２０１４年度　青森県立保健大学大学院博士論文

Nutritional status of children and their mothers, and its determinants in urban capital and rural highland in Papua New Guinea

分野名　　生活健康科学分野
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２０１４年度青森県立保健大学大学院博士論文要旨

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Ⅰ　はじめに

パプアニューギニア(PNG)では依然として乳幼児死亡率が高く（出生 1,000 対 69)、死因のうちマラリアや下痢等の小児感染症が約 4 割占めている。その主な要因として予防接種率の低さと栄養不良の蔓延が考えられている。特にインフラが十分に整備されていない高地農村部では、食料へのアクセスの限界(food insecurity)が深刻である(Bourke RM, 2001)。

同国に関して、食事と栄養状態の関係を取り上げた研究(Okuda T, 1981)、人類学的見地から、イモ食文化（低たんぱく・高エネルギー、低塩）への適応(nutritional adaptation)をテーマとした研究(Koishi H, 1990; Norgan NG, 1995)の報告があるが、近年は詳細な栄養疫学研究は実施されていない。そこで、１）都市部、農村部の食料・栄養問題を把握し、地域間／地域内でみられる格差の背景要因、２）小児・母親それぞれの栄養状態および食事摂取状況の地域的特徴、３）母子間の栄養状態の相関、４)母子の栄養状態の影響因子を明らかにすることを本研究の目的とした。

Ⅱ　研究方法と対象

都市部は首都ポートモレスビー(POM)、高地農村部は Sandaun 県 Nuku 郡(NUKU)を対象地とし、それぞれ 2010 年 10 月、2011 年 9 月に調査を実施した。調査拠点クリニックおよび保健センターに定期予防接種プログラムのために来院した 6-59 カ月児をもつ母親に対して、本研究の趣旨を説明し、同意の得られた全 201 組の母子（POM89 組、NUKU112 組）を調査対象とした。

身体測定項目は、小児は身長、体重、上腕周囲長(MUAC)、母親は身長、体重、腹囲とした。また、母親を対象に、質問紙を用いたインタビュー調査（小児の既往歴、家庭の経済状況、母親の妊娠回数及び生活習慣、母乳・離乳食の習慣等の Infant feeing practice)、並びに 24 時間思い出し法と食物摂取頻度調査(FFQ)による食事調査を行った。

Ⅲ　結　　果

小児の栄養不良(Stunting, Underweight)および母親の低体重（BMI<18.5kg/m^2）は NUKU の方が多く、両地区で小児にはほとんど肥満が認められなかった。Food security の問題は NUKU の方が深刻であった一方で、罹病率は POM の方が高かった。POM では半数近くの母親が過体重・肥満（BMI≧25kg/m^2）であったが、貧困家庭で極度の低体重がみられた。低体重の母親に栄養不良の小児が多く、母子間で栄養状態の相関が認められた。また、早期に離乳食が開始された小児に栄養不良が多い傾向がみられた。

Ⅳ　考　　察

本研究において、PNG における都市部と農村部で小児の栄養状態、母親の身体状態、食物へのアクセス（Food security）に関して異なる問題があることがわかった。このことは、nutrition transition にある他の国での都市・農村部間の比較研究では、すでに報告されていることであるが、PNG では初めて明らかにされた知見である。小児の栄養不良の背景因子として早期の離乳食開始が明らかになったことから適切な Infant feeing practice に関する栄養教育の必要性が示唆された。今後、PNG における“double burden of malnutrition”の解決に向けた取り組みにおいては、都市部と農村部の異なる地域的特徴を踏まえたアプローチを強化させることが重要である。

Nutritional status of children and their mothers, and its determinants in urban capital and rural highland in Papua New Guinea

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Abstract

In Papua New Guinea (PNG), under-five mortality rate still remains high (69 per 1,000 live birth), and infectious diseases contribute to 38% of deaths among under-five children, possibly due to not only low immunization coverage but also undernutrition. The situation is especially serious in rural highland, where accessibility to foods available outside village is very limited due to poor infrastructure for transportation, leading to persistent food insecurity. Under this circumstance, this study was undertaken with the aim to assess nutritional status of children and their mothers in the urban capital (Port Moresby (POM)) and rural highland (Nuku district, Sandaun Province (NUKU)). Fieldwork was carried out in October 2010 in urban POM and in September 2011 in rural NUKU. In total 201 pairs of children aged 6-59 months and their mothers were measured for anthropometry following the standard method. Data on household characteristic, dietary intake, infant feeding practice, child's disease history and mother's lifestyle habit were obtained by interviews with mothers.

Prevalence of stunting and underweight was higher in rural NUKU than urban POM ($p<0.05$). Whilst food insecurity was more serious in rural NUKU, morbidity of children was higher in urban POM. Distribution of mothers' BMI was quite different between two sites, with higher proportion of overweight/obesity in urban POM (47.6%) and underweight in rural NUKU (10.8%). People in POM appeared better-off, though it was recognized poor households were disadvantaged. Characteristics of infant feeding practice were also different between two sites.

Early introduction of the first liquid/food other than breastmilk was associated with undernutrition among children. The findings of this study would suggest that area-specific approach for “double burden of malnutrition” should be enhanced, considering differential regional characteristics affecting the nutritional status of children and mothers in PNG.

Chapter 1: Introduction

1.1 Background

> We, the Ministers and the Plenipotentiaries representing 159 states and the European Economic Community at the International Conference on Nutrition (Rome, December 1992), declare our determination to eliminate hunger and to reduce all forms of malnutrition. Hunger and malnutrition are unacceptable in a world that has both the knowledge and the resources to end this human catastrophe, We recognize that access to nutritionally adequate and safe food is a right of each individual. We recognize that globally there is enough food for all and that inequitable access is the main problem.
>
> (Citation from "World Declaration on Nutrition" [1])

Whilst more than 20 years has passed since the World Declaration on Nutrition in 1992, many people in the world still suffer from hunger and undernutrition, with 842 million being unable to meet the minimum energy requirement [2]. In particular, under-five children in developing countries are vulnerable to nutrition-related problems (e.g. chronic food shortage from poverty, inadequate diet in terms of quantity and quality, frequent infectious diseases).

Papua New Guinea (PNG) is one of the poorest countries in the Oceania region, with the Gross National Income (GNI) per capita of US1,430 [3]. The country is also classified as a "Low-Income and Food Deficit Country", together with Kiribati and Solomon Islands in Oceania, by the Food and Agriculture Organization of the United Nations (FAO) (70 countries in 2011), based on the GNI per capita and the net (i.e. gross imports less gross exports) food trade position [4].

According to the definition of FAO, “Food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” [5]. In reality, however, one in eight people in the world cannot obtain adequate foods and achieve healthy life [2]. Food insecurity in PNG is due to a variety of factors such as seasonal food shortage, the imbalance between local production and population growth, a wide income disparity, an increased dependency on cash income to purchase food items and the declining trade balance [6]. The situation is especially serious in rural highland, where accessibility to foods available outside village is very limited due to poor infrastructure for transportation, leading to persistent food insecurity [7, 8].

It has been reported that major causes of death among under-five children in the world are infectious diseases such as pneumonia, diarrhea, measles and malaria, and that half of these deaths are associated with undernutrition [9]. Likewise, 38% of deaths among under-five children in PNG are caused by infectious diseases (e.g. malaria, ARI, diarrhoea), possibly due to not only low immunization coverage but also undernutrition [10]. The national average of stunting, underweight and wasting among under-five children is 43%, 18% and 5%, respectively. Consequently, the country’s under-five mortality rate still remains high (69 per 1,000 live birth), with the 49th highest rank in the world [11].

So far, the available data on the nationwide nutritional surveys were limited to the children

under the age of five [12], or children aged 6-59 months and non-pregnant women of child bearing age 15-49 years [13]. However, none of these studies included dietary intake data, which is vital for nutritional assessment (e.g. to identify nutritional deficiency). While previous studies in 1980s and 1990s focused on nutritional adaptation to low protein PNG diets [14-16], it was also noted that slow growth was associated with slower development, reduced functional capacity and increased risk of serious illness and death [17].

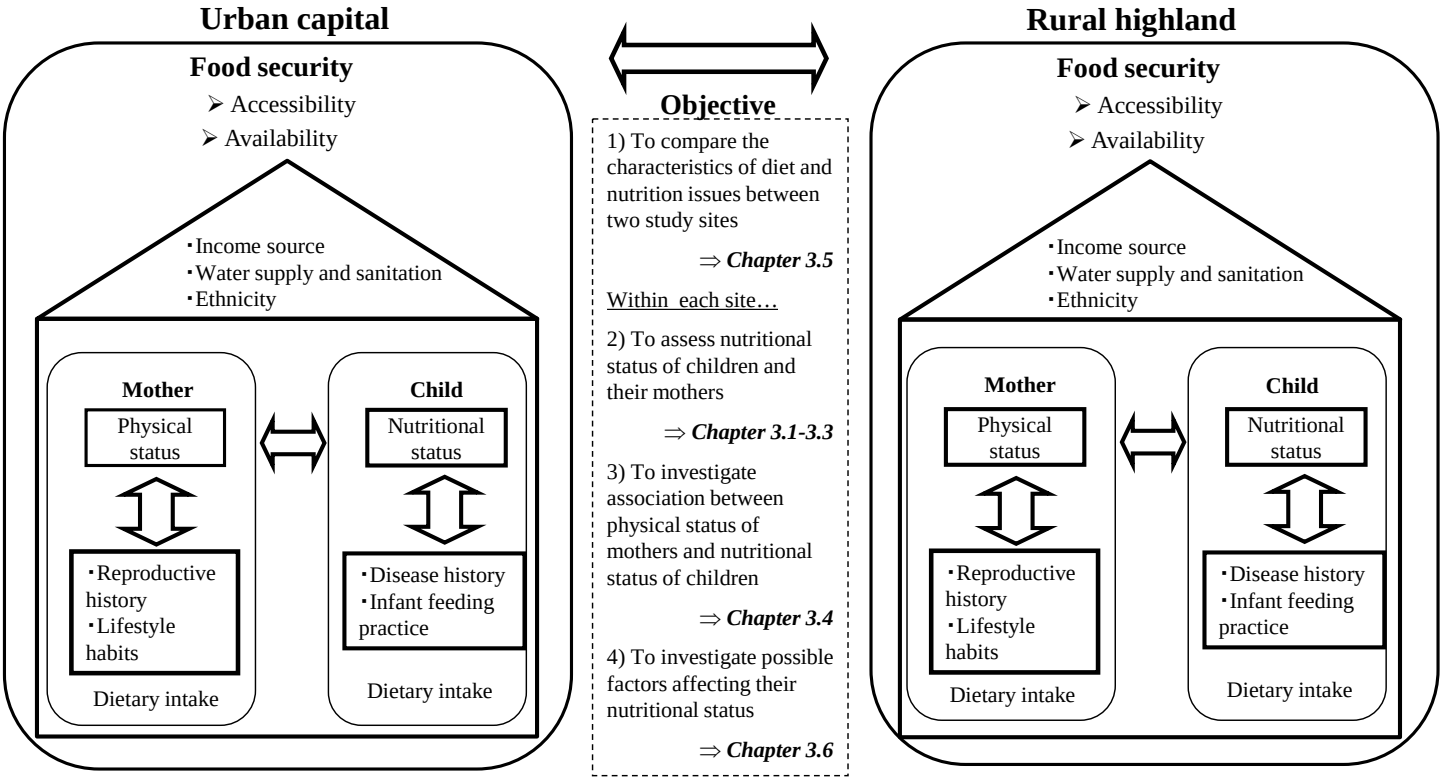
Recently, overweight and obesity, as well as non-communicable diseases (NCDs), have been increasing in Asian-Pacific region by nutrition transition as economic development progress. As a result, a new public health problem called “double burden of malnutrition” is emerging, in which undernutrition and overnutritoin co-exist in a country [18,19]. Whilst food insecurity and undernutrition remain as significant problems, obesity and hypertension associated with overnutrition have been increasingly reported in PNG, too [20, 21].

Yet, there are no latest studies on the situation analyses of the regional public health issues or the double burden of malnutrition in PNG. With a growing attention on maternal and child nutrition at the Department of Health in PNG, this study was undertaken with the aim to assess nutritional status of children and their mothers in two contrasting location, urban capital vs. rural highland, as well as to investigate the association with possible determinants (e.g. socio-demographic or lifestyle factors).

1.2 Structure of the thesis

This introductory chapter provides a general background of the subject under study and sets out the study objective. **Chapter 2** contains descriptions of the study population, followed by the study design, and details of the methods used in data collection and analysis. **Chapter 3** presents the socio-demographic characteristics of the study subjects and the results of the study. **Figure 1** illustrates a framework of this study, showing the sections to present the results for each specific objective. **Chapter 4** discusses the main findings and makes recommendations, and **Chapter 5** summarizes the conclusion of this study [22].

Figure 1. Framework of the study



Chapter 2: Methods

This chapter provides descriptions of the methodological approaches used in conducting this research, including the study design, data collection methods and data analysis.

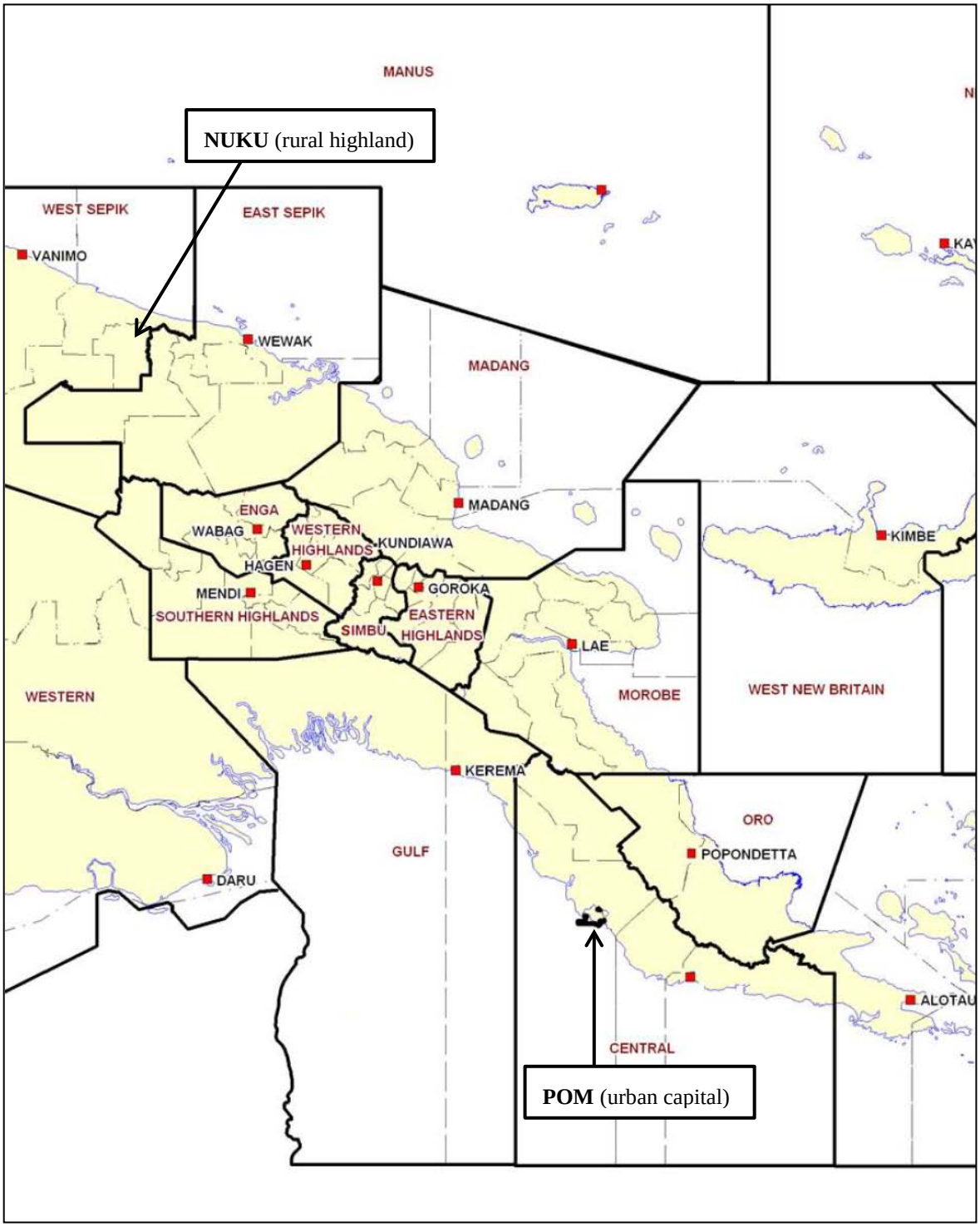
2.1 Study design

To address the objectives outlined in **Chapter 1**, this study employed cross-sectional comparisons of children aged 6-59 months and their mothers in two study sites of contrasting geographical characteristics. Fieldwork was carried out in October 2010 in urban capital, and in September 2011 in rural highland, following a feasibility study in July 2010.

2.2 Description of the study sites

PNG is one of the most culturally diverse countries with 850 native languages. Administratively, PNG has four regions and 22 provinces (20 integrated provinces, the autonomous province of North Solomons (Bougainville) and the National Capital District). Each province has one or more districts, and each district has one or more Local Level Government (LLG) areas [23]. This study was conducted in Port Moresby of the National Capital District, Papua region (POM) for urban capital and Nuku district of Sandaun province, Momase region (NUKU) for rural highland (**Figure 2**). Total population of each study site is 254,158 and 46,021, respectively [24].

Figure 2. Map of PNG and study sites



From POM, NUKU can be reached by domestic flight to Wewak (2 hours) first, followed by 8-10 hours' drive depending on the road condition. NUKU had the highest annual average number of malnourished children in Sandaun Province [25].

2.3 Selection of the study sites

In PNG, routine immunizations are provided by the government and carried out by health clinic and center. Study sites were identified based on the discussion and field visit with a local counterpart (Dr. Job Hawap, Department of Health, PNG) during the feasibility study conducted in July 2010. In POM, “Well baby Clinic, Port Moresby General Hospital” was selected for data collection as the largest health clinic belonging to a national hospital. In NUKU, based on the discussion at the district health office and health center during the feasibility study, it was decided to carry out data collection at the Nuku district Health Center.

2.4 Selection of the study subjects

All the mothers who visited the study clinic or health center for routine immunization of children aged 6-59 months, during our visit were explained about this study. Pregnant mothers were excluded. In total, 201 pairs (89 in POM and 112 in NUKU) of children aged 6-59 month and their mothers who agreed to participate joined in this study.

2.5 Ethical clearance

Ethical approval was obtained from the Medical Research Advisory Committee, Department of Health, PNG (Ref. MRAC No. 10.33) (**Appendix 1**), the ethical committee of the National Institute of Health and Nutrition (Ref. 20100824-01) and that of the Aomori University of

Health and Welfare (Ref. 11013).

At each study site, permission was sought from the Director of each clinic and health center. Local counterpart and research assistants explained the purposes and procedures of the study and secured informed consent using “Consent Form (**Appendix 2**)” from the study mothers.

2.6 Recruitment and training

The field team comprised the principal investigator (Miki Miyoshi), a local counterpart (Dr. Job Hawap) and 4 research assistants for each study site. The local counterpart participated in the feasibility study, training and data collection throughout, together with the principal investigator. Research assistants were recruited locally from the village health workers at each study site, and trained for questionnaire interview. For anthropometric measurement, all the measurements were performed by the principal investigator throughout the survey.

2.7 Data collection

2.7.1 Anthropometric measurement

Height /length, weight and mid upper arm circumference (MUAC) were measured for children and height, weight and abdominal circumference were measured for mothers. Height was measured using a “Seca Leicester Portable Height Measure (Seca, UK)” to the nearest 0.1cm, and recumbent length (for children < 2 years) was measured using a “Rollameter 100 (Child Growth Foundation, UK)”. Weight was measured using a digital scale “SECA877”

with capacity of 200kg×100g (SECA, Japan). Children and mothers were weighed bare-foot, wearing minimal clothes, and their weight was recorded to the nearest 0.1kg. MUAC was also measured to assess their thinness, using an insertion tape with three coloured zones. A cut-off of 13.5cm was used to classify the undernourished children [26, 27]. A plastic tape measure was used to measure mothers' abdominal circumference. These anthropometric data were recorded in "Recording sheet for anthropometric measurement" (**Appendix 3**).

2.7.2 Questionnaire interview

Mothers were interviewed by the research assistants, using the structured questionnaires. Questions include the socio-demographic characteristics of the households (number of household member, birth order of study child, number of siblings, occupation as main income source, source of drinking water, type of toilet), child health (birth weight, disease history (fever, diarrhoea and cough in the past two weeks; malaria, measles and acute respiratory infections (ARIs) in the past) , mother's lifestyle habits and reproductive history (alcohol drinking, chewing betel nuts, smoking, number of pregnancy and delivery), and infant feeding practices (colostrum, duration of exclusive breastfeeding, first liquid other than breastmilk and foods given to the child, timing to stop breastfeeding) (**Appendix 3-5**). Besides, dietary intake data of mothers and their children were obtained by 24-hour recall methods (**Appendix 5**) and Food Frequency Questionnaire (FFQ) (**Appendix 6**). Portion size was estimated using the Food Model Booklet [28] and a regional food composition table [29]

was used to refer nutrition composition of each food item. Food list for FFQ was developed based on observation at the feasibility study in July 2010.

2.8 Fieldwork data quality control

The local counterpart supervised the questionnaire interview throughout. Each completed questionnaire was checked by the principal investigator before proceeding to the anthropometric measurement so that the missing information could be obtained on the spot. All the anthropometric measurements were performed by the principal investigator throughout the survey to avoid inter-individual error..

2.9. Data analysis

2.9.1 Calculation of anthropometric indices of children

Children's anthropometric status was used as a proxy measurement for nutritional status, based on three indices; height-for-age Z-score (HAZ), weight-for-age Z-score (WAZ) and weight-for-height Z-score (WHZ). A cut-off of -2SD was used to distinguish normal children from those stunted (HAZ < -2), underweight (WAZ < -2) or wasted (WHZ < -2). The calculation of HAZ, WAZ and WHZ was performed using WHO Anthro [30].

2.9.2 Data analysis

The data entered and calculated by WHO Anthro were later transferred into IBM SPSS Statistics for further analyses with other variables. The chi-square (χ^2) test was performed to assess the association between categorical variables. The Mann-Whitney U test was used to compare differences between two groups for ordinal variables. The t-test was applied to compare the means of two groups. One way analysis of variance (ANOVA) was used to compare the means of several groups and the F-test was applied for the significance test. For χ^2 test, t-test and F-test, 0.05 (two-tailed) was taken as the level of statistical significance.

Chapter 3: Results

3.1 Socio-demographic characteristics of children and mothers

Demographic characteristics of children and mothers, together with household characteristics are shown in **Table 1**. Mean ages of the child and mother were 11.1 months (SD: 5.9) and 28.2 years old (SD: 6.0) in urban POM and 32.5 months (SD: 17.2) and 30.1 years old (SD: 7.3) in rural POM.

The most common water and sanitation facilities for urban POM were tap water at home (94.3%) and flushed toilet (84.1%), whereas those for rural NUKU were deep well (73.0%) and pit latrine (98.2%). While a majority of the households in urban POM gain their income from employed jobs (except for two unemployed and one with support from church), more than half the households (71.4%) in rural NUKU were subsistence farmers with sifting cultivation, livestock and foraging as their main source of livelihood.

Table 1. Characteristics of study children, mothers and households by study site

	Variables	Category	Port Moresby (n=89)	Nuku(n=112)
			n (%)	n (%)
Children				
	Sex	Boy	39 (43.8)	62 (55.4)
		Girl	50 (56.2)	50 (44.6)
	Age	6- 12 months	60 (67.4)	19 ((17.0)
		12-23 months	26 (29.2)	21 (18.8)
		24-35 months	1 (1.1)	24 (21.4)
		36-47 months	2 (2.0)	16 (14.3)
		48-59 months	- (-)	32 (28.6)
	Birth order	1	36 (41.4)	27 (24.1)
		2	27 (31.0)	21 (18.8)
		3	12 (13.8)	19 (17.0)
		4	7 (8.0)	18 (16.1)
		5≤	5 (5.6)	27 (24.1)
Mothers				
	Age group	< 20 yrs	4 (4.7)	2 (2.0)
		20-29 yrs	45 (52.3)	48 (49.0)
		30-39 yrs	33 (38.4)	36 (36.7)
		40 yrs ≤	4 (4.7)	12 (12.2)
	No of delivery	1	34 (39.5)	25 (22.3)
		2	28 (32.6)	18 (16.1)
		3	11 (12.8)	23 (20.5)
		4	7 (8.1)	13 (11.6)
		5≤	6 (7.0)	33 (29.5)
Households				
	Source of drinking water	Tap at home	83 (94.3)	17 (15.3)
		Public tap	1 (1.1)	12 (10.8)
		Tank water	2 (2.3)	0 (0)
		Deep well	1 (1.1)	81 (73.0)
		River/spring	1 (1.1)	1 (0.9)
	Type of toilet	Flush	74 (84.1)	0 (0)
		Pit latrine	13 (14.8)	109 (98.2)
		No toilet	1 (1.1)	2 (1.8)

3.2. Nutritional status and morbidity of children

Prevalence of stunting (HAZ < -2) and underweight (WAZ < -2) was significantly higher in rural NUKU (Stunting 26.8%, Underweight 8.9%) than urban POM (Stunting 4.5%, Underweight 2.2%) (**Table 2**). In both sites, prevalence of stunting was significantly higher in boys than girls (POM 10.3% vs. 0.0%, NUKU 30.6% vs. 22.0%; $p<0.05$). Within rural NUKU, children from a remote village (Namblo) were more likely to be undernourished compared to those living around the Nuku district health center, in terms of stunting (29.0% vs. 23.3%) and low MUAC (< 13.5cm) (27.5% vs. 14.0%). The number of children with low birth weight (< 2,500g) was seven in both sites. Out of seven reported in rural NUKU, six were from Namblo.

On the other hand, morbidity of children in the past 2 weeks were significantly higher in urban POM than rural NUKU; diarrhea (23.9% vs. 8.3%), fever (45.4% vs. 17.3%) and cough (62.5% vs. 30.0%). Likewise, more children in urban POM, than in rural NUKU, have ever suffered from Malaria in the past (5.7% vs. 0%).

Table 2. Prevalence of undernutrition and morbidity among children by study site

		Port Moresby (n=89)	Nuku(n=112)	*p*-value†
		n (%)	n (%)	
Nutritional status				
	Stunting (HAZ < -2)	4 (4.5)	30 (26.8)	0.000
	Underweight (WAZ < -2)	2 (2.2)	10 (8.9)	0.042
	Wasting (WHZ < -2)	4 (4.5)	2 (1.8)	0.240
	MUAC (<13.5 cm)	24 (27.0)	25 (22.3)	0.275
	Low birth weight (< 2,500g)	7 (8.1)	7 (8.3)	0.591
Morbidity*				
	Diarrhoea	21 (23.9)	9 (8.3)	0.002
	Fever	40 (45.5)	19 (17.3)	0.042
	Cough	55 (62.5)	33 (30.0)	0.000
	Malaria	1 (1.1)	0 (0)	0.444
	Measles	5 (5.7)	0 (0)	0.016
	Acute Respiratory Infections	9 (10.2)	7 (6.2)	0.232

*Disease history in the past 2 weeks for diarrhoea, fever and cough, and in the past for malaria, measles and Acute Respiratory Infections.

† χ^2 test

3.3 Anthropometric status of mothers and lifestyle habits

Prevalence of underweight (BMI < 18.5) was higher in rural NUKU (10.8%) than in urban POM (5.8%). Out of 12 underweight mothers in rural NUKU, seven were the mothers from Namblo. On the other hand, the prevalence of overweight (25.0 ≤ BMI < 30.0) and obesity (BMI ≥ 30.0) among mothers was 26.7% and 20.9% in urban POM and 10.8% and 1.8% in rural NUKU, respectively In both sites, mothers' mean BMI increased with age groups (under 20 years, 20-29 years, 30-39 years, over 40 years). The association was statistically significant in urban POM, though significance was not detected in rural NUKU (**Table 3**).

Table 3. Mean BMI in mothers according to age group

	Port Moresby		Nuku	
	n	Mean (SD)	n	Mean (SD)
< 20 yrs	4	20.3 (2.0)	2	20.7 (2.8)
20-29 yrs	45	24.6 (4.8)	48	21.4 (2.0)
30-39 yrs	32	26.8 (6.4)	36	21.9 (2.9)
40 yrs ≤	4	34.8 (2.7)	11	23.4 (4.2)
F-test	6.28; p=0.001		1.86; p=0.141	

When looked at the association with the type of water supply and toilet, mothers from the households with "water tap" and "flush toilet" had higher mean BMI than those with "deep well" or "no toilet", through the association was not statistically significant.

Table 4 shows the characteristics of mothers' lifestyle habits; alcohol intake, chewing betel nuts and smoking. Drinking is more common among mothers in urban POM (1-2 days/month (12.3%), 1-2 days/week (3.3%)). On the other hand, more frequent chewing betel nuts and smoking were reported in rural NUKU, compared to urban POM.

Table 4. Characteristics of lifestyle habit among mothers by study site

variables	Category	Port Moresby	Nuku
		n (%)	n (%)
Alcohol drinking	Every day	0 (0)	0 (0)
	1-2 days/week	3 (3.3)	0 (0)
	1-2 days/month	11 (12.3)	1 (0.9)
	Quit drinking	6 (6.7)	0 (0)
	Never/Hardly	68 (76.4)	109 (97.3)
	No answer	1 (1.1)	2 (1.8)
Betel nuts chewing	≥ 6 /day	21 (23.6)	45 (40.2)
	1-5/day	19 (21.3)	14 (12.5)
	Once/day	5 (5.6)	5 (4.5)
	Not every day	20 (22.5)	19 (17.0)
	Never	23 (25.8)	27 (24.1)
	No answer	1 (1.1)	2 (1.8)
Smoking	Everyday	7 (7.9)	23 (20.5)
	Sometimes	7 (7.9)	9 (8.0)
	No smoking	73 (82.0)	78 (69.6)
	No Answer	2 (2.2)	2 (1.8)

No association was observed between mothers' BMI and alcohol drinking or betel nuts chewing. Non-smokers had higher BMI than smokers in NUKU ($p < 0.05$), but not in POM.

3.4 Association between mothers' BMI and anthropometric status of children

Table 5 shows mean HAZ, WAZ and WHZ of children according to mothers' BMI. Children of underweight mothers had the lowest mean values of HAZ, WAZ and WHZ ($p<0.05$ for each in POM), though the association was not statistically significant in NUKU.

Table 5. Mean HAZ, WAZ and WHZ of children according to their mothers' BMI

	Mothers' BMI*		HAZ	WAZ	WHZ
POM		n	Mean (SD)	Mean (SD)	Mean (SD)
	< 18.5	5	-1.80 (1.52)	-1.65 (1.22)	-0.84 (1.68)
	18.5-24.9	40	0.67 (1.16)	-0.06 (0.98)	-0.49 (1.00)
	25.0-29.9	23	0.06 (1.26)	0.20 (0.84)	0.32 (1.09)
	30.0 ≤	18	0.61 (1.18)	0.45 (0.93)	0.26 (0.80)
	F-test		6.91, p=0.000	6.79, p=0.000	4.78, p=0.004
NUKU		n	Mean (SD)	Mean (SD)	Mean (SD)
	< 18.5	12	-1.79 (0.62)	-1.43 (0.62)	-0.55 (0.63)
	18.5-24.9	85	-1.11 (1.36)	-0.82 (1.01)	-0.27 (0.99)
	25.0-29.9	12	-0.87 (0.89)	-0.88 (0.96)	-0.19 (0.87)
	30.0 ≤	2	-1.20 (0.65)	-0.58 (0.62)	-0.18 (0.35)
	F-test		1.1, p=0.35	1.45, p=0.23	0.37, p=0.77

*Body Mass Index

3.5 Dietary intake and infant feeding practice

Like in other areas of PNG, the study subjects took meals three times a day in both sites. Our dietary survey by 24-hour recall methods explored less availability of a variety of foods in rural NUKU, as well as a larger portion size of staple intake among mothers in urban POM.

The results of FFQ, revealed that the main foods consumed daily were *kaukau* (sweet potato), rice, bread, hard cracker and butter in urban POM and *sago* (a kind of palm), coconut and banana in rural NUKU (**Figure 3-6**). On the other hand, the consumption of the green leafy vegetable was relatively high in both sites, where 45.0% of children and 88.8% of mothers in urban POM and more than 60% of children and mothers in rural NUKU took green vegetable at least once a day. Main protein resources were fish, meat, egg and milk in urban POM and fish (with limited availability) in rural NUKU (**Table 6)**.

Figure 3. *Kaukau* in a market (POM)

Figure 4. Hard cracker (as main staple or snack)

Figure 5. Cooking Sago powder (NUKU)

Figure 6. Coconut (NUKU)

Table 6. Frequency of food intake listed in FFQ for children and mothers

Food item	Study site	Children							Mothers						
		More than once/day	Once/day	3-6 times /week	1-2 times /week	Once/moth or less	Never	*p*-value[†]	More than once/day	Once/day	3-6 times /week	1-2 times /week	Once/moth or less	Never	*p*-value[†]
Breastmilk	POM	75.3%	3.4%	4.5%	0.0%	0.0%	16.9%	< 0.001							
	NUKU	47.3%	7.1%	1.8%	0.0%	0.0%	42.0%								
Powder milk	POM	**30.3%**	**10.1%**	2.2%	1.1%	1.1%	55.1%	0.016							
	NUKU	6.3%	3.6%	0.0%	13.4%	17.0%	59.8%								
Hard cracker	POM	7.9%	**24.7%**	5.6%	9.0%	1.1%	51.7%	0.255	**37.1%**	**36.0%**	9.0%	9.0%	1.1%	7.9%	< 0.001
	NUKU	1.8%	8.0%	8.0%	32.1%	**37.5%**	12.5%		3.6%	1.8%	7.1%	**33.9%**	**38.4%**	15.2%	
Bread	POM	**7.9%**	**27.0%**	4.5%	10.1%	0.0%	50.6%	0.015	**28.1%**	**43.8%**	7.9%	11.2%	1.1%	7.9%	< 0.001
	NUKU	0.0%	1.8%	1.8%	17.0%	**33.9%**	45.5%		1.8%	0.0%	2.7%	23.2%	**40.2%**	32.1%	
Flour	POM	4.5%	9.0%	5.6%	6.7%	1.1%	73.0%	< 0.001	**22.5%**	**27.0%**	13.5%	16.9%	2.2%	18.0%	< 0.001
	NUKU	5.4%	8.0%	8.0%	**56.3%**	16.1%	6.3%		3.6%	8.0%	9.8%	**56.3%**	17.0%	5.4%	
Rice	POM	**22.5%**	**38.2%**	2.2%	5.6%	1.1%	30.3%	0.001	**59.6%**	**34.8%**	1.1%	0.0%	0.0%	4.5%	< 0.001
	NUKU	5.4%	7.1%	13.4%	**49.1%**	14.3%	10.7%		5.4%	7.1%	16.1%	**51.8%**	16.1%	3.6%	
Cassava	POM	0.0%	0.0%	3.4%	6.7%	2.2%	87.6%	0.103	5.6%	14.6%	16.9%	**19.1%**	7.9%	36.0%	< 0.001
	NUKU	0.0%	0.9%	0.9%	9.8%	10.7%	77.7%		0.9%	2.7%	4.5%	19.6%	7.1%	65.2%	
Kaukau (sweet potato)	POM	**24.7%**	**33.7%**	7.9%	10.1%	1.1%	22.5%	0.028	**21.3%**	**38.2%**	11.2%	14.6%	4.5%	10.1%	0.010
	NUKU	9.8%	17.9%	25.0%	40.2%	3.6%	3.6%		14.3%	16.1%	**25.9%**	**34.8%**	3.6%	5.4%	
Sago	POM	0.0%	3.4%	1.1%	6.7%	3.4%	85.4%	< 0.001	2.2%	4.5%	5.6%	15.7%	28.1%	43.8%	< 0.001
	NUKU	**51.8%**	7.1%	3.6%	25.9%	1.8%	9.8%		**58.0%**	8.0%	6.3%	26.8%	0.0%	0.9%	
Banana	POM	15.7%	**27.0%**	12.4%	11.2%	3.4%	30.3%	0.048	**20.2%**	**40.4%**	9.0%	21.3%	3.4%	5.6%	0.301
	NUKU	**18.8%**	**19.8%**	25.0%	33.0%	2.7%	0.9%		**19.6%**	**22.3%**	**25.9%**	**29.5%**	0.9%	1.8%	
Coconut	POM	6.7%	5.6%	3.4%	5.6%	3.4%	75.3%	< 0.001	18.0%	**33.7%**	11.2%	10.1%	5.6%	21.3%	0.013
	NUKU	**26.6%**	**19.8%**	16.1%	30.4%	0.9%	4.5%		**33.0%**	**22.3%**	13.4%	29.5%	0.0%	1.8%	
Fish	POM	9.0%	**22.5%**	7.9%	9.0%	3.4%	48.3%	0.077	20.2%	23.6%	22.5%	21.3%	5.6%	6.7%	< 0.001
	NUKU	4.5%	8.0%	4.5%	**50.9%**	27.7%	4.5%		5.4%	8.9%	8.0%	45.5%	28.6%	3.6%	
Beef	POM	3.4%	2.2%	3.4%	9.0%	2.2%	79.8%	0.001	**11.2%**	**7.9%**	9.0%	25.8%	7.9%	38.2%	0.002
	NUKU	0.0%	1.8%	2.7%	4.5%	43.8%	47.3%		0.0%	0.9%	7.1%	12.5%	40.2%	39.3%	
Chicken	POM	7.9%	**23.6%**	6.7%	14.6%	2.2%	44.9%	0.153	**14.6%**	**33.7%**	19.1%	24.7%	2.2%	5.6%	< 0.001
	NUKU	0.9%	1.8%	1.8%	27.7%	**44.6%**	23.2%		0.9%	1.8%	5.4%	34.8%	41.1%	16.1%	
Green Vegetable	POM	**16.9%**	**28.1%**	2.2%	6.7%	1.1%	44.9%	< 0.001	**33.7%**	**55.1%**	3.4%	2.2%	0.0%	5.6%	0.083
	NUKU	**61.6%**	2.7%	1.8%	25.0%	0.9%	8.0%		**65.2%**	0.0%	3.6%	28.6%	0.9%	1.8%	
Egg	POM	**32.6%**	**28.1**	2.2%	12.4%	3.4%	21.3%	< 0.001	**13.5%**	**19.1%**	10.1%	23.6%	10.1%	23.6%	< 0.001
	NUKU	0.0%	0.0%	2.7%	38.4%	35.7%	23.2%		1.8%	2.7%	5.4%	33.9%	34.8%	21.4%	
Milk	POM	**28.1%**	**29.2%**	2.2%	3.4%	3.4%	33.7%	< 0.001	**16.9%**	**30.3%**	18.0%	6.7%	2.2%	25.8%	< 0.001
	NUKU	1.8%	0.9%	2.7%	21.4%	14.3%	58.9%		1.8%	1.8%	2.7%	21.4%	12.5%	59.8%	
Butter	POM	7.9%	3.4%	3.4%	4.5%	0.0%	80.9%	0.780	**24.7%**	**36.0%**	9.0%	9.0%	1.1%	20.2%	< 0.001
	NUKU	0.0%	0.0%	0.9%	9.8%	14.3%	75.0%		0.0%	0.0%	0.9%	11.6%	15.2%	72.3%	
Peanut butter	POM	6.7%	7.8%	2.2%	2.2%	1.1%	79.8%	0.436	**20.2%**	**37.1%**	5.6%	11.2%	2.2%	23.6%	< 0.001
	NUKU	0.0%	0.9%	0.9%	10.7%	17.9%	69.6%		0.9%	0.0%	0.9%	14.3%	15.2%	68.8%	
Fruit juice	POM	18.0%	**38.2%**	5.6%	7.9%	1.1%	29.2%	< 0.001	**24.7%**	**30.3%**	10.1%	20.2%	2.2%	12.4%	< 0.001
	NUKU	8.0%	9.8%	8.0%	17.0%	15.2%	42.0%		8.0%	15.2%	4.5%	15.2%	15.2%	42.0%	

[†] Mann-Whitney U test

Characteristics of infant feeding practice were also quite different between two sites, except that most of mothers gave colostrum to their new-born babies in both sites (POM 89.5%, NUKU 89.9%). Early introduction of liquid and food (before 6 months of age) were typically observed among mothers in rural NUKU (89.2%) (vs. 53.2% in urban POM), where 73% of mothers started giving foods from 4 months. Furthermore, 30.4% of mother continues to give breastmilk after two years old, which was not observed in urban POM. Complementary foods were consisted of *kaukau*, pumpkin, papaya, banana, egg in urban POM, whereas *sago*, *kaukau*, yam, banana and papaya were predominant in rural NUKU. 40.4% of the study children were given powder milk daily in urban POM, while this proportion was less than 10 % in rural NUKU (**Table 6**).

3.6. Possible factors affecting nutritional status of children

Neither type of water supply and toilet had association with children's nutritional status in urban POM, whereas prevalence of stunting was highest in children from households with "deep well" and "no toilet", respectively. Mothers with frequent betel nuts chewing habits were more likely to have stunted or underweight children, though the association was not statistically significant.

Table 7 shows the prevalence of stunting, underweight and wasting (WHZ < -2) according to the timing of introduction of the first food. Early introduction of the first liquid/food, other

than breastmilk, was associated with higher prevalence of undernutrition among children.

Table 7. Prevalence of undernutrition according to the timing of introducing the first food

Age of months*	Port Moresby				Nuku			
	n	Stunting (HAZ<-2)	Underweight (WAZ<-2)	Wasting (WHZ<-2)	n	Stunting (HAZ<-2)	Underweight (WAZ<-2)	Wasting (WHZ<-2)
< 6 months	42	3 (7.1%)	1 (2.4%)	2 (4.8%)	96	27 (28.1%)	9 (9.4%)	2 (2.1%)
≥ 6 months	37	0 (0.0%)	0 (0.0%)	1 (2.7%)	12	3 (25.0%)	1 (8.3%)	0 (0.0%)

*Age of months when a mother started giving foods to a child for the first time

Chapter 4: Discussion

This study attempted to explore the nutritional situation in urban and rural areas of PNG. Overall, children and mothers were more disadvantaged in rural NUKU, than urban POM, in terms of both nutritional/physical status and food availability. Although nutritional status of children in urban POM was better than those in rural NUKU, higher susceptibility to the infectious diseases could suggest the fragility in their living environments in urban settings [31]. This was particularly obvious in poor households, due to high dependency of cash income which would affect the food choice and health service utilization. On the other hand, with the limited access to the markets and medical facilities, only locally available foods and few medicine could be obtained in rural NUKU.

Stunting is a valuable proxy of deprivation, reflecting socio-economic factors and unhealthy living conditions [32, 33]. In the study sites, the prevalence of stunting, underweight and

wasting was lower than national average [11]. Since this study was conducted in the midst of the dry season, only for 2-3 months in a year, the dietary data appeared relatively good compared to those in the rainy season. It must be noted, however, that the amount of their intake of each food item (except for staple foods) was extremely small, and also that little variation was observed in the diets among the study households, especially in rural NUKU. Considering that the seasonality greatly affects the food availability, as well as the incidence of infectious diseases, our findings could have underestimated the actual nutritional vulnerability among the study children, particularly in terms of wasting.

One of the limitations of this study was selection bias, as the data collection was undertaken at the health centers in this study, instead of household visits, due to the security/safety reason. Consequently, mothers and children from the relatively better-off households who could regularly visit for the immunization might have been possibly sampled in this study. An earlier study also explored that children of educated mothers had better nutritional status [34]. Besides, our findings of the association between mothers' BMI and children's anthropometric status also suggest that high prevalence of obesity/overweight among study mothers could have been the reason of the low prevalence of undernutrition in urban POM. Yet, few children were identified as obesity in both sites.

High prevalence of overweight/obesity among mothers in urban POM was possibly due to a great dependency on energy-dense staple foods [29], with little physical activity in their daily

lives in urban settings. Further investigation with the data obtained by 24-hour recall methods is recommended to confirm the association with dietary intake quantitatively.

Adverse health effects of betel nut chewing habit have been documented, including higher risk of obesity, metabolic syndrome and low birth weight [35, 36]. However, this association was not observed in this study.

It is said that the growth retardation would occur as early as 6-12 months, mainly due to the inappropriate feeding practices and high exposure to infections [27, 33]. According to the recommendation by WHO and UNICEF, the infants should be exclusively breastfed for at least the first 4 months, and if possible, up to the 6 months of age, followed by appropriate complementary feeding and continued breastfeeding for two years [37]. Our study, however, identified the common practices of early introduction of complementary foods and breastfeeding longer than recommended duration in rural NUKU. Our findings also suggested the adverse impact of early introduction of the first food on children's nutritional status. Furthermore, the use of powder milk observed among mothers in urban POM would implicate the problems associated with artificial feeding. It is therefore recommended to introduce nutrition education for mothers on the importance of appropriate infant feeding practices. Furthermore, a combined effect can be expected by enhancing routine immunization programs to toward reduction of under-five mortality rate, as was suggested in an earlier study [38].

Chapter 5: Conclusion

This study confirmed an urgent need of area-specific approach for “double burden of malnutrition”, considering the differential regional characteristics affecting nutritional status of children and mothers in the study areas. PNG is characterized by its multi-ethnicity and diverse topography, and thus, it is essential to consider the different features of each site, so as to identify the problems of priority and the most vulnerable group. Actually, it is not easy to improve the self-sufficiency of foods in the areas where the most of the farmer engage in the sifting cultivation. The continuous efforts, therefore, will be required to enhance the agricultural sector, as well as health sector. These approaches include nutrition education for mothers on the importance of exclusive breastfeeding and appropriate complementary food to be enhanced in the prenatal care service.

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Appendix

1. Ethical approval letter from the Medical Research Advisory Committee, Department of Health, PNG
2. Consent form
3. Recording sheet for anthropometric measurement
4. Questionnaire
5. Dietary intake recording sheet
6. Food Frequency Questionnaire

Appendix 1: Ethical Approval letter from the Medical Research Advisory Committee, Department of Health, PNG

GOVERNMENT OF PAPUA NEW GUINEA
MEDICAL RESEARCH ADVISORY COMMITTEE
Department of Health

Telephone: +675 301 3650
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PO Box 807
Waigani, NCD 131
Papua New Guinea

28th June 2010

Dr. Job Hawap
National Health Services Division
Department of Health
P.O. Box 807
WAIGANI, NCD
Papua New Guinea

Dear Dr. Hawap,

This is to certify that the proposal:

Epidemiological and study of nutritional status of children in PNG

Submitted by you and your colleagues has been examined by the Medical Research Advisory Committee of Papua New Guinea and assigned **MRAC No. 10.33**. The proposal was approved and given ethical clearance for it to be carried out in Papua New Guinea.

The Medical Research Advisory Committee of Papua New Guinea act as the National Ethical Clearance Committee and as the Institutional Ethical Committee for the Papua New Guinea Institute of Medical Research and so there is no further bar to this project being carried out in Papua New Guinea.

Investigators are reminded of the importance of keeping provincial health and research authorities informed about their study and its progress, and of submitting progress and outcome reports to the Medical Research Advisory Committee.

With best wishes

Yours sincerely

Mrs. Elizabeth Gumbaketi
Chairperson

Appendix 2: Consent form

CONSENT FORM

Nobuo Nishi
Center for Collaboration and Partnership
National Institute of Health and Nutrition, Japan

In response to the letter on October 25, 2010, I accept to participate in the nutrition survey as requested.

For mother:

Signature: _____ Date: _____
(day/month/year)

Printed Name: _____
(Last/Family Name) (First/Given Name) (Middle Name)

For child (to be written by his/her mother):

Signature: _____ Date: _____
(day/month/year)

Printed Name: _____
(Last/Family Name) (First/Given Name) (Middle Name)

Appendix 3: Recording sheet for anthropometric measurement

Name of Study site_____ Date_____

Household number_____ Name_____

Recording Sheet
Anthropometric measurement

Record of Child

Name: _____ Sex (please circle): 1. Male 2. Female

Date of Birth: day/ month / year (Age: months/year)

Number of siblings: (Birth order: th Child)

1. Height/length

1st measurement	2nd measurement	Average
cm	cm	cm

2. Weight:_____ kg

3. Mid Upper Arm Circumference (MUAC):_____ cm

Record of mother

Name: _____

Date of Birth: day/ month / year (Age: year)

Number of pregnancy/delivery: Pregnancy:____ times Delivery:____ times

1. Height

1st measurement	2nd measurement	Average
cm	cm	cm

2. Weight:_____ kg

3. Abdominal circumference:_____ cm

Appendix 4: Questionnaire

Name of Study site_____ Date_____

Household number_____ Name_____

Questionnaire

Information on household

1. Number of house member ____ *Ethnicity _____
2. Main income source for the family
   Type of occupation:_____ (Person mainly involved: _____)
3. Source of drinking water (please circle):
   a. water tap (at home) b. water tap (public) c. deep well d. river/spring
   e. other (please specify:_____)
4. Type of toilet
   a. flush toilet b. pit latrine c. other (please specify:_____) d. no toilet

Questions on the child (Name: _____)

1. Birthweight: _____g
2. Has the child got any of the following diseases in the past?
   a. Diarrhoea Past 2 weeks Yes / No
   b. Fever Past 2 weeks Yes / No
   c. Cough Past 2 weeks Yes / No
   d. Measles Yes (when? _____) / No
   e. Malaria Yes (when? _____) / No
   f. Dengue Yes (when? _____) / No
   g. Acute Respiratory Infections (ARIs) Yes (when? _____) / No
   h. Other (please specify: _____) Yes (when? _____) / No

Questions on the mother (Name: _____)

1. How often do you drink alcoholic beverage (e.g. beer, wine)?
   a. Everyday b. ____days/week c. ____days/months
   d. Quit drinking (I have not drunk for more than one year) e. Never/hardly drink
2. How many betel nuts do you chew every day?
   a. more than 6 b. 1-5 c. only one d. not every day e. Never
3. Are you a current smoker (during the past one month)?
   Please circle the most appropriate answer.
   a. I smoke cigarettes/brus every day.
   b. I sometimes smoke cigarettes/brus (How often? __ days/week)
   c. I have not smoked cigarettes/brus (during the past one month)

Appendix 5: Dietary intake recording sheet

Name of Study site_____ Date_____

Household number_____ Name_____

Dietary Intake Recording Sheet

Name of Child:_____

	Dish name	Food items	Purchased?	Amount taken (portion size)
Breakfast				
Lunch				
Dinner				
Snack				

Name of Mother:_____

	Dish name	Food items	Purchased?	Amount taken (portion size)
Breakfast				
Lunch				
Dinner				
Snack				

Questions for mothers on infant feeding practices

1. After delivery, did you give the first breastmilk (colostrum) to him/her?

   Yes No (if no, why?_____)

2. When did you start giving food other than breastmilk to the baby?

   Liquid:____ months (What?____) Food:____ months (What?____)

3. When did you stop breastfeeding? _____ months

Appendix 6: Food Frequency Questionnaire

Name of Study site_____ Date_____

Household number_____ Name_____

Food Frequency Questionnaire

How often do you and your child eat the following food items (during the past one year?) Please put ✓ in each food item.

Name of Child:_____ Name of Mother:_____

	Every day		3-6 times /week	Once or twice /week	Once /month or less	Never
	More than once per day	Once per day				
Breastmilk						
Powder milk						
Hard cracker						
Bread						
Flour						
Rice						
Cassava						
KauKau						
Banana						
Coconut						
Sago						
Fish						
Beef						
Chicken						
Green veg.						
Egg						
Sausage						
Bacon						
Milk						
Butter						
Peanut butter						
Fruit juice						
Other fruits ( )						

	Every day		3-6 times /week	Once or twice /week	Once /month or less	Never
	More than once per day	More than once per day				
Hard cracker						
Bread						
Flour						
Rice						
Cassava						
KauKau						
Banana						
Coconut						
Sago						
Fish						
Beef						
Chicken						
Green veg.						
Egg						
Sausage						
Bacon						
Milk						
Butter						
Peanut butter						
Fruit juice						
Other fruits ( )						