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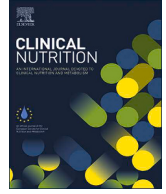
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Original article

A multidisciplinary Delphi consensus on the formulation of an optimized oral diet for dysphagia and malnutrition (FOOD-DM)



Lisa Brux^a, Sriramy Lapa^b, Jule Hofacker^a, Cinja Huber^a, Gero Lueg^c, Anne Jung^d, Paul Muhle^d, Sonja Suntrup-Krueger^d, Rainer Wirth^c, Sven G. Meuth^a, Tobias Warnecke^e, Rainer Dziewas^e, Bendix Labeit^{a,*}

^a Medical Faculty and University Hospital Duesseldorf, Department of Neurology, Heinrich-Heine-University Duesseldorf, Duesseldorf, Germany

^b Department of Neurology, Goethe University Frankfurt, University Hospital Frankfurt, Frankfurt/Main, Germany

^c Department of Geriatrics, Ruhr University Bochum, Marien Hospital Herne, Herne, Germany

^d Department of Neurology, University Hospital Muenster, Muenster, Germany

^e Department of Neurology and Neurorehabilitation, Klinikum Osnabrueck - Academic Teaching Hospital of the University Muenster, Muenster, Germany

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SUMMARY

Background & aims: Dysphagia and malnutrition frequently co-occur and are associated with aspiration pneumonia, sarcopenia, increased mortality, reduced quality of life and restricted social participation. Yet foods and drinks for individuals with dysphagia and malnutrition are inconsistently specified and lack objective standards. This study aimed to develop a consensus-based, expert-derived framework for evaluating foods and drinks perceived suitable for individuals with dysphagia and malnutrition (FOOD-DM).

Methods: A two-round online modified Delphi study was conducted (October 2024–May 2025). International experts in medicine, speech-language pathology and nutrition were eligible with ≥ 5 years of clinical experience and a Hirsch-index ≥ 5 . In round 1, participants rated nine prespecified items relating to texture, nutritional composition and labeling on a 9-point Likert scale. Consensus required $\geq 70\%$ ratings at 7–9 (critically important) and $< 15\%$ at 1–3 (not important). Round 2 provided aggregated results, item refinements and a comparison of the International Dysphagia Diet Standardisation Initiative (IDDSI) with quantitative texture measures expressed in the International System of Units (SI).

Results: Forty-eight experts participated in round 1. All nine items achieved consensus and were reaffirmed in round 2 (44/48; 92% retention). The final FOOD-DM framework comprises nine criteria across three domains: (1) Texture: availability of consistent textures, accuracy of texture descriptions (IDDSI and/or SI-based rheology), ability to customize texture, and ability to measure texture modifications (IDDSI and/or SI-based rheology); (2) Nutrition: availability of high-calorie options (e.g., 1.5–2.0 kcal/mL), flexibility to adjust calorie content, availability of high-protein options ($\geq 20\%$ energy from protein), and adaptable macronutrient composition; (3) Labeling: clear indications of suitability for dysphagia and malnutrition including detailed explanations of their specifics and composition. Overall, 91% of experts perceived the proposed measures as potentially helpful in improving access to appropriate nutrition; 61% favored a combined IDDSI-plus-SI model for texture description.

Conclusions: Distinct from existing approaches focusing on texture or nutrition alone, FOOD-DM integrates standardized texture specification with nutritional optimization and labeling within a single framework. Implementation of the FOOD-DM framework may support standardized, customizable, and

Abbreviations: 3D, Three-Dimensional; BCS-S, Board Certified Specialist in Swallowing and Swallowing Disorders; CCC-SLP, Certificate of Clinical Competence in Speech-Language Pathology; FOOD-DM, Formulation of Optimized Oral Diet Characteristics for Dysphagia and Malnutrition; h-index, Hirsch Index; IDDSI, International Dysphagia Diet Standardisation Initiative; kcal, Kilocalorie; kg, Kilogram; mL, Milliliter; N-s, Newton-second (unit of impulse/adhesiveness); Pa-s, Pascal-second (unit of dynamic viscosity); SI, International System of Units (Système International d'Unités).

* Corresponding author. Department of Neurology, Medical Faculty and University Hospital Duesseldorf, Moorenstraße 5, 40225, Duesseldorf, Germany.

E-mail address: benlabeit@gmail.com (B. Labeit).

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transparent nutrition and foster collaboration between clinical nutrition, dysphagia therapy, and the food industry.

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1. Introduction

Dysphagia is a common and clinically significant symptom across a broad range of neurological [1], geriatric [2,3], otolaryngological [4], gastroenterological [5], and other medical conditions. It frequently occurs after stroke [6], in Parkinson's disease [7], in neuromuscular [8,9] and neurodegenerative disorders [10], in neuroimmunological conditions [11,12], and among patients with head and neck cancer [4] or esophageal dysfunction [5]. Age-related decline in swallowing function, termed presbyphagia, further contributes to its high prevalence among older adults [3,13,14]. Globally, dysphagia affects an estimated 8 percent of the population, corresponding to approximately 580 million individuals [15].

Dysphagia and malnutrition are closely interrelated [16,17]. Swallowing impairment may restrict oral intake, leading to weight loss and nutrient deficiencies. Conversely, malnutrition, particularly when associated with sarcopenia and frailty, can exacerbate swallowing dysfunction and create a self-perpetuating cycle [18]. Malnutrition is highly prevalent in neurological, medical, and geriatric populations, affecting up to 18 percent of community-dwelling older adults [19] and nearly 30 percent of patients with chronic disease [20].

Both dysphagia and malnutrition substantially increase morbidity, mortality, and healthcare costs [16,21–23]. Dysphagia predisposes individuals to aspiration pneumonia [16], dehydration [24], choking [25], and medication related difficulties [26]. Addressing these interdependent conditions is therefore essential to improve clinical outcomes.

From a management perspective, modifying the texture of foods and drinks remains a widely used strategy, intended to increase swallowing safety and efficiency in individuals with dysphagia, though its clinical effectiveness continues to be a matter of debate [27]. The International Dysphagia Diet Standardisation Initiative (IDDSI) provides a globally harmonized terminology and measurement framework for food and liquid consistencies [15]. In parallel, nutritional medicine emphasizes individualized assessment of calorie and nutrient requirements and the use of targeted supplementation, including oral high-calorie and high-protein options, to prevent or treat malnutrition [28].

Beyond medical considerations, eating and drinking also have profound social and cultural relevance, and dysphagia can lead to social isolation, stigma, and reduced quality of life [29]. Despite increasing awareness of dietary preferences or restrictions such as vegetarian, vegan, or allergen-free options, individuals with dysphagia remain largely excluded from everyday dining contexts. Texture-modified or nutritionally enriched meals are rarely available outside institutional settings, and when offered, they often lack standardized preparation and labeling. This highlights both a clinical and societal gap in ensuring equitable access to adequate nutrition.

This gap reflects the absence of a comprehensive, consensus-based framework defining food and drink characteristics suitable for individuals with dysphagia and malnutrition. Existing approaches typically address only one dimension of the challenge. The IDDSI framework focuses primarily on defining and

standardizing texture, but does not evaluate whether foods meet nutritional requirements. Conversely, nutritional medicine emphasizes calorie and macronutrient composition, yet frequently overlooks texture and swallowability. As a result, dysphagia management and malnutrition treatment are often addressed separately, despite their coexistence and mutual reinforcement. This separation is particularly problematic as interventions that improve one domain may inadvertently compromise the other; for instance, pureeing foods can reduce calorie density or protein availability. A holistic, integrated perspective is therefore needed.

To bridge this divide, we conducted a modified Delphi process involving international experts in speech-language pathology, nutrition, and clinical medicine. Our aim was to establish the FOOD-DM framework, a multidisciplinary set of objective criteria defining food and drink characteristics that are perceived both adequate to swallow and optimized for malnutrition according to the experts. This framework is intended as a consensus-derived basis reflecting expert opinion, to support integrated clinical practice and promote the perceived potential for inclusive, barrier-free nutrition across diverse care and community settings.

2. Methods

2.1. Study design

This study followed a structured, modified, multiprofessional Delphi design [30,31] to establish consensus on objective and clinically relevant criteria for foods and drinks perceived suitable for individuals with dysphagia and malnutrition. The objective of the Delphi process was to establish expert consensus; it was not designed to assess clinical effectiveness or patient outcomes. The overall process included six consecutive stages (illustrated in Fig. 1): (1) definition of items by a multidisciplinary author panel, (2) expert recruitment, (3) first-round Delphi rating, (4) data aggregation and feedback, (5) second-round Delphi rating, and (6) consensus definition of the final FOOD-DM criteria.

Items were first rated independently by experts in Delphi round 1. Quantitative ratings and qualitative comments were then aggregated and reviewed by the author panel, who evaluated suggested refinements against predefined inclusion criteria and discussed potential modifications. Items were refined where appropriate and subsequently re-evaluated in Delphi round 2, after which final consensus was determined using predefined quantitative thresholds.

Anonymity, iterative feedback, and controlled communication were maintained throughout to minimize bias and promote independent judgment [32]. Experts rated each item related to food and drink characteristics using a 9-point Likert scale, where 1–3 indicated “not important,” 4–6 “important but not critical,” and 7–9 “critically important.”

2.2. Definition of items by the author panel

The initial questionnaire was collaboratively developed by the author team, comprising speech-language pathologists, neurologists, and geriatricians with clinical expertise in dysphagia and malnutrition. The team first defined the overarching aim and

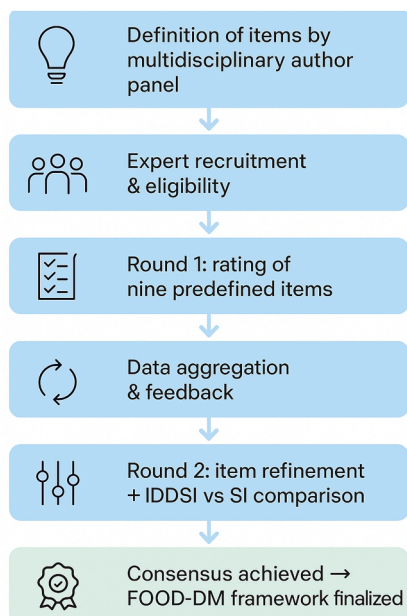


Fig. 1. Study design of the FOOD-DM Delphi consensus process. Abbreviations: **FOOD-DM**, Formulation of Optimized Oral Diet Characteristics for Dysphagia and Malnutrition; **IDDSI**, International Dysphagia Diet Standardisation Initiative; **SI**, International System of Units.

scope of the study, as well as the key conceptual domains to be addressed. Based on this, four inclusion criteria were established to guide both the formulation of the initial questionnaire and the potential addition of new items suggested during the Delphi rounds:

- (1) relevance to tangible food or drink characteristics;
- (2) measurability and objectivity, allowing evaluation within a checklist-based framework (e.g., exclusion of subjective aspects such as palatability);
- (3) medical relevance excluding non-medical (such as economic) factors;
- (4) specific focus on dysphagia and/or malnutrition, excluding dietary restrictions due to unrelated conditions (e.g., food intolerances).

Expert input from within the author team was synthesized through iterative discussion meetings to ensure that all items were clinically meaningful, contextually relevant, and consistent with the inclusion criteria. An initial pool of candidate items was drafted for evaluation in the Delphi rounds. The items were critically reviewed for clarity, redundancy, and alignment with the study objectives. Based on collective feedback, items were revised, removed, or subdivided to ensure comprehensive coverage of relevant topics while minimizing respondent burden.

This process resulted in nine core items addressing key aspects of food texture, nutritional composition, and labeling. To enhance face and content validity, the refined questionnaire was pre-tested with a small group of independent experts who were not involved in its development. Their feedback on wording, clarity, and structure was reviewed, leading to minor adjustments to improve usability and interpretability. The final version of the questionnaire, which served as the basis for the first Delphi round contained the following items under three thematic domains:

- (1) Texture characteristics:
 - Availability of foods and beverages with consistent textures suitable for dysphagia (e.g., easy to chew, soft, moist, or pureed).
 - Accuracy of texture descriptions (e.g., using the International Dysphagia Diet Standardisation Initiative [IDDSI] framework).
 - Ability to customize texture to individual needs.
 - Ability to objectively measure any texture modifications made, e.g., by using the International Dysphagia Diet Standardisation Initiative [IDDSI] framework.
- (2) Nutritional characteristics:
 - Availability of high-calorie options (e.g., 1.5–2.0 kcal/mL).
 - Flexibility to tailor caloric content to individual requirements.
 - Availability of high-protein options (e.g., $\geq 20\%$ energy from protein).
 - Ability to customize nutritional composition (e.g., protein) to specific dietary needs.
- (3) Transparency and labeling:

Clear labeling as suitable for those with dysphagia and/or malnutrition, including detailed explanations of their specifics and composition.

2.3. Participants

Experts were recruited internationally through professional societies (e.g., the European Society for Swallowing Disorders via email announcements) and social media outreach (LinkedIn posts). Inclusion criteria required at least 5 years of clinical experience focusing on dysphagia and malnutrition (self-report) and a Hirsch index (h-index) of ≥ 5 with publications on the respective topic. These eligibility criteria were defined a priori to ensure that participating experts possessed both substantial clinical and scientific expertise in dysphagia and malnutrition. A minimum of 5 years of clinical experience was chosen to ensure familiarity with practical management challenges and real-world decision making, in line with Delphi recommendations to recruit experienced subject-matter experts. An h-index ≥ 5 was required to indicate ongoing scholarly contribution and familiarity with methodological and evidence-based concepts relevant to the development of FOOD-DM. Because FOOD-DM was designed not only as a clinically oriented checklist but as a structured and potentially measurable framework, we considered it important that panel members were able to critically appraise scientific constructs such as operationalization of texture parameters, reproducibility of measurement approaches, and the translation of research findings into standardized criteria. Together, these criteria were designed to balance inclusivity with the need for a sufficiently qualified expert panel.

The study aimed to recruit a minimum of 30 experts from multiple disciplines to ensure diverse representation [33]. Experts interested in participation contacted the study team by email. Eligibility was then assessed by verifying fulfillment of the h-index criterion using public databases (e.g., ResearchGate, Google Scholar, and PubMed). Eligible participants subsequently received an email containing the link to the online Delphi survey. We sent up to four reminders to maximize participation. All participants provided electronic informed consent and were informed about data protection and anonymity procedures. At the beginning of the survey, participants confirmed that they had at least five years of clinical experience in the management of dysphagia and/or malnutrition (self-report). Participants then self-reported their professional background by selecting the most applicable option:

(1) physician, (2) speech-language pathologist, (3) nutritionist/dietitian, or (4) other. Physicians were additionally asked to indicate their areas of specialization (multiple selections allowed), including neurology, otolaryngology/phoniatrics, gastroenterology, geriatrics, nutritional medicine, rehabilitative medicine, or other. In this context, no distinction was made between predominantly clinical and predominantly research roles; participants were asked to report a single primary profession and field of work. Further, participants had to state their age, sex and country of residence. These self-reported responses were used to describe participant characteristics.

2.4. Delphi-round 1

In round 1, participants rated the perceived importance of the nine predefined items addressing characteristics of adequate foods and drinks for individuals with dysphagia and malnutrition. Each item was rated on a 9-point Likert scale ranging from 1 (not important) to 9 (critically important).

Participants also rated the overall perceived effectiveness of implementing these measures in promoting barrier-free access to appropriate nutrition for people with dysphagia and malnutrition on a 9-point Likert scale ranging from 1 (not effective at all) to 9 (extremely effective). Open-ended comment fields allowed participants to suggest additional items, refinements, or removal of existing items for consideration in round 2.

2.5. Qualitative analysis

In round 1, free-text comments were analyzed using a descriptive content analysis approach. Two authors independently reviewed all comments and grouped them into thematic categories. In a second step, each comment was independently mapped against the predefined inclusion criteria (tangible food or drink characteristics; objectifiable and measurable; medically relevant; specifically related to dysphagia and/or malnutrition). For each comment, the reviewers documented whether the content fulfilled all four inclusion criteria. Discrepancies regarding thematic categorization or inclusion/exclusion were resolved through discussion until mutual consensus was reached. If consensus had not been achievable, a third author would have been consulted; however, this was not required. Comments that met the predefined inclusion criteria were considered for refinement of items presented in round 2.

In round 2, qualitative comments were not independently coded, as no further adaptation of items was planned; instead, comments were reviewed and summarized narratively and incorporated into the discussion where relevant.

2.6. Delphi-round 2

Responses from round 1 were aggregated and fed back to participants in round 2. Feedback included distribution graphs stratified by profession and anonymized qualitative comments to allow informed reflection on group-level patterns.

A key modification based on round 1 feedback was the integration of quantitative texture measurement expressed in the International System of Units (SI) as a complementary approach to IDDSI terminology. This adjustment reflected expert recommendations to enhance objectivity, reproducibility, and industrial applicability. Specifically, the following two items were revised:

- Accuracy of texture descriptions, e.g., by using the International Dysphagia Diet Standardisation Initiative (IDDSI) framework and/

or quantitative rheological measures in Standard International (SI) units.

- The ability to objectively measure any texture modifications made, e.g., by using the International Dysphagia Diet Standardisation Initiative (IDDSI) framework and/or quantitative rheological measures in Standard International (SI) units. Minor wording refinements were also made for clarity and consistency.

In round 2, participants re-evaluated the nine revised items using the same 9-point Likert scale (1 = not important; 9 = critically important). Additionally, they rated five statements comparing IDDSI- and SI unit-based approaches to texture description to further validate the introduction of SI units within the framework. Agreement with the following statements was rated on a 9-point Likert scale (1 = totally disagree; 9 = totally agree):

1. IDDSI is sufficiently objective and suitable to evaluate food and drink textures for people with dysphagia/malnutrition and can therefore be used to describe food and drink textures.
2. Quantitative measurement descriptions of texture, including maximum force, cohesiveness, and adhesiveness measured in Standard International (SI) units, are sufficiently objective and suitable to evaluate food and drink textures for people with dysphagia/malnutrition and can therefore be used to describe food and drink textures.
3. IDDSI and quantitative measurement descriptions of texture (including maximum force, cohesiveness, and adhesiveness, measured in SI units) are both sufficiently objective and thus both suitable to evaluate food and drink textures for people with dysphagia/malnutrition and can therefore be used to describe food and drink textures.
4. Only IDDSI, but not quantitative measurement descriptions of texture (including maximum force, cohesiveness, and adhesiveness, measured in SI units), is sufficiently objective and suitable to evaluate food and drink textures for people with dysphagia/malnutrition and should be used to describe food and drink textures.
5. Only quantitative measurement descriptions of texture (including maximum force, cohesiveness, and adhesiveness, measured in SI units), but not IDDSI, are sufficiently objective and suitable to evaluate food and drink textures for people with dysphagia/malnutrition and should be used to describe food and drink textures.

This step allowed systematic evaluation of expert preferences regarding complementary versus exclusive use of IDDSI- and SI-based systems with regard to texture description.

2.7. Data analysis

Descriptive statistics were used to summarize ratings. Consensus thresholds followed established Delphi criteria [34]. Consensus was predefined as $\geq 70\%$ of participants rating an item as critically important (scores 7–9) and $< 15\%$ rating it as not important (scores 1–3) [35]. To assess the robustness of the consensus, we conducted a sensitivity analysis using more stringent thresholds ($\geq 75\%$ and $\geq 80\%$ of participants rating an item as critically important). Missing data were handled using a complete-case approach within each Delphi round. All analyses included only experts who provided ratings for a given item. The questionnaire was programmed to require responses to all items before submission, ensuring that no item-level data were missing within

completed rounds. To evaluate potential dropout bias, we examined the retention rate between rounds.

3. Results

3.1. Delphi-round 1

Of the 53 respondents, 48 met the inclusion criteria (mean age 45.7 years; 63% female). The sample comprised 58% physicians, 33% speech-language pathologists, and 8% nutritionists, representing 19 countries, most commonly Germany (42%). All round-1 items were rated by the full sample of participating experts ($n = 48$).

In the first Delphi round, all nine predefined items were rated as “critically important” (scores 7–9) by at least 70% of experts, while fewer than 15% rated any item as “not important” (scores 1–3). Consequently, consensus was achieved for all items in the initial round. Applying stricter consensus thresholds within a sensitivity analysis to round 1 ratings did not change the overall pattern of findings. All nine items met the $\geq 75\%$ criterion for ratings of 7–9. When applying an $\geq 80\%$ threshold, eight of nine items continued to meet consensus. The only item falling marginally below this level was item 4 (“Ability to objectively measure texture modifications”), which had 79% of experts rating it as critically important. Overall, the sensitivity analysis demonstrated that consensus across the proposed criteria was robust and not dependent on the specific consensus threshold applied. Detailed, item-wise results stratified by professional background, including the full distribution of Likert-scale ratings for each item in Delphi round 1, are provided in [Supplementary Material S1](#).

The lowest consensus level was observed for Item 4 (“Ability to objectively measure texture modifications, e.g., by using the IDDSI framework”). When stratified by profession, consensus was not reached among physicians, of whom only 68% ($n = 19/28$) assigned scores of 7–9.

Beyond the nine individual items, 79% ($n = 38/48$) of experts rated the statement “If all the accessibility measures previously mentioned are implemented, how effectively do you believe they enable barrier-free access for individuals with swallowing disorders and malnutrition?” as “extremely effective” (scores 7–9). None rated it as “not effective” (1–3), thereby also fulfilling the predefined consensus threshold.

A total of 30 participants provided qualitative comments in round 1. Using descriptive content analysis, comments were grouped into the following categories: palatability, sensory appeal, and patient acceptance (2 comments); the need for individualized adaptation to dysphagia profiles (3 comments); food allergies, intolerance, or dietary restrictions due to unrelated medical conditions (1 comment); cultural aspects (2 comments); cost and socioeconomic barriers (7 comments); staff or caregiver training and awareness (7 comments); the importance of screening or assessment (4 comments); access to eating aids or suction devices (1 comment); the influence of the care environment on meal support (3 comments); aspects of product availability and supply barriers (2 comments); and general study feedback (2 comments). These themes, although relevant for implementation, did not meet the predefined inclusion criteria for Delphi item generation and were therefore summarized narratively rather than added as new items.

Two experts specifically highlighted that quantitative measurement in SI units may offer advantages over IDDSI terminology for industrial scalability, reproducibility, and quality control. One expert noted that, in contrast to SI units, the IDDSI framework might not be suitable for accurately describing texture properties. Both reviewers agreed that these comments fulfilled all four

predefined inclusion criteria (i.e., they referred to tangible food or drink characteristics, were objective and measurable, medically relevant, and specifically related to dysphagia and/or malnutrition). Accordingly, the reviewers recommended that the author panel consider incorporating SI-based texture measurement into the subsequent Delphi round. Following this recommendation, the author panel discussed the further handling of these comments in a meeting. As one expert explicitly suggested that only SI-based measurements, but not IDDSI, should be used for texture description, the author panel decided to further explore expert preferences regarding the suitability of IDDSI- and SI-based approaches. To this end, participants in Delphi round 2 were asked to rate statements addressing whether (1) IDDSI is sufficiently suitable to describe texture, (2) SI-based measurements are sufficiently suitable to describe texture, (3) both approaches are suitable, (4) only IDDSI, or (5) only SI-based measures are suitable for describing food and drink textures in the context of dysphagia and malnutrition. This approach was chosen to comprehensively capture expert perspectives and to clarify whether a single or combined texture description strategy would be most appropriate according to the expert opinion. Based on the expectation that both approaches might be considered complementary, SI-based texture descriptors were integrated into the proposed FOOD-DM framework alongside IDDSI terminology.

3.2. Delphi-round 2

Forty-four experts completed round 2 (retention rate 92%) and all round-2 items were rated by the full sample of participating experts ($n = 44$). The distribution of professional backgrounds, disciplinary affiliation and geographic regions was comparable to round 1 and is illustrated in [Fig. 2](#).

Consensus was reaffirmed for all nine items, which were refined and formulated as follows:

1. *Availability of foods and drinks with consistent texture suitable for dysphagia (e.g., easy to chew, soft, moist, pureed).*
2. *Accuracy of texture descriptions for foods and drinks, e.g. by using the International Dysphagia Diet Standardisation Initiative (IDDSI) framework and/or quantitative rheological measurement descriptions in Standard International (SI) units.*
3. *The ability to customize the texture of foods and drinks to meet individual needs.*
4. *The ability to objectively measure any texture modifications made to foods and drinks, e.g. by using the International Dysphagia Diet Standardisation Initiative (IDDSI) framework and/or quantitative rheological measurement descriptions in Standard International (SI) units.*
5. *Availability of high-calorie foods and drinks (e.g., 1.5–2.0 kcal/mL) for nutritional support.*
6. *Flexibility to adjust the calorie content of foods and drinks based on individual dietary needs.*
7. *Availability of high-protein foods and drinks (e.g., $\geq 20\%$ energy from protein).*
8. *The option to customize variable nutritional components (e.g. protein) to cater to specific dietary needs.*
9. *Clear labeling of foods and drinks as suitable for those with dysphagia and malnutrition, including detailed explanations of their specifics and composition.*

In the sensitivity analysis, all nine items also exceeded the $\geq 75\%$ and $\geq 80\%$ consensus thresholds, with agreement levels above 90% for nearly all criteria, further confirming the stability and robustness of the consensus across Delphi round 2. Item 4 (“Ability to objectively measure texture modifications”), which

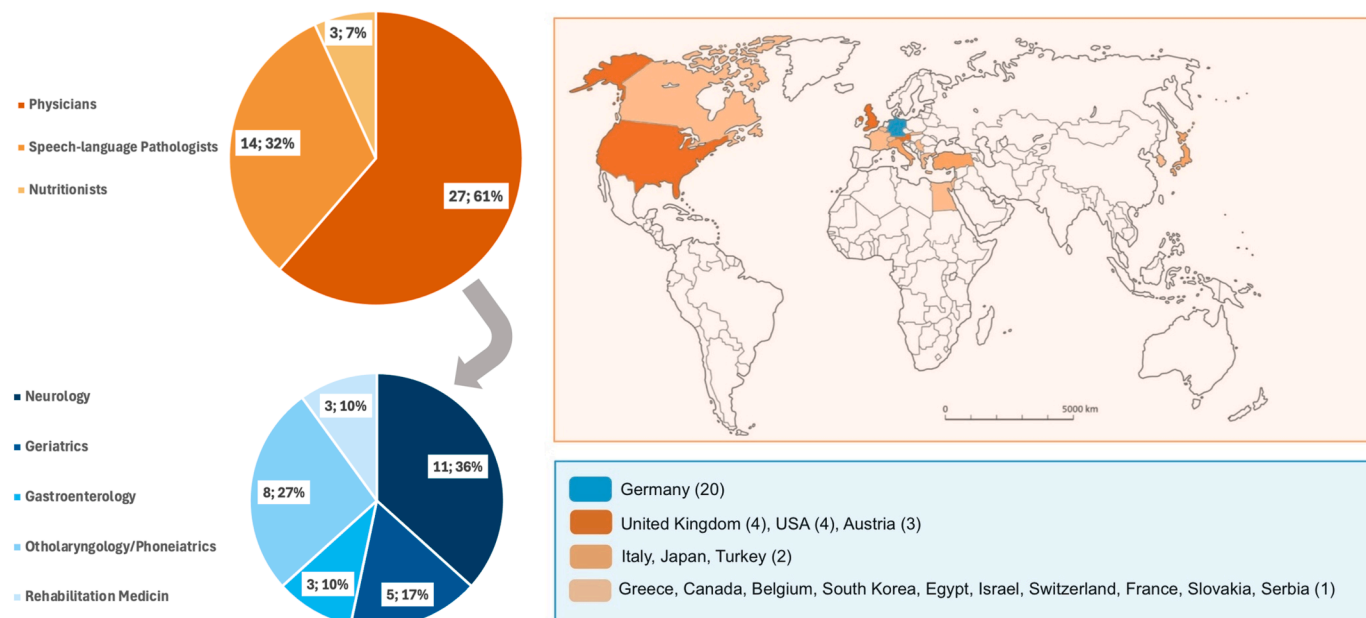


Fig. 2. Professional background, disciplinary affiliation, and geographical distribution of Delphi expert participants in round 2 (n = 44 experts).

had been closest to the threshold in round 1, increased to 86% agreement in round 2. Agreement among physicians for this item, which had not reached consensus in round 1, also increased to 78% (n = 21/27). These results demonstrate that consensus strengthened after feedback and item refinement, and that the overall conclusions remained unchanged under all tested thresholds. Figure 3 illustrates the distribution of Likert-scale ratings for all nine FOOD-DM items in Delphi round 2, demonstrating the level of expert agreement across the three framework domains. Detailed, item-wise results stratified by professional background, including the full distribution of Likert-scale ratings for each item in Delphi round 2, are provided in Supplementary Material S2. Overall, 91% of experts assigned ratings of 7–9 (“extremely effective”) to the item assessing the overall perceived helpfulness of the proposed measures. Figure 4 provides a schematic overview of the final FOOD-DM framework, summarizing the nine consensus-based criteria across the domains of texture characteristics, nutritional characteristics, and transparency and labeling.

Regarding the comparison between IDDSI- and SI-based texture description systems, a majority of participants supported the complementary use of both approaches: 61% rated the combined approach in the agreement range (7–9), while fewer than 10% rated it in the disagreement range (1–3). Qualitative feedback from eight participants reiterated themes of practicality, objectivity, and clinical applicability. Some experts noted that rheological measurements in SI units require temperature control and may not always be feasible in clinical settings, supporting the continued use of IDDSI for bedside application. Conversely, others emphasized the advantages of SI-based quantification for research and industrial quality control. Participants also highlighted the perceived need for equitable access, professional training, and caregiver education to facilitate implementation of the FOOD-DM framework.

4. Discussion

4.1. Principal findings

This study presents a multidisciplinary expert consensus on key characteristics of foods and drinks perceived as suitable for

individuals with dysphagia and malnutrition. The proposed FOOD-DM framework reflects expert agreement rather than empirically validated clinical effectiveness and therefore requires further empirical evaluation. Importantly, FOOD-DM is not intended to function as a clinical guideline and does not provide prescriptive recommendations for individual patient management. It rather serves as a framework for defining and evaluating food and drink characteristics.

The FOOD-DM consensus identified nine core criteria perceived as appropriate for diets for individuals with dysphagia and malnutrition. This reflects strong interdisciplinary and multi-professional agreement. The criteria are organized into three overarching domains: (1) texture characteristics, (2) nutritional characteristics, and (3) transparency and labeling. While existing approaches typically address either texture or nutritional composition in isolation, FOOD-DM explicitly integrates standardized texture specification, nutritional optimization, and transparent labeling within a single, consensus-based framework. By doing so, it addresses the frequent coexistence of dysphagia and malnutrition and provides an evaluative structure that reflects expert-perceived requirements at the interface of swallowing safety and nutritional adequacy. The domains emphasize the perceived need for standardized and customizable texture definitions, objective and reproducible methods for texture verification, the availability and flexibility of high-calorie and high-protein options, and clear product labeling. Together, these expert perspectives provide an initial, consensus-based foundation that is perceived by the experts as having the potential to support more equitable access to adequate nutrition for people with dysphagia and malnutrition. The study benefited from participation of experts across 19 countries (although German experts predominated) and multiple professional disciplines. The Delphi design ensured anonymity, structured iteration, and feedback, facilitating consensus formation while minimizing social bias.

4.2. Texture characteristics

Texture consistency and its accurate description emerged as foundational components of dysphagia management [15].

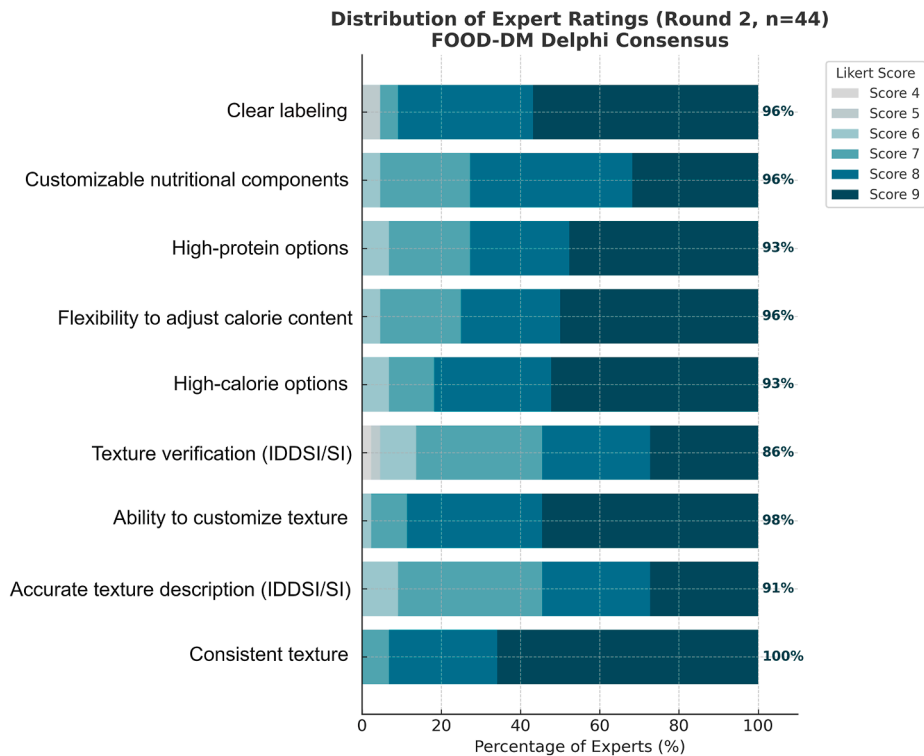


Fig. 3. Distribution of expert ratings for the nine FOOD-DM items in Delphi round 2. Each bar represents the proportion of experts assigning scores from 1 (“not important”) to 9 (“critically important”) on the Likert scale. All items were rated by the full round-2 sample (n = 44 experts). Abbreviations: **FOOD-DM**, Formulation of Optimized Oral Diet Characteristics for Dysphagia and Malnutrition; **IDDSI**, International Dysphagia Diet Standardisation Initiative; **SI**, International System of Units.

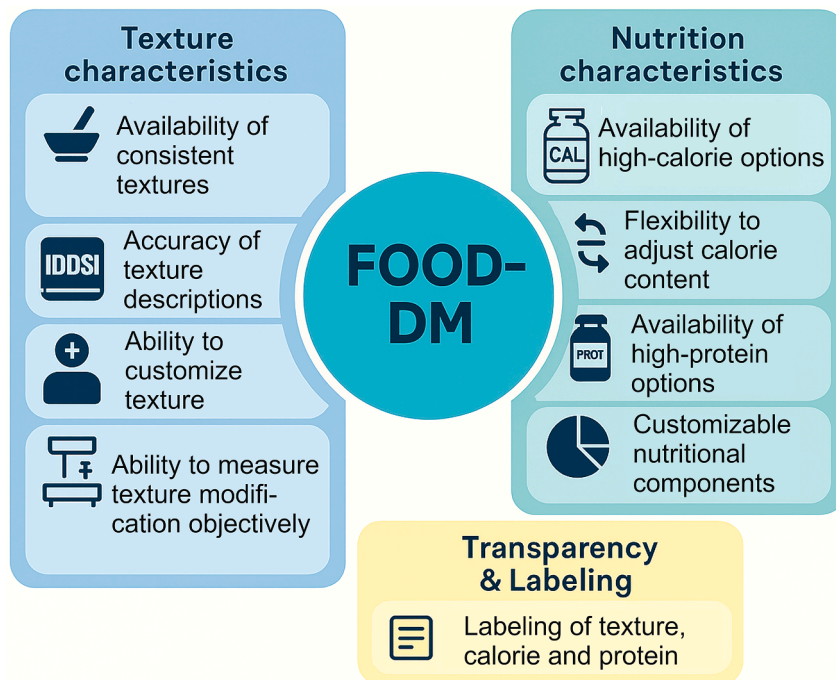


Fig. 4. Final consensus based FOOD-DM framework comprising nine criteria across three domains. The framework integrates texture characteristics (Items 1–4), nutritional characteristics (Items 5–8), and transparency and labeling (Item 9). Abbreviations: **FOOD-DM**, Formulation of Optimized Oral Diet Characteristics for Dysphagia and Malnutrition.

Although texture modification is widely used to support swallowing safety, its broader clinical impact remains debated. Potential drawbacks such as reduced intake or diminished quality of life have been noted [36–41]. In selected clinically stable patients

with chronic aspiration, free water protocols that allow controlled water intake despite aspiration have been shown not to increase pneumonia risk [42]. This indicates that texture modification should not be applied indiscriminately. Nevertheless, many

individuals with dysphagia depend on modified consistencies to maintain adequate oral intake [43–45]. Therefore, texture modification should be viewed as an individualized intervention guided by both patient-reported outcomes and instrumental assessments (videofluoroscopy or swallowing endoscopy). Nutritional sufficiency and patient acceptance should be monitored closely.

4.3. Nutritional characteristics

The strong consensus on the importance of nutritional composition aligns with established recommendations for high-calorie and high-protein options for malnourished populations [28]. In this context, the definitions of high-calorie (e.g. 1.5–2.0 kcal/mL) and high-protein (e.g., providing $\geq 20\%$ of total energy from protein) foods and drinks used in the FOOD-DM framework are consistent with clinical guideline recommendations for oral nutritional supplements [28]. However, standardized definitions for high-calorie and high-protein meals outside the context of oral nutritional supplements remain limited. Alongside general target values, individualized approaches are frequently recommended to optimize nutritional outcomes [28]. The multicenter randomized controlled EFFORT trial [46] evaluated whether individualized, goal-directed nutritional therapy improves clinical outcomes in hospitalized, malnourished medical patients. The intervention followed a structured yet patient-tailored approach comprising five key components: (1) determination of calorie requirements using the Harris–Benedict equation or indirect calorimetry; (2) provision of increased protein intake of 1.2–1.5 g/kg/day; (3) routine administration of multivitamins; (4) consideration of disease-specific nutritional needs (e.g., electrolyte adaptation in renal insufficiency); and (5) regular reassessment of nutritional status with escalation of nutritional therapy if targets were not achieved. The trial demonstrated that such personalized nutrition support significantly reduced mortality and complications compared with standard care. These findings align with the FOOD-DM consensus, which emphasizes the availability of high-calorie and high-protein options as well as adaptable calorie and macronutrient composition. The framework should therefore be interpreted as complementary to personalized nutritional assessment. Micronutrients were intentionally excluded, as these are more appropriately addressed through medical supplementation rather than food texture and formulation.

4.4. Customizability and innovation

An important component of FOOD-DM is customizability, referring to the ability to tailor texture, calorie content, and macronutrient composition to individual patient needs. Such flexibility is more readily achieved in settings where meals are routinely adapted, such as restaurants or hospital kitchens. However, it may present challenges in standardized production environments such as supermarkets or large-scale catering. Recent technological advances suggest that 3D food-printing targeting texture and macronutrient composition, and emerging process innovations (e.g., non-thermal softening, emulsion/gel structuring), can support on-demand personalization at the point of consumption [47,48]. In addition, further pragmatic developments such as modular packaging concepts and smart customization systems (e.g., texture-modifying cartridges, nutrient-fortification sachets, or self-service blending devices) may enable similar personalization in community and retail contexts.

These innovations have the potential to extend FOOD-DM principles beyond clinical settings, across diverse food environments. At the same time, the framework itself highlights the

expert-perceived need for continued development of such adaptable systems.

4.5. Integration of IDDSI and SI-based approaches to describe textures

Expert responses suggested that IDDSI terminology and SI-based rheological measures may serve complementary roles, reflecting their distinct but synergistic strengths. The IDDSI framework provides a practical and globally recognized system for clinical use [49]. It classifies foods and liquids into eight levels (0–7) based on their flow and textural properties. These are determined through simple empirical tests easily applicable at the bedside or in other settings [15]. In contrast, SI-based rheological measurements allow for objective and reproducible quantification of texture properties, which may facilitate standardization in research, product development, and industrial quality control [50]. However, implementation of SI-based texture measurement is associated with substantial practical limitations, including the need for specialized equipment, standardized testing conditions such as temperature control, trained technical personnel, and additional financial and logistical resources. These requirements substantially limit feasibility in bedside care, community settings, and low-resource environments, where IDDSI remains the more practical option.

Within the FOOD-DM framework, IDDSI primarily serves clinical and on-site assessment needs, while SI-based measurements may inform research and industrial implementation where appropriate infrastructure exists. The integration of both perspectives within FOOD-DM should be understood as a consensus-based perceived potential rather than as an assumption of broad or universal feasibility across all care environments. Future adaptations of FOOD-DM may integrate evolving methodologies for texture measurement and modification to reflect advances in both clinical and food technology domains.

4.6. Implementation aspects

Although FOOD-DM focuses on objective and measurable characteristics of foods and drinks, qualitative comments highlighted broader factors influencing accessibility. These include affordability, sensory appeal, availability of assistive devices, cultural aspects and the critical role of professional and caregiver education. These aspects extend beyond the scope of the FOOD-DM criteria but are essential for real-world implementation. Furthermore, the predominance of experts based in Germany means that the perspectives represented in the framework may be shaped by German and, more broadly, European healthcare structures, regulatory environments, and food-service systems. Consequently, extrapolation of the FOOD-DM framework to international food systems should be undertaken with caution. This particularly applies to regions with different regulatory systems, resource availability, culinary traditions, and modes of food provision. Adaptation to local dietary practices, supply chains, and healthcare infrastructures may be required before implementation outside German or European contexts.

Together, these broader perspectives emphasize that FOOD-DM addresses a specific dimension of accessibility: the concrete, physical and objectifiable characteristics of food and drink with a sole focus on dysphagia and malnutrition. However, socio-psychological, educational, economic, and cultural factors must also be addressed to achieve truly barrier-free nutrition besides the expert-consensus based checklist-criteria in FOOD-DM.

A further aspect concerns the nutritional implications of including or excluding certain food categories when applying

FOOD-DM criteria. Foods differ substantially in their natural macronutrient composition. To this end, many textures commonly used for dysphagia (e.g., purées) tend to be relatively low in protein or calorie content [51,52]. As a result, reliance on such foods without additional fortification may inadvertently limit the feasibility of meeting high-protein or high-calorie targets. Conversely, high-protein options such as meats or legumes may require substantial texture modification to become dysphagia-appropriate. However, texture modifications can change their nutrient density or portion size. These inherent differences emphasize the importance of tailored fortification, modular nutrient additions, and specialized formulations when implementing FOOD-DM. Acknowledging these potential biases is essential to avoid underestimation of nutritional needs and to ensure that calorie- or macronutrient targets remain achievable across diverse food environments.

4.7. Framework structure and operationalization

FOOD-DM may be used in a dual manner: first, as a consensus-based clinical orientation and evaluation framework to assess how well access to expert-perceived appropriate nutrition is supported across different environments. Second, as a practical guidance framework for the development and adaptation of foods and drinks for individuals with dysphagia and malnutrition.

When applied as an orientation and evaluation framework, the nine criteria function as interdependent checklist items describing different dimensions. In this context, some criteria may appear conceptually overlapping. For example, the ability to adapt food texture presupposes the availability of dysphagia-appropriate textures. Similarly, the option to adjust calories assumes the availability of high-calorie options. These overlaps are intentional as they enable a graduated, checklist-based assessment. For instance, a supermarket may offer pre-prepared meals with dysphagia-appropriate textures (item 1), accurate texture description (item 2), high-calorie (item 5) and high-protein options (item 7), and clear labeling (item 9). Yet it may lack any possibility for individual texture or macronutrient adaptation (items 3 and 8). By contrast, a hospital kitchen with on-demand meal preparation may be able to customize texture levels (item 3), objectively describe the texture modification (item 4), and adjust calorie (item 6) or macronutrient composition (item 8). FOOD-DM may thus be used as a consensus-based orientation tool, reflecting expert opinion, to grade and evaluate the availability of perceived appropriate options in such settings item-wise. In restaurants and cafés, it may support evaluation of whether texture-modified meals can be prepared on request and whether staff can communicate relevant nutritional characteristics. In hospitals, rehabilitation centers, and long-term care facilities, FOOD-DM can serve as an expert-derived benchmark for grading menu offerings across all framework criteria. Based on these dimensions, graduated levels of FOOD-DM compliance (e.g., basic, advanced, full) could be conceptualized in future work to enhance transparency for patients, caregivers, professionals, and policy makers. However, any future use of FOOD-DM as a basis for product certification would require empirical validation, external governance, and regulatory oversight beyond the scope of the present Delphi consensus. Importantly, within the FOOD-DM framework, the labeling domain refers exclusively to transparent description of food and drink characteristics, composition, and intended target population. It should not be interpreted as implying certification or endorsement.

Beyond its evaluation function, FOOD-DM may also serve as a development and production tool. This is particularly relevant in settings where foods are individually prepared, such as hospital

and rehabilitation kitchens, long-term care facilities, or restaurants offering special-needs menus. In the food industry, FOOD-DM may be used as a product specification framework to ensure that ready-to-eat or reconstitutable foods meet the defined texture and nutritional criteria and to guide appropriate fortification and stabilization processes.

4.8. Future validation and research directions

As a consensus-based framework, FOOD-DM requires empirical validation before its feasibility, relevance, and broader applicability can be established. As short-term priority, a first step in this process should be the assessment of inter-rater reliability to determine the consistency with which different professional groups or patients apply the FOOD-DM criteria. Such analyses could involve independent rating of identical food and drink products by clinicians, speech-language pathologists, nutrition professionals, food-service staff, and patients across different settings.

Building on satisfactory inter-rater reliability, longer-term research goals include pilot implementation studies in diverse clinical and non-clinical environments to assess feasibility, usability, and contextual adaptability of the framework under real-world conditions. Specific attention should be given to potential need for cultural adaptation of the FOOD-DM criteria, including evaluation of their applicability to different dietary traditions, food preparation practices, and eating cultures, as well as to implementation in low-resource settings.

In addition, patient- and caregiver-centered outcomes such as perceived accessibility, nutritional adequacy, social participation, and quality of life should be evaluated as further long-term research goals. Together, these validation steps would be essential to confirm the robustness of FOOD-DM beyond expert consensus, to inform context-specific refinement, and to guide any future consideration of broader implementation or externally governed evaluation approaches.

4.9. Limitations

Several limitations should be acknowledged. First, the expert panel was not representative and may be subject to selection bias. The majority of participants were based in Germany, which likely reflects our recruitment channels and may introduce geographic, regulatory, and cultural bias. As a result, the consensus reached may disproportionately reflect perspectives embedded in German and European healthcare and food-service systems, potentially limiting direct transferability to international food systems with different structural, economic, and cultural conditions. Therefore, the generalizability of FOOD-DM to other healthcare systems and food-service environments should be interpreted with caution. Future studies should include broader geographic representation and examine how FOOD-DM may require adaptation to local dietary practices, service infrastructures, and resource conditions. Moreover, the inclusion criterion of an h-index ≥ 5 may have introduced academic selection bias. Although intended to ensure both clinical experience and scientific engagement, this requirement may have favored research-oriented experts over frontline clinicians with limited publication records. As a result, clinically highly experienced practitioners who are involved in day-to-day dysphagia and nutrition management but less engaged in academic publishing may have been underrepresented. This selection strategy may have influenced the prioritization of methodological rigor, objectifiability, and standardization at the expense of pragmatic considerations that are particularly relevant in routine clinical care.

Second, the initial set of items was generated entirely by the author team, which may have constrained the diversity of perspectives represented in round 1. Although participants were given the opportunity to propose additional items and provide free-text comments, the author-defined structure may still have shaped the scope of the discussion and introduced framing bias.

Third, due to the medically focused scope of the study, perspectives from patients, caregivers, and representatives of the food industry were not formally incorporated. As a result, important aspects related to lived experience, usability, acceptance, and real-world implementation may not be fully represented. Also, several conceptually important factors raised by participants during the qualitative feedback, including affordability, cultural food practices, sensory appeal, and broader socioeconomic constraints, were intentionally excluded. While this approach was necessary to maintain a clear methodological focus, it represents an important scope limitation. Excluded factors may be critical determinants of real-world accessibility, acceptance, and equity in nutrition for individuals with dysphagia and malnutrition. Their exclusion means that FOOD-DM should be interpreted as addressing only one dimension of perceived barrier-free nutrition, namely objective and measurable food and drink characteristics.

Fourth, hydration-related considerations were not addressed within the current framework.

Fifth, as with all Delphi studies, the resulting framework reflects expert consensus and expert perception and not empirical validation or demonstrated clinical effectiveness. Future clinical and implementation studies are needed to verify its impact on nutritional outcomes, safety, cost-effectiveness, and real-world feasibility across diverse care and community settings.

5. Conclusion

This Delphi consensus established FOOD-DM as a multidisciplinary, expert-derived framework defining key characteristics of foods and drinks perceived as suitable for individuals with dysphagia and malnutrition. By integrating expert-perceived considerations of texture specification, nutritional composition, and product labeling within a single framework, FOOD-DM addresses an important gap at the interface of dysphagia management and clinical nutrition. The framework emphasizes a hybrid approach to texture description (with IDDSI and SI units) that combines clinical usability with reproducibility and potential industrial applicability. Further empirical validation is required, including assessment of reliability, feasibility, cultural adaptability, and patient-centered outcomes.

Author contributions

All authors: Conceptualization; Methodology; Writing – review & editing; Validation; final approval of the version to be published; agreement to be accountable for all aspects of the work.

LB and BL: Data curation; Formal analysis; Visualization; Writing – original draft.

BL: Supervision; Project administration; Funding acquisition.

No one eligible for authorship has been excluded from the list of authors.

Data sharing

The anonymised quantitative Delphi ratings supporting the findings of this study are provided in the Supplementary Material. The qualitative free-text comments from individual participants cannot be made publicly available due to data protection and confidentiality requirements.

Ethical approval

The study complied with the Declaration of Helsinki and was approved by the Ethics Committee of Heinrich Heine University Düsseldorf (approval number: 2024–2827). All participants provided electronic informed consent.

Declaration of generative AI in the writing process

During the preparation of this work the authors used ChatGPT 5.1 and 5.2 to improve wording and grammar. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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Conflict of Interest

SL: has received honoraria and travel grants for lectures and conferences from the German Society for Clinical Neurophysiology and Functional Imaging (DGKN), Phagenesis Ltd, the United European Gastroenterology (UEG), the German Stroke Society (DSG), argenx, AbbVie, and Merck, and serves as a consultant for Phagenesis Ltd.

AJ: has received a travel grant for a conference from the German Society for Dysphagia (DGD) and honoraria for lectures from the German Society for Clinical Neurophysiology and Functional Imaging (DGKN) and Phagenesis Ltd.

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Appendix A. Supplementary data

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