Short Communication

Nutritional status and dietary diversity of Kamea in Gulf Province, Papua New Guinea

Janny M Goris MSc, MPH, APD[1], Nienke Zomerdijk BS-Psych, PhD (c)[2], Victor J Temple MSc, PhD[3]

[1]*PNG Corporate Mission, North Tamborine, Australia*
[2]*School of Medicine, The University of Queensland, Australia*
[3]*Micronutrient Research Laboratory, Division of Basic Medical Sciences, School of Medicine and Health Sciences, University of Papua New Guinea, Papua New Guinea*

Background and Objectives: To assess the nutritional status of infants, children and non-pregnant women and underlying factors, dietary diversity and community food security, in the Kamea community in Gulf Province, Papua New Guinea. **Methods and Study Design:** Prospective cross sectional study. Study population 69 infants (0-59 months), 151 children (6-12 years) and 79 non-pregnant women from 10 villages in Kotidanga Local Level Government, Kerema District, Gulf Province, Papua New Guinea. **Results:** Among infants prevalence of moderate stunting, wasting and underweight were 38.9%, 8.3% and 44.4%, respectively; after adjusting Hb concentration for altitude, the anaemia prevalence was 53.8%. Among children prevalence of severe stunting was 21.2%; moderate stunting, wasting and underweight were 57.6%, 12.2% and 48.5%, respectively; anaemia was 30.3%; median urinary iodine concentration was 32.0 µg/L and iodine deficiency was prevalent among 88.1%. Among women, mean height, weight and BMI were 1.46±0.04 m, 43.9±5.91 kg and 20.4±2.32 kg/m^2, respectively; low BMI (<18.5 kg/m^2) and anaemia were prevalent among 22.8% and 35.4%, respectively; median urinary iodine concentration was 36.0 µg/L and iodine deficiency was prevalent among 80.3%. Exclusive breastfeeding was universal for young infants; complementary foods were limited in variety and frequency. Dietary diversity was limited, implementation of the universal salt iodisation strategy restricted and community food security was inadequate. **Conclusions:** The high prevalence of malnutrition and anaemia among the three age groups, including moderate status of iodine deficiency among women and children, are significant public health concerns. Improvements in dietary diversity, adequate use of iodised salt and community food security are needed.

Key Words: malnutrition, iodine deficiency, dietary diversity, food security, Papua New Guinea

INTRODUCTION

In Papua New Guinea (PNG), malnutrition remains the leading cause of maternal and child morbidity and mortality.[1] According to the PNG Child Health Policy and Plan 2009-2020, two-thirds of all child deaths in PNG are associated with moderate or severe malnutrition.[2] Current data on monitoring and evaluation of the nutrition and health status of PNG children are limited.[2-4] Published data on the prevalence and underlying factors of malnutrition among children and women in the Gulf province are scant, especially in isolated communities in the inaccessible highlands of Kerema district.[5] The objectives of the current study were to assess the nutrition status of infants, children and non-pregnant women and underlying factors, dietary diversity and community food security, in the Kamea community in Gulf Province, PNG.

SUBJECTS AND METHODS

Population and study site

The Kamea are members of the Angan-speaking group, which consists of approximately 70,000 people. They are part of the Kotidanga Local level Government (LLG), and inhabit an area covering parts of Morobe, Gulf, and Eastern Highland Provinces.5 In Kotidanga LLG, there is one Health Centre at Kanabea with a Health Extension Officer, servicing a population of around 20,000 Kamea people.[6] Kanabea is approximately 1,320 m above sea level with a minimum temperature of 12°C, maximum of 27°C and a yearly rainfall of 4000-7000 mm.[7,8] There are no roads to the study site; the only way of getting there is by walking along mountain paths or by air transport.

Study design

This cross-sectional study was conducted during March-April 2015. Ten villages were selected using convenience sampling, because they were the easiest to access on foot, and were all within one-day walking distance from the Kanabea Health Centre. The villages were combined into five clusters, with a total of 85 households, of which 15

Corresponding Author: Dr Janny M Goris, PNG Corporate Mission, North Tamborine, QLD 4272, Australia.
Tel: +61 755452286, +61 439505706; Fax +61 755452099.
Email jannygoris@gmail.com
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(17.6%) were found empty. All the 70 households were enrolled in the study, as the population was below 2,500 people. All eligible infants, children and women were invited to participate in the study. The selected participants included 69 infants and young children in the age group 0-59 months, and 79 non-pregnant women. In addition, 151 children aged 6-12 years were selected from the three different elementary and primary schools in the five clusters.

Ethical approval

Ethical approval was obtained from the PNG National Department of Health Medical Research Advisory Committee (NDoH MRAC) and the Ethics and Research Grant committee in School of Medicine and Health Sciences (SMHS), University of PNG (UPNG). Informed consent was obtained from Village authorities, and each adult participant and primary care giver of the children.

Case definitions and inclusion criteria

Each 'household' included people who slept in the house the night before and ate from the same cooking pot/hearth. The age of infants and children was established, based on the information in the Child Health Record book, the parents' report, or school records. A child was excluded from the study if their age could not be determined from the information provided. A women's age was based on self-report or estimated by using a local events calendar.

Survey instruments

Shorr board (Weigh and Measure, US) was used to measure the heights of infants and children, according to standard procedures.[9] The adult extension piece was attached to the Shorr board to measure the height of non-pregnant women. For measuring the weights of infants and young children, a Seca 354 baby/child scale was used and a standard weighing scale was used for children and women. Assessment of bilateral oedema was based on World Health Organisation (WHO) criteria.[9] Growth standards (WHO 2006) were used to interpret the anthropometry results for children.[10] Nutritional status of women was assessed using WHO-recommended categories for BMI.[11]

The HemoCue Hb 301 was used to measure the Haemoglobin (Hb) concentration, according to the standard procedure.[12] The Hb results were adjusted, based on altitude.[13,14] For altitudes of 1311 m a reduction in individual Hb concentration of -3 g/L was applied.

Salt samples were collected from households and also purchased from local markets and iodine content in salt was measured.

On-the-spot urine sample was collected from each consented child and non-pregnant woman. Assay of urinary iodine concentration (UIC) was by Sandell-Kolthoff reaction.[15]

Infant and young child (IYC) feeding related variables were assessed using eight core and optional feeding practice indicators developed by the WHO for assessing the adequacy of IYC feeding practices.[16,17] Questionnaires were pre-tested and modified for the local situation, in English and Pidgin.

Household dietary diversity, defined as the number of unique foods consumed by household members over a given period, has been validated to be a useful approach for measuring household food access.[17-19] This study assessed the quality of diet consumed through validated questionnaires,[17,18] using the household dietary diversity score as a proxy measure.

To assess community food security, a total of 7 in-depth interviews were conducted with key community leaders in the 5 clusters; one ward councillor, four headmen, and two teachers. A pre-tested and modified questionnaire was developed to cover several topics including food production and uses, agricultural techniques, food transfer, livestock ownership, based on the SMART methodology[20] and International Federation of Red Cross methodology.[21]

Data analysis and interpretation

All continuous data were checked for normality using the Kolmogorov-Smirnov test. Analyses of anthropometrics were carried out in ENA (SMART methodology),[20] Epi Info 7, and SPSS-PC software (version 20, 2011). A $p<0.05$ was considered statistically significant.

The boundaries for exclusion of anthropometric data were defined as ±3×SD of *weight-for-height z-score* (WHZ) from the observed WHZ mean; ±3×SD *length/height-for-age* z-score (L/HAZ) from the observed L/HAZ mean; ±3×SD *weight-for-age z-score* (WAZ) from the observed WAZ mean.

The ranges used for assessing the Hb concentration in the IYC were 100-109 g/L for mild anaemia, 70–99 g/L for moderate anaemia and below 70 g/L for severe anaemia.[13] For non-pregnant women, the ranges used were 110-119 g/L for mild anaemia, 80-109 g/L for moderate anaemia, and <80 g/L for severe anaemia.[13]

The iodine content in salt samples was measured using the WYD iodine checker and expressed in parts per million (ppm).[22] UIC values were expressed in micrograms of iodine per liter of urine (µg/L).[15] The current WHO/UNICEF/ICCIDD guidelines and PNG Salt Legislation were used for interpretation of the results.[23,24] Iodine content in salt should be greater than 15ppm in over 90% of households; in addition, the iodine content in salt should not be less than 30 ppm.[25,26] Iodine deficiency should be considered as a public health problem, if the median UIC is below 100.0 µg/L and more than 20% of the target population have UIC below 50.0 µg/L. Specific cut-off points for the UIC were used for classifying the status of iodine nutrition into different degrees of public health significance.[23]

Bivariate analyses were carried out to identify the potential association of IYC feeding and nutrition status.

RESULTS

Nutrition status and anaemia among infants and young children (IYC)

Of the 69 IYC, 39 (56.5%) were boys and 30 (43.5%) were girls. Table 1 shows the prevalence of stunting, wasting and underweight among the IYC in the age groups 0 to 23 and 24 to 59 months. Among the IYC, the prevalence of stunting (HAZ) was 62.3% (95% CI: 43.0, 78.4), with a mean of -2.16±0.93. The IYC in the 0-23 months age group had a lower ($p<0.05$) overall preva-

Table 1. Prevalence of stunting, wasting and underweight among infants and young children (IYC) in the age groups 0-23 and 24-59 months

Variables		All the children (n=69)		0-23 months (n=36)		24-59 months (n=33)	
		n	%	n	%	n	%
Stunting	Severe	10	14.5	3	8.3	7	21.2
	Moderate	33	47.8	14	38.9	19	57.6
Total		43	62.3	17	47.2	26	78.8
Wasting	Severe	0	0	0	0	0	0
	Moderate	7	10.1	3	8.3	4	12.2
Total		7	10.1	3	8.3	4	12.2
Underweight	Severe	3	4.3	1	2.8	2	6.1
	Moderate	32	46.4	16	44.4	16	48.5
Total		35	50.7	17	47.2	18	54.6

Stunting: length/height-for-age z-score; Wasting: weight-for-length/height z-score; Underweight: weight-for-age z-score.

lence of stunting (47.2%), compared with the 24 to 59 months age group (78.8%). Prevalence of wasting (WHZ) was 10.1% (95% CI: 3.0, 29.1), with a mean of -0.81±0.93. Oedema was not detected in any of the IYC. The IYC in the 0-23 months age group had a lower (p<0.05) overall prevalence of wasting (8.3%), compared with those in the 24 -59 months age group (12.1%). Prevalence of underweight (WAZ) was 50.7% (95% CI: 23.3, 77.7). The mean WAZ was -1.82±0.8. Those in the 0-23 months age group had a lower (p<0.05) overall prevalence of underweight (47.2%), compared with those in the 24-59 months age group (54.6%). Prevalence of anaemia (Hb <110 g/L) was 40.7% among the IYC. Although none of the IYC had severe anaemia, 33.9% had moderate anaemia. Anaemia was higher among those in the 6-23 months (53.8%), compared with the 24-59 months age group (30.3%).

Nutrition status and anaemia among the non-pregnant women

The mean age, height, weight and BMI of all the women were 31.3±8.45 years, 1.46±0.04 meters, 43.9±5.91 kg and 20.4±2.32 kg/m^2, respectively. The BMI ranged from 15.0 to 26.9 kg/m^2, and 22.8% of all the women had a BMI below 18.5 kg/m^2. A total of 32 (40.5%) women were shorter than 145 cm. The prevalence of anaemia (Hb <120 g/L) was 35.4%. Prevalence of moderate and mild anaemia was 12.7% and 22.8%, respectively.

Salt iodisation

Of the 70 households that participated in this study, traditional salt ("Kweka salt") was present in 8 (11.4%) and commercial salt in 16 (22.9%) households. Commercial salt coverage was significantly lower than the 90% recommended for effective implementation of the universal salt iodisation (USI) strategy.[15,24,26] The iodine content was zero (0.0 ppm) in all the traditional salt samples. Iodine content was <15 ppm in salt from 9 (56.3%) of the 16 households with commercial salt, and it was <30 ppm in the salt from 13 (81.3%) of the 16 households.

Status of iodine nutrition

Non-pregnant women

The median UIC for the women was 36.0 µg/L and the Interquartile Range (IQR) was 21.0-82.0 µg/L. The UIC in the urine of 80.3% of the women was less than 100.0 µg/L and 57.7% had UIC below 50.0 µg/L. Severe, moderate and mild status of iodine nutrition were prevalent among 19.7%, 38.0% and 22.5% of the women respectively.

Children 6 to 12 years

The median UIC for the children was 32.0 µg/L and the IQR was 15.5-65.5 µg/L. The UIC in the urine of 88.1% of the children was less than 100.0 µg/L, and 64.2% had UIC below 50.0 µg/L. Severe, moderate and mild status of iodine nutrition were prevalent among 31.8%, 32.4% and 23.8% of the children, respectively.

Feeding of infants and young children (IYC)

All 36 (100%) mothers of the infants (age group 0-23 months) interviewed reported initiating breastfeeding within the first 24 hours after birth. Among these women, 36.1% initiated breastfeeding in the first hour after birth and 63.9% within 1-23 hours after birth. Six (16.6%) of the 36 infants received water to drink in the first three days after delivery.

All the 69 IYC were breastfed up to one year of age, and they were still breastfed a minimum of once daily at 18 months of age. None of the IYC was fed infant formula or feeding from a bottle with a nipple. Most IYC were introduced to complementary foods around 4-5 months of age (median 4.6 months, range 2.3-8.2 months). To meet energy requirements, WHO recommends a minimum of two and three meals per day for breastfeeding IYC between the age 6-8 and 8-23 months, respectively.[16-18] Our data shows that more than half (66.6%) of the IYC received below the recommended minimum meal frequency. Sixty-one percent of the IYC had a dietary diversity below the minimum dietary diversity recommended by the WHO (<4 food groups). The median dietary diversity score was three. The majority (97.2%) of mothers in this study reported that IYC consumed complementary foods made from white roots and tubers (white sweet potato, taro, cooking banana); most (94.4%) consumed dark leafy vegetables; 75.0% consumed vitamin-A rich fruits and vegetables such as sweet banana and yellow pumpkin. However, flesh meat (mainly frogs and cuscus) was consumed by 33.3% of the IYC; 22.2% consumed nuts/seeds; 2.8% fish; 2.8% consumed eggs and 2.8% consumed

Table 2. Household dietary diversity: Common names of foods in the various food groups and percent (n) of households consuming the various foods.

Food groups	Households (n=70), % (n)	Most frequently consumed food[8,32]
White roots and tubers	100 (70)	Taro, sweet potato, manioc
Foods made from grains	4.3 (3)	White rice
Vegetables, tubers fruits that are yellow or orange inside	41.4 (29)	Yellow sweet potato, pumpkin, Sweet banana, tamarillo ('tree tomato'), pineapple, mandarin
Dark green leafy vegetables	100 (70)	Aibika (Pidgin name for dark green leafy vegetables) including Amaranthus, young shoots of choko plant 'krusako', rungia, taro leaves ('kaukau') pumkin tips, blackberried nightshade 'karakap', bamboo shoots, peanut leaves, wild edible leaves
Other fruits or vegetables	5.7 (4)	Cucumber 'ipanga', spring onions, avocado, pitpit, sugar cane, marita fruit from pandanus tree
Organ meat	0	
Flesh meat	28.6 (20)	Frogs, cuscus (possum), bush rat
Grubs, snails or insects	7.1 (5)	Beetles, grubs, spiders, caterpillars, mantids, ants, cicadas, green grasshoppers or other leaf insects
Eggs	5.7 (4)	Chicken or other bird
Fish (tinned)	5.7 (4)	Mackerel in tin
Legumes, nuts, seeds	28.6 (20)	Peanuts, finchia nut, lablab bean, pumpkin seeds
Milk (powder), cheese, yoghurt products	0	
Oils, fats, butter, coconut	74.3 (52)	Palm oil
Sugary foods	2.9 (2)	Tea with sugar
Other foods or drinks	48.6 (34)	Traditional medicine/plants, salt/flavouring from local bush 'kweka', ginger
Betel nut, kabibi (Areca palm), tobacco	85.7 (60)	Betel nut chewed with slaked lime powder; smoking of dried tobacco leaves in piece of thin bamboo or dried leaves

grain-based foods. In addition, 22.2% of IYC were fed with the minimum acceptable diet (combination of minimum meal frequency and minimum diet diversity). There were no statistically significant (p>0.05) associations between stunting, wasting or underweight status of the IYC and their feeding practices.

Household dietary diversity

The data for foods and drinks consumed in the 70 households 24 hours preceding the survey showed that the median dietary diversity score for the households was three. Fifty-one percent of the households had a dietary diversity below the minimum dietary diversity recommended by the WHO (consumption <4 food groups).[17] The majority of the 70 households received foods from three food groups: white roots and tubers (100%), dark green leafy vegetables (100%) and oils and fats (74.3%). Orange or yellow fruits were consumed by 41.4% of households, legumes, nuts and seeds by 28.6% and only 28.6% had eaten flesh (mainly bush meat), 5.7%-tinned fish, and 5.7%-eggs. Grain-based foods were consumed by 4.3%. Betel nut, kabibi or tobacco was used by 85.7% of households. Table 2 shows the common names of unique foods in the various food groups and percent of households consuming the various foods.

Community food security

Most households lived in traditional houses made from bamboo or pitpit canes, built in a circular or rectangular shape. They cooked and slept in the communal, open-space living area, with no electricity. According to in-depth interviews with 7 community leaders, land in Kotidanga LLG is occupied and used under *customary tenure*.[8] All households were reported to have access to land to grow staples and greens in small, intensively cultivated house gardens around the edge of the house or settlement. They used their own harvested seeds and did not make use of fertilisers and pesticides. Most households (92.9%) practiced subsistence agriculture; the excess products were sold or exchanged at the local markets. Crops regularly failed, due to extreme rainfall and overcast conditions (September-April) or drought.[7,8] The livestock used were mainly chickens and pigs, only consumed at special occasions. Pigs are the household investment and important for ceremonial exchanges, compensation and trade. Food preparation in the household was usually done by the women, using wood for fuel. Sweet potato, taro and cooking banana were usually roasted in the open fire or on hot coals; greens were usually boiled in water in a large bamboo stem or in metal cooking pots placed over open fire or hot coals. Occasionally, the ground oven-style of cooking called "mumu" was used. Large bamboo stems were used as containers for food storage.

DISCUSSION

Compared with the 2005 PNG National Nutrition Survey,[27] which gave regional and national data, the present study found a relatively higher prevalence of stunting, wasting and underweight among IYC. This may indicate that both chronic and acute malnutrition are more preva-

lent in the present study area, compared with the other provinces in the Southern Region. Prevalence of anaemia (40.7%) in children 6-59 months, obtained in the present study, was lower than the 55.6% reported for children in the Southern Region and the national average of 48.1%.[3,27] The prevalence (35.4%) of anaemia among women was similar to the national prevalence of 35.7%, but lower than the 44.2% prevalence reported for women in the Southern Region of PNG.[3]

Maternal and child malnutrition and dietary risks were the highest-ranking risk factors for morbidity and mortality in PNG in 2013.[1,28-30] The Kamea have a low dietary diversity and consume few protein- and micronutrient-rich foods to meet their dietary needs. Low intake of these foods is a serious risk factor for stunting. Prevalence of stunting, with or without presence of wasting, considerably increases the risk of infectious diseases, leading to high child morbidity, disability and mortality.[28,29]

IYC in the age group 0-23 months had lower prevalence rates of stunting, wasting and underweight, compared with those in the 24-59 months age group. It is very likely this is due to continued breastfeeding until at least 18 months of age. Black et al reported that the peak prevalence of anaemia due to iron deficiency occurs around 18 months of age and then falls, as iron requirements decline and iron intake is increased through complementary foods.[28] In the present study, anaemia prevalence was higher in the age group 6-23 months, compared with 24-59 months. This may be due to low iron content in the complementary foods or poor bioavailability of the iron caused by the presence of chelators or inhibitors. Anaemia, together with iodine deficiency, negatively affects child cognitive development and reduces their intellectual potential.[28]

The nutritional status of women before and during pregnancy is important for healthy pregnancy outcome.[28,31] Results of this study showed the prevalence of short stature (40.5%) and low BMI (22.8%) of the women combined with a high prevalence of anaemia (35.4%). According to Black et al, short stature and iron deficiency anaemia in mothers increase their risk of death during delivery and can account for up to 20% of maternal mortality.[28] Most Kamea women deliver their babies in the "bush" and do not have access to proper health services. There is an urgent need to advocate for adequate nutritional support and medical care for Kamea women.

The results obtained for salt iodisation in Kotidanga LLG indicated poor implementation of the USI strategy and PNG Salt legislation. Iodine deficiency among non-pregnant women and school-age children was at the level of public health significance.

Conclusion

The study concluded that there was a high prevalence of malnutrition and anaemia among the three age groups, including moderate status of iodine deficiency among the women and children. The data indicate that exclusive breastfeeding of infants was universal, and that complementary foods were limited in variety and frequency, mainly due to inadequate dietary diversity and food security among the community. This is a significant public health concern and there is urgent need to advocate for a significant improvement in the nutritional status of women and children in the Kamea community. Aggressive advocacy of appropriate and adequate use of iodised salt to control iodine deficiency, and general nutrition education should be carried out at all levels in the district.

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AUTHOR DISCLOSURES

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