Original Article

Development of a nutrient profiling scoring system for Thai meals: a prototype for healthier meal choices in Thailand

Pakpadsorn Sarachantapong MSc[1], Pimnapanut Sridonpai MSc[2], Orada Chansa MSc[1,2], Pornnutcha Sopawong MSc[3], Wantanee Kriengsinyos PhD[2]

[1]Health and Nutrition Promotion Section, Ajinomoto Co., (Thailand) Ltd., Bangkok, Thailand
[2]Human Nutrition Unit, Institute of Nutrition, Mahidol University, Nakhon Pathom, Thailand
[3]Bioinformatics and Computational Biology Program, Chulalongkorn University, Bangkok, Thailand

Background and Objectives: In Thailand, meals are commonly consumed as combinations of multiple dishes, yet no established nutritional criteria exist to evaluate the healthfulness of meals. This study aimed to develop healthy meal criteria for Thai diets using a nutrient profile model. **Methods and Study Design:** The Nutrient Profiling System for Meals (NPS-M) was developed with six nutritional components: energy, protein, vegetables, total fat, added sugar, and sodium. A scoring algorithm was created. Meal combinations were considered healthier if they achieved scores ≥70%, with no zero score in any one component. A total of 72,149 meals were constructed and evaluated. Criterion validity was assessed by comparing NPS-M with the Nutrient-Rich Foods Index 6.3 (NRF6.3), Health Star Rating (HSR), and Thailand's Healthier Choice logo for ready-to-eat foods (HCL-RTE) using Spearman's rank correlation. **Results:** The median NPS-M score of all meal combinations was 58 (interquartile range: 45.0-72.0). After excluding meals with zero scores in any component, 10,148 meals (14.1% of total) remained. Among these, 7,252 meals (10.1% of total) achieved scores ≥70%. Sodium was a predominant limiting factor, disqualifying 80% of meals. Criterion validity testing showed moderate correlation with NRF6.3 (ρ = 0.566, *p* <0.001), moderate reverse correlation with HSR (ρ = –0.527, *p* <0.001), and strong correlation with HCL-RTE (ρ = 0.796, *p* <0.001). **Conclusions:** The NPS-M provides a practical framework for evaluating meal healthfulness in the Thai context. The model has potential for use in restaurants, canteens, and public health programs to improve meal quality and support healthier diets in Thailand.

Key Words: Thai food, nutrient profile, nutrition labelling, healthy meal criteria, healthy environment

INTRODUCTION

In recent years, nutrient profiling models (NPMs) have emerged as effective tools for promoting healthier food choices and supporting public health policies worldwide.[1-4] These systems classify or rank foods based on their nutrient composition, to identify those that contribute to better or poorer health outcomes. NPMs are increasingly used to guide food reformulation, regulate marketing, and implement front-of-pack labelling strategies aimed at addressing diet-related noncommunicable diseases such as obesity, diabetes, and cardiovascular diseases.[5-7]

Several countries have successfully implemented front-of-pack labelling schemes based on NPMs, such as the Healthier Choice symbol in Thailand,[8] Singapore,[9] and Malaysia;[10] the Health Star Rating (HSR);[11] Nutri-Score in Europe;[12] and the Keyhole food label.[13] These tools not only facilitate informed consumer choices but also influence the food industry to improve the nutritional quality of products.

In Thailand, the Healthier Choice logo (HCL) has been implemented for over a decade, primarily applied to packaged food and beverages.[14] The initiative has contributed to product reformulation and increased public awareness of healthier options. However, Thai people commonly consume cooked meals from restaurants, street vendors, and home kitchens, rather than packaged foods.[15] Thai meals typically consist of rice and a variety of side dishes shared among diners, emphasizing balance and diversity. Despite these traditional strengths, modern Thai diets have shifted toward high-calorie, low-nutrient options, contributing to the national burden of noncommunicable diseases.[15,16]

Countries such as Japan have developed NPMs for individual menu items with the complexity of combination meals typically consumed in their country.[17-19] Although

Corresponding Author: Assoc. Prof. Wantanee Kriengsinyos, Human Nutrition Unit, Institute of Nutrition, Mahidol University, Salaya, Phutthamonthon, Nakhon Pathom 73130, Thailand
Tel: +66868829551
Email: wantanee.krieng@mahidol.ac.th
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Thailand has developed criteria to identify healthy meals, little progress has been made in translating these criteria into practice for freshly prepared foods or in testing their feasibility for food providers.[20] Currently, Thailand has no standardised system to assess the nutritional quality of cooked or mixed meals, which limits efforts to promote healthier eating in everyday food environments.

To address this gap, this study describes the development of a nutrient profiling scoring system for Thai meals (NPS-M), tailored to the dietary patterns and cultural context of Thailand. The NPS-M is designed to evaluate overall nutritional quality of complete meals, incorporating key nutrient criteria aligned with national dietary guidelines. This article describes development of the NPS-M, algorithm validation, and its assessment of commonly consumed Thai meals, along with suggestions for its application to promote healthier eating. The goal is to provide a scientific and practical tool that can be used by policymakers, food vendors, and health professionals to promote healthier food environments. With policy support, the NPS-M has potential to encourage food service providers to offer healthier meals and empower consumers to make better dietary choices, contributing to long-term public health improvement in Thailand.

METHODS

NPS-M development

The development of NPS-M is based on several key principles to ensure that the system is both scientifically valid and practical for real-world applications. First, the NPS-M is designed for the general healthy adult population, without specific adjustments for age, sex, or disease conditions. All nutrient reference values used in the system are based on general dietary recommendations for the overall adult population. Second, the system does not categorise individual dishes as simply healthy or unhealthy but, rather, assesses the nutritional quality of meals, recognising that a healthy meal can be formed through the combination of multiple dishes. This approach aligns with Thai dietary culture, which commonly involves consumption of various side dishes within a single meal. Third, in this study, the term meal refers to a single-person portion in the context of Thai eating habits. This includes either a one-dish meal that incorporates multiple nutritional components (e.g., rice, protein, and vegetables in one plate) or a combination of several side dishes consumed together as a complete meal. Fourth, the NPS-M evaluates portion sizes based on actual serving sizes typically found in restaurants, adjusted to reflect an amount that is reasonable for one person to consume in a single meal. Fifth, the nutrient criteria and scoring system were designed to be practical and applicable for both food vendors and consumers. The system aims to support vendors in offering meals that align with nutritional balance while also helping consumers make healthier choices without needing to completely change their eating preferences.

Nutrient selection and nutrient target values of a meal

Six nutritional components were selected as the focus of the NPS-M, based on their relevance to major public health concerns in Thailand:[16,21] energy (kcal), protein (g), vegetables (g), total fat (g), added sugar (g), and sodium (mg). The selection also aligns with food groups and nutrients commonly addressed in dietary recommendations and national health policies.

Vegetables were selected as a target food group instead of dietary fibre due to their practicality in both consumer communication and recipe reformulation by food vendors. In this context, the term vegetables includes both vegetables and fruits that are cooked and served as part of a meal, recognizing that some fruits are commonly used in Thai cuisine during cooking (e.g., pineapple in curry).

Added sugar, in this model, refers to sugar or sweetened products intentionally added during cooking, including ready-to-use sauces that are preformulated and require no further seasoning (e.g., kaprow sauce). It does not include base sauces like oyster sauce or soy sauce, which are used as components in cooking and not considered final seasonings, even if they contain some sugar.

The nutrient target values (NTVs) for these six nutritional components were calculated based on the Thai Recommended Daily Intakes,[22] the Thai Food-Based Dietary Guidelines,[23] and national recommendations for fruit and vegetable intake,[24] in accordance with previous studies.[25] These values were adjusted to reflect the nutritional goals per meal, based on three meals per day. The resulting NTVs for a single meal are as follows: energy, 533 kcal; protein, 15 g; vegetables, 53 g; total fat, 19 g; added sugar, 1.6 g; and sodium, 667 mg.

Developing the NPS-M algorithm

The six nutritional components were categorised into three main groups based on their health impact: promoting components, those encouraged for increased consumption, comprised protein (g) and vegetables (g); limiting components—those recommended to be limited, comprised total fat (g), added sugar (g), and sodium (mg); and a neutral component, energy (kcal), which should be consumed in appropriate amounts, where both excess and deficiency may negatively impact health.

To establish the scoring algorithm, the NTV for each component was standardised to a maximum of 10 points, as summarised in Table 1. For promoting components, the score starts at 10 and decreases by 1 point for every 10% below the NTV, down to a minimum score of 0. For limiting components, the score starts at 10 and decreases by 1 point for every 10% above the NTV, also down to a minimum score of 0. An exception was applied to added sugar, for which the score decreased by 1 point for every 0.5 g of added sugar, to enhance practicality. For energy, considered a neutral component, the score is 10 when energy content is within ±5% of the NTV. For every additional 5% deviation (either increase or decrease) from the NTV, the score is reduced by 1 point, with a minimum score of 0.

Each meal is evaluated using the NPS-M algorithm across all six nutritional components, yielding a maximum total score of 60 points. The final score is then converted to a percentage to facilitate interpretation, with higher scores indicating better nutritional quality. However, to ensure nutritional adequacy and safety, meals receiving a score of 0 in any critical nutrient (especially limiting nutrients) may be considered unacceptable,

Table 1. NPS-M scoring algorithm

Points	Neutral		Promoting		Limiting		
	Energy† (NTV=533 kcal)		Protein‡ (NTV=15.0 g)	Vegetables‡ (NTV=53 g)	Total fat§ (NTV=19.0 g)	Added sugar§ (NTV=1.6 g)	Sodium§ (NTV=667 mg)
10	507-560		≥15.0	≥53	≤19.0	≤1.6	≤667
9	480-506	561-587	13.5-14.9	48-52	19.1-20.9	1.7-2.1	667.1-733.7
8	453-479	588-613	12.0-13.4	42-47	21.0-22.8	2.2-2.6	733.8-800.4
7	427-452	614-640	10.5-11.9	37-41	22.9-24.7	2.7-3.1	800.5-867.1
6	400-426	641-667	9.0-10.4	32-36	24.8-26.6	3.2-3.6	867.2-933.8
5	373-399	668-693	7.5-8.9	27-31	26.7-28.5	3.7-4.1	933.9-1000.5
4	347-372	694-720	6.0-7.4	21-26	28.6-30.4	4.2-4.6	1000.6-1067.2
3	320-346	721-747	4.5-5.9	16-20	30.5-32.3	4.7-5.1	1067.3-1133.9
2	293-319	748-773	3.0-4.4	11-15	32.4-34.2	5.2-5.6	1134.0-1200.6
1	267-292	774-800	1.5-2.9	5-10	34.3-36.1	5.7-6.1	1200.7-1267.3
0	<267	>800	<1.5	<5	>36.1	>6.1	>1267.3

NTV, nutrient target values.
†Total energy points decrease by one for every ±5% deviation from the NTV (decrease, left column; increase, right column).
‡Protein and vegetable points decrease by one for every -10% from the NTV.
§Total fat and sodium points decrease by one point for every 10% increase above the NTV. Added sugar points decrease by one point for every 0.5 g increase to enhance practicality.

regardless of the total score achieved from other components. Figure 1 summarizes the steps to calculate the NPS-M final score.

Existing meal combination evaluation utilising the NPS-M

A total of 2,347 recipes from a previous study[25] constituted the basis for meals evaluated using the NPS-M. These recipes were classified into three groups: (1) 1,782 side-dish recipes, which were used to generate combination meals; (2) 520 single-dish recipes, representing nutritionally complete meals; and (3) 45 small side-dish items, which were excluded from the combination process due to their minor contribution to the overall meal.

For side dishes, multiple recipe variations under the same dish name were consolidated into 380 distinct menu items, using the median nutrient composition of all recipe variations as the representative value for each menu name. These standardised menu items were then paired in sets of two and combined with a standard rice portion to create combination meals reflecting typical Thai eating patterns. Similarly, the 520 single-dish recipes were grouped into 139 unique single-dish meals, with the median nutrient values of each recipe group used to represent the corresponding dish. Each single-dish meal was treated as an individual unit for assessment.

All constructed combination meals and single-dish meals were evaluated using the NPS-M algorithm. Portion sizes were adjusted to represent appropriate single-meal servings for a general adult. These portions were derived by averaging common hospital serving sizes and rounding the results to the nearest 10 grams. This rounding was applied to maintain consistency across similar food categories and to ensure the portions were practical and simplified for implementation, following the methodology of the original study.[25]

Setting healthier criteria for combination meals

To determine an appropriate cut-off NPS-M score for identifying healthier meals, it is important to balance nutritional adequacy with practical feasibility in real-world settings. The percentage of meal combinations falling

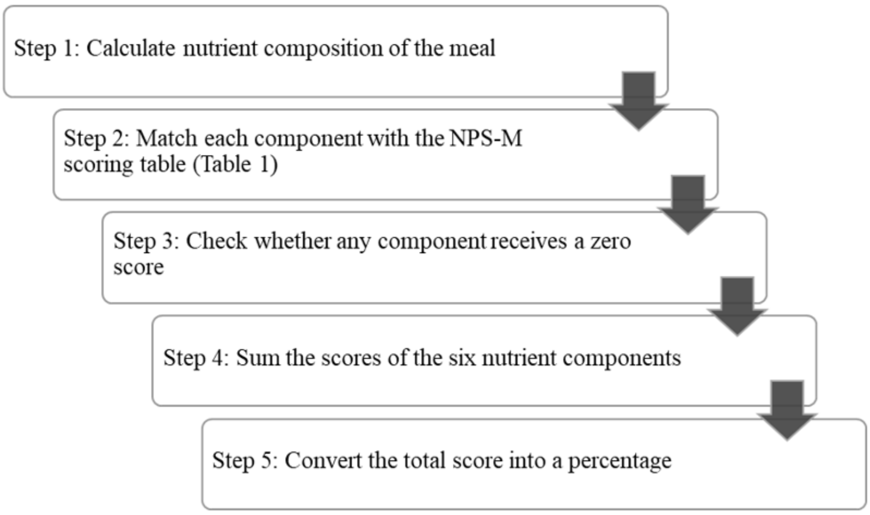

Figure 1. Flowchart of the calculation process for the Nutrient Profiling System for Meals (NPS-M). The procedure includes five steps: (1) calculating the nutrient composition of the meal, (2) matching each component with the NPS-M scoring table, (3) checking whether any component receives a zero score, (4) summing the scores of the six nutrient components, and (5) converting the total score into a percentage

within various NPS-M score ranges (e.g., 90-100, 80-100, 70-100) was calculated. The score range in which approximately 10-20% of all meal combinations were classified was proposed as the initial threshold for a "healthier meal" criterion.

This threshold was set based on empirical distribution to ensure that the criterion is neither too strict nor too lenient. A standard that is too difficult to achieve may discourage food vendors from attempting to reformulate their recipes. Conversely, if the standard is too easy, it may not effectively promote meaningful improvements in meal quality. Setting a realistic and achievable benchmark is essential, especially in the initial phase of implementation, to encourage participation and gradual improvement.

As the healthy food environment expands and the quality of meals improves over time, the criteria can be revised and made more stringent following a stepwise model similar to the Thai Healthier Choice logo (HCL) system.[14]

NPS-M validation

Combination meals and single-set meals were used to validate NPS-M. Criterion validation of NPS-M was conducted by comparing NPS-M scores with those from existing NPMs: Nutrient-Rich Foods index (NRF6.3), which calculates the sum of six nutrients to encourage minus the sum of three nutrients to limit[26], Health Star Rating (HSR),[11] and HCL for ready-to-eat meals (HCL-RTE).[14] The strength of correlation (Spearman's rho, ρ) was interpreted as follows: $\rho \geq 0.70$ indicates strong correlation; $\rho = 0.40\text{-}0.69$, moderate correlation; and $\rho < 0.40$, weak correlation.[27] This analysis aimed to determine the extent to which NPS-M aligns with existing nutrient profiling standards and supports its applicability for evaluating the nutritional quality of Thai meals.

Statistical analysis

Statistical analyses were performed using PASW Statistics for Windows, version 18.0 (SPSS Inc., Chicago, IL, USA). All statistical tests were conducted with a significance level set at $p < 0.05$. Normality of data was tested with the Shapiro-Wilk test. Nutritional values of each menu are summarised as medians and interquartile ranges (IQRs). NPS-M scores across evaluated meals are presented in histogram format, with accompanying median and IQR values. Additionally, the frequency and percentage of meal combinations within specific NPS-M score ranges were calculated to help determine cut-off criteria for healthier meals. The criterion validity of the NPS-M was assessed by analysing the correlation between NPS-M scores and scores from other established nutrient profiling systems using Spearman's rank correlation coefficient.

RESULTS

Meal combination evaluation utilising the NPS-M

A total of 72,010 combined meals were generated from 380 distinct menu items, which were assessed alongside 139 single-dish meals. This resulted in a total of 72,149 possible meal combinations. The NPS-M scores of these combinations had a median of 58 (IQR: 45.0-72.0; Figure 2).

Healthier criteria for meals

In accordance with the NPS-M criteria, combinations receiving a score of zero in any nutrient component were excluded from further analysis. Consequently, of the 72,149 total meals evaluated, 62,001 combinations (85.9%) were removed for inadequate scores in sodium [57,808 (80.1%)], total fat [19,053 (26.4%)], energy [18,325 (25.4%)], added sugar [14,843 (20.6%)], and/or vegetables [978 (1.36%)]. Notably, no combination received a zero score for protein. After this exclusion step, 10,148 (14.1%) valid meal combinations remained for analysis. The distributions of NPS-M scores among all

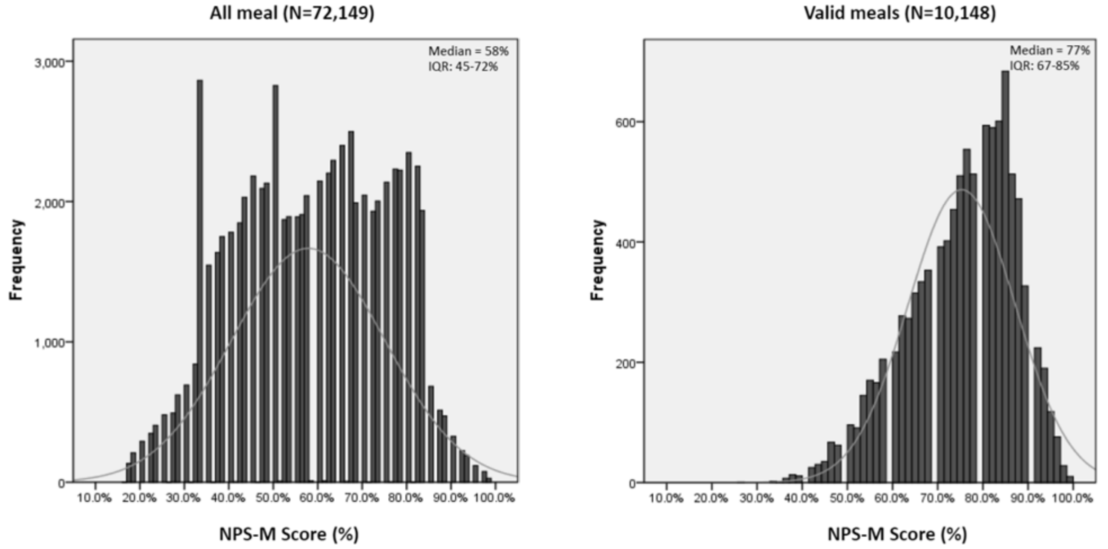

Figure 2. Distribution of Nutrient Profiling System for Meals (NPS-M) scores among all meal combinations (N = 72,149; left) and valid meals after excluding those with zero scores in any nutrient component (N = 10,148; right). Histograms show the frequency of meals across score ranges (0-100%), with fitted curves illustrating overall distribution patterns. Within each 10% interval, six discrete bars are presented, corresponding to the conversion from the 0–60 raw score scale to a percentage basis.

meals and valid meals are presented in Figure 2.

Percentages of meal combinations classified across NPS-M score ranges (e.g., 90-100%, 80-100%, and 70-100%) was examined to identify a practical threshold for defining healthier meals. Only a small percentage of meals achieved scores; 1.3% (973 meals) for the 90-100% range and 6.3% (4,527 meals) for the 80-100% range, whereas 10.1% of the original 72,149 combinations (7,252 meals) achieved NPS-M scores 70-100%, reflecting a favourable nutritional profile. To establish a benchmark for defining a "healthier" meal, the threshold was set at NPS-M ≥70%, with the additional requirement that no nutrient component received a score of zero. This dual criterion ensured that meals considered healthier were not only high scoring overall but also nutritionally balanced, with no key nutrient category entirely lacking.

Comparison of NPS-M with existing nutrient profiling systems

The NPS-M score demonstrated a moderate positive correlation with NRF6.3 ($\rho = 0.566$, $p < 0.001$), a moderate negative correlation with HSR ($\rho = -0.527$, $p < 0.001$), and a strong positive correlation with HCL-RTE ($\rho = 0.796$, $p < 0.001$). The corresponding scatter plots illustrating these relationships are presented in Figures 3-5. These findings indicate that the NPS-M aligns well with established nutrient profiling systems, particularly with the HCL-RTE, which specifically applies to ready-to-eat foods.

DISCUSSION

Portion-based approach reflecting Thai context

The NPS-M was developed to suit the Thai context, particularly for use by food providers such as restaurants and meal service operators. Unlike most global nutrient profiling systems, which base their calculations on 100 kcal, 100 g, or 100 mL, an approach suitable for packaged food labeling,[8-14,28-30] the NPS-M employs portion size as the base unit. Using serving size as the basis of calculation may better reflect actual consumption and aligns with the Thai eating culture, where foods are typically consumed as complete meals. Additionally, the Nutrient Profiling Model for Japanese Dishes (NPM-JD) and an NPM developed for UK meals also employ serving size as the basis for calculation.[17,31] This approach also enhances applicability for public food providers, including restaurants and cafeterias. Using portion size enhances practicality, allows clearer nutrient communication to consumers, and supports real-world application without requiring further calculation by the consumer.[32]

Nutrient selection and contextual considerations

The six nutritional components included in the NPS-M, energy, protein, vegetables, total fat, added sugar, and sodium, were chosen to balance public health priorities with feasibility for real-world applications. In Thailand, the Healthier Choice logo for ready-to-eat foods (HCL-RTE) considers energy and eight nutrients, including calcium and iron. These micronutrients can be accurately assessed in manufactured products through laboratory analysis, reflecting Thailand's concern over deficiencies in calcium and iron.[33-37] However, when expanded to freshly prepared meals that are not mass-produced, such detailed assessment is less feasible, highlighting the need to focus on a smaller set of key nutrients.

In contrast, the U.S. Food Compass applies a broad framework that includes nine domains and 54 components, such as phytochemicals, food additives, and processing-related factors.[38-40] While this offers comprehensive assessment suitable for highly processed and fortified foods, such detail is not practical for evaluating cooked Thai meals, where nutrient values are estimated primarily through food composition databases. Reliance on laboratory-dependent nutrients, including vitamins that degrade during cooking and storage, further underscores the

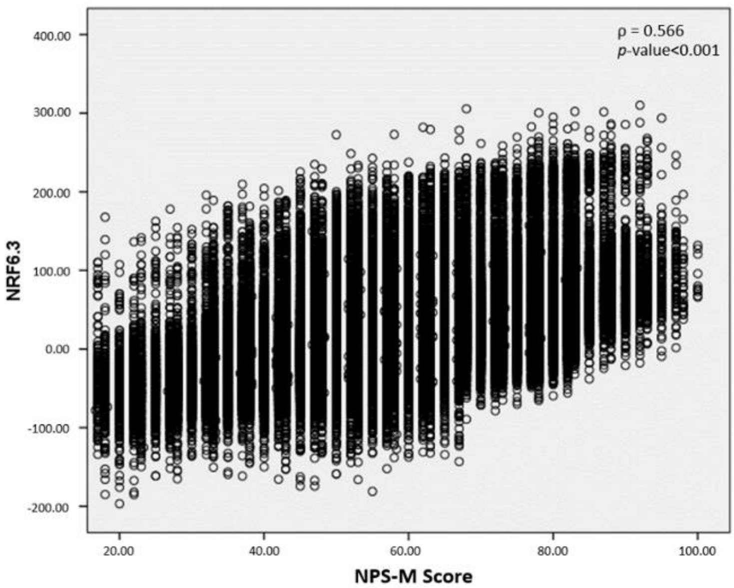

Figure 3. Scatter plot of the Nutrient Profiling System for Meals (NPS-M) scores and NRF6.3 scores. Each point represents an evaluated meal (N=72,149). A moderate positive correlation between NPS-M and NRF6.3 ($\rho = 0.566$, $p < 0.001$) indicates that meals receiving higher NPS-M scores tended to have higher NRF6.3 scores

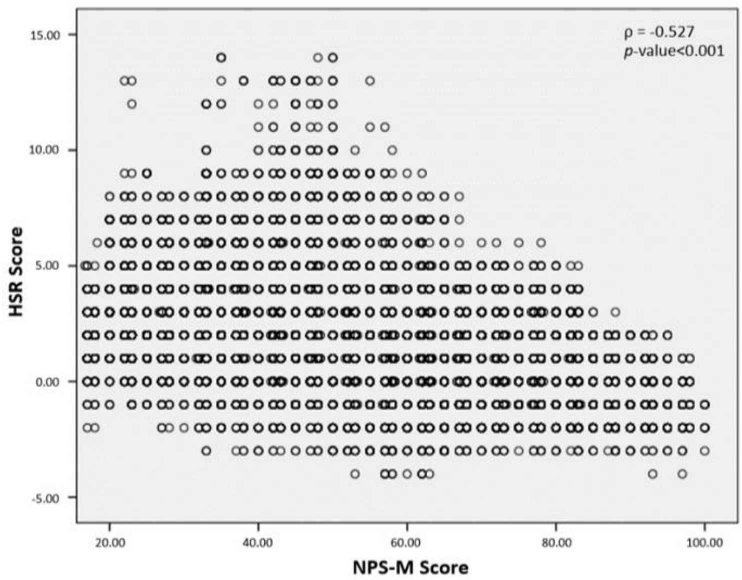

Figure 4. Scatter plot of the Nutrient Profiling System for Meals (NPS-M) scores and Health Star Rating (HSR) profiler scores. A moderate negative correlation between NPS-M and HSR profiler scores ($\rho = -0.527$, $p < 0.001$) reflects the inverse scoring structure of the HSR algorithm relative to the NPS-M

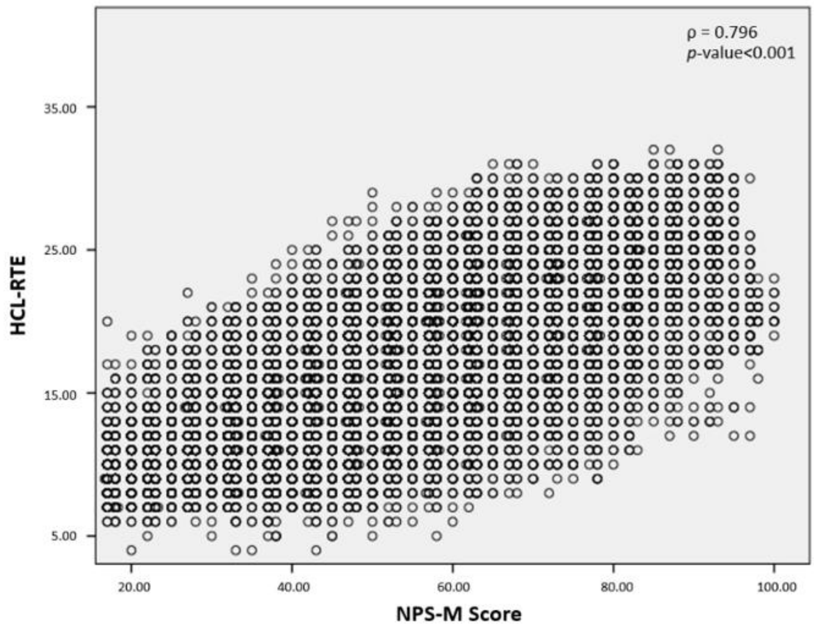

Figure 5. Scatter plot of the Nutrient Profiling System for Meals (NPS-M) scores and Healthier Choice logo for ready-to-eat foods (HCL-RTE) scores. The NPS-M showed a strong positive correlation with HCL-RTE scores ($\rho = 0.796$, $p < 0.001$), consistent with the additive scoring approach shared by both profiling systems

limitations of applying such a detailed model to ready-to-eat meals.

Japan provides additional examples of context-specific nutrient selection. The Ajinomoto Nutrient Profiling Systems, developed by Jinzu H. and colleagues, and another system by Furuta C. and colleagues, were designed for cooked meals and include only four components: vegetables, protein, saturated fatty acids, and sodium; sugar is not included, as sugar reduction was not considered a national dietary priority in Japan.[18,19] In contrast, the NPM-DJ (version 1.0), developed by Tousen Y. and colleagues , expanded the scope to include energy, saturated fatty acids, sugar, sodium, vegetables, protein, and dietary fibre.[17] The development of NPM-DJ was also influenced by its sibling system designed for processed foods, the Nutrient Profiling Model for Processed Foods in Japan (NPM-PFJ).[29] As a result, nutrients choices in both NPM-DJ and NPM-PFJ share a common conceptual foundation.

Taken together, these comparisons emphasise that the six core components of NPS-M reflect both Thailand's priority dietary risks, particularly sodium and sugar, and the practical constraints of evaluating cooked meals. This balance ensures that the model remains contextually relevant and feasible for implementation in food service settings.

Scoring and criteria in NPMs

The NPS-M employs a simplified additive scoring system in which higher scores indicate healthier meals. This approach conceptually aligns with the HCL in Thailand[14] and the Ajinomoto Nutrient Profiling Systems,[18,19] which also use additive scoring, whereas other systems apply different methods.[11-13,17,29,41] For example, Nutri-Score employs a deduction model, subtracting points for risk nutrients from cumulative points for positive nutrients.[12]

In terms of criteria, the NPS-M defines healthier meals using a cut-off of 70%, a threshold comparable to Food Compass 2.0.[39] Other grading systems typically set their cut-off between 60% and 80%,[41,42] while the HCL-RTE requires at least 20 of 40 points (50%) to qualify.[14] Importantly, the HCL-RTE also incorporates progressive revisions of nutrient thresholds, particularly sodium, every 3-5 years, making the criteria increasingly stringent to encourage continuous recipe reformulation and adaptation to healthier food environments.

In summary, while scoring methods differ across models, the NPS-M aligns closely with additive approaches such as HCL, yet its cut-off criterion is more stringent than the HCL-RTE and is positioned within the international range, balancing clarity, feasibility, and the potential for future refinement.

Nutritional challenges identified in Thai meals

In this study, application of NPS-M to 72,149 meal combinations revealed that sodium and fat were the most frequent limiting factors, with sodium alone responsible for 80% of disqualified meals, followed by total fat and energy. Added sugar contributed to meal disqualification to a lesser extent. Four contextual factors likely contributed to these findings: (1) the flavour profile of Thai cuisine, which balances multiple seasonings and can lead to compensatory increases in salt or fat from coconut milk, which is the main ingredient of many recipes in Thailand;[25] (2) the proportion of liquid to solid ingredients, as soups and dressings often contain dissolved sodium and fat; (3) nutrient estimation based on the meal served, not consumed, potentially overestimating intake for dishes where broth is not fully consumed; and (4) the effect of menu combination, as pairing two high-sodium items results in an overall excessive sodium content, or two high-fat items results in an overall excessive fat content, whereas balanced pairings can yield healthier outcomes.

Protein was the only component for which no meal received a zero score, reflecting the generally adequate protein content of Thai diets. This outcome is partly explained by the NTV of protein: the minimum requirement for protein is only 1.5 g per meal, to avoid a zero score, while a full score is given at 15 g. Consequently, even a staple food without an explicit protein-rich dish can contribute enough to prevent disqualification. Similarly, for vegetables the minimum threshold is set at 5 g per meal, which ensures that even small amounts of vegetables contribute positively to the score. These thresholds were designed to enhance feasibility and inclusivity across diverse meal types. Importantly, the dual criteria of NPS-M, requiring both a total score ≥70% and the absence of zero scores in any nutrient component, ensures that meals with very low contributions of protein or vegetables, although not disqualified by zero scores, are still unlikely to achieve the overall threshold for the “healthier meal” category.

Comparison with established systems

According to the validation results, the NPS-M demonstrated moderate correlations with NRF6.3 and the HSR and a strong correlation with the HCL-RTE.[11,14,26] Several factors may explain these findings. Both NRF6.3 and HSR apply algorithms that subtract scores for risk nutrients from cumulative scores for positive nutrients, whereas the HCL-RTE, similar to NPS-M, relies on summing scores across nutrients. This methodological similarity likely accounts for the stronger correlation between the NPS-M and HCL-RTE.

Despite this alignment, notable differences across systems may also affect the degree of correlation. The final score of each system is expressed on different scales: for NRF6.3, scores are calculated from percentage daily values and can be either negative or positive, resulting in a wide range (–300 to +600). For HSR, scores are compressed into only 11 possible star categories (0, 0.5, 1… 5 stars), so the present study used the HSR profiler score, the underlying raw score prior to star conversion (≤–11 to ≥25), for validation instead of the star rating, which has a narrow scale. For the HCL-RTE, the total score ranges from 0 to 40 (0-5 points across eight nutrients). In contrast, NPS-M uses a 0-100 percentage score, designed to facilitate clarity in consumer communication. Furthermore, for validation the present study employed Spearman’s rank correlation, which captures monotonic relationships but not absolute equivalence, and this may also influence the interpretation of correlations.

The Healthy Eating Index (HEI)[43] was not used for validation due to the limited availability of fatty acid data in the nutrient database, which is required for HEI components. Furthermore, the HEI is designed to assess overall dietary quality over time, rather than for single meals, and its 1,000-kcal standardization is incompatible with the typical energy ranges of NPS-M meals.

Strengths and limitations

This study has several notable strengths: (1) It is among the earliest attempts to evaluate meal combinations rather than individual food items, thereby better reflecting the cultural eating patterns of the Thai population. (2) The use of a large dataset comprising 72,149 possible meal combinations provided statistical robustness and wide coverage of dietary scenarios. (3) The external validation of the NPS-M through positive correlations with internationally recognised nutrient profiling systems (NRF, HSR, and HCL-RTE) enhances the credibility of these results. These study strengths support broad adoption of the NPS-M. In addition, the portion-based scoring, instead of the conventional 100 g or 100 kcal references, increases practicality and relevance of the NPS-M for real-world applications in restaurants and canteens. The dual-condition criteria, requiring both an overall score of ≥70% and the absence of zero scores in any nutrient, ensures that meals classified as healthier are not only high scoring but also nutritionally balanced. These factors enhance the potential for widespread adoption of the NPS-M in the Thai food environment.

This study has several limitations: (1) The use of standardised recipes and portion sizes may not fully capture the variability of cooking practices and actual eating behaviours. (2) Data on cooking yields and nutrient retention were not available for several food items, so it is possible that the estimated nutrient values may not fully reflect nutrient changes occurring during food preparation. (3) Nutrient calculations were based on the meals as served, not as consumed, which may overestimate liquid-based dishes, such as soups or salad dressings, that are not typically consumed in their entirety. (4) The NPS-M is based on average serving sizes for hospitalized adults and is based on the Thai RDI[22] for the general population. It may not reflect the needs of specific groups (e.g., children, athletes, pregnant women, the elderly, or individuals with chronic diseases). Therefore, it should be applied with caution in these populations.

Conclusions

This study demonstrates the application of the Nutrient Profiling System for Meals (NPS-M) to assess the nutritional quality of Thai prepared meal combinations. Among more than 72,000 possible combinations, only a small percentage (~10%) met the model's criteria for healthier meals (scores ≥70% and no category with 0 value); sodium content emerged as the predominant limiting factor. The portion-based design of the NPS-M, combined with its simplified scoring algorithm and validation against existing profiling systems, highlights its potential as a practical and contextually appropriate tool for evaluating and promoting healthier meal patterns in Thailand.

The findings suggest that the NPS-M could serve as a practical framework for restaurants, canteens, and meal service operators to design healthier menus. Policymakers could adopt the model to extend nutrition labelling and certification beyond packaged foods to include freshly prepared meals. Given that sodium was the most frequent disqualifying nutrient, public health initiatives should prioritise sodium reduction strategies, including reformulation and consumer education. Future refinements of the NPS-M should consider periodic revisions of cut-off thresholds, similar to the Healthier Choice logo system, to encourage continuous improvement of the food environment. Integration of the system into digital platforms, such as menu labelling, mobile applications, and meal planning tools, could further enhance its impact by empowering both providers and consumers to make healthier choices.

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DISCLOSURE ON THE USE OF AI AND AI-ASSISTED TECHNOLOGIES

AI technologies (OpenAI, San Francisco, CA, USA) were used for language proofreading. The author reviewed and edited the content and takes full responsibility for the content of the publication.

CONFLICT OF INTEREST AND FUNDING DISCLOSURES

One of the authors (P.Sar) is an employee of Ajinomoto Co., (Thailand) Ltd., and two authors (O.Cha and P.Sop) were contracted for this project through personnel support provided by the same company. The company had no role in the study design, data collection, analysis, interpretation, or manuscript preparation. The authors declare no additional conflicts of interest.

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