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Measuring Quality of Dietary Life and its Fundamental Issues: Capability Approach and Empirical Application in Japan

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Abstract

Well-being has become a key concept in the context of food studies, whereas food insecurity, as its deprivation, has become an issue that requires political commitment. These two academic traditions, although having been developed somewhat independently, can be connected by using Amartya Sen's capability approach. In this study, we applied the Alkire-Foster multidimensional poverty/well-being measurement method, which was theoretically informed by the capability approach, to develop a new method for measuring the quality of dietary life in high-income societies. The data were obtained from a web-based questionnaire conducted with the Japanese population ($n = 973$). Our demonstration identified about 40% of the population as having high food capabilities to lead one's valuable dietary life, as well as about 20% of the population as living under food poverty. The results also showed that socioeconomic status (SES) was correlated with food poverty, but not with eating well, and that gender- and age-based inequalities in food capabilities were larger than SES ones. We also discussed fundamental issues relevant to this measurement, including the lack of social consensus about the quality of dietary life, the complex relationship between dietary.

JEL Codes: I14, I32



1. Introduction

1.1. Measurement of Well-Being in the Context of Food

There has been an increasing demand for alternative approaches to nutritional assessment to evaluate people's comprehensive dietary standards. This orientation is driven, on the one hand, by critical reflection on the nutrition-centered tendency in current food and health interventions (Scrinis, 2008; Poulain, 2017) and, on the other hand, by the recognition of socio-culturally diverse values (e.g., van der Heijden et al., 2021) and of various ethical issues attached to contemporary eating (Thompson, 2015).

It is in this context that a growing body of literature on food-related well-being or eating well has emerged. In terms of its supporting disciplines, there are three traditions on food-related well-being: the public health (e.g., Falk et al., 2001; Lappalainen et al., 1998; Povey et al., 1998; Takemi, 2001), psychology (e.g., Ares et al., 2014, 2015) and, more recently, economic/ethics traditions (Burchi & de Muro 2016; Ueda, 2022a, 2022b, 2023a, 202b, 2024). Each tradition has its own strengths and weaknesses in relation to general well-being studies (for a review, see Alkire, 2010).

Although rich empirical insights about certain aspects of food-related well-being have been obtained, the common challenge in the previous literature is to determine how these findings can be integrated to (re)conceptualise food-related well-being by going beyond a simple profile-based measurement. Given the increasing importance of food-related well-being as the ultimate target of food policies, such an integrated indicator is necessary – and even enlightening – for decision markers. Integrated indicators have already been developed for well-being and general welfare policy (most notably, Human Development Index: UNDP, 2022), but not yet in the specific context of food.

1.2. Food Insecurity or Food Poverty

Interestingly, most scholars have tackled the measurement of food-related well-being independently from the perspective of food insecurity issues. Food insecurity is defined as the lack of physical, social and economic access to food that would result in a healthy and active life (FAO, 2009); thus, it concerns both multiple influencing factors and the multidimensionality of eating lives.

However, there remains a large gap between the ideal of ensuring food security and the reality. Although various food insecurity measurement methods have been operationalised (e.g., Carlson et al., 1999; Cafiero et al., 2018), most instruments measure 'the financial constraints associated with acquiring sufficient amounts of food' and fail to assess the multidimensionality of food insecurity (for a review, see Ashby et al., 2016). Here, criticism is directed at two types of reductionism: (i) the totality of eating, not merely material or nutritional satisfaction, and (ii) multiple influencing factors, not solely monetary constraints.

For example, in the US Household Food Security (USDA, 2022), one of the most widely-used tools in high-income countries, most of the 10 questions concern the material aspects of eating

(‘hungry’, ‘enough food’, etc.), although one question concerns the quality aspect (‘balanced meals’). Although these tools are effective in identifying severe material food poverty, they might underestimate the true prevalence of food insecurity. This feature becomes problematic, particularly in high-income countries, where material food insecurity is largely overcome and where food insecurity manifests itself differently from that in low-income countries (Bartelmeß et al., 2022).

In a critical recognition of this limited perspective, some scholars and policymakers prefer to use the term ‘food poverty’ to capture the true prevalence of food-related deprivation in countries such as France (Paturel, 2017; Paturel & Bricas, 2019; CNA, 2022) and Japan (MAAF 2019; Ueda, 2023a, 2023b, 2024). However, the major challenge is how to operationalise this holistic perspective with a practical measurement. To find a way to overcome this difficulty, it is necessary to go back to the theoretical basis of food insecurity, namely Amartya Sen’s capability approach (CA).

1.3. The Capability Approach and Multidimensional Measurement

The CA is an ethical theory that positions a person’s capability, that is, freedom to achieve his or her well-being as the informational basis of evaluation (Sen, 1980, 1992). It is also a framework that can connect the two abovementioned academic discourses. In food insecurity studies, the CA has played a pivotal role in shifting the evaluative focus from commodities (food availability) to capabilities (freedom of food access and utilisation) (Barret, 2010). In well-being studies (as the economic/ethics tradition), the CA also provides an effective way to conceptualise and measure well-being.

Following the terminology in previous CA-based food studies (Sen, 1981; Drèze & Sen, 1989; Burchi & de Muro, 2016; Ueda, 2021), we define ‘food capability’ as the freedom to achieve food-related well-being, or, shortly speaking, ‘well-eating’. Well-eating consists of ‘food functionings’ that refer to various food-related beings and doings (such as three meals a day and conviviality) that a person has reason to value.

Although the CA has been applied primarily to poverty and famine in low-income countries (Sen, 1982), scholars have recently advanced its analytical potential for various contemporary food issues in high-income countries (Hart & Page, 2020; Visser & Haisma, 2021; Ueda, 2022a, 2022b, 2023a, 2023b, 2024). However, none has tackled the development of integrated indicators for food-related well-being or food insecurity. The current study is therefore an attempt to take on this challenge by applying the multidimensional poverty/well-being measurement method (Alkire & Foster, 2011) to assess both conditions.

Theoretically informed by the capability approach, the Alkire-Foster method was developed to overcome the reductionist view of income-based poverty and is currently one of the most widely used poverty measurement techniques. This method generally involves taking the following steps: (i) determine evaluative dimensions that express the multidimensionality of poverty (e.g., life expectancy, years of schooling, income); (ii) set a deprivation threshold for each dimension, below which the person is considered to be deprived of the capability to achieve adequate functioning

(i.e., valuable beings and doings) in the given dimension; (iii) determine the poverty threshold, that is, how many deprivations are needed to identify the person as ‘poor’, and calculate H, the poverty headcount ratio; and (iv) calculate A, the average deprivation share of the identified poor. This process ultimately generates HA, the multidimensional poverty index, which is sensitive to both the probability and the severity of poverty.

The Alkire-Foster method has also been adapted for multidimensional well-being measurement. The most notable example is Bhutan’s Gross National Happiness (GNH) index (Ura et al., 2012). While the GNH’s measurement process is essentially the same as the original method for poverty, it requires new considerations about a different set of parameters (i.e., a ‘sufficiency’ cut-off for each dimension and the ‘well-being’ threshold as the second cut-off). This process ultimately generates 1-HA, the well-being (happiness) index, which is also sensitive to both the probability and the severity of insufficiency.

Both measurement approaches, whether for food poverty or well-being, have great potentials for food policies by identifying those in need and relevant inequalities in food capabilities. In Japan, current food policies lack a method to effectively capture the population’s quality of dietary life. In light of the shameful fact that the poverty rate in Japan is 15.4%, the highest among high-income countries (OECD, 2021a), the Ministry of Health, Labor and Welfare clearly situated ‘health disparity’ since 2013 as one of the policy pillars and launched a survey that led to elucidating eating standards among low-income families (Hayashi et al., 2015; Hazano et al., 2017; Nishi et al., 2017). However, only ‘regional inequality’ was currently set as an indicator for measuring its policy impact (MHLW, 2023), with inadequate commitment being made to solve and understand other socio-economic inequalities in dietary lives.

Despite the measurement issue, recent global sanitary and food crises (such as COVID-19 and Russia’s invasion of Ukraine) provided momentum for the Ministry of Agriculture, Forestry and Fisheries to start a critical reflection with a view to developing a new integrated food policy that integrates well-being and the inequality perspective (MAFF, 2022). Against this backdrop, the development of an integrated indicator for measuring its policy impact has become vital.

Drawing on the above background, we aim to propose a new measurement method for food poverty and food-related well-being by using the Alkire-Foster method and its adapted version for the GNH index. We first demonstrate the proposed method by using the national data obtained from the web-based questionnaire towards 973 Japanese population and identify what social inequalities in food capabilities. Based on empirical findings, we also discuss some fundamental issues regarding this type of measurement, such as the lack of social consensus about the quality of dietary life, the complex relationship between dietary achievement and freedom (capability), and the practical implications for food policies.

2. Method

2.1. Data collection

The data used was obtained from the Survey of Your Eating Life, a web-questionnaire survey conducted in 2021 to identify the norms and practices of eating well among the population in Japan

($n = 973$). The details of this survey were reported in our previous studies (Ueda 2022a, 2022b), so we focus here on describing only the essential information. First, the respondents were aged 20–69 (excluding students) and their socio-demographic profiles represented the national average of the population in Japan (Table 1). Second, the questionnaire covered 10 dimensions of eating well: (1) meal frequency, (2) place of eating, (3) timing of meals, (4) meal duration, (5) persons to eat with, (6) place of procurement, (7) quality of food, (8) pleasure of eating, (9) meal content and (10) nutritional status. The nutritional dimension was measured by using the dietary variety score (Kumagai et al., 2003). The score (1–10) was calculated from the number of the 10 food groups (meat, seafoods, eggs, milk, beans, vegetables, seaweeds, potatoes, fruits and oils) taken every other day or more.

Except for the nutritional dimension, the other nine dimensions were derived from socio-anthropological theories of food (Poulain, 2002, 2017; Warde, 2016; Ueda & Poulain, 2021). The validity and extensiveness of these dimensions in relation to people’s subjective valuations were also confirmed (Ueda, 2022a), which process was important for the capability approach, which values the ‘choice’ dimension of eating lives (Drèze & Sen, 1989; Sen, 1985).

Table 1. Survey Respondents’ Profile ($n = 973$)

Gender	Male	Female				
Sample	48.1	51.9				
Average	48.7	51.3				
Age	20–29	30–39	40–49	50–59	60–69	
Sample	19.6	19.8	19.5	20.3	20.7	
Average	16.2	18.3	23.8	20.9	20.8	
Income	Bottom 20%	20–40%	40–60%	60–80%	Upper 20%	
Sample	25.7	18.3	19.2	18.5	18.3	
Average	20	20	20	20	20	
Social class	Capitalist	New middle class	Old middle class	Working class	Underclass	Housewife/unemployed
Sample	10.8	21.7	7.8	23.9	12.8	22.9
Average	4.1	20.6	12.9	35.1	14.9	12.6
Education	High school	Junior college/technical college		University		
Sample	32.3	22.5		45.2		
Average	62.8	15.8		21.4		

Note ¹ For the detail of categorisation, see the previous studies (Ueda, 2022a, 2022b)

Each dimension (excluding nutritional status) was explored in terms of dietary norms and practices (Lahlou, 1995; Poulain, 2002, 2017). Here, ‘norms’ signify the person’s desired or valued level of functioning achievement, whereas ‘practices’ refer to their actual achievement. These achievement levels can be determined by asking questions such as, ‘How many times per day would you like to eat?’ (norms) and ‘How many times did you eat yesterday?’ (practices). Furthermore, the norm–practice gaps can be interpreted as an indicator of one’s capability, in which smaller gaps generally signify the situation in which the person is better able to achieve his or her ideals and thus has a higher capability (Goto, 2017). Among the various outputs from the Survey of Your Eating Life, we used primarily the practice data as the basis for the cut-offs, while the norms were partially integrated for some difficult-to-standardise dimensions, such as quality and pleasure. This survey

was in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Ritsumeikan University (ID: 2020-49).

2.2. Food deprivation and food sufficiency cut-offs

The Alkire-Foster method is a dual cut-off counting method that requires setting food deprivation (or sufficiency) cut-offs and the food poverty (or well-eating) cut-off. The cut-offs used for our demonstration are summarised in Table 2, and we discuss the general principles that underpin setting these cut-offs.

Table 2. Food Deprivation and Sufficiency Cut-offs

Dimensions	Deprivation cut-offs	%	Sufficiency cut-offs	%
Meal frequency	Less than 3 meals per day	10.2	3 meals per day for all 7 days per week	67.7
Place of eating	Eat-Out: 0 day per week or	22.3	Eat-Out: 1–3 days per week or	56.6
	Eat-In: ≤ 3 days per week		Eat-In: 7 days per week	
Timing of meals	Starting dinner 9 pm or after	13.1	Starting dinner 7 pm or before	65.9
Meal duration	≤ 10 mins for all three meals	7.3	At least 2 meals of the following: ≥ 20 mins for breakfast, ≥ 30 mins for lunch and ≥ 30 mins for dinner	41.1
Persons to eat with	Eating alone for all three meals	20.9	Eating together with others for ≥ 2 meals	51.3
Place of procurement	Use of discount supermarkets, convenience stores and drugstores exclusively	9.2	Use of one's 1st and 2nd valued places of procurement	42.9
Quality of food	Achieved ≤ 4 criteria	14.8	Achieved all 13 criteria (seasonal, social good, etc.)	45.2
Pleasure of eating	Achieved ≤ 3 criteria	16.4	Achieved ≥ 7 criteria (shopping, cooking, conviviality, etc.)	38.7
Meal content (dish)	Less than a 'staple + 1 dish' for all three meals	12.1	More than a 'staple + 2 dishes' for ≥ 1 meal(s)	60.2
Meal content (nutrition)	0 dietary variety score	18.4	≥ 4 dietary variety scores	29.4

Note ¹ For concrete questions of each dimension, see the previous study (Ueda, 2022b)

Note ² Dining out and taking in for dinner ('Eat-Out') are essential for one's well-eating, excluding those who completely idealise eating at home ('Eat-In').

First, the food deprivation cut-offs were primarily derived from the previous survey on single mothers in Japan (Ueda, 2023a, 2023b). This study included in-depth interviews with 53 single mothers regarding their dietary norms and practices in the same 10 dimensions as in this article. Single mothers are the most high-risk social group in Japan, with a poverty rate of 51.4%. Thus, and their voices could fully inform the deprivation cut-offs, below which their eating standards should be considered 'necessary for social interventions'. Some minor adjustments were made for our methodological demonstration, mainly due to data availability.

More importantly, we applied the common cut-offs (that were originally derived from the survey on single mothers) to the whole population. This choice was made, on the one hand, by the limited data availability about other subgroups and, on the other hand, by the need to avoid unnecessary complication in presentation (because we already use 10 evaluative dimensions).

Second, the food sufficiency cut-offs were determined based on a number of practical considerations. The first consideration was given to current policy discourse in Japan. Some

functionings – such as having three meals per day, starting dinner at regular hours, having at least one meal per day with 30 minutes or longer, eating together with others, having at least one ‘proper’ meal (i.e., a staple and two or more dishes) – are all set as health policy objectives in food policy (MHLW, 2023); thus, they were referenced when determining the sufficiency cut-offs.

Another consideration is the data availability. We aimed to keep the sufficiency population below 60% for each dimension (and below 30% for the deprived population) so that these cut-offs could have reasonable classifying power. Nevertheless, some dimensions needed to exceed these references. For example, the meal timing dimension did not have a more restricted condition than starting dinner at 7 pm or before, which resulted in identifying 65.9% as the sufficiency population.

2.3. Food poverty and well-eating cut-offs

Having set the food deprivation (or sufficiency) cut-offs, the next task was to determine the food poverty (or well-eating) cut-off. Figure 1 shows how different cut-offs k generate different identification results. For example, if we choose to determine that individuals with three deprivations or more ($k = 3$) deserve social intervention, the identified food-poor population will be 20.6%. Similarly, the choice of $k = 2$, $k = 4$ or $k = 5$ identifies a 41.9%, 9.1% or 3.6% food-poor population respectively. Likewise, if we choose to determine that the individuals with six sufficiencies ($k = 6$) deserve a social attention, the identified well-eating population will be 40.5%. The choice of $k = 5$ or $k = 7$ identifies a 57.5% or 23.4% well-eating population respectively.

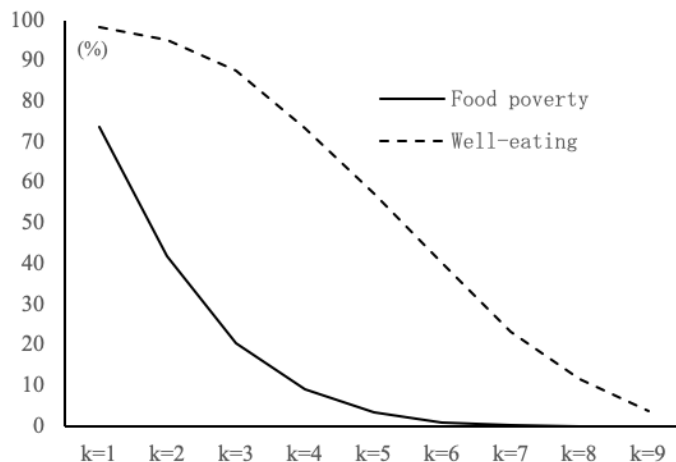


Figure 1. Food Poverty and Well-Eating Cut-offs k

Since there is no agreed-upon definition of well-eating, any definition has to remain operational, while the choice of any cut-off depends largely on policy objectives and data availability. The conceptualisation of well-eating and the visualisation of food capability inequalities across social groups are potentially useful for policy developments, but further social discussion needs to take place regarding what a good enough dietary standard should be in a given society.

For our demonstration, we chose $k = 3$ as the food poverty cut-off (20.6% food-poor population) and $k = 6$ as the well-eating cut-off (40.5% well-eating population). This choice can be justified by a couple of practical considerations. Regarding the food poverty cut-off, the process of elimination was taken into account. The identified food-poor population derived from $k = 2$ becomes too large and not particularly effective for policy targeting, whereas the result derived from $k = 4$ might be viewed too small, given Japan's relative poverty rate of 15.7% (OECD, 2022a) and its material severe food insecurity rate of 3.8% (FAO, 2022). This line of reasoning does not relate to the direct relationship between economic poverty and food poverty, but this number zone might be compelling for the development of anti-food poverty policy.

On the other hand, regarding the well-eating cut-off, we applied the same selection process as that in GNH index. The GNH's method first creates a 'happiness gradient' that sets three different well-being/happiness cut-offs ($k = 5, 6$ and 7) and identifies four sub-populations divided by these cut-offs, namely the 'deeply happy' (with seven and more sufficient dimensions), the 'extensively happy' (with six), the 'narrowly happy' (with five) and the 'not-yet-happy' (with less than five). The GNH index is then calculated based on the middle cut-off ($k = 6$). Although there was a slight difference in the total number of evaluative dimensions between Bhutan's GNH ($d = 9$) and our survey ($d = 10$), the distribution of the identified sub-group population (i.e., 'well-eating gradient') was quite similar to the happiness gradient; thus, the middle one ($k = 6$) could be reasonably used as the well-eating cut-off for our demonstration as well.

Having set the abovementioned principles, we also acknowledge that any specific choice of cut-offs, no matter how well grounded, is somewhat arbitrary (Alkire & Foster, 2011). This does not exclude most dietary assessments; however, it seems that such normativity does not capture explicit attention and critical discussion. We shall revisit this methodological issue in the discussion section, but we first move on to demonstrate the method and its relative advantage over existing methods.

3. Results

3.1 Food poverty index and inequalities by sub-group

Table 3 contains a summary of the food poverty measurement results by subgroup. Again, the food poverty index, HA, concerns both the prevalence of food poverty, H, and the severity experienced by the food poor, A. For example, 32.2% of men in their 20s, who experienced an average of 3.66 food deprivations, were identified as food-poor.

We can observe large gender- and age-based inequalities. Men (excluding those in their 60s) were generally more deprived than women. Even men in their 50s ($HA = 0.094$), the second-least deprived among men, were more deprived than the women in their 20s ($HA = 0.075$), the most deprived among the women. For both men and women, the middle-aged (30–40s) and the young (20s) were more deprived than the older (50–60s) groups. For example, only 6.9% of women in their 60s were identified as living in food poverty.

Table 3. Food Poverty Index by Sub-Group

	<i>HA</i>	<i>H</i>	<i>A</i>		<i>HA</i>	<i>H</i>	<i>A</i>
Men 20s	0.118	0.322	0.366	Income I (low)	0.082	0.220	0.371
Men 30s	0.154	0.440	0.350	Income II	0.075	0.213	0.353
Men 40s	0.130	0.330	0.393	Income III	0.078	0.219	0.356
Men 50s	0.094	0.237	0.396	Income IV	0.069	0.178	0.388
Men 60s	0.043	0.131	0.331	Income V (high)	0.072	0.191	0.376
Women 20s	0.075	0.198	0.380	Underclass	0.076	0.208	0.365
Women 30s	0.046	0.137	0.336	Working class	0.079	0.206	0.383
Women 40s	0.055	0.141	0.386	Old middle class	0.053	0.158	0.333
Women 50s	0.037	0.099	0.370	New middle class	0.092	0.246	0.373
Women 60s	0.024	0.069	0.343	Capitalist class	0.088	0.229	0.383
Total	0.076	0.026	0.368				

Note ¹ *HA*: food poverty index; *H*: headcount ratio ($k = 3$); *A*: average deprivation share of the food-poor

In terms of income, a non-negligible inequality was observed between the low-income group (I) and other income groups (II–V), although rankings among the latter groups were not perfectly consistent. Regarding social class, interestingly, we can observe reversed effects: the new middle class ($HA = 0.092$) and capitalist class ($HA = 0.088$) were more likely to fall into food poverty than the lower social class groups. Nevertheless, it is important to note that the inequalities based on socioeconomic status (SES) were not larger than the gender- and age-based inequalities.

3.2 Well-eating index and inequalities by sub-group

Table 4 contains a summary of the well-eating measurement results by subgroup. Again, well-eating index $1-HA$ is sensitive to both the prevalence of non-well-eating H , and the severity (the number of insufficient dimensions) experienced by the non-well-eating A . A larger well-eating index represents a better national dietary situation. While 40.5% of the population was identified as achieving well-eating, the other 59.5% were not yet achieving well-eating and experienced an average of 6.48 insufficiencies (insufficient food capabilities).

Similarly to food poverty, we can observe large gender- and age-based inequalities in food capabilities. The men (excluding those in their 60s) were generally more deprived of food capabilities than the women. Even the men in their 40s ($1-HA = 0.556$), the second-least deprived among the men, were more deprived than the women in their 20s ($1-HA = 0.630$), the most deprived of the women. For both men and women, the young (20s) and the middle-aged (30–50s) were more deprived than the elderly (60s). For example, only 33.3% of the women in their 60s were identified as not yet achieving well-eating.

On the other hand, in contrast to food poverty, no consistent SES-based inequalities were observed. The middle-low income group (II) was more likely to lead well-eating lifestyles than the higher income groups (II–IV), while there was no large difference between even the lowest (I) and the highest income groups (V). Regarding social class, the new middle class and the working class were much less likely to lead well-eating lives than the underclass. Three social class groups (the underclass, the old working class and the capitalists) had a higher likelihood of well-eating

despite their different places in the social hierarchy. This result implies that the social class factor related more to time constraints (self-employed, irregular working, etc.) than social ranking.

Table 4. Well-Eating Index by Sub-Group

	1- <i>HA</i>	<i>H</i>	<i>A</i>		1- <i>HA</i>	<i>H</i>	<i>A</i>
Men 20s	0.468	0.778	0.684	Income I (low)	0.608	0.612	0.640
Men 30s	0.462	0.846	0.636	Income II	0.640	0.551	0.654
Men 40s	0.556	0.659	0.673	Income III	0.592	0.626	0.652
Men 50s	0.518	0.722	0.669	Income IV	0.621	0.590	0.643
Men 60s	0.697	0.495	0.612	Income V (high)	0.615	0.590	0.653
Women 20s	0.630	0.584	0.634	Underclass	0.631	0.584	0.632
Women 30s	0.685	0.500	0.629	Working class	0.577	0.644	0.657
Women 40s	0.632	0.556	0.662	Old middle class	0.680	0.513	0.623
Women 50s	0.658	0.535	0.639	New middle class	0.558	0.656	0.671
Women 60s	0.798	0.333	0.606	Capitalist class	0.645	0.562	0.652
Total	0.592	0.595	0.648				

Note ¹ 1-*HA*: well-eating index; *H*: headcount ratio of the non-well-eating ($k = 6$); *A*: average insufficiency share of the non-well-eating

3.3 Dimension-specific deprivation

The measurement results are also decomposable by dimension and we demonstrate here by taking the example of food poverty index. The rows in Table 5 break these food poverty levels down by dimension, where H_j is the share of the individuals who were both food-poor and deprived in dimension j (described in percentage terms) and it simply represents the given dimension's contribution to each group level of *HA* (see the formula, Alkire & Foster 2011). For simplicity, only the sub-groups whose food poverty index was large or small are presented in Table 5.

Table 5. Dimensional Contribution to Food Poverty Index

	<i>HA</i>	Contri. (%)	H_1	H_2	H_3	H_4	H_5	H_6	H_7	H_8	H_9	H_{10}
Total	0.076	100	8.6	9.2	9.6	5.7	12.5	5.6	12.6	14.3	9.0	12.9
Men 20s	0.118	100	8.5	8.5	10.4	5.7	12.3	4.7	11.3	13.2	6.6	18.9
Men 40s	0.130	100	6.8	5.9	12.7	7.6	11.0	5.9	13.6	16.1	8.5	11.9
Men 60s	0.043	100	2.3	7.0	0.0	4.7	16.3	4.7	9.3	16.3	23.3	16.3
Women 20s	0.075	100	7.9	6.6	7.9	6.6	13.2	7.9	18.4	10.5	9.2	11.8
Women 40s	0.055	100	14.8	16.7	11.1	5.6	9.3	1.9	13.0	13.0	9.3	5.6
Women 60s	0.024	100	12.5	8.3	4.2	4.2	16.7	4.2	12.5	8.3	16.7	12.5
Income I	0.082	100	6.4	8.3	4.9	7.4	13.2	7.8	16.7	14.7	8.8	11.8
Income V	0.072	100	10.9	11.7	13.3	5.5	12.5	5.5	6.3	14.1	9.4	10.9

¹ H_j : share of individuals who are both food-poor and deprived in dimension j (described in percentage terms)

² $j = 1$: meal frequency \sim 2: place of eating, 3: timing of meals, 4: meal duration, 5: persons to eat with,

6: place of procurement, 7: quality of food, 8: pleasure of eating, 9: meal content, 10: nutritional status

For the low-income group (I), deprivations in the meal content (8.8%) and nutritional dimensions (11.8%) certainly contributed to the food poverty index; however, deprivations in other dimensions made higher contributions, such as quality (16.7%), pleasure (14.7%) and conviviality (13.2%). This result expresses the diversity of their deprivations, which can hardly be captured by existing instruments that are focused on material food deprivation.

On the other hand, the high-income group (V) was characterised more by deprivations in the frequency, place and timing dimensions and less by procurement and quality dimensions than the low-income group. This demonstrates how food poverty can occur without economic deprivation.

It is also worth mentioning some notable deprivation profiles of sub-groups by age and gender. The contribution of nutritional deprivation was relatively high for men (20s: 18.9%, 40s: 11.9%, 60s: 16.3%), the last of which also had a high rate of meal content deprivation (23.3%). This pattern of material deprivation was in common with that of the elderly women.

Deprivations of shopping-related capabilities (procurement: 7.9%, quality: 18.4%) were characteristic of the young women, meaning that this population was more likely to be forced to purchase low quality daily food at discount supermarkets or convenience stores than the other sub-groups. There were no particular characteristics (which means wide-ranging deprivations) for the middle-aged group, aside from the middle-aged women's relative tendency to skip meals (14.8%) and outsource meals too often (16.7%).

4. Discussion: Fundamental Issues in Measuring Quality of Dietary Life

4.1. Key properties and complementarity to existing dietary assessment

The key idea behind the proposed method was to measure the totality of eating (Poulain, 2002, 2017) based on a critical understanding that existing dietary assessment methods often involve reductionism, such as the limited focus on 'the financial constraints associated with acquiring sufficient amounts of food' (Ashby et al., 2016). In contrast, our approach concerned the multidimensionality of one's dietary life that was expressed by 10 evaluative dimensions for our demonstration, but this choice remains flexible for addition or integration of further dimensions.

This multidimensional feature might not be entirely new to the food-related well-being literature, which has a similarly wide-ranging focus on eating well (e.g., Lappalainen et al., 1998; Povey et al., 1998; Takemi, 2001; Ares et al., 2014). However, our method marks a sharp contrast from these studies by enabling the development of an integrated indicator for food-related well-being (and food poverty) and the assessment of inequalities of food capabilities.

In other words, our approach facilitates the conceptualisation of food poverty and well-eating. There is no official definition of these dietary conditions in high-income countries (Bartelmeß et al., 2022); but, operational definitions are still needed for the development of food policy. In this article, we defined food poverty as a situation with three or more deprivations of food capabilities across the 10 dimensions ($k = 3$), while well-eating being defined as a situation with six or more sufficiencies ($k = 6$). This operational setting resulted in identifying a 20.6% food-poor population and a 40.5% of well-eating population, as well as disclosing SES-based inequalities and even

larger gender- and age-based inequalities. This way of visualising food poverty and well-being is effective for food policy and can be used as a complementary tool to existing dietary assessment methods.

4.2. Social consensus about the quality of dietary life

Nevertheless, our measurement method is not without methodological challenges. As already noted prior to demonstration, the fundamental challenge is the absence of social consensus about food poverty, which led to operational issues in setting effective thresholds and weights. These challenges are in common with the studies of multidimensional poverty measurement, for which several solutions have been proposed (Alkire & Foster, 2011b; Alkire & Santos, 2014; Alkire et al., 2015).

Robustness test refers to the process to assess how sensitive identification results are to the selection of a set of parameters. One of the useful ways is by computing a rank correlation between the original ranking (e.g., HA and 1-HA) and the alternative rankings. The alternative specification may be a different food poverty cut-off (k), a different set of deprivation cut-offs (for 10 dimensions), a different set of weights, or a combination of three. To demonstrate the robustness test, we set the following three patterns of alternative rankings for food poverty indexes (HA): (i) different food poverty cut-offs ($k = 2, 4, 5$); (ii) larger weights (twice) given to ‘dish’ and ‘nutritional’ dimensions and smaller weights (0.5 times) to temporal (‘timing’ and ‘duration’) and shopping (‘procurement’ and ‘quality’) dimensions, with which adjustment total number of dimensions ($d = 10$) remain unchanged; the stringent possible deprivation cut-offs for ‘meal frequency’ (less than two meals per day), ‘quality’ (0 achieved criteria) and ‘pleasure’ (0 achieve criteria) dimensions.

Table 6 contains the results of Spearman's rank correlation test between the original ranking and these alternative rankings. We can observe that the original ranking was quite robust to changes in a set of parameters, with coefficients being generally above 0.9 and 0.768 as the lowest coefficient. While further sets of parameters need to be tested, it seems that we should not be so embarrassed by the arbitrariness in setting parameters. In fact, it is important to recall that Amartya Sen (1997) saw the need to consider different parameters in multidimensional measures as a ‘strength’ that can facilitate public discussion about well-being and poverty.

Table 6. Robustness test to food poverty indexes

Alternatives	Correlation coefficient
(i): different food poverty cut-offs	0.986 ($k = 2$), 0.914 ($k = 4$), 0.768 ($k = 5$),
(ii): different weights	0.961
(iii) different deprivation cut-offs	0.900

Note ¹ Spearman's rank correlation coefficient ranges from -1 to 1, with 1 being the strongest positive correlation.

Note ² The total 15 rankings among all gender-, age- and income-based subgroups were compared here.

4.3. A complex relationship between capabilities and functioning achievements

Another challenge concerns our choice of measuring functioning achievements (i.e., what the person actually achieved) as the basis of food capabilities. Again, this informational basis needs to be distinguished from food capability (i.e., what the person can do) as the ultimate target of the capability approach. The underlying assumption in our demonstration was that, given the absence of available data to directly measure capability, capability levels can be inferred from the achieved functionings as derivative informational bases (for this methodological issue, see Sen, 2009). However, there might be some cases in which persons with low food capabilities happen to eat better than usual on the surveyed day (e.g., by timely food aids and income), the focus of which can lead to unethical targeting in food policy. To reduce such possible inconsistency between achievement and capability, other informational basis can also be considered for the measurement, including relevant conversion factors such as food literacy, time constraint, taste/habitus, and local food systems (Ueda, 2023a).

The key point is not how many variables we should focus on, but which variables (Burch & de Muro, 2016); but, selecting such variables would require further works in a new direction. In other words, discussion needs to be extended from what constitutes the total quality of dietary life (that was targeted in our article) to what constitutes the food capability. It is possible to refer to existing literature on central human capability and health capability (Nussbaum, 2013; Ruger, 2010), as well as a growing body of studies on food literacy in public health and nutritional sciences (e.g., Vidgen & Gallegos, 2014).

4.4. Linkage with food policy

The last issue is how to establish an effective linkage with food policy. While being not so troublesome with well-eating, one of the major difficulties is to build a solid understanding about the relative nature of food poverty in contemporary societies. As mentioned in the introduction, the current focus in food insecurity measurement tends to be put on the material and economic concern, relegating other temporal, social, qualitative and affective components to the secondary matter (Ashby et al., 2016; Bartelmeß et al., 2022). The relative understanding of poverty has progressed close to a theoretical consensus since the 1970s (Townsend, 1979; Sen, 1980), but not in practice until today.

Recent food policies in Japan have started to emphasise the concepts, such as ‘inequalities’ and ‘disparities’ (MHLW, 2022; MAFF, 2022), but have failed to specify what inequalities and disparities. Recent studies on low-income households in Japan have helped to elucidate their dietary situations (Hayashi et al., 2015; Hazano et al., 2017; Nishi et al., 2017), but these results also led to reinforcing the view that the quality of dietary life is associated with socioeconomic affluence, which masks other types of inequalities in food capabilities. Contrary to this prevailing idea, we demonstrated that well-eating in contemporary Japan was not simply determined by SES factors, implying that socioeconomic affluence does not guarantee well-eating.

The findings also seem to suggest the critical role of time constraints among the various conversion factors (van der Heijden et al., 2021; Ueda, 2023a), particularly in Japan, which has

been notoriously characterised as having the longest working hours of all the high-income countries (OECD, 2022b; Takami, 2021). Although the time factor was not integrated into the present survey, higher SES is correlated with longer working hours and therefore larger time constraints (Hashimoto, 2017), which might have caused insufficiency, notably in the temporal dimensions, and undermined a consistent expression of the SES effects on food capability.

Importantly, one also needs to pay more attention to gender and age disparities when discussing food capability inequalities in Japan. Our findings showed that men, the young and the middle-aged groups were more likely to have a lack of freedom to lead well-eating lifestyles than women and the elderly. Such gender- and age-based inequalities have been undermined in current well-eating (and food insecurity) discourses, which have an exclusive focus on SES inequalities.

These findings resonate with long-debated social problems in Japan, such as the greatest gender inequality (Ochiai, 2019; World Economic Forum, 2022) and the fastest rate of ageing of the high-income countries. The former problem has distanced men from the kitchen sphere and prevented them from cultivating their capability to eat well. The latter issue is closely related to an increasing reflection on the current prioritisation of the elderly in general social policies (pension, healthcare, etc.) in the ageing Japanese society. This social debate should also be extended to food policy to address the generational inequality of food capabilities.

In this section, discussion was contextualized in light of the Japanese social condition but it may still have international implications. Even in the country with the worst poverty rate in the developed countries, the problem lies not in the quantity of available foodstuffs but in the quality of dietary life. This finding can encourage officials in other high-income countries, where conditions are superior to those that obtain in Japan, to also rethink their evaluative approaches to food poverty or well-eating.

Declaration of interest

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