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Nutritional Status as a Predictive Indicator for Recovery Outcomes Among Hospitalized Patients Including Those With HIV

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Abstract
Nutritional status is a critical determinant of health outcomes in hospitalized patients, influencing recovery trajectories, length of stay, and overall survival. Malnutrition, whether due to inadequate intake, underlying illness, or increased metabolic demands, is associated with impaired immune function, delayed wound healing, and higher rates of infection. Among patients living with HIV, nutritional status assumes even greater significance, as the virus itself accelerates nutrient depletion, increases energy requirements, and contributes to chronic inflammation and weight loss. This dual burden of infection and malnutrition compounds vulnerability, often resulting in poorer recovery outcomes and higher healthcare utilization. Emerging evidence demonstrates that baseline nutritional indicators—such as body mass index (BMI), mid-upper arm circumference, serum albumin, and micronutrient profiles—can serve as predictive markers for patient outcomes. Malnourished patients are consistently shown to have longer hospital stays, higher complication rates, and increased mortality compared to well-nourished counterparts. In HIV-positive individuals, poor nutritional status not only predicts delayed recovery but also worsens adherence to antiretroviral therapy (ART), amplifying disease progression and undermining long-term prognosis. Conversely, timely nutritional interventions, including therapeutic feeding, micronutrient supplementation, and targeted dietetic support, have been associated with improved functional recovery, reduced hospital costs, and enhanced quality of life. Given the strong predictive value of nutritional status, systematic nutritional assessment should be integrated into hospital admission protocols. Incorporating routine screening tools such as the Subjective Global Assessment (SGA) or the Malnutrition Universal Screening Tool (MUST) can provide clinicians with actionable insights to guide individualized care. Particularly in resource-limited settings with high HIV prevalence, linking nutrition to recovery outcomes offers a cost-effective strategy to optimize healthcare delivery. Recognizing nutrition as both a clinical and prognostic factor underscores its role not only in-patient management but also in advancing broader public health goals related to survival, resilience, and equity.

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1. Introduction

Nutritional status has long been recognized as a fundamental determinant of health, influencing not only disease susceptibility but also the pace and quality of recovery among hospitalized patients (Ojonugwa *et al*., 2021; Oluoha *et al*., 2021). Adequate nutrition supports immune competence, tissue repair, and metabolic balance, all of which are essential for overcoming acute illness and surgical stress. In contrast, malnutrition weakens immune defenses, delays healing, and increases vulnerability to

secondary infections, thereby complicating clinical management (Ojonugwa *et al*., 2022; Merotiwon *et al*., 2022). Hospitals across the world face the challenge of managing malnourished patients whose outcomes are consistently poorer than those of their well-nourished counterparts (Ikponmwoba *et al*., 2022; Chima *et al*., 2022).

Malnutrition is a pervasive global health issue, affecting an estimated one in three hospitalized patients. Its prevalence reflects not only limited food intake but also the metabolic disruptions induced by chronic and acute illnesses. In resource-limited settings, the problem is compounded by late presentation of disease, insufficient healthcare resources, and limited access to specialized nutritional support (Oluyemi *et al*., 2020; Akinrinoye *et al*., 2020). In high-income countries, despite more advanced healthcare systems, malnutrition remains underrecognized, often overshadowed by the primary diagnosis. The consequences are profound, including increased mortality, longer hospital stays, higher readmission rates, and escalated healthcare costs (Aduwo and Nwachukwu, 2019; Oluyemi *et al*., 2020).

The relevance of nutritional status becomes particularly acute in patients living with HIV. HIV infection accelerates nutrient depletion by increasing metabolic demands, impairing absorption, and causing chronic inflammation that drives muscle wasting and weight loss (Osabuohien, 2017; Oyeyemi, 2022). Opportunistic infections further compromise nutritional balance, while comorbidities such as tuberculosis or hepatitis exacerbate deficiencies. In this context, nutrition is not only a supportive therapy but also a cornerstone of disease management, directly influencing immune recovery, treatment adherence, and survival (Kingsley *et al*., 2020; Akinrinoye *et al*., 2021).

Despite its significance, poor nutritional status is often underdiagnosed and inadequately managed in hospital settings. Routine screening for malnutrition is not consistently implemented, and nutritional interventions are frequently reactive rather than proactive (Evans-Uzosike *et al*., 2021; Uddoh *et al*., 2021). This oversight has critical consequences: patients with undetected malnutrition are more likely to experience delayed recovery, prolonged hospital stays, higher morbidity, and greater risk of mortality. For HIV-positive patients, the problem is magnified. Suboptimal nutrition undermines the effectiveness of antiretroviral therapy (ART), accelerates disease progression, and limits the capacity to recover from opportunistic infections or other hospital-related complications (Ikponmwoba *et al*., 2020; Kufile *et al*., 2022). The absence of systematic nutritional assessment in this high-risk group perpetuates a cycle of poor health outcomes and increased healthcare burden.

This seeks to address these gaps by evaluating nutritional status as a predictive indicator for recovery outcomes among hospitalized patients, with particular emphasis on individuals living with HIV (Isa *et al*., 2021; Komi *et al*., 2022). The first objective is to establish the extent to which nutritional indicators such as body mass index (BMI), serum albumin, and mid-upper arm circumference can predict recovery trajectories, including morbidity, mortality, and length of hospital stay. The second objective is to examine the specific implications of malnutrition in HIV-positive patients, focusing on how nutritional status interacts with ART adherence, immune reconstitution, and overall prognosis. By framing nutrition as a measurable and actionable predictor, the analysis aims to strengthen evidence for integrating nutritional assessment into hospital protocols. Ultimately, this approach highlights nutrition not merely as a supportive element of care but as a central determinant of recovery outcomes, especially in populations where vulnerability is compounded by HIV and other chronic conditions (Kufile *et al*., 2022; Osabuohien, 2022).

2. Methodology

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology was applied to conduct a systematic review on the role of nutritional status as a predictive indicator for recovery outcomes among hospitalized patients, including those with HIV. A comprehensive search strategy was designed to identify peer-reviewed and grey literature published between 2000 and 2025 across multiple databases, including PubMed, Web of Science, Scopus, Cochrane Library, and Google Scholar. Search terms combined descriptors for "nutritional status," "malnutrition," "HIV," "hospitalized patients," "clinical outcomes," and "recovery." Boolean operators and controlled vocabularies such as MeSH were used to maximize sensitivity and specificity, and reference lists of included articles were screened to capture additional relevant studies.

Eligibility criteria included studies that evaluated nutritional indicators such as body mass index (BMI), mid-upper arm circumference, weight-for-height, serum albumin, or micronutrient status in relation to recovery outcomes such as length of hospital stay, morbidity, mortality, treatment response, or immune reconstitution. Both observational and interventional studies were eligible if they provided quantitative or qualitative evidence linking nutritional status with recovery trajectories. Excluded were studies without clear nutritional assessments, case reports without generalizable findings, and publications not available in English.

The study selection process was conducted in two phases. Two independent reviewers screened titles and abstracts for relevance, followed by full-text evaluation of shortlisted articles. Disagreements were resolved by consensus or through a third reviewer's input. Data extraction employed a standardized template to collect information on study design, sample size, patient population, type of nutritional assessment, recovery outcomes measured, and key findings. For HIV-specific studies, additional data were extracted on antiretroviral therapy (ART) status, CD4 count, and comorbidity profiles.

Quality assessment was performed using standardized appraisal tools for observational and interventional studies, focusing on methodological rigor, clarity of nutritional assessment methods, outcome measurement reliability, and control for confounders. Risk of bias was assessed at both the study and outcome levels, with particular attention to sample representativeness and completeness of follow-up data.

Synthesis of findings was carried out narratively and, where possible, with comparative tabulation to highlight patterns in how nutritional status predicts recovery outcomes. Subgroup analyses considered differences between general hospitalized populations and patients with HIV, noting the interaction between malnutrition, immune suppression, and response to treatment. Studies were also compared by type of nutritional indicator to evaluate which measures had the strongest predictive value.

The PRISMA flow diagram was used to document the selection process, including the number of records identified,

screened, excluded, and included. This transparent and structured approach ensures reproducibility of the review and strengthens the evidence base on the utility of nutritional status as a predictor of recovery outcomes in hospitalized patients, including those with HIV. The methodology provides a comprehensive framework for evaluating the integration of nutritional assessments into clinical care pathways to improve patient management and health outcomes.

2.1. Conceptual Framework

Nutritional status refers to the physiological state of an individual as determined by the balance between nutrient intake, absorption, and metabolic demands. It reflects both macronutrient adequacy—such as protein and energy—and micronutrient sufficiency, including vitamins and minerals that support immune and metabolic functions. Clinical assessment of nutritional status employs a range of indicators. Body Mass Index (BMI) is one of the most widely used tools, offering a proxy measure of body fat and lean mass relative to height. However, in clinical populations, especially those with chronic illness, BMI may fail to capture subtle or acute nutritional deficits (Olajide *et al*., 2021; Komi *et al*., 2022). Mid-upper arm circumference (MUAC) provides an additional measure of muscle and fat reserves, particularly valuable in resource-limited settings where scales or height measurements may be unavailable. Serum albumin, although influenced by acute illness and inflammation, is often used as a biochemical marker of nutritional adequacy, reflecting protein-energy status. Micronutrient levels, such as vitamin A, zinc, and iron, further refine assessments by indicating deficiencies that compromise immunity, wound healing, and metabolic stability.

Recovery outcomes in hospitalized patients can be understood across several dimensions. Mortality remains the most definitive endpoint, while morbidity indicators capture complications such as infections, impaired wound healing, or progression of underlying disease. Infection rates are particularly relevant, as poor nutrition is strongly correlated with increased susceptibility to bacterial, viral, and fungal pathogens. Hospital length of stay serves as a proxy for recovery efficiency, with prolonged admissions reflecting delayed healing and greater healthcare resource utilization. Finally, quality of life outcomes—including functional independence and post-discharge resilience—represent the broader recovery trajectory, linking clinical progress to long-term well-being.

The conceptual link between nutritional status and recovery outcomes is rooted in the fundamental role of nutrients in maintaining immune competence and metabolic homeostasis. Malnutrition, whether due to insufficient intake, malabsorption, or increased requirements during illness, initiates a cascade of physiological impairments. Protein-energy malnutrition reduces the synthesis of immune cells and cytokines, leading to impaired innate and adaptive immunity. Micronutrient deficiencies further weaken host defenses: zinc deficiency impairs T-cell proliferation, vitamin A deficiency disrupts mucosal barriers, and iron deficiency reduces oxygen transport and cellular energy metabolism (Balogun *et al*., 2020; Ozobu *et al*., 2022). The net result is a state of immune dysfunction characterized by reduced pathogen clearance, increased infection severity, and slower recovery from acute illness.

Delayed recovery in malnourished patients reflects both direct and indirect mechanisms. Directly, impaired tissue regeneration and wound healing prolong hospitalization and increase complication rates. Indirectly, recurrent infections perpetuate a cycle of nutrient depletion, as fever and inflammation elevate metabolic demands while anorexia and gastrointestinal dysfunction limit intake. This bidirectional relationship between malnutrition and illness sustains a feedback loop of declining health, poorer clinical outcomes, and increased healthcare burden.

Among patients with HIV, the interaction between nutrition and recovery outcomes is further complicated by the pathophysiology of the infection. HIV replication is associated with chronic immune activation and systemic inflammation, processes that increase basal energy expenditure and accelerate nutrient depletion. Gastrointestinal manifestations of HIV, including enteropathy and opportunistic infections, impair nutrient absorption and further exacerbate deficiencies. Additionally, HIV-related cachexia, characterized by disproportionate loss of lean body mass, severely undermines functional capacity and immune resilience.

The nutritional-immune interaction in HIV is particularly critical for recovery outcomes. Malnutrition compromises immune defenses, enabling higher viral loads and faster disease progression. Conversely, active viral replication amplifies inflammation, perpetuating nutrient losses and impairing anabolic processes. This synergy produces a vicious cycle where poor nutrition exacerbates immune suppression and immune suppression worsens nutritional deficits. In clinical terms, HIV-positive patients with poor nutritional status exhibit higher morbidity, increased risk of opportunistic infections, reduced responsiveness to antiretroviral therapy (ART), and greater mortality compared to well-nourished peers (Okenwa *et al*., 2019; Ezeilo *et al*., 2022).

Furthermore, ART itself introduces metabolic challenges, including lipodystrophy, insulin resistance, and altered lipid metabolism, which may further complicate nutritional assessment and intervention. These complexities highlight the need for an integrated conceptual framework that situates nutritional status not merely as a background factor but as an active determinant of recovery outcomes, especially in the context of HIV.

This framework positions nutritional status as both a predictor and a modifiable determinant of recovery outcomes in hospitalized patients. On one hand, baseline nutritional indicators provide valuable prognostic information: low BMI, reduced MUAC, hypoalbuminemia, or micronutrient deficiencies signal increased risk of adverse outcomes. On the other hand, timely nutritional interventions—ranging from therapeutic feeding and micronutrient supplementation to tailored dietary counseling—can modify trajectories by enhancing immune function, reducing infection rates, and accelerating recovery (Umekwe and Oyedele, 2021; OLAJIDE *et al*., 2021).

For HIV-positive patients, the framework underscores a dual role of nutrition: as a prognostic marker for hospital recovery and as an adjunctive therapy essential for long-term disease management. By incorporating nutritional assessment into hospital admission protocols and linking it with HIV care pathways, clinicians can better anticipate complications, optimize ART adherence, and improve survival.

The conceptual framework integrates definitions of nutritional status and recovery outcomes with the

pathophysiological mechanisms that link them. It highlights the centrality of nutrition in determining health trajectories, with amplified relevance in the context of HIV. By framing nutrition as a predictive indicator, the model provides both a lens for understanding clinical variability and a practical tool for guiding intervention strategies in hospital care.

2.2. Nutritional Status Assessment in Hospitalized Patients

Nutritional status plays a pivotal role in shaping recovery outcomes, morbidity, and mortality among hospitalized patients. Malnutrition, both undernutrition and micronutrient deficiencies, is prevalent in clinical settings and often remains underdiagnosed, despite its profound impact on immune function, wound healing, and overall recovery as shown in figure 1. Accurate assessment of nutritional status is therefore essential to identify at-risk patients and implement timely interventions. Various tools and biomarkers have been developed to facilitate systematic evaluation, but their application is not without challenges, particularly in resource-constrained settings (Aduwo *et al*., 2019; Ojonugwa *et al*., 2022).

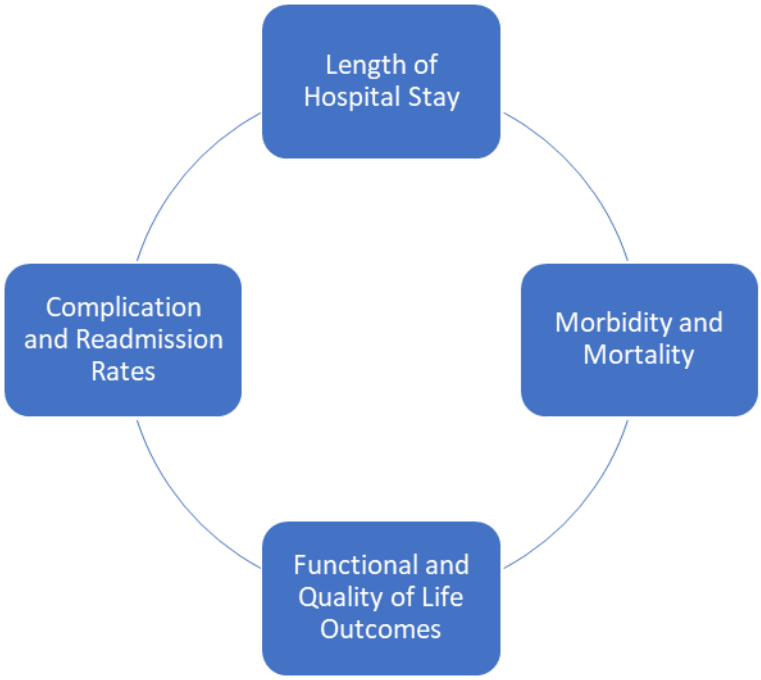

Fig 1: Nutritional Status and Recovery Outcomes in Hospitalized Patients

Screening and assessment tools represent the cornerstone of hospital-based nutritional evaluation. Anthropometric measures such as body mass index (BMI) and mid-upper arm circumference (MUAC) are among the most widely used indicators. BMI, calculated as weight in kilograms divided by height in meters squared, provides a quick assessment of nutritional categories such as underweight, normal weight, overweight, and obesity. However, BMI may not adequately reflect acute changes in nutritional status or body composition. MUAC, on the other hand, is a simple, low-cost, and practical tool especially valuable in settings where scales and stadiometers are unavailable. It has been validated as a predictor of morbidity and mortality, particularly among HIV-infected patients and those with chronic illnesses.

Beyond anthropometry, structured clinical tools such as the Subjective Global Assessment (SGA) and the Malnutrition Universal Screening Tool (MUST) have been developed to provide a more comprehensive view. The SGA combines patient history—such as weight changes, dietary intake, and gastrointestinal symptoms—with physical examination findings like muscle wasting and fat loss. It is widely used due to its holistic approach, though it relies heavily on clinician expertise and subjective judgment. The MUST, developed for use across healthcare settings, incorporates BMI, unintentional weight loss, and the impact of acute illness on nutrition. It generates a risk score that stratifies patients into low, medium, or high risk of malnutrition, guiding subsequent interventions. These tools are particularly useful in standardizing assessments across institutions and improving the detection of malnutrition at admission (Anyebe *et al*., 2018; Mitchell *et al*., 2022).

Laboratory markers offer an additional layer of precision by capturing biochemical aspects of nutritional status. Serum proteins such as albumin and prealbumin have historically been used as indicators, though their interpretation is complicated by their sensitivity to inflammation and fluid balance. Albumin, with a long half-life, reflects chronic nutritional status but may decrease in response to infection or systemic inflammation independent of nutritional intake. Prealbumin, with a shorter half-life, is more responsive to recent changes in protein intake, yet is similarly confounded by inflammatory processes. C-reactive protein (CRP), an acute-phase reactant, is often measured alongside these markers to differentiate between inflammation-driven reductions in serum proteins and true nutritional deficits. Hemoglobin levels provide insight into iron status and anemia, while micronutrient assays, including vitamin D, zinc, and selenium, can highlight specific deficiencies with clinical consequences for immune function and recovery. Taken together, biochemical assessments complement anthropometry and clinical tools, allowing for a more nuanced evaluation.

Despite the availability of diverse tools, nutritional status assessment faces significant challenges. One major limitation

is the confounding effect of fluid imbalance, which can mask malnutrition. Conditions such as edema, ascites, or aggressive intravenous fluid therapy may artificially inflate body weight and BMI, concealing true nutritional deficits. Similarly, serum albumin levels may be depressed by inflammatory states rather than inadequate protein intake, complicating interpretation. This challenge underscores the importance of integrating multiple assessment modalities rather than relying on a single indicator.

Resource limitations in low- and middle-income countries (LMICs) further constrain effective assessment. Anthropometric tools like MUAC are accessible, but laboratory markers and structured screening instruments may not be routinely available. Shortages of trained personnel, inadequate diagnostic infrastructure, and limited access to micronutrient assays hinder comprehensive evaluations. Moreover, high patient volumes in overcrowded hospitals may restrict the time available for detailed nutritional assessments, leading to underdiagnosis. In such contexts, simplified and validated tools that can be applied rapidly by non-specialists are critical (Ajayi and Akanji, 2022; Oluyemi *et al*., 2022).

Nutritional status assessment in hospitalized patients requires a multifaceted approach integrating anthropometric measures, structured screening tools, and laboratory markers. While BMI, MUAC, SGA, and MUST provide valuable insights into risk stratification, biochemical tests such as albumin, prealbumin, CRP, and micronutrient levels refine diagnosis and monitoring. However, challenges such as fluid imbalance and resource limitations, especially in LMICs, complicate the process. Addressing these barriers through the development of context-appropriate, low-cost, and validated tools will be essential to ensure timely identification and treatment of malnutrition, ultimately improving recovery outcomes in hospitalized populations.

2.3. Nutritional Status and Recovery Outcomes in Hospitalized Patients

Nutritional status is a key determinant of clinical outcomes among hospitalized patients, shaping the trajectory of recovery across short- and long-term dimensions. Adequate nutrition supports immune function, metabolic balance, and tissue repair, while malnutrition compromises physiological resilience, thereby prolonging recovery and elevating risks of adverse outcomes. Evidence from both high-income and resource-limited healthcare systems consistently demonstrates that undernutrition is an independent predictor of poorer prognosis, irrespective of the underlying illness. The effects manifest through multiple outcome domains, including hospital length of stay, complication and readmission rates, morbidity, mortality, and post-discharge quality of life (Eneogu *et al*., 2020; Osabuohien *et al*., 2021).

One of the most consistently reported consequences of poor nutritional status is prolonged hospitalization. Malnutrition impairs wound healing, delays recovery from surgery or infection, and reduces the capacity to mount an effective physiological response to acute illness. Patients with low body mass index (BMI), muscle wasting, or hypoalbuminemia are at greater risk of extended stays compared to their well-nourished counterparts. Prolonged hospitalizations not only increase costs for health systems but also expose patients to additional risks such as nosocomial infections, deconditioning, and psychosocial distress. Importantly, malnourished patients often require greater intensity of care, including extended use of antibiotics, invasive procedures, or nutritional supplementation, further compounding resource utilization.

Beyond length of stay, malnutrition significantly increases the risk of in-hospital complications and post-discharge readmissions. Nutrient deficiencies impair immune competence, rendering patients more susceptible to bacterial, viral, and fungal infections. This vulnerability is particularly critical in surgical patients, where malnutrition is associated with higher rates of wound dehiscence, delayed healing, and surgical site infections. Similarly, in medical wards, malnourished patients show higher incidences of respiratory and urinary tract infections, which extend recovery times (Scholten *et al*., 2018; Aduwo *et al*., 2019). These complications often necessitate unplanned readmissions, creating a cycle of recurrent hospitalization. Studies have demonstrated that patients identified as malnourished at discharge are significantly more likely to be readmitted within 30 days compared to well-nourished peers. Such patterns highlight the predictive role of nutritional status in forecasting both immediate and longer-term recovery outcomes.

Undernutrition is a well-documented independent predictor of increased morbidity and mortality in hospitalized populations. Malnourished patients experience higher rates of multi-organ dysfunction, increased severity of infections, and poorer outcomes from chronic conditions such as heart failure or chronic obstructive pulmonary disease. The biological mechanisms underpinning this association include impaired immune surveillance, reduced muscle strength leading to respiratory compromise, and altered drug metabolism that diminishes therapeutic effectiveness. Mortality rates are particularly elevated among severely malnourished patients, with evidence showing that hypoalbuminemia and low BMI are strong predictors of in-hospital death. In populations with comorbidities such as HIV, the mortality risk is magnified due to the synergistic effects of viral replication, systemic inflammation, and nutrient depletion. Thus, malnutrition is not merely a coexisting condition but a direct driver of poor survival outcomes.

The influence of nutritional status extends beyond hospitalization to long-term functional capacity and quality of life. Malnutrition is associated with sarcopenia, fatigue, and reduced mobility, which limit patients' ability to regain independence after discharge. This impact is especially pronounced in older adults, where malnutrition exacerbates frailty and increases the likelihood of institutionalization. Poor nutritional recovery contributes to persistent fatigue, impaired rehabilitation, and diminished social participation, undermining overall quality of life. For patients with chronic conditions such as HIV, inadequate nutrition compromises adherence to therapy, increases fatigue, and worsens psychosocial well-being. Conversely, timely nutritional interventions during hospitalization—such as therapeutic feeding, protein supplementation, and micronutrient support—have been shown to improve post-discharge outcomes, enhance functional recovery, and reduce long-term healthcare costs (Oloruntoba and Omolayo, 2022; Isa, 2022).

Taken together, these outcome domains underscore the central role of nutritional status as both a predictor and modifier of recovery outcomes. Length of hospital stay, complication rates, morbidity, mortality, and quality of life

are all profoundly influenced by nutritional adequacy. The evidence highlights the need for routine nutritional screening and proactive management as integral components of hospital care. Nutritional interventions should not be limited to reactive strategies but incorporated early in the admission process to optimize recovery trajectories. In this way, nutritional status becomes not only a clinical marker of vulnerability but also a modifiable determinant of patient-centered outcomes.

2.4. Nutritional Status and Recovery Outcomes in HIV-Positive Patients

Nutritional status is a critical determinant of clinical outcomes in HIV-positive patients, shaping immune function, response to therapy, and survival. The relationship between HIV infection and nutrition is bidirectional; the virus and its complications contribute to nutritional depletion, while malnutrition exacerbates disease progression and increases vulnerability to opportunistic infections (Aduwo *et al*., 2021; Oluoha *et al*., 2022). As antiretroviral therapy (ART) has transformed HIV into a chronic, manageable condition, attention has increasingly shifted toward optimizing supportive factors such as nutrition to ensure sustained recovery and improved quality of life.

Unique considerations exist when assessing and addressing nutritional status in individuals living with HIV. One of the central challenges is the increased metabolic demand driven by chronic immune activation and recurrent opportunistic infections. Even in patients on ART, systemic inflammation can elevate resting energy expenditure, leading to higher caloric requirements. Opportunistic infections such as tuberculosis or chronic diarrhea further increase nutrient losses while reducing intake, creating a cycle of progressive wasting. In this context, conventional nutritional needs are amplified, and failure to meet them accelerates clinical deterioration.

Another unique consideration is the side effects of ART, which, while lifesaving, can negatively influence appetite, nutrient absorption, and weight maintenance. Gastrointestinal symptoms such as nausea, vomiting, and diarrhea are common adverse effects that directly impair food intake. Some ART regimens have also been associated with metabolic complications, including lipodystrophy, insulin resistance, and dyslipidemia, which alter body composition and may contribute to malnutrition in the form of wasting or micronutrient imbalances. These complexities necessitate a nuanced approach to nutritional care that balances the benefits of ART with strategies to mitigate its nutritional side effects.

The predictive role of nutritional status in recovery outcomes for HIV-positive patients is well established. Malnutrition has been consistently linked with poor adherence to ART, partly because weakened patients may struggle with the demands of daily therapy and frequent clinical follow-up. Inadequate nutrition also undermines the pharmacokinetics of ART drugs, reducing their efficacy and contributing to treatment failure. Furthermore, undernourished patients are more likely to experience rapid disease progression and higher rates of morbidity. Protein-energy malnutrition and micronutrient deficiencies weaken immune defenses, leaving patients susceptible to opportunistic infections such as tuberculosis, candidiasis, and pneumonia (Taiwo *et al*., 2021; Isa, 2022). These infections, in turn, exacerbate nutritional deficits, creating a vicious cycle that increases the risk of hospitalization and mortality.

Evidence highlights that nutritional depletion is a strong predictor of survival outcomes in HIV-positive patients. Low body mass index (BMI), reduced mid-upper arm circumference (MUAC), and biochemical markers such as hypoalbuminemia have all been associated with increased risk of mortality, even in patients receiving ART. Similarly, micronutrient deficiencies, including vitamin A, zinc, and selenium, have been linked with poor immune reconstitution and elevated risk of infections. Thus, nutritional status serves not only as a clinical marker of disease severity but also as an independent predictor of recovery trajectories.

Given this evidence, there is a compelling case for early nutritional interventions as a cornerstone of HIV care. Micronutrient supplementation has shown benefits in reducing morbidity, improving immune function, and enhancing ART outcomes. Fortified foods, including lipid-based nutrient supplements, provide concentrated calories and essential nutrients that can support weight gain and recovery in severely malnourished patients. Therapeutic nutrition programs, such as those using ready-to-use therapeutic foods (RUTF), have proven effective in restoring nutritional status in HIV-positive adults and children, particularly in resource-limited settings. These interventions are especially critical in the early stages of ART initiation, when patients are at heightened risk of weight loss and opportunistic infections.

Integrating nutrition into HIV care also has broader benefits for adherence and retention in treatment programs. Patients receiving food support are more likely to attend clinical appointments and adhere to ART, underscoring the role of nutrition in strengthening health systems' capacity to manage HIV comprehensively. Furthermore, interventions tailored to local contexts—such as community-based food support or agricultural initiatives—can enhance sustainability while addressing underlying determinants of malnutrition (Awe, 2017; Halliday, 2021).

Nutritional status is both a reflection of and a determinant of recovery outcomes among HIV-positive patients. Unique challenges such as elevated metabolic demands and ART side effects complicate management, while malnutrition itself predicts poor adherence, higher rates of opportunistic infections, and increased mortality. Early intervention with micronutrient supplementation, fortified foods, and therapeutic nutrition programs is essential to break the cycle of malnutrition and disease progression. As global health systems continue to refine HIV care, prioritizing nutrition as a fundamental component of treatment strategies will be key to improving long-term survival and quality of life for people living with HIV.

2.5. Predictive Value of Nutritional Indicators

Nutritional indicators provide powerful insights into the prognosis of hospitalized patients, functioning as both diagnostic markers of physiological reserve and predictors of recovery outcomes. Unlike static clinical descriptors, nutritional status reflects the dynamic interplay between illness severity, immune competence, and metabolic resilience. For this reason, indicators such as body mass index (BMI), mid-upper arm circumference (MUAC), and serum albumin are increasingly recognized as not merely descriptive but prognostic tools as shown in figure 2. Their predictive value is particularly important in vulnerable populations, including individuals with HIV, where

malnutrition compounds immune suppression and amplifies clinical risks.

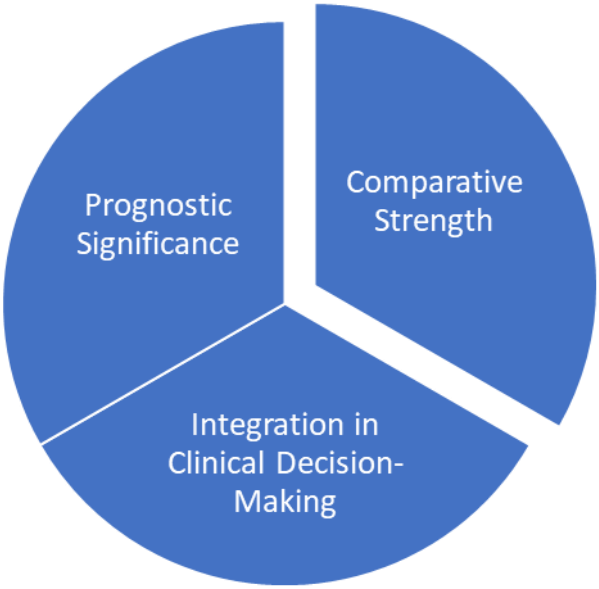

Fig 2: Predictive Value of Nutritional Indicators

Serum albumin has been consistently demonstrated as one of the strongest nutritional predictors of mortality in hospitalized patients. Hypoalbuminemia reflects inadequate protein reserves and systemic inflammation, both of which signal heightened vulnerability to complications and death. Numerous studies show that low albumin levels on admission correlate with prolonged hospitalization, increased infection risk, and elevated short- and long-term mortality. Albumin's utility lies not only in its biochemical precision but also in its widespread availability, making it a practical tool for risk stratification across diverse healthcare settings.

Anthropometric measures such as BMI and MUAC are equally significant predictors of poor outcomes. Low BMI, particularly under 18.5 kg/m², is strongly associated with delayed wound healing, susceptibility to infections, and increased mortality. In resource-limited settings, where laboratory testing may be constrained, MUAC serves as a reliable, low-cost alternative. Reduced MUAC correlates with muscle wasting and diminished functional capacity, both of which forecast poorer recovery (Adeshina, 2022; Okoli *et al*., 2022). Importantly, these indicators capture the cumulative effects of chronic undernutrition and acute illness, thereby signaling patients at greatest risk of adverse trajectories.

When compared with other established predictors, nutritional indicators demonstrate unique and complementary strengths. In HIV-positive patients, for example, viral load and CD4 count remain the gold standards for assessing disease progression and immune competence. However, nutritional markers often outperform these virological measures in predicting short-term recovery outcomes such as length of hospital stay, complication rates, and immediate survival. For instance, an HIV patient with well-controlled viral load but severe wasting remains at high risk of hospitalization and poor recovery. Similarly, comorbidity indices like the Charlson Comorbidity Index provide valuable long-term risk estimates but may fail to capture the acute physiological vulnerability reflected by malnutrition.

The comparative strength of nutritional indicators lies in their ability to provide cross-cutting insights that transcend disease-specific markers. While viral load reflects virological control and comorbidity indices summarize chronic disease burden, nutritional status captures the integrative effect of these factors on the body's functional reserve. This makes nutritional indicators especially useful in heterogeneous hospital populations, where multiple overlapping conditions influence outcomes.

The predictive value of nutritional indicators has significant implications for clinical decision-making. Incorporating measures such as albumin, BMI, and MUAC into patient risk stratification enhances the ability of clinicians to identify high-risk individuals early in their hospital course. For example, hypoalbuminemia at admission may trigger more intensive monitoring, early initiation of nutritional support, or prioritization for multidisciplinary care. Similarly, low MUAC in an HIV-positive patient could prompt tailored nutritional supplementation alongside antiretroviral therapy to optimize recovery potential (Aduwo *et al*., 2021; Ojonugwa *et al*., 2022).

Beyond admission, nutritional indicators can inform care planning and discharge protocols. Identifying malnourished patients before discharge allows for the design of structured rehabilitation programs, targeted dietary interventions, and closer outpatient follow-up. By embedding nutritional screening tools such as the Subjective Global Assessment (SGA) or Malnutrition Universal Screening Tool (MUST) into hospital protocols, clinicians can systematically capture nutritional risks and link them to actionable interventions. Importantly, this integration shifts nutrition from a supportive adjunct to a central component of evidence-based care.

At the policy level, the routine use of nutritional indicators can support resource prioritization and cost reduction by preventing complications, reducing readmissions, and shortening hospital stays. For HIV care programs, integrating nutritional markers into treatment algorithms provides a more holistic framework for patient management, ensuring that virological control is matched with metabolic and functional resilience.

Taken together, the evidence highlights nutritional indicators as both powerful predictors and practical tools for improving

patient care. Serum albumin stands out as a robust biochemical predictor of mortality, while BMI and MUAC provide accessible anthropometric measures that forecast poor outcomes across diverse contexts. When compared with disease-specific markers such as viral load and CD4 count, nutritional indicators offer a more immediate reflection of recovery potential, making them indispensable in acute care settings. Their integration into risk stratification, care planning, and discharge protocols represents a paradigm shift in hospital medicine, one that recognizes nutrition not as peripheral but as central to prognosis and recovery (Kufile *et al*., 2022; Oluoha *et al*., 2022).

2.6. Policy and Strategic Implications

The recognition of nutrition as a central determinant of recovery outcomes in hospitalized patients, including those with HIV, has important policy and strategic implications at hospital, public health, and health system levels. Malnutrition not only undermines clinical recovery but also contributes to prolonged hospital stays, higher readmission rates, and increased healthcare costs (Akinboboye *et al*., 2021; Afrihyia *et al*., 2022). Addressing this challenge requires integrated strategies that bridge clinical practice, public health programming, and health economics to ensure that nutrition is embedded as a fundamental component of patient care.

At the hospital level, routine nutritional screening upon admission is a critical starting point for effective policy implementation. Malnutrition is often underdiagnosed in clinical settings due to time constraints and the absence of standardized screening practices. Policies mandating systematic use of validated tools such as the Malnutrition Universal Screening Tool (MUST) or Subjective Global Assessment (SGA) at admission and throughout hospitalization can enable early detection and intervention. Embedding nutritional status as a vital sign alongside temperature, blood pressure, and heart rate ensures that it becomes a routine component of patient monitoring.

Implementing hospital-level strategies also requires a multidisciplinary approach involving dietitians, physicians, nurses, and, where possible, social workers. Dietitians can provide specialized assessments and design individualized nutritional interventions, while physicians and nurses integrate these into treatment plans. Multidisciplinary collaboration enhances patient-centered care, ensuring that nutrition is not treated as an adjunct but as an essential aspect of recovery. Hospitals can strengthen this approach by establishing nutrition support teams that oversee assessment, intervention, and monitoring, especially for high-risk patients such as those with HIV, cancer, or critical illnesses.

Public health and HIV programs represent another crucial domain for integrating nutritional strategies. The intersection between HIV care and nutrition has been well documented, with evidence showing that malnutrition worsens disease progression and undermines antiretroviral therapy (ART) effectiveness. Strategic integration of nutrition support into HIV programs is therefore vital. This includes routine nutritional screening for people living with HIV, provision of micronutrient supplementation, and access to fortified foods. Moreover, therapeutic feeding interventions, such as ready-to-use therapeutic foods (RUTF), can be scaled up in resource-limited settings to address severe malnutrition among HIV-positive patients. Linking nutritional support with ART initiation programs strengthens patient adherence, reduces early mortality, and improves overall recovery outcomes (Oluyemi *et al*., 2020; Ajayi and Akanji, 2021).

Scaling up nutrition-sensitive HIV interventions also requires alignment with broader public health strategies. National HIV programs should incorporate nutrition explicitly into guidelines and funding priorities, supported by international organizations such as the World Health Organization (WHO) and UNAIDS. Community-based delivery models, including food supplementation linked to ART clinics or through community health workers, can extend access to nutrition services beyond hospital settings, especially in low- and middle-income countries where hospital infrastructure is often overstretched. Such integration ensures that nutrition is addressed not only during hospital admissions but also as a continuous part of outpatient and long-term HIV management.

The health economics dimension underscores the cost implications of malnutrition on health systems. Malnourished patients typically experience extended hospital stays due to delayed recovery, increased susceptibility to infections, and greater complication rates. These extended hospitalizations not only occupy valuable bed space but also drive up healthcare costs, placing significant strain on already burdened systems. Moreover, malnutrition is associated with higher readmission rates, further amplifying costs and undermining efficiency. Economic evaluations consistently demonstrate that investing in early nutritional interventions—such as routine screening and therapeutic feeding programs—is cost-effective, as it reduces hospital length of stay, prevents complications, and lowers readmission rates.

From a policy perspective, these economic arguments provide a strong rationale for prioritizing nutrition in healthcare financing and planning. Policymakers should recognize nutrition support not as an optional service but as a cost-saving intervention that enhances system sustainability. Insurance schemes, donor funding, and national health budgets should allocate dedicated resources to hospital-based nutrition programs and community-level interventions, with emphasis on high-burden populations such as HIV-positive patients. Additionally, integrating nutrition indicators into national health information systems would enable better tracking of progress and resource allocation.

The policy and strategic implications of addressing nutritional status in hospitalized patients extend across clinical practice, public health programming, and health economics. Hospital-level strategies such as routine nutritional screening and multidisciplinary care are essential for early detection and effective management. Public health and HIV programs must systematically integrate nutrition into prevention, treatment, and long-term care, while scaling up therapeutic feeding interventions to reach vulnerable populations. Finally, economic evidence highlights the cost-saving potential of nutrition interventions, strengthening the case for policymakers to prioritize nutrition within healthcare (Aduwo *et al*., 2020; Sobowale *et al*., 2022) systems. By embedding nutrition into hospital protocols, national HIV strategies, and financing frameworks, health systems can achieve improved recovery outcomes, reduced healthcare costs, and enhanced quality of care for all patients, particularly those living with HIV.

2.7. Challenges and Limitations

While nutritional status has proven to be a powerful predictor of recovery outcomes among hospitalized patients, several

challenges and limitations constrain its consistent application in clinical and research contexts as shown in figure 3. These limitations stem from variability in assessment tools, the influence of confounding factors, and gaps in the evidence base beyond HIV and related conditions (Chima *et al*., 2022; Akinboboye *et al*., 2022). Addressing these challenges is crucial to strengthening the predictive validity of nutritional indicators and ensuring their effective integration into patient care.

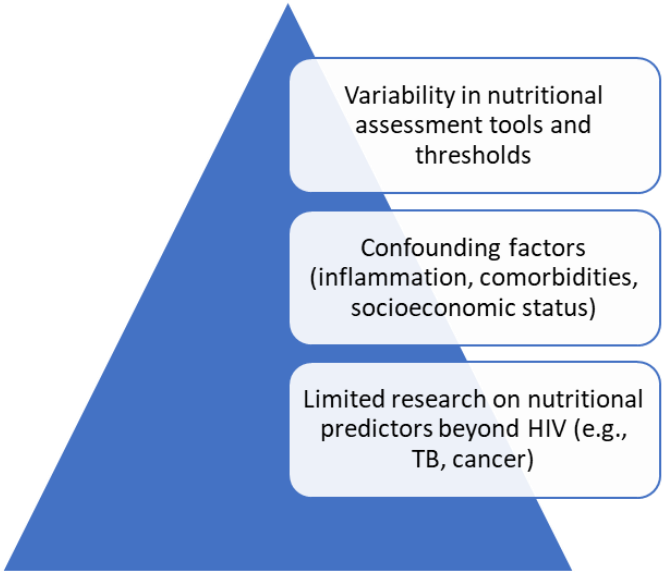

Fig 3: Challenges and Limitations

One major limitation lies in the heterogeneity of nutritional assessment methods. Tools such as body mass index (BMI), mid-upper arm circumference (MUAC), serum albumin, and comprehensive screening instruments like the Subjective Global Assessment (SGA) or Malnutrition Universal Screening Tool (MUST) are widely used, yet their thresholds and definitions of malnutrition vary across settings. For example, BMI cutoffs that define undernutrition differ between populations due to variations in body composition, ethnicity, and age. Similarly, serum albumin, while a common biochemical marker, is strongly influenced by acute inflammatory states, making it an imperfect reflection of nutritional reserves. The absence of standardized thresholds complicates comparisons across studies and limits the generalizability of findings. This variability also creates challenges for clinicians, who may be uncertain about which tool provides the most reliable prognostic value in a given context.

Another key limitation is the impact of confounding factors that influence both nutritional indicators and recovery outcomes. Inflammation is a prime example, as it lowers serum albumin and alters nutrient metabolism independent of actual dietary intake. Chronic comorbidities such as diabetes, cardiovascular disease, or chronic kidney disease may also distort nutritional markers while independently affecting recovery trajectories. Socioeconomic status is an additional confounder: patients from disadvantaged backgrounds are more likely to be malnourished, but they also face barriers to healthcare access, treatment adherence, and post-discharge rehabilitation. These overlapping influences make it difficult to disentangle the independent predictive contribution of nutritional status from broader determinants of health (Oluyemi *et al*., 2021; Umana *et al*., 2022). Without careful adjustment for these factors, studies risk overestimating or underestimating the role of nutrition in recovery outcomes.

A further limitation is the concentration of research on nutritional predictors in HIV-positive populations, where the association between malnutrition, immune suppression, and poor outcomes is well established. While this evidence base is robust, it leaves significant gaps in understanding how nutritional indicators function in other conditions with high hospitalization burdens, such as tuberculosis, cancer, or chronic liver disease. For example, cancer-related cachexia represents a distinct nutritional pathology with unique metabolic drivers, yet studies on the predictive role of BMI, MUAC, or albumin in oncology remain limited. Similarly, tuberculosis patients often suffer from profound malnutrition, but research on how specific indicators predict treatment adherence, recovery, or mortality is sparse. This lack of cross-disease evidence restricts the applicability of nutritional indicators as universal predictors across diverse patient populations.

The predictive value of nutritional status is tempered by important challenges. Variability in assessment tools and thresholds undermines consistency and comparability. Confounding influences—ranging from inflammation and comorbidities to socioeconomic determinants—complicate causal interpretations. Finally, the narrow research focus on HIV leaves unanswered questions about the broader role of nutrition in conditions like tuberculosis and cancer. These limitations do not negate the importance of nutritional assessment but rather highlight the need for standardization, methodological rigor, and expansion of research (Ajayi and Akanji, 2022; Oluoha *et al*., 2022). Addressing these gaps will be essential to realize the full potential of nutritional status as a predictive indicator of recovery outcomes in hospitalized patients.

2.8. Future Directions

The growing recognition of nutritional status as a determinant of recovery outcomes in hospitalized patients calls for strategic advances in research, clinical practice, and health

system integration. While existing tools provide valuable insights into malnutrition and its consequences, the complexity of hospital care, combined with the unique challenges of chronic diseases such as HIV, highlights the need for innovation. Future directions must focus on the development of standardized nutritional indices, predictive models that incorporate real-time data, the use of digital health technologies for monitoring, and longitudinal studies to understand the long-term interplay between nutrition and chronic conditions (Omolayo *et al*., 2022; Ojonugwa *et al*., 2022).

A key priority is the development of standardized nutritional indices for hospitalized patients. Current assessments rely on diverse tools such as BMI, MUAC, the Subjective Global Assessment (SGA), and the Malnutrition Universal Screening Tool (MUST), each of which has strengths but also important limitations. The absence of a universally recognized, composite index hampers comparability across studies and healthcare systems. Developing standardized indices that combine anthropometric, biochemical, and functional parameters would provide more accurate and comprehensive assessments of nutritional risk. Such indices could be tailored to specific patient populations, including those with HIV, whose nutritional needs and recovery trajectories differ due to chronic inflammation and ART-related metabolic challenges. Standardization would not only improve clinical decision-making but also facilitate multicenter research and the integration of nutrition into quality-of-care benchmarks.

Another promising area is research on real-time predictive models that incorporate both nutritional and clinical parameters. Advances in big data analytics and artificial intelligence (AI) create opportunities to design predictive models that can dynamically estimate recovery outcomes based on variables such as nutritional status, comorbidities, laboratory markers, and treatment adherence. For instance, models could predict which HIV-positive patients initiating ART are at highest risk of early mortality due to malnutrition, enabling targeted nutritional interventions. Real-time integration of data from electronic health records (EHRs), laboratory systems, and bedside assessments could transform nutrition into a predictive rather than reactive element of patient care. Such models would be invaluable in resource-limited settings, where optimizing resource allocation is critical.

The exploration of digital health tools for nutritional monitoring offers another avenue for innovation. Mobile applications, wearable devices, and telehealth platforms could provide continuous monitoring of dietary intake, body weight, physical activity, and even biochemical markers using point-of-care diagnostics. In HIV programs, where frequent clinic visits can be challenging, digital platforms could support self-monitoring and remote consultations, enhancing adherence to nutritional interventions. Integration of these tools into hospital and community care systems could allow for seamless data flow, personalized recommendations, and early detection of nutritional decline. Furthermore, digital innovations may democratize access to nutritional support by empowering patients to take an active role in managing their health.

Finally, longitudinal studies are essential to deepen understanding of the long-term interactions between nutrition, chronic conditions, and recovery outcomes. Most current studies provide cross-sectional or short-term evidence, which, while valuable, fails to capture the cumulative impact of malnutrition over time. Longitudinal research in populations living with HIV, cancer, or cardiovascular disease could elucidate how nutritional status influences not only immediate recovery but also long-term survival, quality of life, and economic productivity. Such studies would also inform the sustainability of interventions such as micronutrient supplementation or therapeutic feeding programs. Importantly, longitudinal evidence could strengthen the policy case for investing in nutrition as a cost-effective strategy for managing chronic diseases.

The future of nutritional assessment and intervention in hospitalized patients lies in innovation and integration. Standardized nutritional indices, real-time predictive models, digital monitoring tools, and longitudinal studies will together advance both clinical practice and research (Menson *et al*., 2018; Frempong *et al*., 2022). These directions hold particular significance for populations with chronic conditions such as HIV, where nutrition remains both a vulnerability and a powerful lever for improving recovery outcomes.

3. Conclusion

Nutritional status emerges as a robust and consistent predictor of recovery outcomes in hospitalized patients, reflecting the body's physiological reserve and its ability to withstand acute illness. Indicators such as body mass index (BMI), mid-upper arm circumference (MUAC), and serum albumin provide valuable prognostic insights, linking malnutrition with prolonged hospital stays, increased complication and readmission rates, higher morbidity and mortality, and impaired post-discharge quality of life. Among vulnerable groups, particularly individuals living with HIV, the predictive value of nutrition is even stronger. The interplay between viral replication, chronic inflammation, and nutrient depletion amplifies the risks associated with poor nutritional status, making timely assessment and intervention indispensable in this population.

Looking forward, the strategic implications of these insights are significant. Early identification and correction of malnutrition can shorten hospital stays, improve functional recovery, and reduce overall healthcare costs. Proactive nutritional interventions—ranging from therapeutic feeding and micronutrient supplementation to structured rehabilitation support—have the potential to not only improve prognosis at the individual level but also alleviate the burden on overstretched health systems. By integrating nutritional assessment into hospital admission protocols and HIV care pathways, clinicians can move from reactive to preventive management, ensuring better outcomes for high-risk patients.

A clear call to action is warranted. Greater investment in nutrition screening, surveillance, and tailored interventions should be prioritized within hospital systems, with particular emphasis on HIV care programs. Developing standardized tools, training healthcare workers, and embedding nutrition into clinical governance frameworks will be critical steps toward institutionalizing this practice. By recognizing nutrition as both a prognostic indicator and a therapeutic target, health systems can strengthen recovery outcomes, enhance equity, and ultimately advance the broader goals of global health and patient-centered care.

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