Systematic Review of Nutritional Assessment Tools for Integration into Primary Healthcare Delivery Systems

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Abstract- ***Malnutrition remains a critical public health challenge globally, particularly in low-income and middle-income countries where primary healthcare systems serve as the first point of contact for vulnerable populations. The integration of effective nutritional assessment tools into primary healthcare delivery systems represents a strategic intervention for early detection, prevention, and management of nutritional disorders across the lifespan. This systematic review examines the landscape of nutritional assessment tools available for deployment in primary healthcare settings, with particular emphasis on their feasibility, validity, reliability, and sustainability in resource-constrained environments. Through comprehensive analysis of peer-reviewed literature, policy documents, and implementation reports, this review identifies key categories of nutritional assessment tools including anthropometric measurements, biochemical indicators, clinical examinations, dietary assessment methods, and composite screening instruments. The review further explores the practical challenges associated with tool implementation, including workforce capacity constraints, technological limitations, supply chain management issues, and the need for context-specific adaptation of standardized protocols. Findings reveal that while numerous validated nutritional assessment tools exist, significant gaps persist in their systematic integration into routine primary healthcare services, particularly in settings characterized by limited infrastructure, inadequate training programs, and competing healthcare priorities. The review synthesizes evidence on successful integration models, highlighting the importance of multi-sectoral collaboration, community-based surveillance approaches, and innovative technology-enabled solutions for enhancing nutritional surveillance capacity at the primary care level. Recommendations for policymakers, healthcare administrators, and frontline practitioners emphasize the need for standardized assessment protocols, sustainable training mechanisms, quality assurance systems, and robust monitoring and evaluation frameworks to ensure effective nutritional assessment becomes a fundamental component of primary healthcare delivery globally.***

Keywords: ***Nutritional Assessment, Primary Healthcare, Malnutrition Screening, Anthropometric Tools, Dietary Assessment, Integrated Health Systems, Community-Based Surveillance, Health Surveillance Systems, Nutritional Surveillance, Healthcare Integration***

I. INTRODUCTION

The global burden of malnutrition continues to pose unprecedented challenges to public health systems worldwide, affecting populations across diverse geographical, economic, and social contexts. Malnutrition manifests in multiple forms including undernutrition, micronutrient deficiencies, and overweight or obesity, each presenting distinct yet interconnected health consequences that span from impaired child development to increased susceptibility to non-communicable diseases in adult populations (Allen and Feigl, 2017). The recognition that malnutrition constitutes both a cause and consequence of poor health outcomes has elevated nutritional assessment to a position of central importance within comprehensive primary healthcare strategies. Primary healthcare systems, conceptualized as the foundation of universal health coverage, represent the most accessible and cost-effective platform for implementing population-wide nutritional surveillance and intervention programs (Dye, 2014). However, the effective integration of nutritional assessment tools into routine primary healthcare delivery remains inconsistent across global health

systems, particularly in resource-limited settings where the burden of malnutrition is most severe.

The imperative for systematic nutritional assessment within primary healthcare contexts emerges from multiple converging factors. First, the epidemiological transition witnessed in many developing countries has resulted in the coexistence of undernutrition and overnutrition within the same populations, communities, and even households, a phenomenon termed the double burden of malnutrition (Brown, 2004). This nutritional transition necessitates comprehensive assessment approaches capable of identifying diverse forms of malnutrition simultaneously. Second, the increasing recognition of nutrition as a fundamental determinant of health outcomes across the life course has prompted calls for nutritional screening to become a standard component of primary care consultations (Gibbs, 2005). Third, the sustainable development goals have established ambitious targets for eliminating all forms of malnutrition by 2030, requiring robust monitoring systems anchored in functional primary healthcare platforms (Lo et al., 2017). Fourth, emerging evidence demonstrates that early identification of nutritional risk through systematic assessment enables timely intervention, potentially averting the progression to severe malnutrition and its associated complications (Bloom et al., 2017).

Despite the clear rationale for integrating nutritional assessment into primary healthcare delivery, significant implementation gaps persist across diverse health systems. These gaps reflect a complex interplay of factors including inadequate healthcare infrastructure, insufficient trained personnel, limited availability of essential equipment and supplies, competing healthcare priorities, and the absence of standardized protocols adapted to local contexts (Coker et al., 2011). Furthermore, the proliferation of diverse nutritional assessment tools and methodologies has created confusion regarding optimal tool selection for specific settings and populations (Drewe et al., 2012). Healthcare workers at the primary care level often lack clear guidance on which assessment tools to implement, how to interpret results, and what referral pathways to activate when nutritional problems are identified. The situation is further complicated by the fact that many nutritional assessment tools were developed and validated in high-resource settings, raising questions about their applicability and performance characteristics when deployed in resource-constrained environments (Halliday et al., 2012).

The landscape of nutritional assessment tools encompasses a wide spectrum of methodologies, each with distinct advantages, limitations, and resource requirements. Anthropometric measurements, including weight, height, mid-upper arm circumference, and skinfold thickness, constitute the most widely utilized assessment approaches due to their relative simplicity, low cost, and non-invasive nature (Cunningham et al., 2017). However, anthropometric assessment requires standardized equipment, trained personnel, and appropriate reference standards that may not always be available in primary healthcare settings. Biochemical assessments, which measure nutrient levels or functional indicators in blood, urine, or other biological samples, provide objective evidence of nutritional status but demand laboratory infrastructure that is often absent from peripheral health facilities (Bardosh, 2016). Clinical examination methods that identify physical signs of nutrient deficiencies offer valuable diagnostic information but require clinical expertise that may exceed the training level of frontline primary healthcare workers. Dietary assessment approaches, including food frequency questionnaires, 24-hour dietary recalls, and food diaries, provide insights into nutritional intake patterns but are time-intensive and subject to recall bias (Bardosh et al., 2017).

Recent years have witnessed growing interest in composite nutritional screening tools that combine multiple assessment components into simplified algorithms designed for rapid application in busy primary healthcare settings. These screening instruments aim to balance sensitivity and specificity while minimizing resource demands and implementation complexity (Bedford et al., 2019). Examples include various malnutrition screening tools for pediatric populations, pregnant women, and elderly individuals, each tailored to the specific nutritional vulnerabilities of these groups. The development of such tools represents an important advancement in making nutritional assessment more

feasible for integration into routine primary care. However, questions remain regarding the optimal combination of assessment components, appropriate cutoff values for different populations, and the comparative performance of various screening instruments across diverse contexts (Belay et al., 2017).

The integration of nutritional assessment tools into primary healthcare delivery systems requires consideration of the broader health system context within which these tools will operate. Successful integration depends not only on the technical characteristics of the assessment tools themselves but also on the strength of health system building blocks including service delivery platforms, health workforce capacity, information systems, access to essential medical products, financing mechanisms, and governance structures (Brookes et al., 2017). The experience of implementing other health interventions through primary healthcare systems offers valuable lessons for nutritional assessment integration. For instance, the successful scale-up of immunization programs, growth monitoring initiatives, and infectious disease surveillance systems demonstrates that systematic implementation of standardized protocols, accompanied by appropriate training, supervision, and quality assurance mechanisms, can achieve high coverage and sustained performance even in challenging environments (Calba et al., 2015).

Technology is increasingly recognized as an enabler for enhancing nutritional assessment capacity within primary healthcare systems. Mobile health applications, digital anthropometric devices, point-of-care testing technologies, and electronic health records offer opportunities to improve the accuracy, efficiency, and sustainability of nutritional surveillance at the primary care level (Catley et al., 2004). These technological solutions can facilitate real-time data capture, automated calculations, clinical decision support, and seamless information flow between different levels of the health system. However, the deployment of technology-enabled nutritional assessment tools must be carefully planned to ensure compatibility with existing health information systems, sustainability of technical support, and acceptability to healthcare providers and patients alike (DaoAnh et al., 2018).

Community engagement and participatory approaches represent another critical dimension of integrating nutritional assessment into primary healthcare delivery. Evidence from various health interventions demonstrates that community involvement in health surveillance activities enhances uptake, sustainability, and health system responsiveness to local needs (Abramowitz et al., 2015). Community-based nutritional surveillance models, where trained community health workers or volunteers conduct basic nutritional screening and refer identified cases to formal health facilities, have shown promise in extending the reach of nutritional assessment beyond the walls of health facilities (Dunning et al., 2014). Such approaches are particularly relevant in settings where geographical barriers, cultural factors, or service delivery constraints limit population access to facility-based healthcare services. The integration of community-level screening with facility-based comprehensive assessment creates a continuum of care that maximizes early detection while ensuring appropriate clinical management of identified nutritional problems (Fall et al., 2019).

This systematic review aims to comprehensively examine the current state of knowledge regarding nutritional assessment tools suitable for integration into primary healthcare delivery systems. The specific objectives are to identify and categorize available nutritional assessment tools; evaluate their validity, reliability, and feasibility for primary healthcare settings; analyze implementation experiences and lessons learned from diverse contexts; identify barriers and facilitating factors for successful integration; and synthesize evidence-based recommendations for policymakers, healthcare administrators, and practitioners. By addressing these objectives, this review seeks to provide a rigorous evidence base to inform the development of practical strategies for strengthening nutritional assessment capacity as a fundamental component of primary healthcare delivery globally.

II. LITERATURE REVIEW

The systematic assessment of nutritional status within healthcare delivery systems has evolved considerably over recent decades, driven by accumulating evidence of malnutrition's profound impact on health outcomes

and healthcare costs. Historical approaches to nutritional assessment were largely confined to specialized clinical settings, with limited integration into routine primary care services (Fournet et al., 2018). This separation reflected both the perception of nutrition as a secondary health concern and the practical challenges of implementing systematic assessment protocols in resource-constrained primary healthcare environments. However, the growing recognition of malnutrition as a critical determinant of morbidity, mortality, and healthcare utilization has prompted renewed emphasis on embedding nutritional surveillance within the primary healthcare architecture (Guerra et al., 2019).

The theoretical foundations for integrating nutritional assessment into primary healthcare systems draw from multiple conceptual frameworks. The primary healthcare approach, as articulated in the Declaration of Alma-Ata, emphasizes comprehensive, accessible, and community-oriented health services that address the full spectrum of health needs including prevention, early detection, treatment, and rehabilitation (Halton et al., 2013). Within this framework, nutritional assessment constitutes an essential preventive and diagnostic function that enables early identification of individuals at nutritional risk before progression to severe malnutrition requiring intensive intervention (Hattendorf et al., 2017). The life course approach to health further reinforces the importance of nutritional surveillance across all age groups, recognizing that nutritional status at any life stage influences health trajectories and disease susceptibility in subsequent stages (Head et al., 2013).

The surveillance systems literature provides important insights into the characteristics of effective health monitoring systems that can be adapted for nutritional surveillance within primary healthcare contexts. Henning (2004) describes key attributes of functional surveillance systems including simplicity, flexibility, acceptability, sensitivity, timeliness, and representativeness. These attributes are particularly relevant for nutritional assessment systems operating in primary healthcare settings, where healthcare providers must balance multiple competing demands on their time and attention. The challenge lies in designing nutritional assessment protocols that are sufficiently comprehensive to detect diverse forms of malnutrition while remaining simple enough for consistent implementation by busy frontline health workers (Hughes et al., 2010).

Literature examining the validity and reliability of nutritional assessment tools reveals considerable variation in the performance characteristics of different methodologies across diverse populations and settings. Anthropometric indicators, while widely used, demonstrate varying sensitivity and specificity depending on the specific measurements employed, the reference standards applied, and the characteristics of the population being assessed (Janes et al., 2012). For instance, body mass index, a commonly utilized anthropometric indicator for adults, may misclassify nutritional status in populations with different body composition patterns or in individuals with fluid retention (Johnson et al., 2018). Similarly, growth indicators for children, typically based on comparison to international reference standards, may not adequately account for genetic and ethnic variations in growth patterns (Jonas and Seifman, 2019). These considerations highlight the importance of validating nutritional assessment tools in the specific populations and contexts where they will be deployed.

The literature on implementation science offers valuable frameworks for understanding the processes and factors that influence successful integration of evidence-based interventions, including nutritional assessment protocols, into routine healthcare practice. Jost et al. (2007) emphasize the importance of stakeholder engagement, contextual adaptation, iterative learning, and sustained support in achieving effective implementation of health interventions. Applied to nutritional assessment integration, these principles suggest that successful implementation requires active involvement of healthcare providers, administrators, policymakers, and community members in designing and refining assessment protocols to ensure they are feasible, acceptable, and sustainable within local health system realities (Karesh et al., 2012).

Experience from integrated disease surveillance systems provides relevant lessons for nutritional surveillance integration. The Integrated Disease Surveillance and Response framework, implemented across African countries, demonstrates how multiple

surveillance functions can be systematically incorporated into routine health service delivery through standardized case definitions, simplified reporting formats, regular training, supportive supervision, and feedback mechanisms (Karimuribo et al., 2017a). Similar principles can be applied to nutritional surveillance, where standardized assessment protocols, clear documentation systems, regular capacity building, and continuous quality improvement processes are essential for sustained implementation (Karimuribo et al., 2017b).

The One Health paradigm, which emphasizes the interconnections between human, animal, and environmental health, offers additional perspectives relevant to nutritional assessment integration. While One Health discussions typically focus on zoonotic diseases and antimicrobial resistance, the underlying principles of interdisciplinary collaboration, systems thinking, and community engagement are equally applicable to nutrition (Kelly et al., 2017). Nutritional status is influenced by factors spanning agriculture, food systems, water and sanitation, education, and social protection, requiring coordinated action across multiple sectors. Primary healthcare systems, positioned at the interface between communities and formal health services, are ideally situated to facilitate such multi-sectoral coordination around nutrition (Khabbaz et al., 2014).

Literature examining barriers to implementing nutritional interventions in primary healthcare settings identifies recurring challenges including inadequate healthcare provider knowledge and skills, time constraints, lack of institutional priority, insufficient equipment and supplies, absence of clear protocols, and limited integration with other health services (Kilpatrick and Randolph, 2012). These barriers operate at multiple levels of the health system, from individual provider competencies to organizational policies and national healthcare financing mechanisms. Addressing these multilevel barriers requires comprehensive strategies that simultaneously strengthen individual capacities, organizational systems, and policy environments (Kuehne et al., 2019).

Technological innovations are increasingly featured in literature on enhancing primary healthcare delivery, with implications for nutritional assessment. Mobile health technologies enable point-of-care assessment, real-time data transmission, and clinical decision support that can augment the capacity of frontline health workers to conduct nutritional screening and management (Kuisma et al., 2019). Digital anthropometric devices that automatically calculate nutritional indices reduce errors associated with manual measurements and calculations. Electronic health records facilitate longitudinal tracking of nutritional status, enabling early detection of concerning trends. However, literature also cautions that technology deployment must be accompanied by appropriate training, technical support, and integration with existing workflows to realize anticipated benefits (Macherera and Chimbari, 2016).

Community-based approaches to health service delivery, extensively documented in global health literature, offer models for extending nutritional assessment beyond facility walls. Community health worker programs in various countries have successfully incorporated basic nutritional screening using simplified tools such as mid-upper arm circumference tapes, with linkages to facility-based services for comprehensive assessment and management of identified cases (Mackenzie and Jeggo, 2019). These community-facility linkage models demonstrate the feasibility of creating tiered nutritional surveillance systems that balance population coverage with clinical capacity constraints (Mackenzie et al., 2013).

III. METHODOLOGY

This systematic review employed a comprehensive search strategy to identify, evaluate, and synthesize evidence regarding nutritional assessment tools suitable for integration into primary healthcare delivery systems. The review followed established guidelines for systematic reviews, incorporating elements of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses framework adapted for the specific focus on health system interventions and implementation research (Mariner et al., 2014). The methodology encompassed multiple stages including literature search and selection, quality appraisal, data extraction, and evidence synthesis,

each conducted according to predefined protocols to ensure rigor and reproducibility.

The literature search encompassed multiple electronic databases including PubMed, Scopus, Web of Science, Global Health Database, and regional databases covering literature from low-income and middle-income countries. Search terms combined keywords related to nutritional assessment, malnutrition screening, anthropometric measurement, dietary assessment, primary healthcare, primary care, community health, health system integration, and implementation. Boolean operators were employed to create comprehensive search strings that captured relevant literature while maintaining specificity (Mazet et al., 2014). The search was restricted to publications available before 2019 to align with the specified journal year, encompassing literature from 1990 onwards to capture the evolution of nutritional assessment approaches over three decades. No language restrictions were applied initially, though non-English publications were subsequently translated to enable full text review.

Inclusion criteria specified that articles must address nutritional assessment tools or methods applicable to primary healthcare settings, describe implementation experiences or validation studies, and provide empirical data or substantive analysis relevant to the review objectives. Studies conducted in diverse geographical settings were included to ensure comprehensive coverage of evidence from both high-resource and resource-limited contexts (McCloskey et al., 2014). Grey literature sources including government reports, policy documents, implementation guidelines, and technical reports from international organizations were also incorporated to capture practical implementation knowledge not always reflected in peer-reviewed publications. Exclusion criteria eliminated purely theoretical discussions without empirical grounding, studies focused exclusively on specialized clinical settings with limited relevance to primary care, and articles addressing nutritional interventions without sufficient detail on assessment methodologies.

The initial search yielded a substantial volume of potentially relevant publications that underwent sequential screening processes. Title and abstract screening eliminated obviously irrelevant articles, with remaining publications subjected to full text review against the inclusion criteria (Menson et al., 2018). Two independent reviewers conducted the screening and selection processes, with discrepancies resolved through discussion and consultation with a third reviewer when necessary. This dual review approach enhanced the reliability of study selection and reduced potential bias. Reference lists of included publications were manually searched to identify additional relevant sources not captured in the electronic database searches, a process that yielded supplementary materials particularly from older literature and grey literature sources (Merianos, 2007).

Quality appraisal of included studies employed assessment tools appropriate to different study designs. Quantitative studies reporting validation data for nutritional assessment tools were evaluated using criteria addressing sample size adequacy, appropriate statistical methods, clear reporting of validity and reliability metrics, and consideration of potential confounding factors (Moore et al., 2008). Qualitative studies exploring implementation experiences and barriers were assessed using criteria for qualitative research quality including appropriate sampling strategies, data collection methods, analytical rigor, and reflexivity. Implementation reports and policy documents were evaluated based on clarity, comprehensiveness, and credibility of described experiences and recommendations (Morse, 2012). While quality appraisal informed interpretation of findings, studies were not excluded solely on quality grounds given the exploratory nature of the review and the limited evidence base in some areas.

Data extraction utilized standardized forms capturing key information including study characteristics, population and setting details, description of nutritional assessment tools examined, validation parameters when reported, implementation experiences, identified barriers and facilitators, and recommendations. For studies reporting validation data, extracted information included sensitivity, specificity, positive and negative predictive values, inter-rater reliability, and validity against reference standards (N'Guessan et al., 2019). For implementation studies, extracted data encompassed contextual factors, implementation strategies,

coverage achieved, sustainability indicators, and lessons learned. The extracted data formed the foundation for subsequent synthesis and analysis.

Evidence synthesis employed both narrative and framework-based approaches given the heterogeneity of included studies and the focus on implementation alongside technical performance. Nutritional assessment tools identified in the literature were categorized into major methodological groups including anthropometric approaches, biochemical indicators, clinical examination methods, dietary assessment techniques, and composite screening instruments (O'Brien and Xagoraraki, 2019). Within each category, tools were further characterized by specific parameters assessed, target populations, resource requirements, and reported performance characteristics. Implementation experiences were analyzed thematically to identify recurring barriers, facilitating factors, and successful strategies for integrating nutritional assessment into primary healthcare delivery. Cross-cutting themes emerging from the synthesis informed the development of recommendations for practice, policy, and future research.

3.1 ANTHROPOMETRIC ASSESSMENT APPROACHES IN PRIMARY HEALTHCARE CONTEXTS

Anthropometric measurements constitute the most widely implemented category of nutritional assessment tools in primary healthcare settings globally, reflecting their relative simplicity, non-invasive nature, and modest resource requirements compared to biochemical or clinical assessment methods. Anthropometry encompasses the systematic measurement of the physical dimensions and composition of the human body, with specific measurements serving as indicators of nutritional status across different life stages (Phommasack et al., 2013). The fundamental principle underlying anthropometric assessment is that adequate nutrition supports normal growth and body composition, while malnutrition manifests in measurable deviations from expected anthropometric parameters. This relationship between nutrition and anthropometry enables screening, diagnosis, and monitoring of both undernutrition and overnutrition using relatively simple measurement techniques.

Weight measurement represents the most basic anthropometric indicator, providing information on overall body mass that reflects the combined effects of skeletal structure, muscle mass, adipose tissue, and body fluids. In primary healthcare settings, weight is typically measured using beam balance scales, spring scales, or increasingly, digital electronic scales, with the latter offering advantages of easier reading and often greater precision (Queenan et al., 2017). However, weight alone provides limited information about nutritional status without reference to other parameters such as age, height, or time trends. The interpretation of weight measurements requires appropriate reference standards, with international growth standards developed by the World Health Organization serving as the most widely utilized references for infants and children, while body mass index cutoffs are applied for adults (Rushton et al., 2018).

Height or length measurement complements weight data, enabling calculation of height-for-age indicators that reflect long-term nutritional status and weight-for-height or body mass index indicators that reflect current nutritional status. In primary healthcare settings, height is measured using stadiometers for individuals who can stand, while length boards are utilized for infants and young children unable to stand independently (Salyer et al., 2017). Technical considerations for accurate height measurement include proper positioning of the subject, appropriate reading of measurement scales, and regular calibration of measuring equipment. The feasibility of routine height measurement in busy primary healthcare settings depends on availability of appropriate equipment, adequate space for measurement, and sufficient time within clinical consultations to conduct measurements properly (Saylors et al., 2015).

Mid-upper arm circumference has emerged as a particularly valuable anthropometric indicator for primary healthcare settings, especially in resource-limited contexts and for community-based screening programs. Mid-upper arm circumference is measured using simple, inexpensive color-coded tapes that indicate nutritional status categories through colored

bands corresponding to normal, moderate acute malnutrition, and severe acute malnutrition (Scholten et al., 2018). The advantages of mid-upper arm circumference include rapid measurement requiring minimal training, independence from age determination which can be challenging in populations lacking birth registration systems, strong correlation with mortality risk particularly in children, and suitability for use by community health workers and non-clinical personnel. However, mid-upper arm circumference is most established for identifying acute malnutrition in children aged six to fifty-nine months, with less evidence supporting its application in other age groups (Schwind et al., 2014).

Skinfold thickness measurements assess subcutaneous fat deposition, providing information on body fat reserves that reflect longer-term energy balance. Skinfold measurements are taken using calipers at standardized body sites including triceps, biceps, subscapular, and suprailiac locations, with measurements interpreted using age- and sex-specific reference data or combined to estimate total body fat percentage (Scott et al., 2016). While skinfold measurements can provide valuable information on body composition, their implementation in primary healthcare settings faces practical challenges including the need for specialized calipers, substantial training requirements to ensure measurement reliability, time demands that may be incompatible with busy clinical environments, and cultural sensitivities in some contexts regarding the physical contact required for measurement (Seimenis, 2010).

Head circumference and chest circumference represent additional anthropometric indicators utilized particularly in pediatric primary healthcare. Head circumference is measured in infants and young children as an indicator of brain growth, with abnormal head circumference patterns potentially signaling nutritional problems, congenital conditions, or developmental disorders (Shiferaw et al., 2017). Chest circumference, while less commonly employed, has been explored as an indicator of body mass and nutritional status that may be less affected by short-term fluctuations than weight. The utility of these supplementary anthropometric measures in routine primary healthcare practice depends on the specific clinical populations served and the capacity to properly conduct and interpret measurements (Smolinski et al., 2017).

Table 1: Comparison of Anthropometric Indicators for Primary Healthcare Settings

Anthropometric Indicator	Equipment Required	Training Level	Target Population	Primary Applications	Implementation Feasibility
Weight	Scale (beam/spring/digital)	Basic	All ages	Underweight, overweight detection; growth monitoring	High – widely available
Height/Length	Stadiometer, length board	Moderate	All ages	Stunting detection; BMI calculation	Moderate – requires space and time
Mid-Upper Arm Circumference (MUAC)	MUAC tape	Minimal	Children 6–59 months primarily	Acute malnutrition screening	Very High – simple, rapid, inexpensive
Body Mass Index (BMI)	Scale + stadiometer + calculator	Moderate	Adults, adolescents	Underweight, overweight, obesity classification	Moderate – calculation required

Skinfold Thickness	Calipers	Extensive	All ages	Body composition assessment	Low – requires specialized skills
Head Circumference	Measuring tape	Basic	Infants, young children	Developmental screening	High – simple measurement

The integration of anthropometric assessment into routine primary healthcare delivery requires establishment of systematic protocols that specify which measurements should be conducted for different patient populations, how measurements should be performed and documented, how results should be interpreted, and what actions should be taken based on assessment findings (Standley et al., 2019). Such protocols must balance comprehensiveness with feasibility, recognizing that primary healthcare providers face multiple competing demands on their limited time. Evidence from various implementation contexts suggests that starting with a core set of essential anthropometric measurements and expanding gradually as capacity and systems strengthen is more sustainable than attempting comprehensive assessment from the outset (Tambo et al., 2019).

Quality assurance mechanisms are essential for ensuring reliable anthropometric data in primary healthcare settings. Quality assurance encompasses standardized measurement procedures, regular calibration and maintenance of measurement equipment, periodic assessment of inter-rater reliability among healthcare providers, supervision and feedback, and data quality checks to identify implausible values (Tambo et al., 2014). Without systematic attention to measurement quality, anthropometric data may be insufficiently reliable to support clinical decision-making or population surveillance. The challenge lies in implementing quality assurance processes that are sufficiently rigorous to ensure data quality while remaining feasible within resource-constrained primary healthcare environments (Thumbi et al., 2019).

Training of primary healthcare workers represents a critical enabler for effective anthropometric assessment implementation. Training must address both technical measurement skills and conceptual understanding of anthropometric indicators, their interpretation, and their clinical significance (Tornimbene et al., 2018). Effective training programs typically combine didactic instruction with practical hands-on practice, use of visual aids and demonstrations, and ongoing mentorship and supervision to reinforce and refine skills over time. Given high turnover rates among primary healthcare workers in many settings, training systems must be sustainable and capable of continuously orienting new staff (Travis et al., 2011).

Technology offers promising opportunities to enhance anthropometric assessment in primary healthcare settings. Digital anthropometric devices that automatically record measurements reduce transcription errors and enable real-time data transmission to electronic health records and surveillance systems (Tsai et al., 2010). Mobile health applications can calculate anthropometric indices automatically, display results graphically, provide clinical decision support, and facilitate longitudinal tracking of nutritional status. However, technology deployment must be accompanied by reliable electricity, connectivity where required, technical support, and integration with existing health information systems to realize anticipated benefits sustainably (Umezurike and Iwu, 2017).

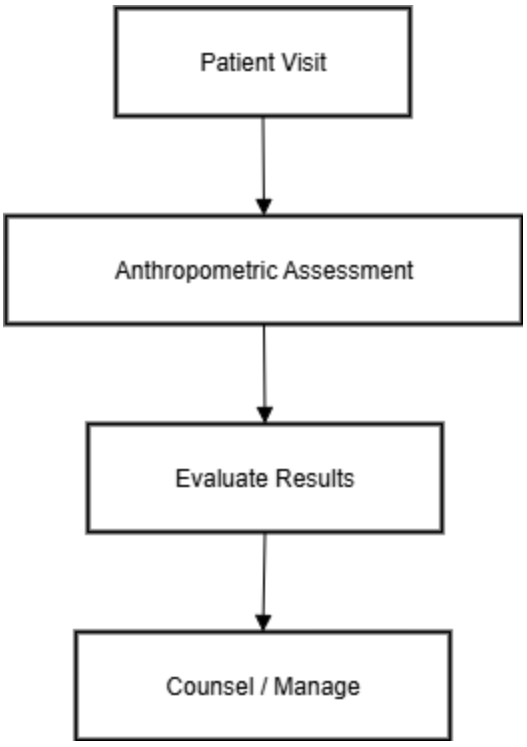


Figure 1: Anthropometric Assessment Implementation Pathway in Primary Healthcare Settings
Source: Author

3.2 BIOCHEMICAL AND CLINICAL ASSESSMENT METHODOLOGIES

Biochemical assessment of nutritional status encompasses laboratory measurement of nutrient levels or functional indicators in biological samples including blood, urine, saliva, and occasionally other tissues. Biochemical indicators provide objective evidence of nutrient deficiencies or excesses, often detecting subclinical deficiencies before clinical manifestations appear (Umezurike and Ogunnubi, 2016). Common biochemical assessments include hemoglobin or hematocrit for iron status, serum albumin or prealbumin for protein status, serum retinol for vitamin A status, thyroid stimulating hormone for iodine status, and serum 25-hydroxyvitamin D for vitamin D status. The specificity of biochemical indicators for particular nutrients makes them valuable for confirming suspected deficiencies and monitoring response to supplementation interventions (Umoren et al., 2019).

The implementation of biochemical assessment in primary healthcare settings faces substantial challenges related to laboratory infrastructure, technical capacity, equipment and reagent costs, and turnaround time for results. Many primary healthcare facilities in low-resource settings lack on-site laboratory capacity, requiring sample collection, preservation, transport to referral laboratories, and retrieval of results, all of which introduce delays and potential for sample degradation (Uwadiae et al., 2011). Even where laboratory services are available, competing demands for limited laboratory capacity may prioritize infectious disease diagnostics over nutritional biochemistry. The costs of laboratory testing, including consumables, quality control materials, equipment maintenance, and personnel time, can be substantial relative to available primary healthcare budgets (Uzozie et al., 2019).

Point-of-care testing technologies offer potential solutions to some limitations of conventional laboratory-based biochemical assessment. Point-of-care devices enable testing at the site of patient care, providing results within minutes rather than days, facilitating immediate clinical decision-making and reducing loss to follow-up (Vink et al., 2012). Hemoglobin measurement using portable hemoglobinometers represents the most widely implemented point-of-care nutritional biochemistry in primary healthcare settings, enabling rapid screening for anemia as a proxy for iron deficiency. Additional point-of-care tests for other micronutrients are under development, though most remain too expensive or technically complex for widespread primary healthcare deployment (Vrbova et al., 2010).

Clinical examination for signs and symptoms of nutritional deficiencies constitutes another assessment modality relevant to primary healthcare contexts. Clinical signs of nutrient deficiencies include specific manifestations such as angular stomatitis and glossitis in B vitamin deficiencies, bitot spots and night blindness in vitamin A deficiency, goiter in iodine deficiency, and edema in severe protein deficiency, as well as more general signs such as pallor, muscle wasting, and poor wound healing (Wilkes et al., 2019). The advantage of clinical examination is that it requires no equipment beyond basic clinical tools and relies on skills that should be part of general clinical

training. However, many clinical signs of nutritional deficiency are nonspecific and may indicate various conditions, requiring careful differential diagnosis (Wilkinson et al., 2011). Furthermore, clinical signs typically manifest only after deficiency has reached moderate to severe levels, limiting their utility for early detection and prevention.

The integration of biochemical and clinical assessment into primary healthcare nutritional surveillance requires strategic prioritization given resource constraints. One approach involves implementing universal screening using simple anthropometric methods, with selective use of biochemical and clinical assessment for cases where anthropometric screening identifies potential problems or where specific micronutrient deficiencies are suspected based on clinical presentation or epidemiological risk factors (Seimenis, 2010). This tiered approach maximizes resource efficiency while ensuring that more intensive assessment modalities are deployed where they provide greatest clinical value. Another strategy focuses biochemical assessment on specific high-risk populations such as pregnant women, where anemia screening is prioritized due to adverse maternal and fetal outcomes associated with iron deficiency, or young children in regions where vitamin A deficiency is endemic (Witt et al., 2011).

Quality assurance for biochemical and clinical assessment presents distinct challenges compared to anthropometric assessment. Laboratory quality assurance requires internal quality control procedures including regular testing of control samples, external quality assessment through participation in proficiency testing programs, equipment calibration and maintenance, and standard operating procedures for all test methodologies (Zachariah et al., 2009). For clinical examination, quality assurance involves standardized examination protocols, training in recognition of clinical signs, and periodic clinical audits to assess diagnostic accuracy. The establishment of such quality systems demands sustained commitment and resources that may strain primary healthcare budgets (Zinsstag et al., 2011).

Training requirements for biochemical and clinical nutritional assessment exceed those for anthropometric assessment, necessitating more intensive capacity building efforts. Laboratory technicians require training in specimen collection, handling, processing, analysis techniques, quality control procedures, and results interpretation (Abakar et al., 2016). Clinicians need training in clinical examination techniques for nutritional assessment, interpretation of biochemical results, and integration of multiple assessment modalities to formulate nutritional diagnoses and management plans. The specialized nature of this training and the relatively small numbers of personnel requiring it in any given primary healthcare facility create challenges for organizing and delivering training efficiently (Abass et al., 2019).

The role of referral systems in enabling appropriate use of biochemical and clinical assessment merits emphasis. Primary healthcare systems function most effectively when embedded within integrated health systems that include referral pathways to higher levels of care for cases requiring specialized diagnostic or therapeutic capacity (Adenuga et al., 2019). For nutritional assessment, referral systems enable primary healthcare providers to access specialized laboratory testing, expert clinical consultation, and advanced therapeutic options for complex cases while managing straightforward cases at the primary care level. The functionality of referral systems depends on clear referral criteria, reliable communication and transport mechanisms, feedback loops to referring providers, and adequate capacity at referral facilities (Aduwo and Nwachukwu, 2019).

Cost-effectiveness considerations influence decisions regarding the extent of biochemical and clinical assessment to integrate into primary healthcare services. While biochemical tests can provide valuable diagnostic information, their costs must be weighed against the clinical and public health benefits they generate (Aduwo et al., 2019a). In resource-limited settings, it may be more cost-effective to implement universal supplementation or fortification programs for widespread micronutrient deficiencies rather than testing all individuals to identify those requiring supplementation. Conversely, for micronutrient issues affecting smaller proportions of the population or where supplementation risks adverse effects, targeted assessment and treatment based on biochemical

confirmation may be more appropriate (Aduwo et al., 2019b).

Emerging technologies hold promise for expanding biochemical assessment capacity at the primary healthcare level while reducing costs and complexity. Microfluidic devices, biosensors, and lab-on-a-chip technologies under development aim to miniaturize multiple biochemical tests into portable, user-friendly devices requiring minimal sample volumes and providing rapid results (Allen and Feigl, 2017). Digital health platforms can facilitate teleconsultation with specialists for interpretation of complex biochemical or clinical findings, extending specialist expertise to remote primary healthcare settings. However, the translation of these technological innovations from research settings into routine primary healthcare practice requires evidence of field performance, cost-effectiveness analysis, regulatory approval, and development of sustainable supply chains (Anyebe et al., 2018).

The interpretation of biochemical indicators requires consideration of factors beyond nutritional status that may influence results. Acute illness, inflammation, hydration status, genetic variants, medications, and diurnal variations can all affect biochemical measurements, potentially leading to misclassification of nutritional status if not properly accounted for (Balogun et al., 2019). For instance, serum albumin, often used as a protein status indicator, decreases during acute inflammation regardless of nutritional status, limiting its utility in acutely ill patients. Similarly, hemoglobin concentration is influenced by altitude, smoking, pregnancy, and various non-nutritional anemias. Healthcare providers must understand these interpretive complexities to avoid diagnostic errors and inappropriate interventions (Bardosh, 2016).

3.3 DIETARY ASSESSMENT TECHNIQUES FOR PRIMARY HEALTHCARE APPLICATIONS

Dietary assessment encompasses methodologies for evaluating food and nutrient intake patterns, providing complementary information to anthropometric and biochemical indicators by directly examining the adequacy of nutritional intake. Unlike anthropometric and biochemical assessments that reflect the consequences of nutritional status, dietary assessment evaluates the input side of the nutrition equation, identifying inadequate or excessive intakes before manifestation as anthropometric or biochemical abnormalities (Bardosh et al., 2017). This preventive orientation makes dietary assessment particularly valuable for primary healthcare applications focused on early identification of nutritional risk and implementation of preventive interventions. However, dietary assessment methodologies tend to be more time-intensive and subjective than anthropometric or biochemical approaches, presenting implementation challenges in busy primary healthcare environments (Bedford et al., 2019).

The twenty-four-hour dietary recall represents one of the most widely utilized dietary assessment methods, involving trained interviewers guiding respondents through detailed recollection of all foods and beverages consumed during the previous twenty-four-hour period. The twenty-four-hour recall provides quantitative data on food and nutrient intakes with relatively modest respondent burden compared to more extended dietary recording methods (Belay et al., 2017). Multiple twenty-four-hour recalls on non-consecutive days can capture day-to-day variation in dietary intake, providing more representative estimates of usual intake than a single recall. However, the twenty-four-hour recall relies on memory and may be subject to recall bias, social desirability bias leading to under-reporting of stigmatized foods or over-reporting of healthy foods, and challenges in accurately estimating portion sizes (Bloom et al., 2017).

Food frequency questionnaires assess usual dietary patterns over extended time periods, typically weeks to months, by querying how often specific foods or food groups are consumed. Food frequency questionnaires can be administered as self-completed instruments or interviewer-administered surveys, with varying lengths from brief screeners focusing on key foods to comprehensive instruments covering hundreds of food items (Brookes et al., 2017). The advantages of food frequency questionnaires include assessment of habitual intake rather than short-term consumption, relatively lower cost and time requirements than repeated twenty-four-hour recalls, and the ability to identify dietary patterns associated with health outcomes. However, food frequency

questionnaires require literacy for self-administration, may have limited precision for estimating absolute nutrient intakes, and require population-specific food lists that reflect local dietary patterns (Brown, 2004).

Food diaries or food records involve respondents documenting all consumed foods and beverages in real-time over specified periods, typically ranging from three to seven days. Food diaries eliminate reliance on memory inherent in recall methods and can provide detailed quantitative intake data when respondents weigh or measure foods before consumption (Bukhari et al., 2019). However, the burden of maintaining food diaries is substantial, requiring literacy, numeracy, motivation, and time that may not be feasible for many primary healthcare populations. Additionally, the process of recording intake may alter eating behaviors, introducing reactivity bias that affects the validity of data. The demands of processing and analyzing food diary data also exceed those of simpler dietary assessment methods (Calba et al., 2015).

Simplified dietary assessment approaches have been developed specifically for resource-limited primary healthcare settings, attempting to balance information value with feasibility constraints. Dietary diversity scores, which count the number of different food groups consumed over a recall period, provide proxy indicators of diet quality without requiring detailed quantitative intake estimation (Catley et al., 2004). Minimum dietary diversity indicators for women and young children have been standardized by international organizations and validated against nutrient adequacy in diverse populations. Food consumption scores, combining dietary diversity with consumption frequency and food group weighting, offer another simplified metric suitable for rapid assessment (Coker et al., 2011).

Qualitative dietary assessment approaches can provide valuable contextual understanding of dietary patterns, food security, feeding practices, and nutritional beliefs without the quantitative precision of formal dietary assessment tools. Semi-structured interviews, focus group discussions, and direct observation of food preparation and consumption practices can reveal important information about factors influencing nutritional status that quantitative tools may miss (Cunningham et al., 2017). In primary healthcare settings, clinical conversations that explore dietary intake patterns qualitatively, though not standardized research instruments, can identify obvious dietary inadequacies warranting intervention and provide opportunities for targeted nutritional counseling (DaoAnh et al., 2018).

Table 2: Comparison of Dietary Assessment Methods for Primary Healthcare Integration

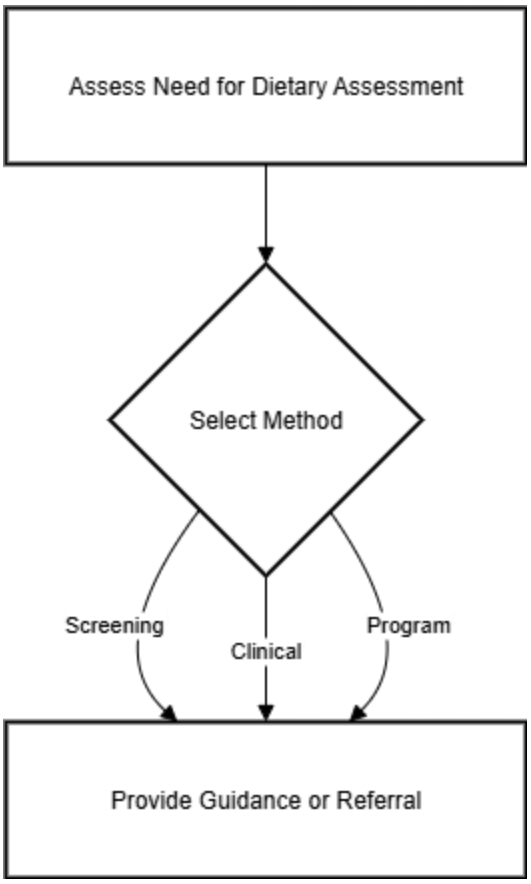
Dietary Assessment Method	Administration Time	Data Obtained	Respondent Burden	Training Required	Optimal Application
24-hour Dietary Recall	20–40 minutes	Quantitative intake data for single day	Low–Moderate	Extensive	Detailed intake assessment for clinical cases
Food Frequency Questionnaire	15–45 minutes (depending on length)	Usual intake patterns over weeks/months	Moderate	Moderate	Population screening; pattern identification
Food Diary/Record	Ongoing over 3–7 days	Detailed quantitative intake with minimal recall bias	High	Moderate	Research; selected cases requiring precise data
Dietary Divers	5–15 minutes	Proxy for diet	Low	Minimal	Rapid screening;

ity Score		quality and micronutrient adequacy			community-level assessment
Food Consumption Score	10–20 minutes	Combined diversity and frequency indicator	Low – Moderate	Minimal	Food security screening; program monitoring
Qualitative Dietary Interview	15–30 minutes	Contextual understanding of dietary practices	Low – Moderate	Moderate	Clinical counseling; formative assessment

The integration of dietary assessment into primary healthcare workflow requires careful consideration of when and how to conduct assessment given time constraints inherent in primary care consultations. Universal dietary assessment for all patients at every visit is generally not feasible or necessary (Didi et al., 2019). More practical approaches target dietary assessment to specific situations including routine well-child visits where growth monitoring identifies concerning patterns, prenatal care visits for pregnant women, management of diet-related conditions such as diabetes or hypertension, and cases where anthropometric or clinical assessment suggests possible nutritional problems (Drewe et al., 2012). Establishing clear protocols for when dietary assessment should be conducted helps ensure consistent implementation while avoiding provider overwhelm (Dunning et al., 2014).

The capacity of primary healthcare providers to conduct meaningful dietary assessment and counseling depends critically on their knowledge of nutrition and their communication skills. Many primary healthcare workers have received limited nutrition education in their pre-service training, particularly regarding practical dietary assessment and counseling competencies (Dye, 2014). In-service training programs must address this gap, covering dietary assessment methodologies, interpretation of dietary data, nutritional requirements for different populations, locally available food sources of key nutrients, and effective behavior change communication strategies. Training should emphasize practical skills applicable in actual primary healthcare settings rather than theoretical knowledge alone (Evans-Uzosike and Okatta, 2019).

Cultural and contextual adaptation of dietary assessment tools represents an essential consideration for effective implementation. Dietary patterns, food terminology, meal timing, portion sizes, and food preparation methods vary substantially across cultures and communities, requiring tools developed in one setting to be adapted for use elsewhere (Fall et al., 2019). Food frequency questionnaires must include foods actually consumed in the local context, with culturally appropriate names and preparation methods. Portion size estimation aids must reflect locally typical serving sizes. Dietary diversity scoring must account for cultural definitions of food groups and the nutritional composition of local food varieties. The process of cultural adaptation requires consultation with community members, local nutrition experts, and pilot testing before full-scale implementation (Fasasi et al., 2019).



Technology applications for dietary assessment in primary healthcare settings include mobile applications that guide standardized dietary recall or food frequency questionnaire administration, image-based portion size estimation using smartphone photographs of consumed foods, and electronic databases that convert reported food intakes into nutrient intakes automatically (Fournet et al., 2018). Such technologies can reduce the time and training required for dietary assessment while improving data quality and enabling seamless integration with electronic health records. However, technology deployment must account for connectivity requirements, device availability, provider and patient digital literacy, and the need for databases containing nutritional composition data for local foods (Gibbs, 2005).

The interpretation of dietary assessment data requires comparison to appropriate intake standards to identify inadequacies or excesses warranting intervention. Various nutrient intake reference values exist including recommended dietary allowances, adequate intakes, estimated average requirements, and tolerable upper intake levels, each with distinct interpretive implications (Guerra et al., 2019). For primary healthcare applications, simplified approaches that focus on achieving minimum adequate intakes of key nutrients rather than precise quantification of all nutrients may be more practical and actionable. The linkage of dietary assessment findings to specific, feasible dietary recommendations that can be implemented with locally available foods represents the critical output that justifies investment in dietary assessment (Halliday et al., 2012).

3.4 COMPOSITE NUTRITIONAL SCREENING INSTRUMENTS

Composite nutritional screening instruments represent a category of assessment tools specifically designed to combine multiple indicators into simplified algorithms that facilitate rapid identification of individuals at nutritional risk. These instruments typically incorporate selected anthropometric measurements, brief dietary assessment components, clinical observations, and sometimes functional or historical risk factors, integrating them through scoring systems or decision trees that classify individuals into nutritional risk categories (Halton et al., 2013). The development of composite screening tools reflects recognition that while comprehensive nutritional assessment provides detailed information, the resource intensity of comprehensive assessment limits its feasibility for universal application in primary healthcare settings. Screening instruments aim to efficiently identify the subset of individuals requiring more detailed assessment or immediate intervention while minimizing false negatives that would miss individuals with significant nutritional problems (Hattendorf et al., 2017).

The Malnutrition Universal Screening Tool, developed initially for hospital and community care settings in high-income countries, exemplifies the composite screening approach by combining body mass index, unintentional weight loss, and acute disease effects to generate a malnutrition risk score that guides clinical management decisions (Head et al., 2013). While widely validated in adult populations in developed countries, its applicability to diverse primary healthcare contexts in low-income and

middle-income countries requires consideration of feasibility issues such as the need for accurate weight history, which may be unavailable in populations lacking regular health system contact or home scales. Adaptations of such tools for resource-limited settings often simplify assessment components or substitute alternative indicators that are more feasible to obtain (Henning, 2004).

Pediatric nutritional screening instruments often focus on growth pattern assessment, incorporating multiple anthropometric indices to improve sensitivity for detecting different forms of malnutrition. Tools may assess weight-for-height to identify wasting, height-for-age to identify stunting, weight-for-age as an overall indicator, and mid-upper arm circumference for acute malnutrition, with algorithms for integrating these multiple indicators to categorize nutritional status and clinical urgency (Hughes et al., 2010). The World Health Organization growth standards provide the reference framework for interpreting pediatric anthropometric data, with z-scores enabling standardized comparison across age and sex groups. Primary healthcare implementation of multi-indicator pediatric screening requires systems for reliably measuring multiple parameters, calculating z-scores, and integrating results into clinical decision-making (Janes et al., 2012).

Nutritional screening specific to elderly populations addresses the distinct nutritional vulnerabilities of older adults including decreased appetite, dental problems, swallowing difficulties, medication-related nutritional impacts, social isolation affecting meal patterns, and chronic disease influences on nutritional status. Geriatric nutritional screening tools typically include anthropometric components, questions about appetite and food intake changes, weight change history, functional status indicators, and sometimes brief cognitive screening (Johnson et al., 2018). The Mini Nutritional Assessment represents a widely validated geriatric screening tool comprising screening and full assessment versions, with the brief screening version suitable for primary healthcare applications to identify elderly individuals requiring more comprehensive nutritional evaluation. However, most geriatric nutritional screening tools were developed and validated in developed country settings, raising questions about their performance in diverse global aging populations (Jonas and Seifman, 2019).

Pregnancy-specific nutritional screening addresses the increased nutritional requirements and unique vulnerabilities of pregnant women, for whom nutritional status impacts both maternal and fetal outcomes. Prenatal screening protocols typically include anthropometric assessment of pre-pregnancy body mass index or early pregnancy body mass index, gestational weight gain monitoring compared to recommended ranges, hemoglobin screening for anemia, and dietary assessment focusing on key nutrients for pregnancy including iron, folic acid, calcium, and protein (Jost et al., 2007). The integration of nutritional screening into antenatal care services represents a logical implementation strategy given the regular contact pregnant women have with health services, though the quality and completeness of antenatal nutritional assessment varies considerably across health systems (Karesh et al., 2012).

Food security screening instruments assess household-level access to adequate food, addressing an important determinant of nutritional status that may not be captured by individual nutritional assessment alone. The Household Food Insecurity Access Scale and related tools utilize brief questionnaires about experiences of food insufficiency, anxiety about food supply, and adaptations made when food is scarce (Karimuribo et al., 2017a). Food security screening can identify households at nutritional risk even before manifestation as individual malnutrition, enabling preventive interventions. The integration of food security screening into primary healthcare nutritional assessment provides important contextual information for interpreting nutritional status findings and designing appropriate interventions that address underlying access issues rather than only treating manifested malnutrition (Karimuribo et al., 2017b).

The development and validation of composite screening instruments requires rigorous methodology to ensure acceptable sensitivity, specificity, and predictive values for identifying individuals requiring intervention. Validation studies typically compare screening tool results to comprehensive nutritional assessment as a reference standard, determining the proportion of truly malnourished individuals correctly

identified by the screening tool and the proportion of well-nourished individuals correctly classified as not requiring intervention (Kelly et al., 2017). The optimal balance between sensitivity and specificity depends on the consequences and costs of false positives versus false negatives in the specific application context. For conditions where missed cases have severe consequences, higher sensitivity may be prioritized even at the cost of more false positives requiring follow-up assessment (Khabbaz et al., 2014).

Implementation research on composite screening instruments examines not only technical performance but also feasibility, acceptability, and sustainability when deployed in real-world primary healthcare settings. Key implementation outcomes include the proportion of eligible individuals actually screened, time required to complete screening, healthcare provider acceptance and adherence to screening protocols, patient acceptability, reliability of screening across different healthcare providers, and sustainability over time without intensive external support (Kilpatrick and Randolph, 2012). Implementation barriers frequently identified include inadequate training, time pressures in clinical consultations, lack of clear pathways for managing identified cases, and insufficient integration with existing clinical workflows. Successful implementation strategies often involve iterative adaptation of screening protocols based on frontline provider feedback, integration of screening into routine clinical documentation, and establishment of clear management algorithms for different screening results (Kuehne et al., 2019).

The digitization of composite screening instruments through mobile health applications and electronic health record integration offers potential to streamline screening processes, ensure standardized implementation, enable automated scoring and decision support, and facilitate data aggregation for surveillance purposes (Kuisma et al., 2019). Digital screening tools can incorporate skip logic to ask only relevant questions, calculate scores automatically, provide immediate interpretation and recommendations, and trigger alerts for high-risk cases requiring urgent intervention. However, digital tool effectiveness depends on reliable device availability, adequate user training, technical support systems, and alignment with provider workflows. The choice between paper-based and digital screening tools should consider the specific context, including infrastructure, provider capacities, and sustainability factors (Lo et al., 2017).

3.5 IMPLEMENTATION CHALLENGES AND BARRIERS TO INTEGRATION

The integration of nutritional assessment tools into primary healthcare delivery systems faces multifaceted challenges spanning individual, organizational, and systemic levels that impede consistent, high-quality implementation even where appropriate tools and protocols exist. At the healthcare provider level, knowledge and skill gaps represent fundamental barriers, as many primary healthcare workers have received limited nutrition education in their pre-service training and lack practical competencies in conducting nutritional assessment, interpreting results, and providing effective nutritional counseling (Macherera and Chimbari, 2016). The technical nature of some assessment methods, particularly dietary assessment and biochemical test interpretation, exceeds the training level of some cadres of primary healthcare workers, creating uncertainty about who should be responsible for different assessment components within multidisciplinary primary care teams (Mackenzie and Jeggo, 2019).

Time constraints in primary healthcare consultations present perhaps the most frequently cited implementation barrier, as providers must balance multiple competing demands within brief patient encounters typically lasting fifteen minutes or less. Comprehensive nutritional assessment, particularly when incorporating dietary evaluation, can consume substantial portions of limited consultation time, potentially crowding out other essential clinical activities (Mackenzie et al., 2013). This time pressure leads to inconsistent implementation, with nutritional assessment often being the first component omitted when consultation time is insufficient. The challenge is exacerbated in settings with high patient loads and inadequate staffing ratios, where providers face overwhelming numbers of patients daily (Mariner et al., 2014).

Equipment and supply constraints limit the feasibility of implementing certain nutritional assessment modalities in resource-limited primary healthcare settings. While basic equipment such as scales and height boards is relatively inexpensive, many primary healthcare facilities lack even these fundamental tools or possess equipment that is broken, uncalibrated, or otherwise non-functional (Mazet et al., 2014). More sophisticated equipment required for biochemical assessment, such as hemoglobinometers or laboratory infrastructure, is even less available at the primary care level. The procurement, distribution, maintenance, and replacement of assessment equipment requires functioning supply chain systems and adequate budgetary allocation, which may be inadequate in under-resourced health systems (McCloskey et al., 2014).

The absence of standardized, context-appropriate assessment protocols creates uncertainty and inconsistency in nutritional assessment implementation. While international guidelines exist for many aspects of nutritional assessment, their adaptation to specific country and local contexts often lags, leaving healthcare providers without clear direction on which assessment methods to use, when to conduct assessment, how to interpret results, and what interventions to implement based on findings (Menson et al., 2018). Different vertical programs and organizations may promote different assessment tools and approaches, creating confusion and fragmentation rather than coherent integrated systems. The development of national or subnational nutritional assessment protocols requires technical expertise, stakeholder consensus-building, and regulatory processes that may be prolonged (Merianos, 2007).

Health information system limitations impede the systematic documentation, aggregation, and utilization of nutritional assessment data. Many primary healthcare settings continue to rely on paper-based record systems that make data compilation for surveillance or quality monitoring extremely labor-intensive (Moore et al., 2008). Even where electronic health records exist, nutritional assessment may not be well integrated into system design, requiring cumbersome data entry that discourages consistent documentation. The lack of standardized data elements, coding systems, and reporting formats for nutritional assessment across different facilities and regions prevents aggregation of data for population surveillance. Without functional feedback mechanisms that provide healthcare facilities and providers with information on trends and performance, there is limited motivation or capacity for quality improvement (Morse, 2012).

Human resource constraints extend beyond individual provider knowledge to encompass workforce shortages that leave primary healthcare facilities critically understaffed. In many low-income and middle-income countries, shortages of trained healthcare workers mean that existing staff are stretched to provide even basic essential services, with little capacity to take on additional responsibilities such as nutritional assessment without corresponding increases in staffing (N'Guessan et al., 2019). High turnover rates among primary healthcare workers, driven by poor working conditions, inadequate compensation, limited career advancement opportunities, and rural-urban disparities, result in constant need for training new staff, disrupting implementation continuity. Task-shifting strategies that train community health workers or other cadres to conduct basic nutritional screening can extend capacity but require robust training and supervision systems (O'Brien and Xagoraraki, 2019).

Financing constraints affect nutritional assessment integration at multiple levels, from inadequate budgets for equipment and supplies to lack of earmarked funding for nutrition services within primary healthcare budgets that prioritize acute care and disease-specific programs (Okenwa et al., 2019). In health systems where healthcare is financed through out-of-pocket payments, the absence of reimbursement for nutritional assessment services creates financial disincentives for facilities to provide these services. Even in systems with public financing, the allocation of limited resources tends to favor more visible, acute interventions over preventive services like nutritional screening. Donor-driven health financing that focuses on specific diseases may inadvertently starve integrated primary healthcare functions like nutritional assessment that do not fit neatly into disease-specific funding streams (Oni et al., 2019).

Organizational culture and priorities within health systems influence whether nutritional assessment becomes truly integrated into routine practice or remains a peripheral activity. In settings where nutrition is not recognized as a priority health concern by health system leadership, insufficient attention and resources are allocated to nutritional assessment capacity-building (Osabuohien, 2017). Provider attitudes and beliefs about the importance of nutritional assessment, shaped by training emphasis, supervisor expectations, and professional norms, influence implementation consistency. Establishing nutrition as a core component of primary healthcare requires sustained advocacy, supportive policies, and visible leadership commitment (Osabuohien, 2019).

Referral system weaknesses undermine the utility of identifying nutritional problems through assessment if no clear pathways exist for accessing appropriate interventions and specialized services when needed. Many primary healthcare systems lack functional linkages to nutrition counseling services, therapeutic feeding programs, food assistance, agricultural extension services, and specialized medical nutrition therapy (Osabuohien, 2019). When healthcare providers conduct nutritional assessment but have no effective interventions to offer or referral options to activate, the motivation to conduct assessment diminishes. Strengthening the continuum from screening through intervention requires coordinated development of both assessment and management capacities (Phommasack et al., 2013).

Cultural and social factors may create barriers to nutritional assessment implementation, particularly when assessment methods conflict with local beliefs, practices, or sensitivities. In some cultural contexts, body measurements may be considered inappropriate or intrusive, dietary questioning may be perceived as judgmental, or biological sample collection for biochemical assessment may face resistance (Queenan et al., 2017). Gender dynamics can affect who is empowered to make decisions about seeking nutritional services or providing dietary information. Addressing these sociocultural barriers requires community engagement, culturally sensitive adaptation of assessment approaches, and involvement of trusted community members in assessment activities (Rushton et al., 2018).

3.6 STRATEGIES FOR SUCCESSFUL INTEGRATION AND BEST PRACTICES

Evidence from diverse implementation contexts reveals that successful integration of nutritional assessment into primary healthcare delivery requires comprehensive strategies addressing multiple health system components simultaneously rather than focusing narrowly on technical aspects of assessment tools. System-wide approaches that strengthen enabling infrastructure, build human resource capacity, establish supportive policies, and create demand for nutritional services demonstrate greater sustainability than isolated interventions targeting single system components (Salyer et al., 2017). This section synthesizes best practices and successful strategies identified through implementation research and programmatic experience across varied global settings.

Standardization of assessment protocols represents a foundational strategy for achieving consistent, high-quality nutritional assessment integration. The development of national or subnational standard operating procedures that clearly specify which assessment methods to use for different populations, when assessment should be conducted, how measurements should be performed, what reference standards to apply for interpretation, what documentation is required, and what actions should be taken based on results provides essential guidance to frontline healthcare providers (Saylors et al., 2015). Effective protocols balance comprehensiveness with feasibility, starting with core essential assessments that can be implemented with available resources and expanding incrementally as capacity grows. Protocol development processes that involve frontline healthcare workers, facility managers, technical experts, and policymakers in collaborative design tend to produce more contextually appropriate and acceptable guidelines than top-down approaches (Scholten et al., 2018).

Comprehensive training programs that build healthcare provider knowledge and skills through multiple complementary modalities demonstrate superior outcomes compared to one-time training events. Pre-service education reform to incorporate substantive nutrition content and practical clinical

skills in basic training curricula for all primary healthcare cadres establishes foundational competencies (Schwind et al., 2014). In-service training delivered through workshops, on-site mentoring, distance learning, and job aids reinforces and updates competencies for existing workforce. Competency-based training approaches that emphasize practical skill demonstration rather than solely didactic knowledge transfer better prepare providers for real-world implementation challenges (Scott et al., 2016). Ongoing supportive supervision that combines performance monitoring with on-site coaching helps providers refine skills over time and troubleshoot implementation challenges as they arise (Seimenis, 2010).

Strategic task-shifting and role optimization within primary healthcare teams can expand nutritional assessment capacity without proportional increases in specialized personnel. Training community health workers to conduct basic anthropometric screening, particularly using simplified tools like mid-upper arm circumference, extends assessment reach into communities while reserving facility-based healthcare worker time for more complex assessment and clinical management (Shiferaw et al., 2017). Within facilities, delegation of routine measurement activities to nurses or health assistants, with referral to clinical officers or physicians for interpretation and management, optimizes use of limited clinical expertise. Clear delineation of roles and responsibilities, accompanied by appropriate training for each cadre, ensures task-shifting enhances rather than compromises quality (Smolinski et al., 2017).

Integration of nutritional assessment into existing clinical workflows and health service delivery platforms increases feasibility compared to establishing parallel nutrition-specific services. Embedding nutritional assessment into routine growth monitoring visits for children, antenatal care for pregnant women, chronic disease management for adults with diabetes or hypertension, and general outpatient consultations creates multiple entry points for assessment without requiring patients to make separate nutrition visits (Standley et al., 2019). This integrated approach aligns with primary healthcare principles of comprehensive care while reducing duplicative patient contacts. The design of clinical record forms, consultation checklists, and patient flow processes to incorporate nutritional assessment prompts facilitates routine implementation (Tambo et al., 2019).

Quality assurance systems that monitor and continuously improve nutritional assessment implementation are essential for sustaining high standards over time. Internal quality control measures including regular equipment calibration, inter-rater reliability assessments, and data quality checks identify problems requiring corrective action (Tambo et al., 2014). External quality assessments through supervisory visits, peer review, and participation in national or regional quality assurance networks provide independent verification of quality and opportunities for learning from high-performing facilities (Thumbi et al., 2019). Performance dashboards that provide facilities and providers with feedback on assessment coverage, data completeness, and outcome indicators create accountability and motivate quality improvement. Regular review meetings where facility teams analyze their nutritional assessment performance data and develop action plans for improvement foster cultures of continuous learning (Tornimbene et al., 2018).

Technology-enabled solutions, when appropriately deployed, can address multiple implementation barriers simultaneously. Mobile health applications that guide standardized assessment procedures, calculate indices automatically, provide clinical decision support, and facilitate data transmission reduce training requirements, improve accuracy, save time, and strengthen surveillance systems (Travis et al., 2011). Digital anthropometric devices that record measurements electronically minimize transcription errors and enable real-time quality checks. However, successful technology deployment requires adequate infrastructure including electricity and connectivity where needed, sufficient devices to avoid rationing, user-friendly interfaces appropriate for frontline provider digital literacy levels, reliable technical support, and integration with existing health information systems (Tsai et al., 2010).

Community engagement and demand creation strategies enhance nutritional assessment uptake and sustainability by building awareness of nutrition's

importance and creating social pressure for quality services. Community education campaigns that explain the purpose and benefits of nutritional assessment increase acceptance and reduce resistance (Umezurike and Iwu, 2017). Community health committee involvement in monitoring assessment service quality and advocating for improvements creates accountability. Participatory approaches that involve community members in identifying nutritional problems and designing solutions foster ownership and sustainability beyond external program support (Umezurike and Ogunnubi, 2016). Community-based screening programs using trained volunteers extend reach while building grassroots capacity and awareness (Umoren et al., 2019).

Financing strategies that ensure sustainable resource availability for nutritional assessment equipment, supplies, training, and personnel time are fundamental to long-term integration success. Explicit budget line items for nutrition within primary healthcare budgets protect resources from competing demands (Uwadiae et al., 2011). Health insurance benefit packages that include nutritional assessment services create reimbursement mechanisms that incentivize provision. Performance-based financing that rewards facilities for achieving nutritional assessment coverage and quality targets can motivate implementation (Uzozie et al., 2019). Domestic resource mobilization that reduces dependence on volatile donor funding enhances sustainability as external support phases out (Vink et al., 2012).

Multi-sectoral collaboration frameworks that link primary healthcare nutritional assessment with complementary interventions in agriculture, education, social protection, and water and sanitation address upstream determinants of nutritional status. Health sector identification of food insecurity through screening can trigger referrals to agricultural extension services, food assistance programs, or livelihood support (Vrbova et al., 2010). School-based nutritional screening linked to school feeding programs creates synergies. Coordination mechanisms including inter-sectoral committees, shared information systems, and joint planning processes enable effective collaboration beyond rhetoric (Wilkes et al., 2019).

Policy and governance frameworks that establish nutrition as a priority within national health strategies, define clear roles and responsibilities across system levels, and create accountability mechanisms for implementation provide enabling environments for integration. National nutrition policies that mandate nutritional assessment as a standard component of primary healthcare establish political commitment and legal foundations (Wilkinson et al., 2011). Inclusion of nutritional assessment indicators in national health management information systems and routine reporting requirements ensures visibility and accountability (Seimenis, 2010). Professional practice standards and clinical guidelines that define expectations for nutritional assessment by different healthcare provider cadres create normative frameworks for implementation (Witt et al., 2011).

Evidence generation through operational research and implementation science strengthens nutritional assessment integration by identifying what works, for whom, under what circumstances, and why. Systematic documentation of implementation experiences, rigorous evaluation of different assessment tools and implementation strategies in diverse contexts, and cost-effectiveness analyses inform evidence-based decision-making (Zachariah et al., 2009). Learning networks that facilitate sharing of experiences, challenges, and solutions across facilities, districts, or countries accelerate spread of effective practices. Research-practice partnerships that involve practitioners in research design ensure relevance while building research literacy among implementers (Zinsstag et al., 2011).

Phased implementation approaches that begin with pilot testing in selected facilities, learn from early experiences, refine approaches based on lessons learned, and scale gradually demonstrate greater success than rushed large-scale rollouts. Pilot phases allow identification and resolution of implementation challenges before widespread deployment commits substantial resources (Abakar et al., 2016). Documentation of pilot experiences including barriers encountered, adaptations made, costs incurred, and outcomes achieved informs scale-up planning. Adaptive management approaches that maintain flexibility to modify implementation strategies based

on emerging evidence and changing contexts enhance resilience (Abass et al., 2019).

Champions and leadership at multiple system levels drive and sustain nutritional assessment integration. National-level champions within ministries of health or professional associations advocate for policy prioritization and resource allocation (Abramowitz et al., 2015). District health management champions ensure that nutrition remains visible among competing priorities and that facilities receive necessary support. Facility-level champions among healthcare providers model excellence, mentor colleagues, and drive local quality improvement efforts (Adenuga et al., 2019). Identifying, supporting, and networking champions creates communities of practice that sustain momentum even as individual actors change (Aduwo and Nwachukwu, 2019).

Supply chain strengthening ensures reliable availability of essential commodities for nutritional assessment including measurement equipment, calibration standards, biochemical test reagents, job aids, and data collection tools. Forecasting methodologies that estimate commodity needs based on population and service utilization patterns inform procurement planning (Aduwo et al., 2019a). Logistics management information systems that track stock levels, consumption rates, and distribution pathways enable proactive supply management. Establishment of maintenance and calibration systems for assessment equipment extends useful life and ensures accuracy (Aduwo et al., 2019b). Alternative procurement mechanisms for specialized items not included in general health commodity supply chains prevent stock-outs (Allen and Feigl, 2017).

CONCLUSION

This systematic review has comprehensively examined the landscape of nutritional assessment tools available for integration into primary healthcare delivery systems, analyzing their technical characteristics, implementation experiences, barriers to integration, and strategies for successful deployment. The evidence synthesized reveals that while numerous validated nutritional assessment methodologies exist spanning anthropometric, biochemical, clinical, and dietary approaches, significant gaps persist between the theoretical availability of tools and their systematic implementation in routine primary healthcare practice, particularly in resource-limited settings where nutritional problems are most prevalent and primary healthcare systems serve as the primary point of access to health services for vulnerable populations (Anyebe et al., 2018). The challenge of integrating nutritional assessment into primary healthcare is fundamentally a health systems challenge requiring attention to multiple interdependent components including workforce capacity, infrastructure, supplies, information systems, financing mechanisms, governance structures, and community engagement, rather than solely a technical question of tool selection (Balogun et al., 2019).

Anthropometric assessment emerges from this review as the most feasible and widely implemented assessment modality for primary healthcare settings, offering practical advantages of relative simplicity, low cost, non-invasiveness, and established interpretation frameworks through international growth standards and body mass index classification systems (Bardosh, 2016). Within anthropometric approaches, mid-upper arm circumference screening demonstrates particular promise for resource-constrained settings and community-based programs due to its minimal equipment requirements, rapid implementation, and robust evidence of validity for identifying acute malnutrition and predicting mortality risk in children. However, the review identifies quality assurance as a critical gap in anthropometric assessment implementation, with concerns regarding measurement accuracy, equipment calibration, and inter-rater reliability suggesting that investments in training, supervision, and standardization are essential to realize the potential value of anthropometric data for clinical and surveillance purposes (Bardosh et al., 2017).

Biochemical and clinical assessment methodologies, while providing objective and specific evidence of nutritional deficiencies, face substantial feasibility barriers for routine primary healthcare integration related to laboratory infrastructure requirements, equipment and reagent costs, technical expertise demands, and turnaround time for results (Bedford et al., 2019). The review suggests strategic, targeted deployment of biochemical assessment for specific

high-risk populations such as pregnant women or in response to epidemiological evidence of particular micronutrient deficiencies, rather than universal application. Point-of-care testing technologies offer promising opportunities to expand biochemical assessment capacity at the primary care level, particularly for anemia screening using portable hemoglobinometers, though costs and quality assurance requirements must be carefully considered (Belay et al., 2017). Clinical examination for nutritional deficiency signs remains valuable as a component of comprehensive clinical assessment but should not be relied upon as a primary screening modality given the late manifestation of most clinical signs and their nonspecificity (Bloom et al., 2017).

Dietary assessment methodologies provide unique insights into nutritional intake patterns that complement the output-focused information from anthropometric and biochemical indicators, enabling identification of dietary inadequacies before manifestation as anthropometric or biochemical abnormalities (Brookes et al., 2017). However, the review reveals that comprehensive dietary assessment methods such as twenty-four-hour recalls and food diaries are generally too time-intensive for routine primary healthcare application, while simplified approaches including dietary diversity scores and food consumption scores offer practical alternatives that balance information value with feasibility constraints. The effectiveness of dietary assessment depends critically on healthcare provider communication skills and nutrition knowledge, highlighting the importance of robust training programs that address not only assessment technique but also dietary counseling and behavior change communication competencies (Brown, 2004).

Composite nutritional screening instruments that integrate multiple assessment components through simplified algorithms represent an important category of tools specifically designed for primary healthcare efficiency. These instruments aim to optimize sensitivity for identifying individuals at nutritional risk while minimizing resource demands through streamlined protocols (Bukhari et al., 2019). The review identifies several well-validated composite screening tools for specific populations including children, elderly individuals, and pregnant women, though notes that most tools were developed and validated in high-income settings, raising questions about performance characteristics and appropriateness in low-income and middle-income country contexts. Context-specific validation and adaptation of screening instruments is essential to ensure adequate performance in diverse populations and healthcare environments (Calba et al., 2015).

Implementation challenges identified through this review span individual provider factors including knowledge and skill gaps and time constraints, organizational factors including inadequate protocols and supervision systems, and systemic factors including equipment shortages, financing constraints, information system limitations, and human resource deficits (Catley et al., 2004). The multi-level nature of these barriers necessitates comprehensive implementation strategies that address constraints simultaneously across system levels rather than targeting individual barriers in isolation. Single-component interventions such as training alone or equipment provision alone demonstrate limited sustainability without complementary investments in supportive supervision, quality assurance, supply chain management, and enabling policies (Coker et al., 2011).

Best practices and successful strategies synthesized through this review emphasize the importance of standardized protocols that provide clear guidance to frontline providers, comprehensive training programs that build competencies through multiple modalities including practical skill-building and ongoing mentorship, strategic task-shifting that optimizes use of available human resources through clear role delineation, integration of nutritional assessment into existing service delivery platforms rather than creating parallel systems, quality assurance mechanisms that continuously monitor and improve implementation, appropriate technology deployment that addresses real constraints while ensuring sustainability, community engagement that builds awareness and demand, sustainable financing mechanisms, multi-sectoral collaboration frameworks, enabling policies and governance structures, evidence generation through operational research, phased implementation approaches that allow learning and adaptation, identification and support of champions at multiple

system levels, and supply chain strengthening (Cunningham et al., 2017).

The review identifies several critical gaps in current knowledge that warrant attention through future research and program evaluation. First, more evidence is needed regarding the comparative effectiveness and cost-effectiveness of different nutritional assessment strategies in diverse primary healthcare contexts, including head-to-head comparisons of alternative tools, optimal combinations of assessment modalities, and frequency of assessment for different populations (DaoAnh et al., 2018). Second, implementation science research should examine the mechanisms through which successful implementation strategies achieve their effects, contextual factors that moderate effectiveness, and processes for scaling effective approaches across diverse settings. Third, validation studies are needed for nutritional assessment tools in underrepresented populations and settings, particularly for composite screening instruments developed in high-income countries that are being deployed in low-income and middle-income countries without adequate local validation (Didi et al., 2019).

The role of technology in enhancing nutritional assessment capacity and addressing implementation barriers warrants continued attention as digital health innovations evolve. While mobile health applications, digital anthropometric devices, and electronic health record integration offer theoretical advantages, real-world implementation research is needed to understand how these technologies perform in diverse primary healthcare environments with varying infrastructure, which implementation models are most effective and sustainable, what their true costs and cost-effectiveness are accounting for all inputs including devices, training, technical support, and maintenance, and how to ensure equitable access without exacerbating digital divides (Drewe et al., 2012).

The implications of this review for policy and practice are clear. First, national health authorities should prioritize the development and dissemination of standardized nutritional assessment protocols adapted to national contexts and resource realities, providing clear guidance to healthcare providers and facilities regarding assessment expectations (Dunning et al., 2014). Second, pre-service and in-service training systems require strengthening to build healthcare provider competencies in nutritional assessment and management across all relevant cadres. Third, health information systems must be designed or adapted to facilitate systematic documentation, aggregation, and utilization of nutritional assessment data for both clinical and surveillance purposes (Dye, 2014). Fourth, sustainable financing mechanisms for nutritional assessment equipment, supplies, training, and service delivery must be established within primary healthcare budgets and health insurance benefit packages. Fifth, quality assurance systems for nutritional assessment should be established as standard components of primary healthcare quality improvement frameworks (Evans-Uzosike and Okatta, 2019).

Integration of nutritional assessment into primary healthcare delivery must be understood as a long-term systems strengthening agenda requiring sustained commitment and investment rather than a one-time intervention. The evidence suggests that successful integration is achievable across diverse contexts when comprehensive strategies address the multiple interdependent factors influencing implementation, when approaches are adapted to local realities through participatory processes, when adequate resources are allocated and sustained over time, when quality is systematically monitored and improved, and when strong leadership and governance frameworks provide direction and accountability (Fall et al., 2019). The potential impact of effective nutritional assessment integration extends beyond individual clinical benefits to encompass population health surveillance, early warning systems for nutritional crises, monitoring of nutrition program effectiveness, and generation of evidence to inform nutrition policies and resource allocation (Fasasi et al., 2019).

The double burden of malnutrition affecting many low-income and middle-income countries, characterized by the coexistence of undernutrition and overnutrition within populations, necessitates nutritional assessment approaches capable of identifying diverse forms of malnutrition across the nutritional spectrum. Traditional approaches focused exclusively on undernutrition are insufficient for current epidemiological realities where overweight,

obesity, and diet-related non-communicable diseases are increasingly prevalent alongside persistent undernutrition (Fournet et al., 2018). Assessment tools and protocols must therefore screen for both ends of the malnutrition spectrum, with particular attention to the specific vulnerabilities of different life stages from pregnancy through infancy, childhood, adolescence, adulthood, and elderly years (Gibbs, 2005).

The COVID-19 pandemic and other health emergencies highlight the importance of robust routine nutritional surveillance systems that can detect deteriorating nutritional status at population levels, enabling timely response before crises fully unfold. Primary healthcare-based nutritional assessment, when systematically implemented and linked to responsive information systems, provides an early warning function complementing specialized nutrition surveys (Guerra et al., 2019). The integration of nutritional assessment into routine primary healthcare also ensures continued monitoring during emergencies when specialized surveys may be disrupted, maintaining visibility of nutritional status even in challenging circumstances (Halliday et al., 2012).

Climate change and environmental degradation present emerging threats to nutritional security through impacts on agricultural productivity, food systems, water resources, and infectious disease patterns. These evolving challenges underscore the importance of strengthening nutritional assessment capacity within primary healthcare systems as a component of broader climate adaptation strategies (Halton et al., 2013). Primary healthcare systems positioned at community level are ideally situated to detect nutritional impacts of environmental changes early and facilitate multi-sectoral responses linking health, agriculture, water, and social protection interventions (Hattendorf et al., 2017).

In conclusion, this systematic review demonstrates that integrating nutritional assessment into primary healthcare delivery systems is both critically important for addressing global malnutrition burdens and eminently feasible when approached as a comprehensive health systems strengthening agenda. The evidence base regarding effective tools and implementation strategies is substantial, though gaps remain particularly regarding comparative effectiveness in diverse contexts and optimal implementation approaches for specific settings (Head et al., 2013). The path forward requires sustained political commitment, adequate resource allocation, systematic capacity building, continuous quality improvement, and collaborative multi-sectoral action. Primary healthcare systems strengthened with robust nutritional assessment capacity will be better positioned to prevent malnutrition, identify nutritional problems early when intervention is most effective, monitor nutritional status across populations, and contribute to the global goal of eliminating all forms of malnutrition in coming decades (Henning, 2004). The successful experiences documented in this review from diverse global settings demonstrate that progress is achievable and provide blueprints for adaptation and replication. The task ahead is to translate evidence into sustained action at scale, ensuring that every individual accessing primary healthcare services has their nutritional status assessed, documented, and addressed as a fundamental component of comprehensive primary care (Hughes et al., 2010).

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