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MARIE L ASKA[1], QUALA MESS[1], PINZO TENGE[1], MONN ENGIMP[1], MAX PETER[1], BAPO IPO[1], RUSSEL KITAU[2], *ELIAS NAMOSHA[3]

1. Jiwaka Provincial Health Authority (JPHA), Jiwaka Province, Papua New Guinea (PNG)
2. National Department of Health, PNG
3. Division of Public Health, School of Medicine and Health Sciences, UPNG

*Corresponding author: elias.namosha@upng.ac.pg

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3. **Division of Public Health, School of Medicine and Health Sciences, UPNG**

***Corresponding author: elias.namosha@upng.ac.pg**

ABSTRACT

Malnutrition remains a major public health challenge in Papua New Guinea (PNG), particularly among children under five years of age. Health workers serve as frontline providers in addressing this burden, and play a critical role in early identification, diagnosis, and management of malnutrition. However, gaps in clinical knowledge may compromise quality of care. The aim of this study was to assess the level of clinical knowledge on malnutrition among health workers in Jiwaka Province and identify factors associated with adequate knowledge. A cross-sectional analytical study was conducted among 151 health workers in Jiwaka Province. Clinical knowledge was assessed using a structured questionnaire. Knowledge scores were categorized as low (<50%), average (50–74.9%), and good (≥75%). Independent sample t-test, one-way ANOVA, Pearson and Spearman correlations, Chi-square tests, and multivariable logistic regression were performed (Binary logistic regression). The mean knowledge score was 17.42% (SD ±2.84). Most participants demonstrated average knowledge (59.6%), while 25.2% had low knowledge and only 15.2% had good knowledge. Significant differences were observed across professional designations, with Community Health Workers scoring significantly lower than Nursing Officers and Health Extension Officers ($p < 0.001$). Attendance at malnutrition-specific training (AOR = 4.87, 95% CI: 1.61–14.75, $p = 0.005$) and university-level training (AOR = 5.76, 95% CI: 1.05–31.54, $p = 0.044$) were significant predictors of adequate knowledge. Significant gaps exist in treatment and management domains. Targeted malnutrition-specific training interventions to strengthen malnutrition management capacity are critical to improving clinical competence among health workers in Jiwaka, PNG.

Keywords: malnutrition, clinical knowledge, health workers, Papua New Guinea, capacity building, training effectiveness.

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INTRODUCTION

Malnutrition remains one of the most significant contributors to morbidity and mortality in children under five years globally, with particularly severe impacts in low-and middle-income countries (LMICs) [1-2]. The World Health Organization (WHO) estimates that approximately 149 million children under five are stunted, 45 million are wasted, and 38 million are overweight globally, with malnutrition accounting for nearly 45% of all deaths in this age group [3-4]. In the Asia-Pacific region, Papua New Guinea (PNG) faces disproportionate nutritional challenges, with childhood malnutrition rates among the highest in the region [5].

In PNG, childhood malnutrition remains a significant public health challenge. According to the PNG Demographic and Health Survey (DHS) report, approximately 46% of children under five are stunted, 18% are underweight, and 5% are wasted [6]. These rates are among the highest in the Pacific region and reflect persistent nutritional inequalities. The PNG National Nutrition Policy (2016–2026) identifies malnutrition as a critical development issue affecting child survival, cognitive development, and long-term economic productivity [7]. Recent national surveys indicate that approximately 37% of children under five experience stunting, while acute malnutrition (wasting) affects 10-15% of children in this age group, with severe acute malnutrition (SAM) requiring immediate clinical intervention [8-9]. The burden is particularly pronounced in rural and remote districts, including Jiwaka Province, where access to adequate nutrition and healthcare services remains limited.

PNG's health system is characterized by a decentralized structure with limited resources, particularly in rural and provincial settings. The health workforce comprises a diverse cadre of providers, including Community Health Workers (CHWs), Nursing Officers (NOs), Health Extension Officers (HEOs), and limited numbers of physicians [10]. At the primary healthcare level, CHWs and health facility staff serve as the backbone of service delivery, often operating with minimal supervision and variable access to training and resources [11].

Geographical isolation, health workforce shortages, limited infrastructure, and inconsistent supply chains further complicate effective management of malnutrition in rural provinces such as Jiwaka [12]. Primary healthcare facilities are often staffed predominantly by CHWs, who serve as frontline providers in assessment and management of childhood illnesses [13]. Moreover, effective management of malnutrition in children requires health workers to possess comprehensive clinical knowledge across multiple domains, including assessment, diagnosis, treatment, and management of different types of malnutrition. The WHO guidelines on prevention and

management of wasting and nutritional oedema in infants and children under five years provide evidence-based recommendations that should guide clinical practice [3]. These guidelines emphasize the importance of early identification, appropriate nutritional assessment, and timely intervention to prevent mortality and morbidity.

Despite national policies and guidelines on malnutrition management in PNG's health systems, limited empirical evidence exists on health workers' knowledge of malnutrition in Jiwaka Province. Understanding the baseline knowledge levels, identifying factors associated with knowledge variation, and recognizing specific domain-specific gaps are essential to guide targeted training interventions aligned with PNG's National Health Plan (2021–2030) [14].

The aim of this study was to assess the level of clinical knowledge on malnutrition among health workers and identify factors associated with adequate knowledge. To our knowledge, this is the first study by Jiwaka Provincial Health Authority (PHA) to assess health workers clinical knowledge on malnutrition in Jiwaka Province, PNG.

METHODOLOGY:

Study setting and population:

The study was conducted in Jiwaka Province, located in the Highlands Region of PNG. Jiwaka was selected as the study site because of the significant burden of childhood malnutrition and the need for evidence to guide capacity-building efforts among frontline health workers in this resource-limited setting.

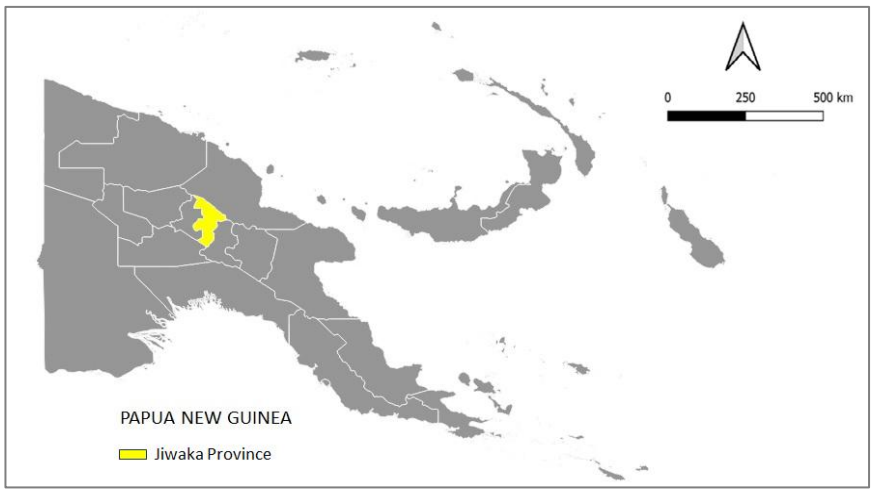

Figure 1. Study location in Papua New Guinea

The province was established in 2010 after separating from Western Highlands Province, with Banz serving as the administrative capital. It consists of three districts; North Waghi, Anglimp-South Waghi, and Jimi covering a land area of approximately 4,798 km^2. The

population was 343,987 in the 2011 census and was estimated to reach 451,496 by 2021 [15]. Most residents live in rural communities and depend on subsistence agriculture, with fertile valley areas supporting coffee, tea, fresh produce, and livestock production.

Health services in the province are managed by the Jiwaka PHA, established in 2019 to strengthen health service delivery. Health care is provided through a network of government and church-run facilities, including hospital, health centres, and rural aid posts, with Kudjip Nazarene General Hospital serving as the main referral hospital.

The study population consisted of all frontline health workers employed in health facilities across Jiwaka Province, including CHWs, NOs, and HEOs. Assessing their knowledge in this context provides critical insights into the state of malnutrition management capacity at the frontline of PNG's health system and to address childhood malnutrition in the province.

Study Design:

A cross-sectional descriptive and analytical study design was used to assess the clinical knowledge of health workers on the identification and management of malnutrition among children under five years. This design enabled the collection of data from participants at a single point in time to provide a snapshot of current knowledge levels among frontline health workers.

The descriptive component summarized the socio-demographic and professional characteristics of participants, including cadre, years of experience, training background, and workplace. It also described their knowledge of key aspects of childhood malnutrition such as diagnosis, classification, and recommended management practices.

The analytical component examined the relationship between knowledge levels and selected factors, including professional category, clinical experience, prior training in nutrition, and facility type. The cross-sectional approach was appropriate because it is efficient and cost-effective, and it provides useful baseline information to inform training, policy, and capacity-building initiatives aimed at improving the management of childhood malnutrition within the health system.

Sample Size and Sampling Method:

A total of 151 health workers participated in this study. The sample comprised frontline health personnel working in government and church-run health facilities across the three districts. Participants were recruited using a combination of purposive and convenience sampling techniques**.** Purposive sampling was used to specifically target health workers who were involved in the clinical management of children, particularly those responsible for diagnosing and treating childhood illnesses such as malnutrition. Convenience sampling was then applied to recruit available and eligible health workers present at the selected facilities during the data collection period.

The inclusion criteria for participation were: (1) currently employed as a health worker in a health facility within Jiwaka Province, (2) having at least six months of work experience in their current role to ensure familiarity with clinical responsibilities, and (3) willingness to participate and provide informed consent**.** Health workers who were on extended leave during the study period or who declined to participate were excluded from the study.

This sampling approach was considered appropriate given the logistical challenges of accessing health workers in geographically dispersed rural settings. It also allowed the study to capture practical insights from those actively delivering frontline health services in the province.

Data Collection Tool:

Data were collected using a structured questionnaire developed specifically for this study. The questionnaire comprised three main sections: 1) Demographic and Professional Information: This section collected data on gender, age, marital status, education level, professional designation, years of experience, type of health facility, and training history. 2) Clinical Knowledge Assessment: A comprehensive knowledge assessment tool was developed to evaluate health workers' understanding of malnutrition across eight specific domains*:* i) Coordination and Leadership Management, ii) General Knowledge on Malnutrition, iii) Availability of Clinical Diagnosis Tools, iv) Availability of Medical Supplies, v) Assessment of Children with Malnutrition, vi) Diagnosis of Types of Malnutrition, vii) Treatment of Malnutrition, and viii) Management of Malnutrition.

Training and Facility Factors: Questions regarding attendance at malnutrition-specific training, health training college attended, post-basic advanced training, and practical training facility type.

The knowledge assessment items were based on WHO guidelines on malnutrition management and international best practices for assessment and diagnosis of acute malnutrition in children [3]. Items were adapted to the PNG context and pretested with a small sample of health workers for clarity and relevance.

Data were collected by trained research assistants who administered the questionnaire through face-to-face interviews with consenting health workers. Each interview lasted approximately 30-45 minutes. Data collection was conducted between April-May 2024, across all three districts of Jiwaka Province.

Study Variables:

Dependent Variable: Clinical Knowledge on Malnutrition. This was assessed using a composite knowledge score derived from responses to multiple-choice questions across the eight domains. Scores ranged from 10 to 23, with higher scores indicating greater knowledge. Knowledge levels were categorized as: Low: <50% of total possible score, Average: 50–74.9% of total possible score, Good: ≥75% of total possible score.

For domain-specific analyses, a 75% competency threshold was applied to classify knowledge as adequate or inadequate, consistent with international standards for clinical competency assessment [16].

Independent Variables: Demographic Variables: Gender, age group, marital status, years of experience, and education level.

Professional Variables: Designation (CHW, NO, HEO), health training college attended (CHW Training School, Nursing School, University), post-basic advanced training (Yes/No), and attendance at malnutrition-specific training (Yes/No).

Health System Variables: Type of health facility (day clinic, health sub-centre, health centre) and practical training facility type.

Data Management and Statistical Analysis:

All completed questionnaires were checked for completeness before data entry. Responses were coded and entered into Epi-Info version 7.2 as a database management tool [17]. Data cleaning included consistency checks and exclusion of cases with missing information to ensure data quality. Data were analysed using IBM SPSS (Statistical Package for the Social Sciences) statistics version 22 [18].

Both descriptive and inferential statistics were used to summarize participant characteristics and responses. Descriptive statistics were calculated to summarize demographic characteristics, knowledge levels, and domain-specific performance. Measures included frequencies, percentages, means, standard deviations, medians, modes, and ranges. Knowledge distribution was presented using frequency tables and summary statistics.

In inferential statistics, an independent samples t-test was conducted to compare malnutrition knowledge scores between males and females. The test examined whether gender differences in mean knowledge scores were statistically significant. A one-way analysis of variance (ANOVA) was performed to determine whether knowledge scores differed significantly across the three professional designations (CHW, NO, HEO). The F-statistic and p-value were reported. Following a significant ANOVA result, Tukey HSD (Honestly Significant Difference) post hoc tests were conducted to identify which specific groups differed significantly from one another.

Pearson correlation analysis was used to examine relationships between knowledge scores and continuous variables (age, years of experience). Spearman's rank correlation was applied to assess relationships between knowledge and ordinal variables (designation, education level).

Chi-square test was conducted to assess associations between categorical independent variables (gender, age group, marital status, education level, training college, post-basic training, malnutrition training attendance) and

categorical knowledge levels (low, average, good). Fisher's Exact Test was used when expected cell frequencies were less than five.

A multivariable binary logistic regression model was used to identify independent predictors of adequate clinical knowledge. The dependent variable was binary (adequate vs. inadequate knowledge, where 1=adequate, 0=inadequate). Independent variables included in the model were those that demonstrated significant associations ($p \leq 0.05$) in bivariate analysis: health training college attended, post-basic advanced training, and attendance at malnutrition-specific training. Crude and adjusted odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to estimate the strength and direction of associations, allowing for adjustment of potential confounders. Model fit was assessed using the Hosmer-Lemeshow goodness-of-fit test. Statistical significance was set at $p \leq 0.05$.

Ethical Considerations:

The study was granted ethical approval from the PNG Medical Research Advisory Committee (MRAC # 24.10). Written informed consent was obtained from all participants prior to data collection. Confidentiality and anonymity were maintained throughout the study. Participants were assured that their responses would not affect their employment or professional standing. Participants were also informed about their right to withdraw from the study at any stage.

RESULTS:

Demographic Characteristics of participants (Table 1):

The study included 151 health workers, of whom 64.2% were female and 35.8% male. The majority were aged 26–30 years (34.4%), followed by 31–35 years (25.2%) and 36–40 years (17.9%) the others are presented in Table 1. Most participants were married (86.8%), with smaller proportions single (9.3%) or divorced/widowed. In terms of education, 62.9% had completed Grade 12, 35.1% Grade 10, and 2.0% Grade 8. Participants were distributed across districts, with Anglimp-South Waghi (43.7%) contributing the largest share, followed by North Waghi (29.8%), Jimi (20.5%), and Western Highlands Province (6.0%). The sample was predominantly composed of CHWs (61.6%), followed by NOs (33.1%) and HEOs (5.3%). Most respondents worked in health sub-centres (48.3%) and health centres (37.7%), with fewer based in day clinics (13.9%).

Clinical Knowledge Levels of Health Workers:

The clinical knowledge scores on malnutrition ranged from 10 to 23, with a mean score of 17.42 (SD ±2.84), a median of 17, and a mode of 16. As shown in Table 2, the majority of health workers demonstrated average knowledge levels (59.6%), while 25.2% had low knowledge (<50%) and 15.2% demonstrated good knowledge (≥75%).

Influence of Sociodemographic, Personal Education, and Health System Factors:

T-test Analysis:

An independent samples t-test was conducted to determine whether malnutrition knowledge scores differed between males and females (Table 3).

There was no statistically significant difference in malnutrition knowledge scores between males (M=17.1, SD=3.1) and females (M = 17.6, SD = 2.7),

$t(149) = -1.11$, $p = 0.27$, 95% CI [-1.49−0.42].

ANOVA Analysis:

A one-way ANOVA was conducted to determine whether malnutrition knowledge scores differed significantly across the three professional designations: CHWs, NOs, and HEOs.

A one-way ANOVA test was statistically significant ($F(2, 148) = 10.56$, $p < 0.001$), indicating that at least one of the three professional groups had a mean knowledge score significantly different from the others. Following the significant ANOVA result, Tukey HSD post hoc tests were conducted to determine which specific designation groups differed significantly from the others (Table 3).

Table 1. Demographic characteristics of study participants (n=151).

Variable	Frequency (n)	Percent (%)
Gender		
Male	54	35.8
Female	97	64.2
Age Group (Years)		
22–25	8	5.3
26–30	52	34.4
31–35	38	25.2
36–40	27	17.9
41–45	8	5.3
46–50	4	2.6
51–55	8	5.3
56–60	2	1.3
61–65	3	2.0
65+	1	0.7
Marital Status		
Single	14	9.3
Married	131	86.8
Divorced	2	1.3
Widowed	4	2.6
Education Level		
Grade 8	3	2.0
Grade 10	53	35.1

Grade 12	95	62.9
District of Residence		
North Waghi	45	29.8
Anglimp-South Waghi	66	43.7
Jimi	31	20.5
Western Highlands Province	9	6.0
Designation		
CHW	93	61.6
NO	50	33.1
HEO	8	5.3
Health Facility Type		
Day Clinic	21	13.9
Health Sub-Centre (HSC)	73	48.3
Health Centre (HC)	57	37.7
Total	151	100%

Table 2. Clinical Knowledge Level of Health Workers in Jiwaka Province (n=151).

Knowledge Level	Frequency (n)	Percent (%)
Low (<50%)	38	25.2
Average (50–74.9%)	90	59.6
Good (≥75%)	23	15.2
Total	151	100

Table 3. Descriptive statistics: Knowledge score by designation (n=151).

Designation	N	Mean	SD	Minimum	Maximum
CHW	93	16.65	2.72	10.00	22.00
NO	50	18.52	2.57	13.00	23.00
HEO	8	19.50	2.78	15.00	23.00
Total	151	17.42	2.84	10.00	23.00

ANOVA Results					
Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	150.95	2	75.47	10.56	<0.001
Within Groups	1057.77	148	7.15		
Total	1208.72	150			

Table 4. Tukey HSD Post Hoc Comparisons: Knowledge Score by Designation

Comparison	Mean Difference	Std. Error	p-value	95% CI
CHW vs. NO	–1.87	0.47	<0.001	–2.98 to –0.76
CHW vs. HEO	–2.85	0.99	0.012	–5.19 to –0.52
NO vs. HEO	–0.98	1.02	0.602	–3.39 to 1.43

As presented in Table 4, CHW vs. NO: CHWs scored significantly lower than NOs (mean difference = –1.87, p < 0.001). The 95% confidence interval (–2.98 to –0.76) does not cross zero, confirming that this difference is statistically reliable and clinically meaningful.

CHW vs. HEO: CHWs also scored significantly lower than HEOs (mean difference = –2.85, p = 0.012). The 95% confidence interval (–5.19 to –0.52) confirms the significance of this difference, with CHWs scoring approximately 2.85 points lower on average.

NO vs. HEO: NOs and HEOs did not differ significantly in knowledge scores (mean difference = –0.98, p = 0.602).

The 95% confidence interval (–3.39 to 1.43) crosses zero, indicating that the observed difference could be due to chance.

Pearson correlation analysis:

A Pearson correlation analysis was performed to examine relationships among malnutrition knowledge, age, and years of experience.

Knowledge vs. Age: r = –0.032, p = 0.698 (not significant). There was no statistically significant relationship between age and malnutrition knowledge.

Knowledge vs. Years of Experience: r = –0.043, p = 0.602 (not significant). Years of work experience was not significantly related to knowledge scores.

Age vs. Years of Experience: r = 0.878, p < 0.001 (highly significant). As expected, age and years of experience were very strongly correlated, indicating that older workers had more years of service.

Spearman's rank correlation:

Spearman's rank correlation analysis was conducted to examine relationships between knowledge and ordinal variables (professional designation and education level) (Table 5).

Table 5. Spearman Rank Correlation Results

Correlation	rho	p-value	Interpretation
Knowledge vs. Designation	0.351	<0.001	Moderate, positive, significant
Knowledge vs. Education Level	0.163	0.046	Weak, positive, significant

Knowledge vs. Professional Designation: rho = 0.351, p < 0.001. A moderate, positive, and statistically significant relationship was found between professional designation and knowledge scores.

Knowledge vs. Education Level: rho = 0.163, p = 0.046. A weak but statistically significant positive relationship was found between level of education and knowledge.

Associations Between Clinical Knowledge and Independent Variables:

Bivariate Analysis: Chi-Square Tests: Chi-square tests and Fisher's Exact tests were conducted to assess whether demographic and training characteristics were associated with clinical knowledge level (categorized as low, average, or good).

Table 6. Chi-Square Test Results: Categorical Variables vs. Knowledge Level.

Variable	Category	χ^2 Value	p-value	Interpretation
Gender	Male/Female	0.174	0.676	No significant association
Age Group	22-25 26-30 31-35 36-40 41-45 46-50 51-55 56-60 61-65 65+ years	5.244	0.803	No significant association
Years of Experience	<1 1-5 6-10 11-20 >20 years	3.992	0.375	No significant association
Marital Status	Single/Married/Divorced/Widowed	0.875	0.884	No significant association
Education Level	Grade 8/10/12	0.296	0.883	No significant association
Health Training College	CHW Sch/Nursing Sch/University	7.937	0.019	Significant association
Practical Training Facility	Aid post/HC/District Hospital/Hospital	6.998	0.072	Approaching significance
Post-Basic Advanced Training	Yes/No	6.900	0.009	Significant association
Attend Malnutrition Training	Yes/No	8.906	0.003	Significant association

Note: Significance evaluated at $p \leq 0.05$

Non-Significant Associations: No significant associations were found for gender ($\chi^2 = 0.174$, $p = 0.676$), age group ($\chi^2 = 5.244$, $p = 0.803$), years of experience ($\chi^2 = 3.992$, $p = 0.375$), marital status ($\chi^2 = 0.875$, $p = 0.884$), or education level ($\chi^2 = 0.296$, $p = 0.883$).

Significant Associations: In contrast, several professional and training-related variables demonstrated significant associations with knowledge level.

Health Training College Attended ($\chi^2 = 7.937$, $p = 0.019$): Significant association. The institution

where initial training was received significantly influenced knowledge outcomes.

Post-Basic Advanced Training (χ^2= 6.900, p = 0.009): Significant association. Health workers who had attended post-basic advanced training demonstrated higher knowledge levels.

Attendance at Malnutrition-Specific Training (χ^2 = 8.906, p = 0.003): Significant association. This was the strongest association identified in the bivariate analysis.

Practical Training Facility (χ^2 = 6.998, p = 0.072): Approaching significance. There was a trend toward different knowledge outcomes depending on whether participants trained at an aid post, health centre, district hospital, or general hospital, though this did not reach statistical significance (Table 6).

Multivariable Analysis: Binary Logistic Regression (Table 7):

Binary Logistic Regression: A multivariable binary logistic regression model was employed to identify independent predictors of adequate clinical knowledge of malnutrition. The dependent variable was binary: adequate knowledge (≥75% of total score) versus inadequate knowledge (<75% of total score). Three independent variables identified as significant in the bivariate analysis were included in the model: (1) health training college attended, (2) post-basic advanced training, and (3) attendance at malnutrition-specific training.

Table 7. Multivariable Binary Logistic Regression: Predictors of Adequate Malnutrition Knowledge.

Variable	Category	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Health Training College					
	CHW Training Sch*	1.00	—	1.00	—
	Nursing School	2.88 (1.08–7.74)	0.035	2.42 (0.74–7.88)	0.143
	University (DWU)	6.30 (1.20–31.35)	0.025	5.76 (1.05–31.54)	0.044
Post-Basic Advanced Training					
	No*	1.00	—	1.00	—
	Yes	3.83 (1.34–11.01)	0.013	2.56 (0.73–8.90)	0.141
Attend Malnutrition Training					
	No*	1.00	—	1.00	—
	Yes	4.34 (1.56–12.07)	0.005	4.87 (1.61–14.75)	0.005

Reference group: *CHW training Sch (Health Training College), *No (Post-Basic training), *No (Attend Malnutrition training). Note: Significance evaluated at p ≤ 0.05

Health Training College Attended: Nursing School (AOR = 2.42, 95% CI [0.74−7.88], p = 0.143): Not statistically significant after adjustment. University (DWU) (AOR = 5.76, 95% CI [1.05−31.54], p = 0.044): Significant predictor. Attending university for health professional training was associated with 5.76 times higher odds of demonstrating adequate

clinical knowledge compared to CHW-training-school graduates.

Post-Basic Advanced Training (AOR = 2.56, 95% CI [0.73−8.90], p = 0.141): Not statistically significant after adjustment.

Attendance at Malnutrition-Specific Training (AOR = 4.87, 95% CI [1.61−14.75], p = 0.005): Strong and significant predictor.

Knowledge Gaps Across Clinical Domains:

To classify knowledge or performance adequacy, a 75% cutoff was applied. Based on these criteria, all the domains (Domains 1-8) were either classified as having inadequate or adequate knowledge or performance.

Table 8. Classification of domain knowledge or performance adequacy.

Domain	N	Mean (SD±)	Range	% Achievement	Competency Status
1. Coordination and Leadership Management	151	1.64 (1.47)	0–6	27	Inadequate
2. General Knowledge on Malnutrition	151	4.68 (1.20)	1–6	78	Adequate
3. Availability of Clinical Diagnosis Tools	151	11.22 (1.97)	6–15	75	Borderline
4. Availability of Medical Supplies	151	3.22 (0.42)	2.33–4.11	78	Adequate
5. Assessment of Children with Malnutrition	151	5.33 (1.30)	1–7	76	Adequate
6. Diagnosis of Types of Malnutrition	151	2.79 (0.95)	0–4	70	Borderline
7.Treatment of Malnutrition	151	2.11 (1.07)	0–5	42	Inadequate
8.Management of Malnutrition	151	1.71 (0.60)	0–3	57	Inadequate

Domain 1: The majority of participants were classified as having inadequate performance in this domain. Domain 2: Most participants (approximately 50%) were classified as having adequate general knowledge of malnutrition. Domain 3: The mean score of 11.22 is slightly below the competency threshold, indicating moderate availability of tools. Domain 4: The mean score of 3.22 is slightly above the competency threshold, indicating adequate availability. Domain 5: Approximately 50% of participants achieved adequate assessment competency. Domain 6: Approximately 50% of participants achieved adequate diagnostic competency. Domain 7: The majority of participants were classified as having inadequate knowledge of malnutrition treatment. Domain 8: The majority of participants were classified as having inadequate knowledge of malnutrition management.

DISCUSSION:

The population for this study consisted primarily of female health workers (64.2%) and individuals in early to mid-career age groups, indicating a relatively young and developing

workforce. The high proportion of married participants reflects common demographic patterns in PNG, while the generally adequate level of secondary education suggests a reasonable foundation for clinical practice. The dominance (61.6%) of CHWs highlights their central role in frontline service delivery, particularly in rural settings, supported by a smaller proportion of NOs and HEOs. Although the distribution of participants was somewhat concentrated in the Anglimp-South Waghi district, it still provides a reasonable representation of the province despite 6% (Table 1) of the participants who are employed by Jiwaka PHA but resides in Western Highlands Province (outside Jiwaka Province). Additionally, the concentration of respondents in health centres and sub-centres aligns with the structure of the primary healthcare system in PNG, where most essential services are delivered.

This study found that the majority of health workers (59.6%) in Jiwaka Province demonstrated average clinical knowledge regarding malnutrition management in children under five years (Table 2). This finding is concerning as it indicates that fewer than two-thirds of health workers possess knowledge at or above the 75% competency threshold recommended for clinical practice. Only 15.2% achieved a good level of knowledge (≥75%), suggesting that the proportion of health workers with a comprehensive understanding of malnutrition management is limited. Conversely, a notable proportion (25.2%) exhibited low knowledge (<50%), highlighting significant gaps in understanding among a substantial minority of the workforce. The mean knowledge score of 17.42 out of 23 (approximately 76%) suggests that while health workers possess a reasonable foundation, they fall short of the 75% competency threshold in several critical domains. Given the essential role that health workers play in identifying, diagnosing, and managing malnourished children in PNG's resource-limited health system, this finding is particularly concerning.

The prevalence of average and low knowledge is consistent with earlier studies in PNG, including a 1993 study conducted in the Eastern Highlands Province, which assessed the clinical competency of CHWs and found significant gaps in knowledge and clinical skills [11]. This suggests that knowledge gaps in malnutrition management persist as a chronic challenge within the PNG health system. More recent evidence indicates that the preparedness for practice among NOs and CHWs in PNG continues to be influenced by the effectiveness of pre-service and in-service training programs [19]. The persistence of these gaps over time suggests ongoing challenges related to limitations in training, continuing professional development, and access to updated clinical guidelines.

Effective management of childhood malnutrition requires early detection, accurate classification (e.g., severe acute malnutrition, moderate acute

malnutrition), and adherence to WHO treatment protocols [15]. However, studies conducted in PNG and other low-resource settings indicate gaps in clinical competency, limited access to refresher training, and variable adherence to Integrated Management of Childhood Illness (IMCI) guidelines [12-13]. In PNG, child wasting treatment services were formally integrated into the national health system in 2014, following international advocacy and capacity-building initiatives. However, the effectiveness of this integration has been variable across provinces, with significant gaps in health worker knowledge and facility capacity documented [9-10]. Studies on the effectiveness of malnutrition training programs have demonstrated that structured educational interventions can significantly improve health professionals' knowledge, understanding, and skills in malnutrition diagnosis and management [20].

An independent samples t-test revealed no statistically significant difference in malnutrition knowledge scores between genders, suggesting that gender does not serve as a meaningful predictor of malnutrition knowledge among health workers in Jiwaka Province [19]. Although females scored on average about 0.53 points higher than males, this difference was not statistically meaningful ($p>0.05$).

A one-way ANOVA test indicated that malnutrition knowledge scores differed significantly across the three professional designations (Table 3): CHWs, NOs, and HEOs ($F (2, 148) = 10.56$, $p < 0.001$). This finding demonstrates that professional designation is a significant factor influencing malnutrition knowledge among health workers in Jiwaka Province. Following this result, a post hoc test (Table 4) showed that CHWs, who represent 61.6% of the sample and serve as the frontline health providers in rural PNG, demonstrated significantly lower knowledge compared to both NOs and HEOs ($p < 0.001$). CHWs had a mean knowledge score of 16.65, compared to 18.52 for NOs and 19.50 for HEOs. This knowledge gap is particularly concerning given the critical role that CHWs play in primary healthcare delivery and malnutrition management in rural PNG. This finding aligns with the hierarchical structure of health professional training in PNG, where CHWs receive shorter, less comprehensive training compared to nursing and health extension officer programs [19].

The similarity in knowledge between NOs and HEOs (no significant difference, $p=0.602$) suggests that these two groups, which have received higher levels of formal training, possess comparable competencies in malnutrition management. This aligns with findings from preparedness studies in PNG, which have documented that the level of pre-service training and professional qualification significantly influences clinical competencies [19]. The knowledge gap between CHWs and higher-cadre workers underscores the need for targeted capacity-building interventions specifically designed for community-level health workers.

A Pearson's correlation analysis revealed no significant relationships between malnutrition knowledge and both age (Knowledge vs. Age: r = –0.032, p = 0.698) and years of experience (Knowledge vs. Years of Experience: r = –0.043, p = 0.602). This lack of significant relationships suggests that demographic factors alone do not determine malnutrition knowledge in this sample. Knowledge acquisition and retention appear to be influenced more by the quality and relevance of training, opportunities for continuing education, and access to evidence-based resources. The absence of a positive experience-knowledge relationship indicates that years of practice without structured ongoing training and knowledge updates may not lead to improved clinical knowledge. However, it is noteworthy that age and years of experience were very strongly correlated (r = 0.878, p < 0.001), indicating that older workers had more years of service.

A Spearman's rank correlation analysis examined relationships between knowledge and ordinal variables (professional designation and education level). A moderate, positive, and statistically significant relationship was found between professional designation and knowledge scores (rho = 0.351, p < 0.001), indicating that individuals in higher designations (HEO or NO) tended to have higher knowledge scores (Table 5). Conversely, a weak but statistically significant positive relationship was found between education level and knowledge (rho = 0.163, p = 0.046), suggesting that higher educational attainment (Grade 12) is associated with slightly increased knowledge, though the effect size is small, ρ (rho)=0.163. These findings indicate that both professional qualification and formal education contribute to malnutrition knowledge, though professional designation appears to be a stronger predictor than general education level. The weak relationship with education level may reflect the fact that formal education does not specifically address malnutrition management unless supplemented with specialized health professional training.

In a bivariate analysis (Table 6), Chi-square tests and Fisher's Exact tests were performed to assess whether demographic and training characteristics were associated with clinical knowledge level (low, average, good). No significant associations were found for gender ($\chi^2 = 0.174$, p = 0.676), age group ($\chi^2 = 5.244$, p = 0.803), years of experience ($\chi^2 = 3.992$, p = 0.375), marital status ($\chi^2 = 0.875$, p = 0.884), or education level ($\chi^2 = 0.296$, p = 0.883). These results suggest that demographic factors alone do not significantly influence malnutrition knowledge levels in this sample. Gender differences were negligible (p = 0.269) as also revealed in the earlier t-test analysis, consistent with trends in many health professions where gender no longer predicts clinical competence. The lack of a significant relationship between age or years of experience and knowledge is particularly noteworthy, underscoring the importance of structured, evidence-based

training and continuing education rather than relying solely on experiential learning.

In contrast, several professional and training-related variables demonstrated significant associations with knowledge level. The institution where initial training was received significantly influenced knowledge outcomes (χ^2 = 7.937, p = 0.019), suggesting that the quality and content of pre-service training programs vary across different training institutions in PNG. Efforts to standardize and strengthen malnutrition content in pre-service curricula could have broad-reaching impacts on workforce competence. Additionally, health workers who attended post-basic advanced training demonstrated higher knowledge levels (χ^2 = 6.900, p = 0.009), indicating that continuing professional education is associated with improved knowledge. Attendance at malnutrition-specific training showed the strongest association identified in the bivariate analysis (χ^2 = 8.906, p = 0.003), highlighting the importance of targeted, disease-specific training interventions.

In a multivariate analysis (Table 7), a binary logistic regression model was employed to identify independent predictors of adequate clinical knowledge of malnutrition. University-level pre-service education was identified as a significant independent predictor of adequate malnutrition knowledge (AOR = 5.76 95% CI [1.05−31.54], p = 0.044), suggesting that broader educational foundations enhance health workers' ability to acquire and apply specialized knowledge. In contrast, attendance at malnutrition-specific training remained the strongest predictor of adequate clinical knowledge (AOR = 4.87, 95% CI [1.61−14.75], p = 0.005), demonstrating that targeted, disease-specific training is more effective than general professional development in improving knowledge of malnutrition management.

Domain Specific Analysis (Domains 1−8):

To classify knowledge or performance adequacy (Table 8), a 75% cutoff was applied to assess knowledge gaps across different clinical domains [16]. For instance, given a maximum score of 6, scores ≤ 4 were classified as inadequate, while scores ≥ 5 were classified as adequate. The analysis of domain-specific knowledge revealed several critical patterns:

Domain 1: Coordination and Leadership Management: The mean score of 1.64 out of 6 indicates that participants achieved only approximately 27% of the expected performance level, reflecting a significant area of concern requiring immediate attention. This suggest that that most health workers demonstrated minimal understanding of coordination and leadership principles in malnutrition management. This domain, which likely assesses health workers' ability to coordinate care, communicate with supervisors, and demonstrate leadership in health facility management, represents a significant area of concern requiring immediate attention [21]. Overall Coordination and Leadership

Management competencies are inadequate in this sample. This gap may reflect limited training in management and leadership skills, as well as the typically hierarchical and supervisory structures in PNG's health system where frontline workers may have limited autonomy or responsibility for coordination.

Domain 2: General Knowledge of Malnutrition: The mean score of 4.68 out of 6 indicates that participants achieved approximately 78% of the expected knowledge level, which exceeds the 75% competency threshold. This suggests that health workers in Jiwaka Province possess a reasonable foundational understanding of malnutrition concepts, including its definition, causes, types, and general consequences [22]. This finding is more encouraging than the low performance in other domains and suggests that basic malnutrition awareness and knowledge are relatively well-distributed among the workforce. General knowledge of malnutrition is adequate in this sample. This competency may reflect the prominence of malnutrition as a health issue in PNG and the inclusion of basic malnutrition content in pre-service health worker training programs.

Domain 3: Availability of Clinical Diagnostic Tools: The average score of 11.22 out of a maximum of 15 indicates that participants achieved approximately 75% of the expected availability level. The mean score of 11.22 is slightly below the competency threshold, indicating moderate availability of tools. This reflects fairly moderate availability of clinical diagnostic tools at the facilities where health workers are employed. However, the range (6–15) and standard deviation (1.97) indicate uneven distribution, with some facilities having substantially fewer diagnostic tools available (score = 6) while others have more comprehensive availability (score = 15). This suggests that resource disparities exist across health facilities in Jiwaka Province, with some facilities well-equipped while others lack essential diagnostic equipment [8-9]. Availability of clinical diagnostic tools is moderate and variable across facilities. This represents a significant health system constraint that may limit health workers' ability to effectively assess and diagnose malnutrition, even if their knowledge is adequate. Efforts to strengthen health facility infrastructure and ensure equitable distribution of diagnostic equipment are needed.

Domain 4: Availability of Medical Supplies: The mean score of 3.22 indicates that participants reported moderate to good availability of medical supplies, with an achievement level of approximately 78% of the ideal. The low variability (SD = 0.42) suggests relatively consistent resource levels across facilities, which is encouraging. The median and mode of 3.22 indicate that most respondents reported similar levels of supply availability. While minor shortages exist (lowest score = 2.33), the

general supply situation appears stable and reasonably adequate. This finding suggests that PNG's health system, despite resource constraints, has achieved reasonable consistency in the distribution of essential medical supplies across provincial facilities. Availability of medical supplies is adequate and relatively consistent across facilities. This represents a relative strength in the health system's capacity to support malnutrition management at the facility level [19,22].

Domain 5: Assessment Practices: Approximately 50% of participants achieved adequate assessment competency (mean score = 5.33 out of 7), reflecting generally strong assessment practices. The mean score of 5.33 out of 7 indicates that participants reported performing approximately 76% of the recommended assessment activities when managing children with malnutrition, which exceeds the 75% competency threshold. The scores ranged from 1 to 7, suggesting that while many health workers perform nearly all required assessments (score = 7), a few perform very few assessment activities (score = 1). This indicates variable assessment practices across the workforce [10]. Assessment competencies are generally satisfactory, with most health workers demonstrating knowledge of essential assessment procedures [13]. This may reflect the relative straightforwardness of assessment techniques (such as anthropometric measurements) compared to more complex clinical tasks. However, the range and moderate variability suggest that a minority of participants conduct incomplete assessments, indicating a need for targeted supervision and training for lower-performing individuals. Assessment practices are generally strong, though variable. While overall performance is satisfactory, a small number of participants may need additional training or supervision to ensure comprehensive assessment practices.

Domain 6: Diagnostic Ability: Diagnostic ability is moderately good. The mean score of 2.79 out of 4 suggests that respondents correctly diagnosed malnutrition types approximately 70% of the time, which is slightly below the 75% competency threshold, meaning that many participants demonstrated reliable ability to identify different malnutrition types (such as severe acute malnutrition [SAM], moderate acute malnutrition [MAM], stunting, and wasting) [16]. However, the standard deviation of 0.95 and range (0–4) indicate substantial variation in diagnostic competence. Some participants diagnosed malnutrition types very accurately (scores 3–4), while others struggled significantly (scores 0–2). The presence of participants with scores of 0 indicates that some health workers could not correctly diagnose any malnutrition types, representing a critical gap. While the group performs at approximately the competency threshold overall, a subset of participants requires additional diagnostic training. This variation in knowledge and clinical

skill may relate to differences in training quality, experience, facility support, and access to diagnostic tools and guidelines [23]. Diagnostic competence is satisfactory on average but unevenly distributed. Targeted training in malnutrition classification and diagnosis is needed for lower-performing health workers.

Domain 7: Treatment Knowledge: Treatment knowledge was assessed as low. The majority of participants were classified as having inadequate knowledge of malnutrition treatment. The mean score of 2.11 out of 5 indicates that participants achieved only approximately 42% of the expected knowledge level, substantially below the 75% competency threshold. This represents a critical knowledge gap, as appropriate treatment is essential for improving child outcomes in malnutrition. Treatment of malnutrition, particularly severe acute malnutrition, requires knowledge of specialized nutritional products (such as ready-to-use therapeutic foods [RUTFs]), appropriate feeding protocols, management of complications (such as refeeding syndrome), and monitoring of clinical response [24-25]. The low performance in this domain suggests that health workers lack comprehensive understanding of these critical treatment principles. Knowledge of malnutrition treatment is inadequate in this sample. This represents a major knowledge gap requiring urgent attention through targeted training programs. The WHO guidelines on malnutrition management provide evidence-based treatment protocols that should be disseminated and implemented across PNG's health system [2-4].

Domain 8: Management Knowledge: Management knowledge was assessed as very low. The majority of participants were classified as having inadequate knowledge of malnutrition management. The mean score of 1.71 out of 3 indicates that participants achieved only approximately 57% of the expected knowledge level, substantially below the 75% competency threshold. This represents a critical gap in knowledge of the holistic management of malnutrition, which extends beyond treatment to include follow-up care, monitoring, prevention of relapse, and integration with other health services. Comprehensive malnutrition management requires understanding of the continuum of care, from prevention and early identification through acute treatment to rehabilitation and long-term follow-up [3-4, 26-27]. The very low performance in this domain suggests that health workers lack this broader, integrated understanding of malnutrition management. Knowledge of malnutrition management is inadequate in this sample. This represents another critical knowledge gap, suggesting that health workers understand individual treatment interventions but lack the broader systems-level understanding needed for comprehensive malnutrition management. This gap may contribute to incomplete treatment pathways and inadequate follow-up of malnourished children.

The domain-specific analysis revealed a critical pattern: while health workers demonstrated adequate foundational knowledge and assessment skills, they exhibited severe deficiencies in treatment and management of malnutrition. In contrast: General knowledge of malnutrition was adequate (78% achievement), Assessment skills were adequate (76%), Diagnostic skills were borderline (70%). This pattern suggests that health workers understand the basics of malnutrition and can perform simple assessments, but lack the detailed clinical knowledge needed for appropriate treatment and the broader systems understanding needed for comprehensive management. In PNG, most cases of SAM and MAM are identified at level 2 and 3 facilities and referred to level 4 and 5 hospitals for specialized care. However, limited or insufficient knowledge among rural health staff may affect the quality of referral, follow-up, and ongoing management when patients return to these facilities, disrupting continuity of care. This gap between foundational knowledge and applied clinical skills is a critical concern, as it suggests that health workers in Jiwaka Province may be unable to effectively translate their basic understanding into appropriate clinical actions.

The WHO guidelines on malnutrition management provide detailed protocols for treatment, including the use of specialized therapeutic foods, micronutrient supplementation, management of complications, and monitoring protocols [3-4]. The low performance of health workers in this domain suggests that these guidelines have not been effectively disseminated or implemented across PNG's health system. The very low performance in coordination and leadership is concerning because malnutrition management requires effective coordination among health workers, communication with supervisors and referral facilities, and leadership in implementing evidence-based practices. This gap may reflect limited training in management and leadership skills, as well as organizational constraints that limit health workers' autonomy and responsibility for coordination.

While this study focused on health worker knowledge, the domain-specific analysis also revealed important health system constraints that may limit the impact of improved knowledge. Clinical diagnostic tools were available at only 75% of the optimal level, and availability varied substantially across facilities. This suggests that even if health workers possessed adequate knowledge, they might be unable to implement it due to lack of essential equipment. However, medical supplies were available at approximately 78% of the optimal level with relatively consistent distribution across facilities, indicating that PNG's health system has achieved reasonable consistency in supply distribution. This relative strength could be leveraged to support improved malnutrition management if combined with improved health worker knowledge.

The knowledge levels documented in this study are consistent with findings from other LMICs. Research on health worker knowledge in malnutrition management in Africa and South Asia has similarly documented gaps in treatment and management knowledge, with health workers often demonstrating better foundational knowledge than applied clinical competencies [8]. The finding that specialized training significantly improves knowledge is also consistent with global evidence demonstrating the effectiveness of focused capacity-building interventions [20]. However, the particularly low performance in treatment and management domains in this study suggests that malnutrition training in PNG may not adequately address these critical clinical areas. Comparison with training programs in other countries that have achieved higher treatment and management knowledge might provide insights for improving PNG's training curricula.

Study Strengths and Limitations:

Study strengths include sufficient sample size (N = 151) with good representation across districts and facility types, Comprehensive assessment across multiple knowledge domains, Rigorous statistical analysis including multivariable modelling, and focus on a critical health issue in PNG with limited existing evidence.

Study limitations include the cross-sectional design, which limits causal inferences, as data collected at a single point in time cannot assess changes in knowledge. Self-reported data; knowledge was assessed through self-reported responses, which may be subject to bias (recall). Sampling method; purposive and convenience sampling may introduce selection bias. Geographic scope; findings are limited to Jiwaka Province and may not be generalizable to other regions.

CONCLUSION:

This study provides important evidence on the clinical knowledge of health workers regarding malnutrition in children under five years in Jiwaka Province. The findings lay the groundwork for developing and implementing evidence-based capacity-building programs to strengthen malnutrition management in PNG.

Future research should include longitudinal studies to assess the sustained impact of training interventions and qualitative studies to understand barriers to knowledge application in practice. Strengthening pre-service education in malnutrition management across all training institutions and ensuring equitable access to in-service training opportunities are critical priorities for PNG's health system.

Recommendations:

Targeted interventions are needed in the following areas; 1) Targeted Training is Essential**:** Prioritize targeted, disease-specific training programs to address critical knowledge gaps, 2) CHWs Require Priority Attention: Given their lower knowledge levels, targeted capacity-building programs should prioritize CHWs, 3)

Training Content Must Be Comprehensive: Programs must extend beyond general knowledge to include detailed treatment protocols and management frameworks guided by WHO guidelines, 4) Ongoing Training is Necessary: Regular training and knowledge updates are essential to maintain and improve competencies, and 5) Health System Support is Critical**:** Improved health worker knowledge must be complemented by health system strengthening, including the availability of diagnostic tools and therapeutic supplies.

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