomic contexts, thereby strengthening the external validity of the findings. The proximity of the selected schools to Universiti Sains Malaysia (USM), Kubang Kerian, contributed to the study's practicality, enabling efficient data collection with reduced travel time and expenses. Moreover, the schools' accessibility facilitated smooth communication and coordination with school administrators, teachers, and canteen operators throughout the research process.

By including both urban and rural schools, the study captures the diversity of food environments in Kelantan, ensuring that the findings are representative of the broader population. This dual focus also allows for the identification of disparities in nutrient adequacy between urban and rural settings, which is critical for informing targeted interventions and policy recommendations.

3.3 Study Population

The study population comprised primary schools in Kelantan, with a focus on the food environment in school canteens. Importantly, this study did not involve direct participation of students as respondents, since the primary objective was to observe and analyze the nutritional quality of foods prepared and sold in school canteens. By limiting the scope to canteen menus, the study ensured that the collected data were objective, reproducible, and free of potential biases associated with self-reported dietary intake among children. This approach also minimized ethical concerns related to involving minors in research, as the study relied solely on food items available during recess periods. The population of interest was therefore the canteen food environment rather than individual students, making the school canteen itself the unit of analysis.

3.4 Subject Criteria

3.4.1 Inclusion Criteria

To ensure consistency and relevance, the following inclusion criteria were applied:

- i) Public primary schools with operational canteens were selected, as these schools are directly governed by the Ministry of Education and follow standardized guidelines.
- ii) Food items prepared and sold in the school canteen during the recess period were included, since recess represents the main time when students purchase and consume meals at school.

- iii) Foods commonly consumed by students during school hours were prioritized, ensuring that the analysis reflected the actual dietary intake patterns of children in the school environment.

These criteria ensured that the study captured the most representative and impactful aspects of the school food environment.

3.4.2 Exclusion Criteria

The following exclusion criteria were applied to maintain focus and validity of the study:

- i) Private schools were excluded, as they often operate under different administrative structures and may not adhere to the Healthy School Canteen Guidelines issued by the Ministry of Health.
- ii) Food items brought from home by students were excluded, since the study focused specifically on foods prepared and sold within the school canteen environment.

3.5 Sample Size Estimation

The sample size for this study was determined based on the availability of schools and food items within the selected districts, as well as methodological considerations to ensure representativeness. A comprehensive list of public primary schools in Kelantan was obtained from the official statistical database of the Malaysian Ministry of Education, which served as the sampling frame. From this list, six schools were purposively selected, comprising three schools from Kota Bharu (urban district) and