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The Effect of Balanced Nutrition Education on Mothers' Perceptions, Intentions, and Knowledge Regarding the Use of Complementary Feeding Broth Powder Made from Grouper Fish Scale Waste

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ABSTRACT

Introduction: *Nutritional problems among children under five in coastal areas remain relatively high, partly due to limited access to animal-based protein sources. On the other hand, the potential of marine resources has not been optimally utilized, including grouper fish scales (Epinephelus sp.), which are rich in protein, calcium, and collagen. The innovation of processing these wastes into complementary feeding (MP-ASI) stock powder holds potential as both a nutritional solution and an environmental management strategy. This study aims to analyze the effect of balanced nutrition education on mothers' knowledge, perceptions, and intentions regarding the use of grouper fish-scale-based MP-ASI stock powder.*
Objectives: *This study aimed to analyze the effect of balanced nutrition education on mothers' knowledge, perceptions, and intentions regarding the use of grouper fish-scale-based MP-ASI stock powder.*
Methods: *This research employed a pre-experimental design with a one-group pre-test–post-test approach involving 30 mothers with children aged 6–24 months in Mekar Jaya Village, Konawe Regency, Southeast Sulawesi. A structured questionnaire was used to measure knowledge, perception, and intention, with prior validity and reliability testing (Cronbach's alpha ≥0.70). Data were analyzed using the Shapiro-Wilk normality test, Levene's homogeneity test, paired t-test, Wilcoxon signed-rank test, and Pearson correlation test.*
Results: *The findings demonstrated a significant improvement in knowledge ($p<0.001$), perception ($p<0.001$), and intention ($p<0.001$) after the educational intervention. Correlation analysis revealed positive associations between knowledge and perception ($r=0.52$; $p=0.004$), knowledge and intention ($r=0.47$; $p=0.009$), and perception and intention ($r=0.61$; $p<0.001$).*
Conclusions: *Balanced nutrition education is effective in enhancing knowledge, fostering positive perceptions, and encouraging mothers' intention to use grouper fish-scale-based MP-ASI stock powder. This study is relevant as a foundation for developing nutrition education strategies and food innovations based on local potential to support the improvement of child nutrition in coastal areas.*

Introduction

Southeast Sulawesi Province possesses vast marine resource potential, with its sea area covering 74% of the total provincial territory. The estimated fishery resource potential reaches 1,520,340 tons per year; however, the utilization rate remains only around 15.41% (Kemenkes RI, 2021). This condition reflects the suboptimal use of marine resources, particularly in the diversification of processed fishery products. One of the areas with predominantly marine-based activities is Mekar Jaya Village, Konawe Regency, Southeast Sulawesi, Indonesia. The local community relies heavily on capture fisheries, aquaculture, and traditional seafood processing. Nevertheless, fishery waste management remains a serious challenge, especially grouper fish (Epinephelus sp.) scales, which have thus far been underutilized and pose a risk of environmental pollution (Kemenkes RI, 2021).

PROFESIONAL HEALTH JOURNAL
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Nutritional problems among infants and young children remain a critical public health concern in Indonesia, particularly due to inadequate complementary feeding practices during the first 1,000 days of life, which significantly contribute to malnutrition, stunting, and impaired cognitive development. Many mothers continue to rely on monotonous complementary foods with low protein and micronutrient density as a result of limited knowledge, persistent misconceptions, and restricted access to locally available nutritious food innovations. In this context, grouper fish scale waste represents a promising yet underutilized resource, as it is rich in collagen, calcium, and essential minerals beneficial for infant growth and development (Mokodompit et al., 2025). Processing this waste into complementary feeding broth powder offers dual benefits by improving the nutritional quality of complementary foods while simultaneously supporting environmental sustainability through waste valorization. However, the successful adoption of this innovation largely depends on mothers' perceptions, intentions, and knowledge, as insufficient understanding may hinder acceptance of complementary feeding ingredients derived from fishery by-products. Therefore, balanced nutrition education emerges as an urgent and strategic intervention to bridge the gap between resource potential and optimal infant feeding practices. Evaluating its effect on mothers' perceptions, intentions, and knowledge regarding the use of complementary feeding broth powder made from grouper fish scale waste is essential to support sustainable nutrition strategies, promote environmentally responsible food innovation, and strengthen maternal capacity to provide nutritionally adequate complementary feeding, particularly in coastal and marine-based communities such as Mekar Jaya Village.

In fact, grouper fish scales contain essential nutrients such as protein, calcium, and collagen, which have considerable potential as raw materials for functional food products. One promising innovation is the development of stock powder for complementary feeding (MP-ASI) (De Luca et al., 2025). This innovation is particularly relevant in the context of persistent global and national nutritional challenges. Worldwide, an estimated 149 million children under five years of age are stunted and 45 million are wasted, largely due to inadequate dietary intake during early childhood, especially in low- and middle-income countries. In Indonesia, nutritional problems among children under five remain a major public health issue, with coastal and rural areas showing disproportionately higher vulnerability. In Southeast Sulawesi, particularly in coastal communities of Konawe Regency, the prevalence of undernutrition and stunting remains relatively high, partly driven by limited access to diverse and affordable sources of high-quality protein despite abundant marine resources. Preliminary observations and community-based assessments conducted in Mekar Jaya Village indicate that fish processing activities generate substantial amounts of grouper fish scale waste that are discarded without further utilization, while mothers commonly rely on monotonous complementary foods with low protein and mineral content due to limited knowledge and food innovation exposure. Therefore, transforming grouper fish scale waste into MP-ASI stock powder offers dual benefits: addressing fishery waste management through value-added processing and providing an affordable, locally available source of animal-based nutrients for infants and young children in nutritionally vulnerable coastal communities (Elvina & Utami, 2022).

However, the development and utilization of MP-ASI stock powder derived from grouper fish scales face several challenges, particularly the limited maternal knowledge regarding its nutritional content and health benefits, as well as concerns related to product safety, quality, and taste (Purnamasari, Wa Ode Aisa Zoahira, et al., 2024). In the broader context of child nutrition management, efforts to address undernutrition traditionally involve pharmacological approaches such as micronutrient supplementation (e.g., iron, zinc, calcium, and vitamin A) and therapeutic feeding for children with severe malnutrition, alongside non-pharmacological strategies including optimal breastfeeding practices, appropriate complementary feeding, dietary diversification, and caregiver nutrition education. In addition, several alternative and complementary approaches, such as the utilization of locally sourced functional foods, food

PROFESIONAL HEALTH JOURNAL
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fortification using natural marine-based ingredients, community-based nutrition counseling, and culturally adapted food processing techniques have increasingly been promoted to improve child nutritional status in resource-limited settings. Nevertheless, the effectiveness of these approaches, including innovative local food products like grouper fish-scale-based MP-ASI stock powder, is highly dependent on mothers' perceptions, knowledge, and intention to adopt them at the household level. Without positive perceptions, adequate understanding, and strong behavioral intention, both conventional and alternative nutrition interventions risk suboptimal uptake. Therefore, balanced nutrition education is expected to function as a key integrative strategy to enhance maternal knowledge, reshape perceptions, and strengthen intention, thereby supporting the acceptance and sustained use of grouper fish-scale-based MP-ASI stock powder as a safe, nutritious, and culturally acceptable complementary feeding option (Ryckman et al., 2021).

This study aims to analyze the effect of balanced nutrition education on mothers' perceptions, intentions, and knowledge regarding the use of grouper fish-scale-based MP-ASI stock powder in Mekar Jaya Village, Soropia Subdistrict, Konawe Regency. More specifically, the study seeks to (1) identify mothers' level of knowledge regarding the nutritional content and benefits of the stock powder, (2) examine mothers' perceptions of product safety, nutritional quality, and taste, and (3) measure mothers' intentions to utilize it as part of their children's complementary feeding. In addition, the study aims to determine the extent to which balanced nutrition education can improve maternal understanding, foster positive perceptions, and strengthen intention to use MP-ASI stock powder as an affordable and nutritious animal protein alternative, thereby supporting efforts to improve child nutritional status in coastal areas.

Methods

This study employed a one-group pre–post design without a control group to evaluate the effect of balanced nutrition education on mothers' knowledge, perceptions, and intentions regarding the use of grouper fish-scale-based complementary feeding (MP-ASI) stock powder (Purnamasari, Zoahira, et al., 2025). The study population consisted of all mothers with infants and young children aged 6–24 months residing in Mekar Jaya Village, Soropia Subdistrict, Konawe Regency, Southeast Sulawesi, Indonesia. The research was conducted in July–August 2025, and a total sample of 30 mothers was recruited using purposive sampling. The sample size was determined based on feasibility considerations and the minimum sample requirement for pre–experimental pre–post intervention studies, which commonly recommend 20–30 participants to detect within-group changes in knowledge, attitudes, and behavioral intentions. Purposive sampling was applied to ensure that participants met specific characteristics relevant to the intervention objectives. The inclusion criteria were: mothers who permanently resided in Mekar Jaya Village, had children aged 6–24 months, were the primary caregivers responsible for infant feeding practices, and were willing to participate in the entire series of nutrition education sessions and complete both pre- and post-intervention questionnaires. The exclusion criteria included mothers whose children had congenital abnormalities or chronic illnesses affecting feeding and nutritional status, mothers who were health professionals or had previously received formal training related to balanced nutrition or complementary feeding innovations, and participants who were unable to attend the full intervention or withdrew during the study period.

The research instrument was developed in the form of a structured questionnaire encompassing three domains: knowledge, perception, and intention to use MP-ASI stock powder. Content validity was established through expert judgment involving three specialists in maternal and child nutrition and community health nursing, who evaluated the relevance, clarity, and appropriateness of each item; items with a content validity index (CVI) below the acceptable threshold were revised prior to data collection (Purnamasari, Said, et al., 2025). Construct validity

PROFESIONAL HEALTH JOURNAL
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was further examined through item–total correlation analysis, with items demonstrating correlation coefficients above 0.30 retained in the final instrument. The perception and intention instruments were constructed using a 5-point Likert scale, with positive items scored directly and negative items (items 17–18) reverse-scored. The subscales included perceived usefulness (items 1–4), perceived ease of use (items 5–8), safety and quality (items 9–12), and behavioral intention (items 13–16). The total score was calculated as the average of all items and interpreted as <2.5 (low), 2.5–3.4 (moderate), 3.5–4.2 (good), and >4.2 (very good). The knowledge instrument consisted of 12 items scored on a 1–5 scale, with negative items (items 10 and 12) reverse-scored, yielding total scores ranging from 12 to 60 and categorized as low (12–28), moderate (29–44), and high (45–60). Instrument reliability was assessed using Cronbach's alpha to determine internal consistency, with values ≥0.70 considered acceptable; all subscales demonstrated satisfactory reliability prior to implementation in the main study (Hadju et al., 2024).

Data collection was conducted in several sequential stages. Initially, eligible participants were identified and recruited based on the predetermined inclusion criteria, followed by the provision of study information and informed consent. Baseline data were then collected by administering structured questionnaires to participants prior to the intervention (pre-test). Subsequently, the balanced nutrition education intervention was implemented through interactive lectures, group discussions, and practical demonstrations on the preparation and utilization of MP-ASI stock powder for children's complementary feeding. After completion of the intervention sessions, post-intervention data were collected using the same questionnaire (post-test). All collected data were coded, checked for completeness, and entered into statistical software for analysis. Univariate analysis was performed to describe respondents' characteristics and the distribution of knowledge, perception, and intention scores. The Shapiro–Wilk test was used to assess data normality, while Levene's test evaluated homogeneity of variance across respondent subgroups. Differences between pre- and post-intervention scores were analyzed using the paired *t*-test for normally distributed data or the Wilcoxon signed-rank test for non-normally distributed data. In addition, correlations among knowledge, perception, and intention variables were examined using Pearson or Spearman correlation tests according to data distribution. Instrument reliability was reported using Cronbach's alpha coefficients, and all statistical analyses were conducted at a significance level of 0.05, marking the completion of the research process (Purnamasari, Said, et al., 2025).

Results

Table 1. Characteristics of Respondents (n = 30)

Characteristics	Frequency (n)	Percentage (%)
Mother's Age		
20–25 years	6	20.0
26–35 years	17	56.7
>35 years	7	23.3
Educational Attainment		
Elementary School	4	13.3
Junior High School	8	26.7
Senior High School	19	63.3
Higher Education	2	6.7
Occupation		
Housewife	21	70.0
Fisherman	5	16.7
Trader	4	13.3
Household Income		
< Provincial Minimum Wage	18	60.0

PROFESIONAL HEALTH JOURNAL
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≥ Provincial Minimum Wage	12	40.0

Table 1 shows that most respondents were in the 26–35 years age group (56.7%), representing productive age and typically active in caring for young children. The majority had completed senior high school (63.3%), indicating that they were relatively capable of receiving and understanding nutrition education. In terms of occupation, most respondents were housewives (70.0%), providing them with more time to engage in educational activities. Meanwhile, the majority of households had income levels below the regional minimum wage (60.0%), which may influence consumption patterns and food choices, including the use of grouper fish-scale-based MP-ASI stock powder.

Table 2. Normality and Homogeneity Tests

Variable	Shapiro-Wilk p (Pre)	Shapiro-Wilk p (Post)	Distribution	Levene's Test p	Homogeneity
Knowledge	0.128	0.094	Normal	0.212	Homogeneous
Perception	0.176	0.062	Normal	0.307	Homogeneous
Intention	0.084	0.072	Normal	0.291	Homogeneous

Note: $p > 0.05$ = data are normally distributed and homogeneous

Table 2 indicates that the Shapiro-Wilk test yielded p-values > 0.05 for all variables in both pre-test and post-test, confirming normal distribution. Similarly, Levene's test results showed $p > 0.05$, indicating homogeneity of variance across groups. Therefore, the data met the assumptions required for parametric testing, such as paired *t*-test for normally distributed variables, while the Wilcoxon signed-rank test was used if data distribution deviated from normality.

Table 3. Comparison of Pre–Post Scores of Mothers' Knowledge, Perception, and Intention (n = 30)

Variable	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	Mean Difference	Statistical Test	p-value
Knowledge	31.8 ± 6.2	48.6 ± 5.4	+16.8	Paired *t*-test	<0.001*
Perception	3.1 ± 0.6	3.9 ± 0.5	+0.8	Wilcoxon Test	<0.001*
Intention	3.0 ± 0.7	4.1 ± 0.6	+1.1	Paired *t*-test	<0.001*

Note: * $p < 0.05$ = significant

Table 3 demonstrates significant improvements across all research variables following balanced nutrition education. Mothers' knowledge scores increased from 31.8 to 48.6, with a mean difference of 16.8 points ($p < 0.001$), indicating that the education effectively enhanced understanding of the benefits and use of MP-ASI stock powder. Perceptions also improved, shifting from moderate (3.1) to good (3.9), with a significant difference ($p < 0.001$), reflecting a positive change in mothers' perspectives toward the product innovation. Furthermore, mothers' intentions increased from 3.0 to 4.1 ($p < 0.001$), showing that education influenced not only knowledge and perception but also the willingness to apply it in daily practice.

Table 4. Correlation between Knowledge, Perception, and Intention in the Use of MP-ASI Stock Powder (n = 30)

Variables	r (Pearson/Spearman)	p-value	Interpretation
Knowledge ↔ Perception	0.52	0.004*	Moderate, significant
Knowledge ↔ Intention	0.47	0.009*	Moderate, significant
Perception ↔ Intention	0.61	<0.001*	Strong, significant

PROFESIONAL HEALTH JOURNAL
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Note: * p < 0.05 = significant

Table 4 illustrates significant associations between mothers' knowledge, perception, and intention to use MP-ASI stock powder. Knowledge showed a moderate correlation with perception (r = 0.52; p = 0.004) and intention (r = 0.47; p = 0.009), suggesting that higher knowledge levels were linked to more positive perceptions and stronger intentions to use the product. The strongest correlation was observed between perception and intention (r = 0.61; p < 0.001), indicating that positive maternal perceptions play a crucial role in shaping the intention to adopt MP-ASI stock powder. These results confirm that balanced nutrition education is pivotal in shaping perception, which in turn drives behavioral change.

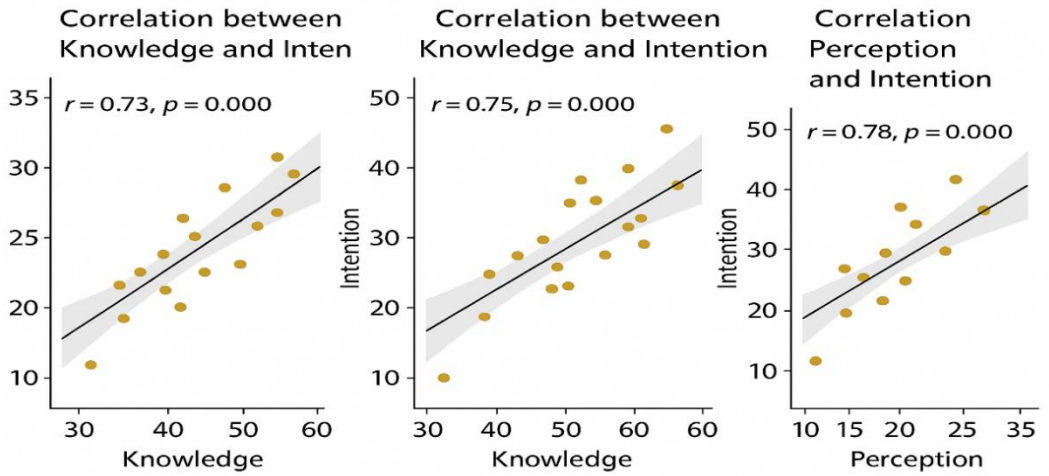

Figure 1. Scatter Plots of Relationships among Variables

The scatter plot results indicate significant positive correlations between mothers' knowledge, perception, and intention to use grouper fish-scale-based MP-ASI stock powder. Knowledge was moderately correlated with both perception (r = 0.52; p < 0.01) and intention (r = 0.47; p < 0.01), suggesting that greater understanding of nutritional benefits and product safety corresponded with more positive perceptions and stronger usage intentions. The strongest relationship was found between perception and intention (r = 0.61; p < 0.001), underscoring that positive perceptions are key determinants of mothers' intention to adopt the innovation. Thus, balanced nutrition education plays an essential role in enhancing knowledge and perceptions, which ultimately foster mothers' intention to adopt functional food innovations based on local resources.

Discussion

1. Mothers' Knowledge of the Nutritional Content and Benefits of Grouper Fish-Scale-Based MP-ASI Stock Powder

In line with the first research objective, this study demonstrated that balanced nutrition education had a significant effect on improving mothers' knowledge regarding the nutritional content and benefits of MP-ASI broth powder derived from grouper fish scale waste (Setyawati et al., 2022). Prior to the intervention, most mothers exhibited low to moderate levels of knowledge, reflecting limited awareness of the nutritional potential of fishery by-products. Following the educational intervention, a substantial shift toward the high knowledge category was observed. This finding is consistent with previous studies indicating that nutrition education effectively enhances maternal understanding of animal

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protein intake and promotes food diversification based on local resources. Adequate nutritional knowledge is a critical foundation for mothers when making informed decisions about complementary feeding, particularly during early childhood when nutritional adequacy is essential for optimal growth and development (Ryckman et al., 2024).

2. Mothers' Perceptions of Product Safety, Nutritional Quality, and Taste

Addressing the second research objective, the results showed a marked improvement in mothers' perceptions of the MP-ASI stock powder after the balanced nutrition education intervention. Mothers' perceptions of product safety, nutritional quality, and taste improved from the moderate to the good category (Qasas et al., 2024). This finding indicates that structured education can positively reshape mothers' attitudes toward innovative food products derived from fishery waste. These results are consistent with the Health Belief Model, which emphasizes that perceived benefits and perceived safety play pivotal roles in influencing acceptance of health-related innovations. As mothers developed more positive perceptions, they became more open to adopting MP-ASI products that were previously unfamiliar or perceived as unconventional (Setyawati et al., 2024).

3. Mothers' Intentions to Utilize MP-ASI Stock Powder in Complementary Feeding

In accordance with the third research objective, this study found a significant increase in mothers' intentions to use grouper fish-scale-based MP-ASI stock powder following the nutrition education intervention. Intention is a key determinant of behavior, as described in the Theory of Planned Behavior (TPB). The findings confirm that mothers' intentions to adopt innovative complementary feeding products are strongly influenced by their knowledge and perceptions. Mothers who demonstrated higher levels of understanding and more favorable perceptions were more likely to express readiness to incorporate the stock powder into their children's diets. These results suggest that balanced nutrition education not only improves cognitive awareness but also strengthens motivational readiness to adopt healthier feeding practices (Nofitasari et al., 2023).

4. Interrelationship Between Knowledge, Perceptions, and Intention

Further analysis revealed significant correlations among knowledge, perceptions, and intention. The strongest association was observed between perception and intention ($r = 0.61$; $p < 0.001$), followed by knowledge and perception ($r = 0.52$; $p < 0.01$), and knowledge and intention ($r = 0.47$; $p < 0.01$). These findings underscore that while knowledge is essential, perception plays a more dominant role in shaping mothers' intentions to use MP-ASI stock powder (O'Connor et al., 2025). This aligns with existing literature suggesting that dietary behavior change is more strongly driven by beliefs, attitudes, and product acceptability than by knowledge alone. Consequently, nutrition education programs should prioritize shaping positive perceptions by emphasizing health benefits, product safety, palatability, and environmental sustainability through fish scale waste utilization (Mokodompit et al., 2025).

5. Implications for Child Nutrition Improvement in Coastal Areas

Overall, this study provides strong evidence that balanced nutrition education is an effective approach to promoting the adoption of locally based food innovations in coastal communities. The observed improvements in mothers' knowledge, perceptions, and intentions highlight the potential of MP-ASI broth powder derived from grouper fish scale waste as a nutritious, affordable, and sustainable source of animal protein (Purnamasari, Saragih, et al., 2024). However, sustained implementation requires continuous mentoring,

PROFESIONAL HEALTH JOURNAL
Volume 8, No. 1 (Page. 82-93)
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E-ISSN 2715-6249
DOI: https://doi.org/10.54832/phj.v8i1.1331

skills training in food processing, and broader community engagement to ensure long-term acceptance and utilization. Thus, this innovation not only contributes to improving child nutritional status but also supports fishery waste management and enhances the socioeconomic welfare of coastal communities.

Conclusion

This study demonstrates that balanced nutrition education significantly improved mothers' knowledge, perceptions, and intentions regarding the use of MP-ASI broth powder derived from grouper fish scale waste. The intervention successfully shifted knowledge levels from low/moderate to high, enhanced perceptions of safety, nutritional value, and taste, and increased mothers' intentions to use the product in complementary feeding. Correlation analysis revealed that perception had the strongest relationship with intention, underscoring the critical role of fostering positive perceptions in ensuring the acceptance of locally-based functional food innovations.

These findings are relevant to efforts addressing nutritional challenges in coastal regions while promoting sustainable fishery waste management. The use of grouper fish scales as raw material for MP-ASI broth powder not only offers nutritional benefits but also provides solutions to environmental problems and supports the economic improvement of coastal communities. Hence, this study contributes practical implications for nutrition education strategies, food innovation, and community empowerment based on local resources.

For future research, it is recommended to expand the study to a larger scale with a greater sample size and to employ experimental designs with control groups to strengthen causal inferences. Moreover, organoleptic testing, food safety assessments, and long-term consumer acceptance studies are necessary to ensure the sustainability of product use. Future studies could also integrate community empowerment approaches, such as fishery waste processing training, to facilitate independent adoption of this food innovation by coastal communities.

Ethics approval and consent to participate

The research obtained ethical clearance from the Ethics Committee of Bani Saleh University, Indonesia with reference number EC.0177/KEPK/STKBS/VI/2025 on 30 Juni 2025.

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PROFESIONAL HEALTH JOURNAL
Volume 8, No. 1 2026(Page. 82-93)
Available Online at https://www.ojsstikesbanyuwangi.com/index.php/PHJ/index
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PROFESIONAL HEALTH JOURNAL
Volume 8, No. 1 (Page. 82-93)
Available Online at https://www.ojsstikesbanyuwangi.com/index.php/PHJ/index
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