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Adapting the Planetary Health Diet Index for rice-based diets in Indonesia

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Abstract. Planetary Health Diet Index (PHDI) is a key component of sustainable food system measurement. However, its application in Indonesia is constrained by structural differences in staple food consumption. This study assesses recalibration of grain-related components. An ecological study was conducted using food consumption data from 324,635 households across 38 provinces from the National Socio-Economic Survey 2023. Whole grains were incorporated alongside refined grains under four scenarios, within 2500 kcal and 2100 kcal. Score stability with the 1:1 weighting and 2100 kcal showing the greatest stability and selected for further analysis with coefficient variation of 12.5. The Kruskal–Wallis's test revealed statistically significant differences across provinces for all food groups and the total score ($p<0.05$). East Nusa Tenggara, East and Southeast Sulawesi, where corn and fish consumption remain dominant, achieved higher scores. East Nusa Tenggara recorded the highest total (73.4) and whole grain scores (4.0), while Southeast Sulawesi recorded the highest fish score (9.9). Urbanized regions such as Jakarta and Yogyakarta recorded moderate scores but still higher than South Kalimantan. While this pattern likely reflects the structural characteristics of Indonesian dietary practices, the implications of PHDI scores for nutrient adequacy require further investigation.

1 Introduction

The EAT–Lancet Commission proposed the planetary health diet as a framework to balance human and planetary health [1]. The Planetary Health Diet Index (PHDI) was subsequently developed to translate this framework into a measurable tool for assessing dietary alignment with sustainability and health targets [2]. Indonesia reflects the complexity of this global challenge. According to the latest Indonesia Health Survey, stunting affects 18.3% of children under five, wasting remains at 9.2%, and underweight prevalence stands at 15.9%, indicating persistent undernutrition [3]. At the same time, overweight and obesity among

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adults have continued to increase, affecting more than one in four adults nationally [3]. Meanwhile, Indonesia is one of the world's largest rice-consuming nations, with polished rice contributing the majority of daily caloric intake [4]. Therefore, applying globally derived dietary metrics without contextual adaptation may influence how sustainability and nutritional performance are assessed. A previous study merged refined grains together with whole grain, yet unclear proportion and boundaries required further analysis [5]. Further, no study has adapted PHDI indicators and cut-offs to Indonesian dietary habits, despite its value for assessing food system performance. This study therefore examines the recalibration PHDI components to better reflect rice-based dietary patterns in Indonesia.

2 Methods

This ecological study used household food consumption data from the 2023 Indonesia National Socio-Economic Survey in 38 provinces. Households with extreme total energy intake (±2 SD) were excluded, reducing the sample from 341,802 to 324,635 [6]. This study adapted the cut off and scoring of a previous study [7]. Refined grain scoring thresholds were adapted from the Healthy Eating Index 2020 [8]. Food was grouped according to the 16 PHDI framework [7]. Each food group was scored on a 0–10 scale using a min–max standardization approach. For moderation components (e.g., refined grains, egg, chicken, red meat, dairy, oils, and added sugars), scores decreased as intake exceeded the maximum value. Meanwhile, for adequacy components, scores increased toward the recommended level. All components were weighted (1.0), except soy and non-soy legumes, which were weighted at 0.5. The grain component was recalibrated by testing four weighting scenarios between whole grains (WG) and refined grains (RG): 1:1, 0.5:0.5, 0.6:0.4 and 0.7:0.3, based on a composite index design, a minimum weight of 1 or comprising multiple indicators with a total weight of 1 [9]. A 90 g whole grain cut-off was applied based on epidemiological evidence [10]. Total PHDI scores were calculated using two energy standards: 2,500 kcal and 2,100 kcal [7, 11]. The final scenario was selected based on CV and parsimony principle, with preference given to the simplest option when stability was comparable, thereby increasing the interpretability [12]. The provincial score was calculated as the mean of individual scores. Provincial differences under the most stable scenario were tested using the Kruskal–Wallis's test. All analyses were conducted using SPSS version 31.

Table 1. PHDI stability based on energy requirements and grain weight modifications.

Variable	Total Score Mean±SD	CV
2,500 kcal scenario		
PHDI score (1WG:1RG)	69.12±8.13	11.8
PHDI score (0.5WG:0.5RG)	68.33±7.97	11.7
PHDI score (0.6WG:0.4RG)	68.32±8.06	11.8
PHDI score (0.7WG:0.3RG)	68.3±8.16	11.9
2,100 kcal scenario		
PHDI score (1WG:1RG)	67.86±8.49	12.5
PHDI score (0.5WG:0.5RG)	67.10±8.38	12.5
PHDI score (0.6WG:0.4RG)	67.29±8.42	12.5

PHDI score (0.7WG:0.3RG)	67.07±8.56	12.8

3 Results and discussions

Total PHDI scores calculated under the 2,500 kcal reference were consistently higher than those under the 2,100 kcal scenario (Table 1). Despite identical coefficient of variation (CV) values across scenarios from 1:1 to 0.6:0.4 under the 2,100 kcal standard, the 1:1 proportion was selected to better capture the energy requirements of the Indonesian population and its structural reliance on refined grains. Therefore, this combination was selected for subsequent analyses. Average total PHDI scores across provinces ranged from 63 to 73. Total scores across provinces were statistically different ($p<0.05$). Higher total scores were consistently observed in provinces that are characterized by greater dietary diversity in fish and non-rice staples. In contrast, several provinces in Kalimantan recorded the lowest scores, including West Kalimantan, Central Kalimantan, and South Kalimantan. Highly urbanized regions such as Jakarta, Central Java, and Yogyakarta showed moderate but relatively lower scores (Fig.1.).

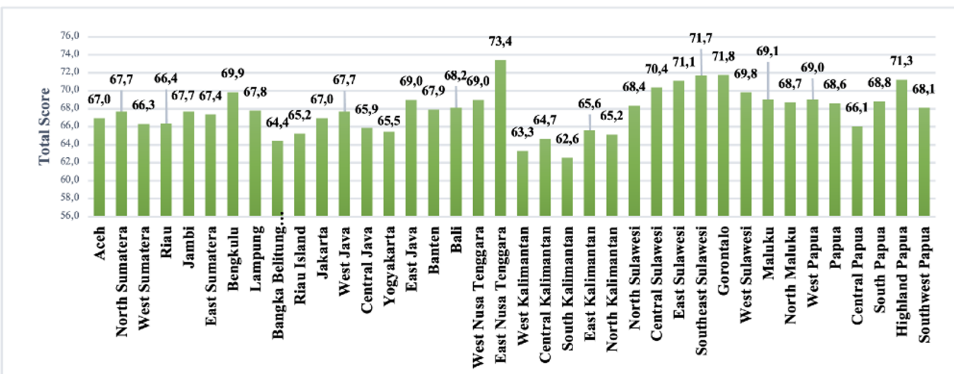

Fig. 1. Indonesia's PHDI total score mapping

Refined grain scores ranged between 0.2 and 6.4. Even in provinces where sago and corn are more commonly consumed, such as Papua and West Papua, the grain component remained relatively low [13, 14]. East Nusa Tenggara recorded the highest whole grain score (4.0), followed by Gorontalo (2.1), yet the grain contribution remained limited to the score. In contrast, animal-source food components showed clearer regional variation. Southeast Sulawesi demonstrated high scores across several protein categories, including fish and shellfish, dairy, eggs, red and processed meat, and poultry. Further, provinces such as West Nusa Tenggara and East Kalimantan recorded lower red and processed meat scores. Fruits and vegetables scores were moderate across regions. Highland Papua and Central Papua recorded the highest vegetable score, while Central and East Sulawesi achieved the highest whole fruit score. Added sugar scores ranged from 4.72 in West Kalimantan to 9.3 in Highland Papua, while fat-related components showed consistently low and relatively narrow variation across provinces.

This study suggested that PHDI scores across Indonesian provinces might reflect local dietary patterns. Indonesia's reliance on rice as refined grains is rooted on food security policy, agricultural intensification, and cultural consolidation as the dominant staple. This pattern may be similar in most Asian countries which rely on rice as a primary energy source. In contrast, in countries such as the United States and the United Kingdom, lower planetary diet alignment is driven more by excessive red meat consumption [1, 5, 7]. Indonesia's grain profile reflects a broader regional food consumption pattern. For sustainable food systems, this implies that dietary transformation must work within staple-based food cultures while gradually expanding diversified carbohydrate sources such as maize, sago, and tubers.

Protein consumption patterns also require contextual interpretation. While lower red and processed meat intake supports sustainability, Indonesia's high consumption of fish, eggs, and poultry reflects a distinct dietary structure, with fish playing a dual role in nutrition and livelihoods [15]. This highlights an opportunity to position blue food systems as a central pillar of sustainable diets through strengthening small-scale fisheries, improving post-harvest systems, and integrating fish into nutrition programs. However, plant-based protein diversification remains constrained by heavy reliance on imported soy, underscoring the need to expand alternative local legumes and improve access to healthier fat sources.

These consumption patterns provide a critical leverage point for reorienting Indonesia's food system beyond a rice-centric model toward more diverse and sustainable food sources, particularly by improving access to blue foods in urban areas. This reveals a structural policy gap. While dietary diversification policy was promoted, it was not yet supported by aligned production and distribution systems. Advancing sustainable diets therefore requires stronger alignment between national and sub-national policies to support production diversification and resilient supply chains, including cold-chain infrastructure, food storage capacity, and reduced reliance on imports. Achieving this transition demands coordinated action across stakeholders, shifting the focus from dietary guidance alone to systemic food system transformation. However, this study relied on secondary data, in which dietary adequacy was assessed using average population-level consumption regardless of age- and sex-specific nutritional requirements. Further, individual-level analyses are needed to evaluate the relationship between the index and nutrient adequacy while accounting for these nutritional requirements

4 Conclusions

This study showed that adapting the PHDI to Indonesia's rice-based dietary context provides a more realistic representation of national dietary patterns. The relatively low scores reflected structurally embedded consumption shaped by policy, culture, and food system dynamics rather than poor dietary performance. The findings highlight opportunities to improve diet quality through diversification, particularly by strengthening non-rice staples and blue foods. Advancing sustainable diets therefore required moving beyond a narrow focus on consumption behavior toward a more integrated approach that aligns production, distribution, and consumption policies to support diversified food systems, improve access to nutritious foods, and reduce structural dependencies. This suggests that adapting global dietary metrics to local contexts is essential not only for accurate measurement but also for generating actionable insights, with successful food system transformation depending on coordinated efforts across sectors and levels of governance.

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