Summary

Non-communicable diseases influenced by poor dietary and lifestyle habits are debilitating on multiple levels. Health promotion, prevention and delayed progression of chronic diseases is of utmost importance and achievable through appropriate dietary management. Many health technology dietary approaches place an overemphasis on calorie counting and individual foods rather than nutritional quality and composite meals. Nutrient profiling based meal scoring takes into account of the variety of factors which contribute to nutritional quality, balance, composition and adequacy. The Food Score system developed by Holmusk employs a meal scoring point system with a unique algorithm to provide intuitive nutrition information. This novel application provides a holistic and practical solution to increasing healthy dietary behaviours, through increasing food knowledge and awareness.

The Epidemic of Noncommunicable Diseases

Noncommunicable diseases (NCDs) are the leading cause of death globally. Seven out of 10 people worldwide die every year from NCDs, comprising mainly of cardiovascular diseases, cancer and diabetes. This is 41 million deaths from NCDs annually and includes 15 million people dying from an NCD between the ages of 30 and 69 years, taking lives when they are most productive. The suffering and premature death caused by NCDs negatively affects national growth, healthcare costs and household incomes.

Nutrition: A Critical Risk Factor

Lifestyle modification can prevent 80% of heart disease, stroke and diabetes. Nutrition particularly has a significant role to play. In particular, a diet inadequate in fruits and vegetable intake, high in calories, salt and unhealthy fat intake is closely linked to overweight/obesity, raised blood pressure, elevated blood sugar and high fats level in the blood, which are the four keys metabolic risk factors that significantly increase the risk of NCDs. Governments and private sectors have initiated many efforts in educating the public, with dietary guidelines, food policies and public education as measures to curb NCDs. However, the worldwide prevalence of obesity has incessantly increased and nearly tripled between 1975 and 2016. Modern busy lifestyles are often at odds with the healthy aspirations of consumers who want to achieve wellness through good nutrition and exercise.
The proliferation of nutrition misinformation on the internet and multiple elements of diet each leading to unique (negative, positive or neutral) health outcomes, make it challenging for consumers to understand what is healthful or not. However, technology has made nutrition education more accessible and fun. Given that the modern lifestyle is relentlessly busy, people value convenient ‘on the go’ access to wellness programs that provide information and advice, real-time self-monitoring, feedback, reinforcement, social support, and rewards. App-based interventions are the answer.

Challenges of Food Journaling As A Solution

Food journaling apps is one of the most effective methods utilising technology to instil healthy eating behaviours. MyFitnessPal and FatSecret are among the most popular apps in this category. They allow users to search for components of a meal against a food database, enter portion information, and journal calories and other nutritional information relative to a daily goal. This in turn can help to prompt people to be more mindful of the quality and quantity of foods they consume. However, manual food recording— even on smartphones— requires a high level of engagement and is burdensome for most people. Another issue is inaccurate and misleading results owing to difficulty finding appropriate entries in food databases, unreliable entries in those databases and difficulty estimating portions. Studies suggest that journaled calories can be out by as much as 20-50%. This is a serious problem when people are relying on these estimates to make decisions about daily intake and expenditure.

Nutritional Profiling

The most common / traditional way of communicating nutrition information relied on nutritional information panel (NIP) on food products. The implied benefits of the presence of NIP are that consumers will be able to observe such information and then make informed food choices. However, nutrition information on food labels is complex and does not always live up to its potential to communicate effectively. Hence this has led to the development of front-of-pack (FoP) nutritional labels by both government and private institute, which actively offer a third-party nutritional opinion serving as a guidance for consumers towards healthier food choices at the point of purchase.
The FoP label format can be different across countries, however most countries have developed the FoP label based on a scoring / rating system. A food will go through a nutritional profiling process, a certain score will be computed to represent its healthfulness. Below are some of the examples of FoP label in different countries:

<table>
<thead>
<tr>
<th>Name</th>
<th>Country</th>
<th>Scoring</th>
<th>Interpretation of Scores</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Star Rating System²³</td>
<td>Australia</td>
<td>½ stars to 5 stars</td>
<td>The more stars, the healthier the choice</td>
<td></td>
</tr>
</tbody>
</table>
| Guiding Stars¹⁴             | USA       | 0 to 3 stars      | 0 star indicates the food does not meet the nutritional criteria to receive a Guiding Star  
1 star indicates good nutritional value  
2 stars indicate better nutritional value  
3 stars indicate the best nutritional value |         |
| Nutri-Score¹⁵               | France    | Different score range is attributed to a certain color | Green: highest quality  
Red: lowest quality |         |
| EWG’s Food Scores¹⁶         | USA       | 1 to 10           | 1 (best) to 10 (worst) | 1.0     |
Limitations of Today’s Nutrient Profiling systems

Nutrient profiling can provide a quick, easy and standardised way for consumers to compare similar packaged food and make better informed choices. **However, it is very much limited to packaged food and raw ingredients only. It does not take into consideration of the food portion, food combinations and cooking methods at a meal level.** This presents a shortcoming, as a balanced diet is about overall meal patterns. Most meals are composed of many different foods, there is a need to develop new metrics to evaluate nutrition quality, correspondence between nutrients, of alternative food combinations in meals.

Unlike packaged food which abides by food laws that require a nutrition information panel, cooked meals do not. This results in limited guidance on the nutritional value of a cooked meal. In recent years, the increasing awareness of unhealthful eating habits and the burden of obesity-related chronic diseases have influenced certain food outlets to include calorie counts of their products. Although this is a quick and simple way to nudge consumers into choosing lower calorie meals, it neglects important aspects of food and nutrition.

Dietary guidelines have been translated from years of research into nutrition and health to promote the benefits of healthy eating. Guidelines across countries such as Australia, Singapore and the United States of America are aligned with the use of the ‘healthy plate’ concept to serve as an easy visual guide. However, it can be difficult for the general population to interpret recommendations from dietary guidelines into their daily lives. The food scoring system takes into account of these evidenced-based guidelines and the principles that govern a ‘healthy plate’ to provide more detailed and concrete guidance.

Food Score: Holmusk’s Nutrient Profiling Based Meal Scoring

To solve the difficult problem of profiling different kinds of foods including cooked foods, Holmusk has developed a proprietary nutrient profiling-based meal scoring system, termed Food Score. The Food Score system has several key advantages:

1. **Versatile.**
   Food Score is applicable to all different kinds of food, drinks and food combination in meals, not just prepackaged food.

2. **Easy to Understand.**
   Numerical scoring from 1 to 5 is intuitive and practical, allowing a typical person to easily understand how a particular food or meal impacts their health.
Food Score provides a simple way of grading a meal to increase awareness of the nutritional value of a combination of food, indicating both nutritional balance and quality which ideally reflects the principles of healthy eating. Similar to the health star rating on food packages in Australia, the food scoring system provides an at-a-glance guide towards the overall quality of a meal. A simple score of 1 to 5 stars, with increments of ½ a star, provides a simple yet adequate range to that takes into account of the 5 key food groups in our diet, condiments, cooking methods and portion size.

Along with a score out of 5, the meal scoring system highlights the key nutrients that contribute to the score. These are differentiated by nutrients that are beneficial to health, and those that are adverse to health. Essential nutrients present in recommended quantities contribute to the promotion of good health and prevention of chronic diseases. In contrast, nutrients which are in excess or insufficient of recommended quantities can contribute to an increased risk of developing chronic disease or worsening health outcomes. With these traits highlighted, consumers will have a better understanding of the quality of their meals and areas of improvement. Highlighting areas of improvement is significant as this nudges consumers to make changes to their dietary habits where appropriate.

A diet with high nutritional quality includes whole grains, mostly non-processed protein choices, healthy fats and plenty of fruit and vegetables. A balance of macronutrient composition as well as adequate intake of fibre, and a range of micronutrients including vitamins, minerals, antioxidants and phytochemicals are key. Consuming a wide variety of food from all food groups helps to increase nutritional adequacy. This is important for weight management, mental health and prevention of chronic diseases and cancer. In the short term, it affects energy levels, mood and sleep quality.

3. Comprehensive.
Food Score takes into account multiple different factors based on key recommendations from dietary guidelines, such as portion sizing, nutrient quality, degree of processing.

4. Scalable.
The Food Score methodology can be translated into a smart algorithm that automatically calculates the scores, and easily deployed on a digital platform or mobile app.
Some of the key recommendations from dietary guidelines include:

1. Increase whole grains intake
2. Increase fruit and vegetables intake
3. Reduce consumption of food and beverages with added sugars
4. Decrease sodium intake
5. Decrease saturated fat intake
6. Enjoy a wide variety of food

**Food Score Methodology**

The Food Score methodology takes into account 8 key factors that affect the nutrient profiling based meal score:

**Table 1: Meal scoring factors**

<table>
<thead>
<tr>
<th>Meal scoring factors</th>
<th>Healthiest &gt; Least Healthy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scores 2 points</td>
</tr>
<tr>
<td><strong>Grains</strong></td>
<td></td>
</tr>
<tr>
<td>Whole grains:</td>
<td>Contains the germ, bran and endosperm</td>
</tr>
<tr>
<td>Refined grains:</td>
<td>Contains only the endosperm</td>
</tr>
<tr>
<td>No grains or starchy vegetables included</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Meat and Alternatives (including dairy)</strong></td>
<td></td>
</tr>
<tr>
<td>Lean:</td>
<td>Meat with minimal fats attached and skin removed, plant based proteins or seafood</td>
</tr>
<tr>
<td>No meat or alternatives included</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vegetables</strong></td>
<td>Adequate serving: At least half a cup of cooked vegetables or 1 cup of salad vegetables included</td>
</tr>
<tr>
<td></td>
<td>Adequate serving: At least half a serving of fruit included</td>
</tr>
</tbody>
</table>
### Added oils/fat (quantity)

<table>
<thead>
<tr>
<th>Added oils/fat (quantity)</th>
<th>Scores 2 points</th>
<th>Scores 1 Point</th>
<th>Scores 0 Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>None or minimal: Cooking methods using less oil include steaming, baking, roasting, grilling, stir frying/pan frying with visibly less oil, soup or sou vide style</td>
<td>-</td>
<td>-</td>
<td>Deep fried or oily: Cooking methods requiring more oil include deep frying, shallow frying or stir frying/pan frying with visibly more oil, confit style</td>
</tr>
</tbody>
</table>

### Added oils/fat (quality)

<table>
<thead>
<tr>
<th>Added oils/fat (quality)</th>
<th>Scores 2 points</th>
<th>Scores 1 Point</th>
<th>Scores 0 Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsaturated fat: Includes avocado, olive oil, canola oil</td>
<td>-</td>
<td>-</td>
<td>Saturated/trans fat: Includes butter, ghee, coconut oil</td>
</tr>
</tbody>
</table>

### Gravies/Condiments

<table>
<thead>
<tr>
<th>Gravies/Condiments</th>
<th>Scores 2 points</th>
<th>Scores 1 Point</th>
<th>Scores 0 Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>No gravies or condiments added</td>
<td>Minimal: Up to approximately 1 tablespoon of gravies/condiments added</td>
<td>Excessive: More than 1 tablespoon of gravies/condiments added</td>
<td>*varies depending on the type of condiment</td>
</tr>
</tbody>
</table>

### Grains

Grains are food mostly made up of wheat, rye, oats, rice, quinoa or millet. The key nutrients in grains are carbohydrates, fibre, vitamin B and minerals such as zinc and magnesium. These play a key role in our metabolism and daily functioning. Whole grains contain the 3 essential layers of the grain- the germ, endosperm and bran. These encapsulates important nutrients like zinc and phytochemicals. Refined grains are processed grains which has the bran and germ layer removed, reducing its nutrient value.

### Meat and Alternatives

Meat and alternatives refers to meat, poultry, fish, seafood, beans, tofu and eggs. These are grouped primary due to its rich protein content. Apart from protein, the key nutrients provided include iron, zinc and vitamin B12. These are essential for muscle and brain function, and plays a role in energy production. Typically animal products such as meat and poultry contain saturated fat. High levels of saturated fat intake is associated with an increase in LDL cholesterol and the risk of heart disease. Healthy sources of protein which are low in saturated fat are often derived from plant sources and seafood.
Vegetables

Vegetables include all types of dark green or cruciferous vegetables, bulb vegetables, legumes/beans and other non-starchy vegetables. This food group is low in calories and rich in fibre, vitamins (vitamin A, C, E, folate), minerals (potassium, magnesium) as well as antioxidants. High intakes of these foods are protective of diet-related chronic diseases and helps with weight management.

Fruit

Any type of fruit, fresh or canned with no added sugars belongs to the fruit food group. Similar to vegetables, fruit is nutrient rich and is high in fibre, vitamins, minerals and antioxidants. It is also a significant source of carbohydrates as a result of the natural fruit sugars. Based on common dietary patterns in Singapore, fruit may not be included as part of a main meal.

Cooking Method: Added fats and oils (quantity and quality)

Food preparation is an important aspect of meal quality. Often oils/fats may be added to cook food. Fat as a macronutrient is the most calorie dense, and the amount added determines how energy dense the meal will be. A meal higher in calories may lead to weight issues such as overweight and obesity. A meal scores 2 point if none or minimal oils are added to cooking. No points are awarded for excessive amounts of added oils.

Apart from the quantity, the type of fat is an integral factor of meal quality. This is categorised by saturated or unsaturated fats. Saturated fats such as butter, lard or ghee are unhealthy fats that increases our risk of heart disease. On the other hand, unsaturated fats such as olive or canola oil are healthy fats which are protective of the heart.

Gravies and Condiments

Gravies and condiments include items such as curry gravy, assam gravy, brown or cream sauce, tomato and chilli sauce. Typically these contain a significant amount of added sugars, saturated fat and sodium. Apart from contributing to the calorie density of a meal, items which are also high in sodium affects our blood pressure and kidney function in the long run. Gravies and condiments are not nutrient rich and are not considered an essential part of a meal.

Portion Sizes

The portion size of a meal takes into account of the portion of individual food groups according to recommendations of ‘My Healthy Plate’ Singapore guidelines. This ensures that the nutrients needed are consumed in the right amounts.
Tabulated Meal Scoring

Every meal is graded along each of the 8 meal scoring factors, and the scores are then transformed into a final output score of 1 - 5. This transformation can be done either manually (through the expertise of a dietitian/nutritionist) or automatically using a specialised algorithm that is developed based on past data. Each meal scoring factor holds a different weightage based on the algorithm that affects the final score.

If any of the meal scoring factors are not clearly specified, the lesser factor would be assumed. Unless a user communicates this information, the point score will then be adjusted and stars re-evaluated by the dietitian or algorithm.

Example For Meal Scoring: Chicken Rice
Example Diagram: Nutritional Quality Of Chicken Rice

- Vegetables
- Portion size
- Gravies/Condiments
- Meat and alternatives
- Added oil/fat (quantity)
- Added oil/fat (quality)

- Grains
- Fruit

- Added oil/fat (quantity):
  - 2.0
  - 1.5
  - 1.0
  - 0.5
  - 0.0

- Added oil/fat (quality):
  - 2.0
  - 1.5
  - 1.0
  - 0.5
  - 0.0

- Portion size:
  - Vegetables
  - Gravies/Condiments
  - Meat and alternatives
  - Grains
  - Fruit

- Vegetables:
  - Added oil/fat (quantity)
  - Added oil/fat (quality)

- Gravies/Condiments:
  - Added oil/fat (quantity)
  - Added oil/fat (quality)

- Meat and alternatives:
  - Added oil/fat (quantity)
  - Added oil/fat (quality)

- Grains:
  - Added oil/fat (quantity)
  - Added oil/fat (quality)

- Fruit:
  - Added oil/fat (quantity)
  - Added oil/fat (quality)
Table 2: Meal scoring factors of chicken rice

<table>
<thead>
<tr>
<th>Meal scoring factors</th>
<th>Whole grains</th>
<th>Refined (1)</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grains</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat and Alternatives</td>
<td>Lean (2)</td>
<td>High fat or processed</td>
<td>None</td>
</tr>
<tr>
<td>(including dairy)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td>Adequate serving</td>
<td>Minimal portion (1)</td>
<td>None</td>
</tr>
<tr>
<td>Fruit</td>
<td>Adequate serving</td>
<td>Minimal portion</td>
<td>None (0)</td>
</tr>
<tr>
<td>Added oils/fat (quantity)</td>
<td>None or minimal</td>
<td>-</td>
<td>Deep fried or oily (0)</td>
</tr>
<tr>
<td>Added oils/fat (quality)</td>
<td>Unsaturated fat</td>
<td>-</td>
<td>Saturated/trans fat (0)</td>
</tr>
<tr>
<td>Gravies/Condiments</td>
<td>None</td>
<td>Minimal amount (1)</td>
<td>Excessive amounts</td>
</tr>
<tr>
<td>Portion sizes</td>
<td>Adequate serving</td>
<td>-</td>
<td>Poor portion size (0)</td>
</tr>
</tbody>
</table>

*Numbers in brackets shows the points awarded for each factor

Chicken rice is a common Singaporean dish. It comprises of steamed or roasted chicken, flavoured rice, slices of cucumber and condiments of chilli sauce and dark soy sauce. Based on the diagram, it fares well as a source of healthy lean protein. However other factors such as the use of refined grains, added chicken fat, high amounts of salt and lack of adequate vegetables falls short of healthy eating recommendations. This meal scores an average of 3 out of 5 stars calculated based on the algorithm.

Use of the Food Score System in Glycoleap

The mobile application Glycoleap uses meal scoring factors to score the nutritional quality of meals. Trained dietitians and nutritionist evaluate these meal scoring factors to produce a final food score from 1-5 stars. They also provide individualised advice on how to improve the food score.
Inter-rater Reliability Test

Our dietitians and nutritionists went through a thorough inter-rater reliability test to ensure that all their food score ratings are standardised. They had to rate 225 random food photos individually without discussing the answers. The answers were then collated and analysed by our data scientist. From the analysis, the average score standard deviation is 0.47. This shows that the rating scores amongst our dietitians and nutritionists differs by 0.47 points on an average.

Key application of the Food Score System

The Food Score system opens an opportunity into a multitude of different areas. This holistic and scalable solution has the potential to revolutionise health promotion. There is a role for the Food Score system to be included in research studies for chronic diseases, as part of workplace and school health promotion or used in combination with other systems to create a more comprehensive lifestyle management tool/programme.
Conclusion

It is evident that nutrient profiling based meal scoring has a significant impact on transforming the healthcare industry. The rise of non-communicable diseases impacted by unhealthful dietary behaviours highlights the need for an effective intervention. As healthy eating habits are multifactorial, and individuals consume composite meals, nutrient profiling based meal scoring provides a more accurate representation of nutritional quality and adequacy. A simple score from 1-5 and key highlights of the nutrients of concern provides an easy way for consumers to increase awareness of their dietary habits and make changes as appropriate.
References


