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Systematic Review Report

Locally Available Foods and Dietary-based Interventions to Improve Health Outcomes for People Living with HIV

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TICAH

Trust for Indigenous Culture and Health

Contents

Foreword

Nutrition is a fundamental pillar in the management of HIV, particularly in regions like sub-Saharan Africa where the burden of the disease intersects with widespread food insecurity. In Kenya, where an estimated 1.4 million people are living with HIV, the integration of nutrition into HIV care is not only beneficial—it is essential. While antiretroviral therapy (ART) has significantly improved treatment outcomes, its effectiveness is often compromised by malnutrition, which weakens immune response and reduces adherence to treatment.

This report presents a systematic review of the role of locally available food and diet-based interventions in improving the health and treatment outcomes of People Living with HIV (PLHIV). Drawing on evidence from 34 studies, the review highlights the potential of food-based strategies to enhance immune function, support nutritional recovery, and improve quality of life. Interventions such as fortified therapeutic foods, micronutrient-enriched diets, plant-based supplements, and antioxidant-rich produce demonstrate that nutrition-sensitive approaches can significantly strengthen HIV care.

The findings of this review are timely and relevant. They underscore the importance of integrating culturally appropriate, accessible, and sustainable food solutions into HIV programs. As the global health community continues to pursue holistic and equitable care models, this report offers practical insights for policymakers, healthcare providers, and program implementers.

We hope this work will serve as a valuable resource in guiding future investments and interventions that place nutrition at the heart of HIV care. By leveraging local food systems and evidence-based strategies, we can move closer to achieving better health outcomes and dignity for all people living with HIV.

Dr. Patrick Amoth, CBS
Director General, Ministry of Health

Preface

Nutrition is a cornerstone of HIV care, yet evidence on effective interventions has often been fragmented and inconsistently applied within health systems. This systematic review was undertaken to consolidate available findings and provide clear evidence based on food and diet strategies designed to improve treatment outcomes for People Living with HIV (PLHIV).

The studies included in this review were thirty-four (34) studies analysed. Out of which nineteen (19) examined food-based interventions such as fruits, vegetables, dairy products, soy-based products, olive oil, Ready-to-Use Therapeutic Foods (RUTF), fish oils, moringa leaves, probiotics enriched with dietary fibres, and corn-soy blends. Twenty-nine (29) studies investigated diet-based interventions, including individualized meal plans, ketogenic and Mediterranean diets and medically tailored food-based interventions.

Findings consistently demonstrated that nutrition interventions improve key health outcomes. Food-based approaches including micronutrient-fortified yoghurt, lipid-based energy-dense pastes, fruits and vegetables, and indigenous leaves significantly enhanced immune function, Body Mass Index, and fat-free body mass. Nutrition interventions tailored to the health needs of PLHIV optimize treatment outcomes.

The findings underscore the necessity of embedding nutrition interventions within health financing mechanisms, service delivery models, and institutional policies. Based on this evidence, key policy recommendations are advanced:

1. The need to expand Social Health Insurance Fund (SHIF) coverage to include therapeutic nutrition and thus eliminating financial barriers to access.
2. Promote indigenous food consumption through national advocacy and awareness campaigns, strengthening cultural sustainability and community-based care.
3. Mainstream locally available foods within health facility and institutional meal plans, aligning with national nutritional guidelines and normalizing their use in HIV care.

By consolidating evidence and highlighting actionable strategies, it aims to strengthen governance, improve service delivery, and enhance treatment outcomes for PLHIV.

Dr. Issak Bashir
Director, Directorate of Family Health- State Department for Medical Services
Ministry of Health

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Finally, we are grateful to the study's technical advisory committee for dedicating their time and effort to guiding and advising the study team throughout the research process. The members of the study's Technical Advisory Committee included: Dr. Desterio Nyamongo, Dr. Peris Kariuki, Dr. Pauline Duya, Dr. Eunice Mutemi, Dr. Meshack Onyambu, Dorothy Onyango, Ruth Adeka, Lilian Ngeny, Laura Kiige, Caroline Chiedo, and Richard Kimitei.

Dr. Andrew Mulwa
Head of National AIDS and STI Control Program (NASCOP)

Acronyms

AIDS	Acquired Immune Deficiency Syndrome
AJOL	African Journals Online
ART	Antiretroviral Therapy
ARV	Antiretroviral (Drugs)
BMI	Body Mass Index
BOI	Burden of Infection
BCT	Behavior Change Technique
CD4	Cluster of Differentiation 4 (T-Lymphocyte Cell Count)
CF	Credit Factor
CI	Confidence Interval
COM-B	Capability, Opportunity, Motivation – Behavior (Model)
CSB	Corn-Soy Blend
CSRUTF	Chickpea Sesame Ready-to-Use Therapeutic Food
DBP	Diastolic Blood Pressure
DHA	Docosahexaenoic Acid
EPA	Eicosapentaenoic Acid
EVOO	Extra Virgin Olive Oil
FPG	Fasting Plasma Glucose
Hb	Hemoglobin
HDL	High-Density Lipoprotein
HIV	Human Immunodeficiency Virus
HRQoL	Health-Related Quality of Life
hsCRP	High-Sensitivity C-Reactive Protein
IDDS	Individual Dietary Diversity Score
IRR	Incidence Rate Ratio
KD	Ketogenic Diet
LBM	Lean Body Mass
LDL	Low-Density Lipoprotein
LNS	Lipid-Based Nutrient Supplement
LRTI	Lower Respiratory Tract Infection
MeSH	Medical Subject Headings
MM	Mokaya Moses (Author Initials)
MO	*Moringa oleifera*
MUAC	Mid-Upper Arm Circumference

Acronyms

NASCOP	National AIDS and STI Control Programme
NCD	Non-Communicable Disease
Ovid	Ovid (Bibliographic Database)
Pg.	Page
PHIV	People Living with HIV
PLHIV	People Living with HIV
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
PROLCARMIV	Soya–Millet–Pumpkin Porridge Formulation
PROSPERO	International Prospective Register of Systematic Reviews
QoL	Quality of Life
QDF	Query Deserves Freshness
RCT	Randomized Controlled Trial
RFS	Ready-to-Use Fortified Spread
RUF	Ready-to-Use Food
RUSF	Ready-to-Use Supplementary Food
RUTF	Ready-to-Use Therapeutic Food
S.	*frutescens Sutherlandia frutescens*
SD	Standard Deviation
SHIF	Social Health Insurance Fund
SLO	Specific Learning Outcome
SF-36	Short-Form 36 Health Survey
T2D	Type 2 Diabetes
TC	Total Cholesterol
TEAC	Trolox Equivalent Antioxidant Capacity
TG	Triglyceride
TICAH	Trust for Indigenous Culture and Health
UNAIDS	Joint United Nations Programme on HIV/AIDS
VACS	Veterans Aging Cohort Study
WB	Wesley Bor (Author Initials)
WHO	World Health Organization
WIC	Women, Infants and Children (Nutrition Program)
µL	Microliter

01 Executive Summary

Kenya continues to grapple with a high HIV burden, with an estimated 1.4 million individuals currently living with the virus. While the scale-up of antiretroviral therapy (ART) has significantly improved access to treatment and reduced HIV-related morbidity and mortality, malnutrition and food insecurity remain persistent challenges. These issues are particularly pronounced among vulnerable populations, where inadequate nutrition undermines the effectiveness of ART, weakens immune response, and diminishes overall quality of life for People Living with HIV (PLHIV).

This systematic review was conducted to evaluate the role of locally available food and diet-based interventions in improving treatment outcomes for PLHIV. The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines and synthesized evidence from 34 studies selected from a pool of 567 records across major databases, including Cochrane Library, Web of Science, PubMed, Scopus, Ovid, and African Journals Online.

The analysis focused on interventions that utilized food and dietary strategies to address nutritional deficiencies and support immune function. These interventions were assessed based on their impact on key health outcomes, including immunological markers (e.g., CD4 cell counts), anthropometric measures (e.g., weight, BMI), metabolic and clinical indicators, and quality of life.

Key findings from the review highlight the significant benefits of food-based interventions in enhancing the health and well-being of PLHIV:

- Ready-to-use therapeutic foods (RUTFs) and lipid-based nutrient supplements (LNS) were effective in promoting weight gain and BMI recovery, particularly in undernourished individuals.
- Micronutrient-enriched foods and probiotic supplements contributed to improved CD4 counts, better haematological profiles, and enhanced gut health.
- Plant-based interventions, such as *Moringa oleifera* leaf powder, demonstrated immunomodulatory properties, supporting immune system resilience.
- Fruits, vegetables, and antioxidant-rich juices were associated with reduced oxidative stress and improved physical health-related quality of life.

The review underscores the importance of integrating locally sourced, culturally acceptable, and nutritionally rich foods into HIV care programs. These interventions not only address immediate nutritional needs but also contribute to long-term health improvements and better ART adherence.

In conclusion, food-based interventions tailored to the specific nutritional and health needs of PLHIV are a vital component of comprehensive HIV care. By leveraging locally available resources, these strategies offer a sustainable and cost-effective approach to improving treatment outcomes. Policymakers, healthcare providers, and community organizations are encouraged to incorporate these findings into program design and implementation to enhance the resilience and well-being of HIV-affected populations in Kenya and similar settings.

02 Background

In 2023, an estimated 1.3 million new HIV infections occurred globally, highlighting the ongoing challenges in transmission prevention. The total number of people living with HIV reached 39.9 million, including 1 million children. Additionally, approximately 630,000 individuals succumbed to AIDS-related illnesses. In Kenya, approximately 1.4 million people are living with HIV, with an adult prevalence rate of 3.2% for adults aged 14 to 49 years (1). The epidemic has profound implications for the nutritional status of infected individuals, as HIV can cause malabsorption of nutrients, increase energy expenditure, and exacerbate loss of appetite and oxidative stress (2). Optimal nutrition is crucial for People Living with HIV (PLHIV) because it supports the immune system, enhances the efficacy of antiretroviral therapy (ART), and improves overall quality of life (3).

Despite progress in ART coverage, with 78% of PLHIV on treatment, there are persistent challenges in nutritional care (4). Malnutrition and food insecurity are common among PLHIV, particularly in rural areas and among vulnerable populations, including women and children (5). Addressing these nutritional needs is essential for achieving the UNAIDS 95-95-95 cascade of care targets (UNAIDS, 2022). To achieve optimal nutrition among PLHIV, there is a need to promote dietary diversity, support healthy dietary choices, and implement targeted, evidence-based nutritional support programs (6).

Nonetheless, PLHIV face considerable barriers to accessing adequate food due to food insecurity, exacerbated by economic challenges, loss of income, and the high cost of nutritious foods (7). It has been reported that using locally available and indigenous foods offers a promising solution. Foods such as amaranth, sweet potatoes, and traditional leafy greens are rich in essential nutrients and culturally accepted (8). Further, herbs and spices like ginger, garlic, and turmeric could enhance the nutritional value of meals and offer adjuvant therapeutic benefits for immune function (9). Promoting the consumption of these locally available foods could improve the nutritional status of PLHIV, reduce food insecurity, and enhance overall health and treatment outcomes (10). Leveraging knowledge of indigenous food and resources could empower communities and provide sustainable solutions to nutritional challenges in HIV care (11).

Notwithstanding the known benefits, current evidence on the impact of locally available foods, including indigenous foods, in improving the nutritional and health outcomes of PLHIV in Kenya is divergent. While existing studies highlighted the importance of proper nutrition and the barriers to accessing adequate food, they often overlooked the potential of locally available, nutrient-rich options that were culturally relevant and accessible to the community (12). Therefore, we conducted a systematic review to consolidate and evaluate the available evidence on the impact of these locally available foods on the health outcomes of PLHIV. This review aimed to provide a comprehensive understanding of the effect of dietary interventions on HIV care as a potential strategy for promoting sustainable and culturally appropriate community empowerment.

Objective of the systematic review

The objective of this systematic review was to examine the role of locally available food and diet-based interventions on treatment outcomes of PLHIV.

03 Methods

This systematic review applied the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines and followed the 14 steps described by Tawfik et al.(13) (Appendix 1). The review has been registered in the PROSPERO International Prospective Register of Systematic Reviews, https://www.crd.york.ac.uk/PROSPERO/ (Registration ID CRD42020154209).

Eligibility criteria

This review applied **Table 1** describes the inclusion and exclusion criteria

Criteria	Inclusion Criteria	Exclusion Criteria
Population or Patient	• Adult patients with HIV in articles published globally	• Studies that do not describe the population to include PLIHVs
Intervention	• Food and diet-based interventions	• Interventions including nutrition supplements. • Studies that do not clearly describe the interventions to include food or diet-based components, • Studies of dietary interventions in non-human subjects or in vitro studies; • Studies with data not reliably extracted, duplicate, or overlapping data
Comparators	• Food or diet-based interventions	• Interventions including nutrition supplements
Outcomes	• Immunological outcomes: Viral load and CD4 • Anthropometric Outcomes: Weight, Waist Circumference, Waist-hip ratio, MUAC • Clinical outcomes: gastrointestinal symptoms, mortality rates and adherence to ART • Metabolic Outcomes: lipid profiles, micronutrient and macronutrient status Quality of life outcomes: physical and mental health domains	• Metabolic outcomes with interventions related to nutrition supplements
Study Type	• Randomized Controlled Trials	• Abstract-only papers as preceding papers, conference, editorial, and author response theses and books • Articles without available full text, • Case reports, case series, and systematic review studies • Studies published in languages other than English, Research protocols, case studies, conference proceedings

Information sources

The study derived information from various databases, including Cochrane and Web of Science Cochrane Library, Web of Science, PubMed, Scopus, Ovid databases and African Journals Online. These databases were systematically searched with Boolean combinations of keywords and Medical Subject Headings (MeSH). Articles were included if they were published between January 2000 and April 2025.

Search strategy

A standard search strategy was developed in PubMed based on the research question formulation (i.e., PICOS) and later modified for each specific database to obtain the most relevant results. The search strategies were constructed to include free-text terms (e.g., in the title and abstract) and any appropriate subject indexing (e.g., Medical Subject Headings-MeSH) expected to retrieve eligible studies as described in Supplementary Table 2, to ensure the searches and mode of saving articles are standardized.

Selection process

The process of selection of the articles was conducted by using search strings based on the search strategy (Appendix 2) and adopted for the specific database using Polyglot (https://polyglot.sr-accelerator.com/). The selection of studies was independently conducted by MM and WB and independently assessed for eligibility by TK, KA, FI and RM.

Data collection process and data extraction items

The reviewers applied three methods in manual searching: (i) searching references from included studies/reviews, (ii) contacting authors and experts, and (iii) looking at related articles/cited articles in PubMed and Google Scholar. Additionally, the reviewers applied three methods to increase and refine the yield of manual searching: (i) searching reference lists of included articles; (ii) performing what is known as citation tracking in which the reviewers track all the articles that cite each one of the included articles, and this might involve electronic searching of databases; and (iii), similar to the citation tracking, we follow all “related to” or “similar” articles. Each of the above-mentioned methods will be performed by 3 independent reviewers/co-consultants (MM, WB and TK). All the possible relevant articles were further scrutinized against the inclusion criteria. The searches were keyed into a standard Microsoft Excel template. The reviewers extracted the following information: name of authors, country of patients, year of publication, study design (case report, cohort study, or clinical trial or RCT), sample size, the dietary or food-based intervention, follow-up interval after intervention, efficacy, safety, adverse effects, and quality assessment sheet.

Effect measures

This study included five categories of outcome measures: 1) immunological, 2) anthropometric, 3) metabolic, 4) clinical outcomes, and 5) quality of life. Immunological measures included viral load and an increase in CD4 and inflammatory markers. Anthropometric measures included weight, BMI, waist-hip circumference, and middle-upper arm circumference. Metabolic measurements included lipid profile, while quality of life measures included physical and mental health domains. Clinical outcomes included gastrointestinal symptoms, mortality rate, and adherence to ART.

04 Results

In total, 34 out of 567 screened RCTs were included in this systematic review (Figure 1). These 48 studies were conducted across 21 countries (Appendix 3).

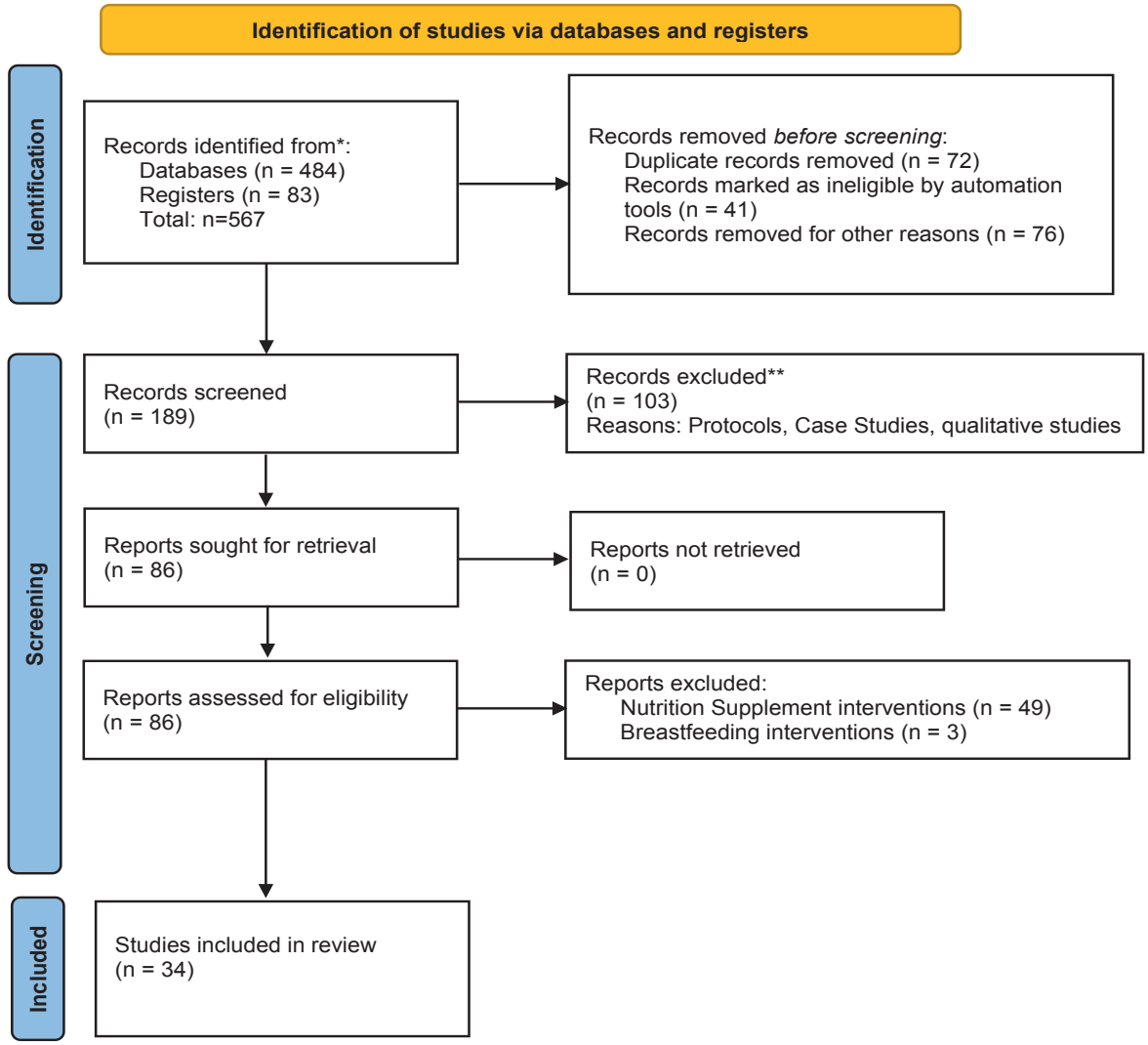

Figure 1. PRISMA Flow Chart

Characteristics of included studies

The study duration for the included studies ranged from 24 hours to a maximum of 16 weeks. Nineteen of the 34 studies focused on food-based interventions including fruits and vegetables, dairy products, soy-based products, olive oil, and Ready-to-use Therapeutic Foods (RUTF). Other food products included fish oils, moringa leaves, probiotics enriched with dietary fibres and corn-soy-blends. Twenty-nine of the studies focused on diet-based interventions including individualized meal plans, fad diets (Ketogenic and Mediterranean), medically tailored meals, ready-to-use fortified spreads, specially designed snacks and nutritional counselling.

Effect of food-based interventions on treatment outcomes for PLHIV

This study revealed that the effect of various food-based interventions improved treatment outcomes for PLHIV. Table 1 summarizes the associated effects of food-based interventions for PLHIV.

Table 1. Associated benefits of food-based interventions on the treatment outcomes of people living with HIV

No	Food-based intervention	Effects on treatment outcomes	Source
1.	Chickpea sesame ready-to-use therapeutic food (CSRUTF)	No association between household food security and average CS-RUTF intake, overall mortality was 45.7% (32/70) for those from the least food-secure households and 33.1% (41/124) for those from the middle and the highest tertile, more food-secure households continued to gain weight in the absence of ART initiation	(14)
	Ready-to-use fortified spread (RUFS) or corn-soy blend (CSB) as a supplement	After 14 weeks, the RUFS group showed a greater increase in BMI and fat-free body mass than the CSB group. No significant differences were observed between the groups in CD4 count, HIV viral load, quality of life, or ART adherence at 14 weeks or a 12-week follow-up after the intervention ended. Supplementary feeding, particularly with the energy-dense RUFS, resulted in faster restoration of normal BMI among wasted HIV-infected adults initiating ART. However, there was no evidence of improved survival, CD4 count, HIV viral load, quality of life, or ART adherence from supplementary feeding.	(15)
	50 g daily serving of a peanut/ soya milk-based spread enriched with micronutrients for a period of up to 6 months for breastfeeding HIV positive mothers (280 kcal energy and 8 g protein)	In the mothers with BMI ≥ 25 kg/m2, and with BMI ≤ 24.9 kg/ m2; no significant effect of the supplementation was seen. In mothers with BMI ≤ 24.9 kg/m2 the supplemented group had a significantly lower loss in LBM (0.098 kg). There is no effect on CD4 count, haematology and albumin. There were no significant differences in the crude incidence rates or incidence rate ratios (IRR) of opportunistic infections such as LRTI, diarrhoea, candidiasis, and TB as well as the depression and Karnofsky scores.	(16)
	Soya, millet, pumpkin Porridge (PROLCARMIV)	Increased BMI, elevation of Hb levels, decreased TC,LDL, HDL, TG	(17)
2.	100 mL of yogurt with Lactobacillus rhamnosus GR-1 and L. reuteri RC-14.	Hematologic Parameters: No significant differences were found between groups in hematologic parameters.CD4 Cell Counts: A statistically significant increase in CD4 cell counts was observed at 15 and 30 days in the probiotic yoghurt group compared to the control group ($P < 0.02$). Diarrhoea, flatulence, and nausea resolved within two days in all subjects in the probiotic yoghurt group,	(18)
	Yoghurt B (Micronutrients Only): Vitamin A (1500 IU), Vitamin E (5.7 IU), Vitamin B1, B6, B12, C, iron, selenium, zinc, DHA, EPA	Micronutrient supplementation (Yogurt B) had the greatest increase in CD4 count (+41 cells/μL)	(19)
	Micronutrient-fortified yoghurt with (probiotics group) or without (control group) Lactobacillus rhamnosus GR-1 for 4 weeks	Probiotic addition to micronutrient-fortified yoghurt was well-tolerated but did not further enhance CD4 count. However, there was an Improvement in the haemoglobin levels.	(20)

No	Food-based intervention	Effects on treatment outcomes	Source
3.	1.2 g/day of probiotics (Lactobacillus acidophilus and Bifidobacteria).11 g/day of soluble fibre (provided separately from HAART by at least 2 hours) in patients with diarrhoea	Mean stool frequency decreased, diarrhoea episodes decreased, CD4 count increased significantly, Viral load remained unchanged, and Significant improvement in physical well-being and emotional and functional well-being.	(21)
4..	Whey protein supplement: 280 kcal containing 40 g of whey protein. Isocaloric control supplement: 280 kcal without added protein (protein source was 0.6 g casein).	**Weight and LBM:** No significant differences were observed between groups in changes in weight or LBM at 6 or 12 weeks. Body Composition: A significant improvement in waist-to-hip ratio was observed in the whey protein group at week 6, but not at week 12. No other significant differences were found in body composition measures. Lipids: Fasting triacylglycerol levels decreased significantly in the whey protein group and increased in the control group at week 12 (P = 0.03). CD4 Lymphocytes: CD4 lymphocyte counts increased significantly at 12 weeks in the whey protein group compared to the control group (P = 0.03). Gastrointestinal Symptoms: Gastrointestinal symptoms were reported more often in the whey protein group. Energy Intake: Total energy intake did not significantly increase in either group due to decreases in self-selected food intake. Protein intake increased significantly in the whey protein group. Carbohydrate intake increased in the control group, but the difference was not significant at week 12.	(22)
5.	Moringa oleifera group (MOG): 15 g of Moringa oleifera leaf powder daily for six months, divided into three 5 g doses with meals.	Moringa oleifera leaf powder supplementation was associated with a significant increase in CD4 cell counts among HIV-positive adults on ART in a resource-limited setting. No significant effects were observed on viral load or anthropometric parameters.	(23)
6.	Sutherlandia frutescens: a southern African legume in the Sweet Pea Family. Various chemical compounds that might be responsible for the activity of Sutherlandia have been isolated. These include triterpenoids, saponins, flavonoids, γ-aminobutyric acid (GABA) and pinitol	CD4 T-lymphocyte count & HIV viral load. No significant difference between S. frutescens and placebo, Burden of Infection (BOI)Participants in the S. frutescens arm had a higher mean BOI, Adverse Events & Safety: No significant changes in biochemical, haematological, or cardiovascular parameters, Quality of Life & Mental Health: No significant changes in depression scores or stress levels. Small but statistically significant improvements in social and mental health scores	(24)
7.	Fish oil omega-3 supplementation on HIV-Seropositive Pregnant Women	Both fish oil and placebo groups showed a reduction in depressive symptoms, possibly due to the Hawthorne effect (the alteration of behaviour by the subjects of a study due to their awareness of being observed). Side effects: Fishy aftertaste, occasional nausea, heartburn, bloating	(25)
8.	Extra virgin olive oil (EVOO) in patients taking lopinavir/ ritonavir.	High-sensitivity C-reactive protein (hsCRP) was significantly lower after EVOO consumption. Hs-CRP is a blood test that measures inflammation in the body, particularly useful for assessing the risk of cardiovascular disease.	(26)
9.	Synbiotic (Lactobacillus and Bifidobacterium strains + 6 g fructooligosaccharides).	Significant reductions were found in nausea/vomiting, diarrhoea, constipation, and dyspepsia.	(27)

No	Food-based intervention	Effects on treatment outcomes	Source
10.	A locally prepared cereal-lentil mixture that delivered approximately 930 kcal per day	The cereal-lentil mixture and multivitamin supplementation provided essential calories and nutrients, which are important for supporting overall health and recovery during tuberculosis treatment.	(28)
11.	Casein maltodextrin-based milk formula provides 100–110 kcal/kg/day and 2.2 g protein/kg/day Low-lactose feeds, micronutrient supplements, maize porridge, vegetable puree, and fermented milk.	Casein maltodextrin-based milk improved weight gain in HIV-infected children with prolonged diarrhoea.	(29)
12.	Lipid-based, energy-dense paste Daily portion equivalent to ~50% of daily caloric needs. Does not require water for preparation (reducing contamination risk)	Supplementary feeding with lipid-based energy-dense daily portion improved BMI and fat-free body mass in wasted HIV-infected adults starting ART.	(30)
13.	Fruit and vegetable Consumption	Fruit and vegetable consumption (β = .23, p = .03) is independently related to better physical HRQOL (using the Medical Outcome Study 36-Item Short-Form (SF-36). Association between Health status (using the Veterans Aging Cohort Study (VACS) Index) and nutrition was statistically significant (β= .24, p = .02)	(31)
14.	Plasma antioxidant capacity of HIV-seropositive and healthy subjects during long-term ingestion of fruit juices	Trolox equivalent antioxidant capacity (TEAC) significantly increased after 16 weeks	(32)

ART, antiretroviral therapy, BMI, body mass index, BOI, the burden of infection, CSB, corn-soy blend, CD4: cluster of differentiation 4, hsCRP: highly sensitive-C-reactive proteins, Hb, haemoglobin, HDL: high-density lipoprotein, LDL: low-density lipoprotein, LBM, low birth weight, LRTI, lower respiratory tract infection, RUFS, ready-to-use-fat spread, Tc total cholesterol, TG, triglycerides.

Table 2 summarizes food and dietary components identified to have varying effects on health outcomes in PHIV.

No	Food or Dietary Component	Associated Benefits
1	Chickpea Sesame Ready-to-Use Therapeutic Food (CSRUTF)	Promoted weight gain in more food-secure households, even without ART initiation.
2	Yoghurt with Probiotics (Lactobacillus strains)	Enhanced CD4 cell counts and resolved gastrointestinal issues like diarrhoea and nausea in HIV-positive individuals.
3	Moringa Oleifera Leaf Powder	Increased CD4 cell counts significantly among HIV-positive adults on ART.
4	Ready-to-Use Fortified Spread (RUFS)	Quicker BMI restoration and fat-free body mass in wasted HIV-infected adults.
5	Peanut/Soya Milk-Based Spread	Reduced lean body mass loss among breastfeeding mothers with low BMI.
6	Sutherlandia frutescens	Improved social and mental health scores slightly, but no significant effect on CD4 counts or HIV viral load.
7	Fish Oil Omega-3 Supplementation	Reduced depressive symptoms due to potential behavioural observation effects.

No	Food or Dietary Component	Associated Benefits
8	Extra Virgin Olive Oil	Lowered high-sensitivity C-reactive Protein, which indicates reduced inflammation and cardiovascular risk.
9	Synbiotic with Fructooligosaccharides	Reduced symptoms like nausea, vomiting, and dyspepsia.
10	Locally Prepared Cereal-Lentil Mixture	Supported recovery during tuberculosis treatment.
11	Casein Maltodextrin-Based Milk Formula	Improved weight gain in HIV-infected children with prolonged diarrhoea.
12	Energy-Dense Lipid Paste	Improved BMI and fat-free body mass in wasted HIV-infected adults starting ART.
13	Fruit and Vegetable Consumption	Better physical health-related quality of life in PLHIV.

Effect of diet-based interventions on treatment outcomes for People Living with HIV

Various diet-based interventions exhibited varying effects on treatment outcomes in PLHIV. These diets included combinations of various foods, composite foods and formulations used in the management of HIV (Table 3).

Table 3: Associated benefits of diet-based interventions on the treatment outcomes of people living with HIV

No	Diet-based intervention	Effect on treatment outcomes	Source
1.	Individualized diet plans were developed through four visits with a dietitian. Behavioural therapy focuses on problem identification and goal setting. Motivational interviewing techniques to enhance adherence	A diet intervention appeared to improve the quality of life among men with HIV and lipodystrophy. While mood did not improve significantly overall, the control group experienced a clinically significant worsening in mood, highlighting the potential benefits of the diet intervention.	(33)
2.	Meals and snacks are designed to meet 100% of daily energy requirements and nutritional guidelines, tailored to the needs of those with HIV and/or type 2 diabetes. The average energy requirements used to design daily meals were 1800–2000 kcal for people living with HIV and 1800 kcal for people with T2DM. Meal plans were based on the Mediterranean diet featuring fresh fruits and vegetables, lean proteins, healthy fats (e.g., olive oil), and whole grains, and were low in refined sugars and saturated fats.	Food security improved significantly (very low food security decreased from 59.6% to 11.5%, $p<0.0001$). Diet quality improved: fat consumption decreased ($p=0.003$), while fruit and vegetable consumption increased ($p=0.011$). Sugar consumption decreased among those with diabetes ($p=0.006$). Depressive symptoms decreased ($p=0.028$). Binge drinking decreased ($p=0.008$). Fewer participants sacrificed food for healthcare ($p=0.007$) or prescriptions ($p=0.046$) or sacrificed healthcare for food ($p=0.029$). Among those with HIV, ART adherence increased (from 47 to 70%, $p=0.046$). Among those with T2DM, diabetes distress decreased ($p<0.001$), and diabetes self-management improved ($p=0.007$). There was a nonsignificant trend towards improved HbA1c. BMI also decreased significantly among participants with T2DM	(34)
3.	Food assistance program providing a monthly food basket	reduced internalized stigma, No significant correlations between objective measures of disease progression (BMI, CD4 count) and stigma	(35)

No	Diet-based intervention	Effect on treatment outcomes	Source
4.	Ketogenic Diet (KD) on Adults Aging with HIV	Trails B scores (a neuropsychological test used to assess visual attention, task switching, and cognitive flexibility) improved significantly in the KD group. Processing Speed: Digit Symbol Substitution Test showed higher performance for KD participants. Memory: Hopkins Verbal Learning Test showed slight, but non-significant, improvement in recall. Metabolic and Biomarker Changes: The KD group exhibited lower insulin resistance. Cognitive benefits Observed at Week 12 were lost after returning to a standard diet, indicating the effects were transient	(36)
5.	Medically tailored meals (MTM) and groceries covering up to 100% of daily energy needs: (5 a day intake of fruits and vegetables, high intake of carbohydrate, high intake of protein of plant origin e.g., kidney beans, soybean etc., high intake of dairy products and water, low intake of fat)	Lower odds of severe, food insecurity. Lower odds of severe depressive symptoms, lower odds of poor adherence, significantly decreased consumption of Fatty food, lower hospitalization risk, and lower Unprotected sex. No significant difference in Viral Non-suppression, Quality of Life (HRQoL), fruit and vegetable intake, Healthcare Utilization (Hospitalization & Unprotected Sex):	(37)
6.	Food basket intervention (provided biweekly for 6 months) including sweet potato leaves, amaranth, pumpkin leaves, onions, oranges, carrots, pumpkins, spinach, Chinese cabbage, and African nightshade. Selected based on micronutrient content (iron, vitamin A, vitamin C, and zinc)	Anaemia prevalence decreased, and slight Serum Ferritin and haemoglobin increased.	(38)
	Monthly food basket containing: Maize, rice, beans, fortified corn-soy blend, and vegetable oil	The food basket improved ART adherence, particularly in timely medication refills.	(39)
7.	Dietary diversity and nutritional status	Dietary diversity was not significantly associated with nutritional status.	(40)
8.	Two high-fat meals at least 24 hours apart: Saturated Fat Meal: Bacon, cheese, egg whites, olives, bagel with margarine, pears, and milk. Polyunsaturated Fat Meal: Salmon, bagel with margarine, cashew butter, parmesan cheese, walnuts, peaches, and water.	The consumption of two high-fat meals led to postprandial LDL cholesterol decreased significantly, and triglycerides increased significantly.	(41)
9.	Shamba Maisha intervention (Microfinance loan (~ USD 175) to purchase farming tools and inputs. Agricultural implements including a human-powered irrigation pump, seeds, and fertilizers. Training on sustainable farming and financial literacy through small-group sessions	Viral suppression improved in both groups, Food insecurity improved more in the intervention group, Mental health: Depression prevalence reduced more in the intervention group, and Self-confidence and social support improved significantly in the intervention group (trend difference = -0.0154, 95% CI: -0.024 to - 0.006, $p < 0.001$).ART adherence and clinic visits no difference in ART adherence, BMI and CD4 count: minimal differences	(42)

No	Diet-based intervention	Effect on treatment outcomes	Source
10.	Insta Foundation blend of maize, Soya, sugar, palm oil, and micronutrients premix composed of 45% of the total energy	Significant ($p < 0.05$) increase in weight, MUAC and BMI after 3 months On follow-up, a decrease in the proportion of severely Malnourished men and women with 24-hour IDDS was significantly higher, morbidity experiences (vomited and oral thrush)	(43)
11.	Ready-to-use fortified spread (RFS) group: Energy-dense peanut-based lipid spread Daily portion of 245g (providing 5,694 kJ) Ready to use Corn-soy blend (CSB) group: Fortified cereal legume mixture Daily portion of 374g (providing 5,694 kJ)	Supplementary feeding with ready-to-use fortified spread (RFS) resulted in greater BMI and fat-free body mass increase than supplementary feeding with corn-soy blend (CSB)	(44)
12.	Meals and snacks designed to comprise 100% of daily energy requirements and meet nutritional guidelines for a healthy diet	The frequency of consumption of fats ($p= 0.003$) decreased, while the frequency increased for fruits and vegetables ($p= 0.011$). Among people with diabetes, the frequency of sugar consumption decreased ($p= 0.006$). We also observed decreased depressive symptoms ($p = 0.028$) and binge drinking ($p= 0.008$). At follow-up, fewer participants sacrificed food for healthcare ($p = 0.007$)	(45)
13.	Nutritional counselling: General healthy eating recommendations, such as the “10 steps to healthy eating.”	Significant reductions in Fasting Plasma Glucose -FPG ($p = 0.008$) and DBP ($p = 0.023$). Adjusted models showed LDL and BMI reductions and further improvements in cardiometabolic parameters. The individualized prescription demonstrated greater clinical effectiveness in improving cardiometabolic outcomes.	(46)

Mechanisms of action for the identified health benefits and the link to the Kenyan guidelines on nutrition in HIV &AIDS

Table 4 summarizes the findings from the review and links the recommendations in the national HIV guidelines and the nutrition guide to the mechanisms of action of the various foods and diets.

Table 4 Linking review findings to existing recommendations and mechanisms of action of foods and dietary components for optimal outcomes in PLHIVs

General Recommendation	Findings from this review	Associated Recommendations	Postulated mechanisms of actions
Food and diet components			
Increase the consumption of fruits and vegetables for general health.	Mediterranean diet featuring fresh fruits and vegetables (34)	PLHIV should be encouraged to eat a balanced diet that includes a variety of vegetables and fruits every day in adequate amounts Pg. 20 (47) Immune-Boosting Foods (12) Fruits (e.g., oranges, mangoes, bananas) – Rich in vitamins (especially vitamin C) to strengthen immunity (47) Vegetables (e.g., spinach, kale, carrots, pumpkin leaves) – Provide essential vitamins (A, C, K) and minerals (iron, zinc) (47)	Polyphenols in fruits and vegetables Polyphenol-rich fruit juices might be favourable to PLHIV due to enhanced proliferation and restoration of disturbances in T-cell homeostasis (32) Fruits prevent LDL oxidation and platelet aggregation, enhancing endothelial function, lowering blood pressure, decreasing inflammation, and activating new proteins that stop cell senescence, grape polyphenols help lessen atherosclerosis (48). Polyphenols, highly abundant in fruits can help mitigate oxidative stress (52) which may be more pronounced in HIV-infected individuals (50) Fibre in fruits and vegetables Fibre has marked effects on satiety and can persistently affect inter-meal intervals, reducing the desire to eat frequently and lowering caloric intakes, improving gut health reducing gut inflammation (51) Micronutrients in fruits and vegetables Various fruits and vegetables have numerous minerals and vitamins that are beneficial to health and in building immunity (52)
Ready to use therapeutic foods and composite flour	Chickpea sesame ready-to-use therapeutic food (CSRUTF) (14) Ready-to-use fortified spread (RUFS) or corn-soy blend (CSB) as a supplement (15)	Recommend utilization of prescribed food supplements (where PLHIV meet the criteria) such as the fortified blended flours, Ready to Use Supplementary foods (RUSF), and Ready to Use Therapy (Pg. 21) (47) Dietary fibre is important because it enhances bowel movement and the overall gut health (Pg. 22) (47) Legumes (beans, lentils, peas) – Good sources of protein and fibre for energy and muscle maintenance (Pg. 22) (47)	Fatty acid composition (specifically, omega- 3 fatty acids) may play a role in infection and inflammation and thus might be a beneficial ingredient in therapeutic food. Legumes used in the formulation of ready-to-use therapeutic foods contain several bioactive substances. These substances may have overlapped and complementary modes of action, such as immune system stimulation, lipid and hormone metabolism regulation, antioxidant, antimutagen, and antiangiogenic effects, a decrease in tumour initiation, and the promotion and induction of apoptosis (53)
Legumes	A locally prepared cereal-lentil mixture (28) Sutherlandia frutescens: a southern African legume in the Sweet Pea Family (24)	Legumes (beans, lentils, peas) – Good sources of protein and fibre for energy and muscle maintenance (12)	Legumes contain several bioactive substances. These substances may have overlapped and complementary modes of action, such as immune system stimulation, lipid and hormone metabolism regulation, antioxidant, antimutagen, and antiangiogenic effects, a decrease in tumour initiation, and the promotion and induction of apoptosis (53)

General Recommendation	Findings from this review	Associated Recommendations	Postulated mechanisms of actions
Animal proteins	Whey protein: 280 kcal containing 40 g whey protein. Isocaloric control supplement: 280 kcal without added protein (protein source was 0.6 g casein). (22) Casein maltodextrin-based milk formula (29)	Protein-Rich Foods (12) Eggs, fish, lean meat – Help repair tissues and maintain muscle mass.	Whey proteins encompass a range of protein fractions including a-lactalbumin, b-lactoglobulin, serum proteins, lactoferrin and a series of immunoglobulins. When taken separately, these fractions are known immune-boosting components that are linked to a variety of bioactive processes, including prebiotic effects, tissue repair stimulation, intestinal integrity maintenance, pathogen death, and toxin removal.
	Consume three servings of milk and dairy products daily and a portion of meats, poultry, fish, or eggs. (46) Nutritional counselling: General healthy eating recommendations, such as the "10 steps to healthy eating." Individualized dietary prescription	Dairy (milk, yoghurt) – Supplies calcium and protein (12)	
Whole grains	Whole grains, with low refined sugars and saturated fats (39) Soya, millet, pumpkin Porridge (PROLCARMIV) (17)	Traditional grains (sorghum, millet, amaranth) – Provide energy and nutrients (12)	Whole-grain trace elements like manganese, copper, zinc, and selenium serve as cofactors for enzymes like glutathione peroxidase and superoxide dismutase that carry out antioxidant tasks. Usually present in whole grains, polyphenols can neutralize carcinogenic N-nitrosamines, hence preventing oxidative DNA damage brought on by these substances (54)
Fish oil omega-3	Fish oil omega-3 supplementation on HIV-Seropositive Pregnant Women (39) Polyunsaturated Fat Meal: Salmon, bagel with margarine, cashew butter, parmesan cheese, walnuts, peaches, and water (41)	Eggs, fish, lean meat – Help repair tissues and maintain muscle mass (12)	Omega-3 fatty acids are essential building blocks for the synthesis of eicosanoids that have a range of host defence functions, including prostacyclins, thromboxanes, leukotrienes, and prostaglandins. Therefore, a lack of them in the diet may affect the production of cytokines (55)
Yoghurt	Yogurt with Lactobacillus rhamnosus	Dairy (milk, yoghurt) – Supplies calcium and protein (12)	The gut microbiota, bowel transit, and improvement of innate and adaptive immune responses in the gastrointestinal tract are most likely the mechanisms via which yoghurt eating improves gastrointestinal function (56).
Olive oil	Extra virgin olive oil (EVOO) in patients taking lopinavir/ ritonavir.	Foods rich in MUFAs include peanuts, coconuts, olives and avocados) (47)	It has also been shown that administering polyphenol-rich olive oil improves endothelial function and lowers inflammatory marker levels (57)

General Recommendation	Findings from this review	Associated Recommendations	Postulated mechanisms of actions
Dietary Interventions			
Mediterranean diet	Mediterranean diet features fresh fruits and vegetables, lean proteins, healthy fats (e.g., olive oil), and whole grains, and is low in refined sugars and saturated fats. (39)	Dietary fibre is important because it enhances bowel movement and the overall health of the digestive system (Pg. 22) (47) Legumes (beans, lentils, peas) – Good sources of protein and fibre for energy and muscle maintenance (Pg. 22) (47)	In people who are not HIV-positive, a Mediterranean diet has been linked to positive benefits on lipoprotein levels, endothelial function indicators, insulin resistance, and metabolic syndrome (58)
Ketogenic Diet (KD)	Hopkins Verbal Learning Test showed slight, but non-significant, improvement in recall. Metabolic and Biomarker Changes: The KD group exhibited lower insulin resistance. Cognitive benefits observed at Week 12 were lost after returning to a standard diet, indicating the effects were transient (36)	N/A	Processing speed and visual scan scores were positively correlated with increased brain ketone uptake (as determined by positron emission tomography), indicating the advantageous impact of ketosis on brain energy metabolism (59).
Herbs			
Moringa	Moringa oleifera group (MOG)	Moringa (drumstick tree) – High in vitamins, minerals, and antioxidants (12)	In addition to being a rich source of essential amino acids, MO leaves are a potent antioxidant, free radical scavenger, anti-inflammatory, anti-endothelial Nitric Oxide Synthase expression, anti-mutagenic, anti-proliferative, anticancer, hepatoprotective, promoter of carbohydrate metabolism, and DNA repairer. These benefits Ameliorate HAART-Induced Pathophysiological Complications (60)

The recommendations have been drawn from Kenyan guidelines and other literature (grey literature). Ten steps to healthy eating: (1) Make at least three meals (breakfast, lunch, and dinner) and two healthy snacks per day. Do not skip meals. (2) Include six portions of the cereal group 3) Eat at least three servings of vegetables daily (4) Eat beans with rice every day or at least five times a week. (5) Consume three servings of milk and dairy products daily and a portion of meats, poultry, fish, or eggs. (6) Consume a maximum of one portion per day of vegetable oils, olive oil, butter, or margarine. (7) Avoid soft drinks and processed juices, cakes, sweet and stuffed biscuits, s. (8) Decrease the amount of salt in the food (9) Drink at least two litres (six to eight glasses) of water a day. (10) Make your life healthier.

05 Discussion

This systematic review synthesized evidence from locally available foods for PLHIV to inform policies and practices, highlight the current state of knowledge, and identify research gaps. The findings indicated that food and diet-based interventions can effectively tackle nutritional and metabolic challenges faced by PLHIV. These interventions contribute to improvements in immunological, anthropometric, metabolic, quality of life, and clinical outcome measures. However, the extent of the improvement varies depending on the type of intervention, the specific target population, and the context in which they are applied.

Effect of the interventions on the immunological outcomes

Food-based interventions have an important role in improving immunological health outcomes in PLHIV. A wide range of effects on immune markers (e.g., CD4 counts, viral load), with varying levels of improvement based on the intervention type, target population, and implementation context. On one hand, incorporating functional foods with probiotics, such as yoghurt fortified with Lactobacillus strains, was found to have the potential to improve CD4 counts. Anukam et al. (18) reported statistically significant increases in CD4 counts and resolution of gastrointestinal symptoms such as diarrhoea and flatulence. Mechanistically, probiotics enhance gut microbiota balance facilitating gut health, and nutrient absorption, contributing to improved immune resilience (61) This review also showed that micronutrient-enriched foods are important interventions in boosting the immunity of PLHIV. Hemsworth et al. (20) showed the highest increase in CD4 counts (+41 cells/μL) through fortified yoghurt containing essential vitamins and minerals. This intervention highlights the importance of micronutrients in immune modulation, likely due to their roles as cofactors in enzymatic reactions essential for immune function (62).

Interventions using plant-based foods, such as Moringa oleifera leaf powder, have also shown promise in optimizing immunological outcomes in PLHIV. Gambo et al. (23) reported a significant increase in CD4 count after six months of supplementation, reinforcing the immunomodulatory potential of plant-bioactive compounds. Conversely, the use of Sutherlandia frutescens, despite its phytochemical richness, yielded no notable improvement in immune or viral parameters (24). This could suggest that not all herbal interventions deliver the intended outcomes. This observation is particularly important due to the widespread use of non-conventional therapies among PLHIV.

Effect of the interventions on the anthropometric outcomes

Energy-dense ready-to-use fortified spreads (RFSs) and lipid-based supplements were consistently shown to improve BMI and fat-free body mass in wasted HIV-infected adults initiating antiretroviral therapy (ART). Specifically, Oakley et al. (17) reported that RUFs accelerated faster restoration of normal BMI compared to corn-soy blends. However, the improvements in BMI did not significantly improve the CD4 count or viral load. Similarly, Manary et al. (30) demonstrated that lipid-based energy-dense portions provided approximately 50% of daily caloric needs, making them particularly effective in addressing malnutrition without requiring water, thereby reducing contamination risks that are common in low-income settings. For breastfeeding HIV-positive mothers, supplements such as peanut/soy milk-based spreads were found to prevent losses in lean body mass, particularly for women with lower BMI (16). These findings reiterate the already-known potential of supplementation in mitigating maternal malnutrition, which is crucial for both maternal and infant health. Additionally, interventions using fortified food, including ready-to-use fortified spreads (RFS), showed associations with improving BMI and fat-free body mass compared to corn-soy blends (44).

Effect of the interventions on the metabolic outcomes

Diet-based interventions play a crucial role in managing health outcomes, particularly among individuals living with HIV/AIDS and related metabolic disorders. The metabolic benefits of plant-based foods are attributed to their antioxidant capacity resulting from the phytochemicals especially polyphenols abundant in them (34). These findings further show the importance of dietary diversity and antioxidant intake in combating oxidative stress associated with HIV infection. Medically tailored meals designed to meet full daily energy requirements showed significant benefits for PLHIV and Type 2 Diabetes (T2D) (39). Mechanistically, the Mediterranean diet, which was central to this intervention, supports metabolic health by reducing inflammation, enhancing insulin sensitivity, and providing a

rich source of polyphenols that regulate oxidative stress. Separately, high-fat meals that include saturated fat and polyunsaturated fat sources were found to influence lipid metabolism, while Volpe et al. (41) reported decreased LDL cholesterol and increased triglycerides post-consumption. These changes are associated with negative effects on metabolic health and risks to non-communicable diseases (63).

Effect of the interventions on the clinical outcomes

These dietary approaches aim to enhance adherence to antiretroviral therapy (ART).
Food assistance programs, such as monthly food baskets, have been linked to reductions in internalized stigma (64). Though these programs primarily aimed to address food insecurity, they indirectly improved ART adherence by alleviating psychological distress associated with economic hardship. The energy-dense peanut-based lipid spreads used in ready-to-use fortified spread facilitated rapid weight gain and improved nutritional status in the PLHIVs. Further, iron-rich foods in food basket interventions including spinach, pumpkin leaves, and sweet potatoes—have been instrumental in reducing anaemia prevalence (38). These foods enhance haemoglobin synthesis and improve oxygen transport in the body. Similarly, micronutrient-enriched food baskets containing fortified corn-soy blends and vegetable oils have been linked to better ART adherence (39). On the other hand, while probiotics alone, as in the study by Hummelen et al. (20), did not enhance CD4 count, they improved haemoglobin levels, suggesting their role in addressing anaemia and supporting haematological health.

Effect of the interventions on quality of life

Fruit and vegetable consumption, alongside antioxidant-rich juices, has revealed improvements in physical health-related quality of life (31). Various nutritional strategies have been explored, ranging from medically tailored meals to individualized diet plans, food assistance programs, and micronutrient-enriched interventions. These dietary approaches mitigate psychological and social stressors such as stigma and depressive symptoms. One of the most effective interventions appears to be individualized dietary plans combined with behavioural therapy. Reid & Courtney (33) showed that structured nutritional counselling improved the quality of life among men with HIV and lipodystrophy. While mood changes were not significant overall, the control group experienced worsening symptoms, suggesting that diet-based interventions may help stabilize emotional health. This review also showed interesting findings from a nutrition-sensitive intervention regarding the quality of life. For example, the Shamba Maisha intervention, which combined microfinance loans with agricultural tools, demonstrated improvements in food insecurity, mental health, and self-confidence (42). This study shows that combining nutrition-sensitive interventions with socio-economic support optimizes sustainable health outcomes in PLHIV. Ketogenic diets (KD), which emphasize low carbohydrate and high fat intake, have shown cognitive benefits in PLHIV. Morrison et al. (36) observed improvements in processing speed and attention, likely due to ketone bodies providing an alternative energy source for neurons. However, these benefits were transient, vanishing after returning to a standard diet.

Effect of interventions on gut health

As shown from this review, various foods play a crucial role in optimizing the health outcomes in PLHIV. Evidence also shows that in PLHIVs, food also improves gut health by preventing dysbiosis, a condition marked by microbial imbalance and inflammation. In this population, dysbiosis is associated with reduced microbial diversity and increased markers of microbial translocation and immune activation, such as lipopolysaccharide (LPS) and sCD14 (65,66). Harmful bacteria like Enterobacteriaceae (e.g., *E. coli, Salmonella, Shigella*) are linked to inflammation, while beneficial microbes such as Lactobacillus, Bifidobacterium, and *Saccharomyces boulardii* have anti-inflammatory effects (67). The use of foods that provide probiotics, such as fermented foods has been shown to enrich gut microbiota, reduce T-cell activation, and restore microbial balance, thereby improving immune function and reducing inflammation in HIV-positive (68,69).

Based on this evidence it is therefore recommended that dietary strategies and interventions for PLHIVs promote the intake of probiotics and prebiotics. Probiotic-rich foods in Kenyan foods include fermented milk (e.g., Mala, Mursik, Maroranu), fermented porridge (Uji) and tamarind juice. These foods introduce beneficial probiotic microbes, which are anti- inflammatory, that help neutralize harmful ones, which are pro-inflammatory. Prebiotics, found in whole-meal ugali, pulses (beans, green grams), nuts, and polyphenol-rich foods (berries, green tea, cocoa), nourish these beneficial microbes and promote the production of short-chain fatty acids that strengthen the gut barrier. Conversely, processed foods, refined sugars, excessive alcohol, and red meat should be avoided as they disrupt gut microbiota and promote inflammation (67).

06 Conclusion

Food-based interventions, tailored to the nutritional and health needs of HIV-infected individuals, help in optimizing treatment outcomes. While energy-dense RUFs and probiotics address malnutrition and gut health, micronutrient-enriched and plant-based options enhance immune function. If these interventions are contextualized and evidence-based, they have the potential to offer sustainable strategies for improving the quality of life and health outcomes in vulnerable populations. Continued research and context-specific implementation are a bedrock to optimizing their impact. Diet-based interventions for PLHIVs and metabolic disorders have demonstrated important benefits in improving health markers, reducing food insecurity, and enhancing psychological well-being. Structured nutritional counselling, medically tailored meals, and micronutrient-enriched interventions emerge as particularly effective strategies. While dietary diversity alone may not significantly influence nutritional status comprehensive and targeted nutritional interventions have the potential for optimizing treatment outcomes in vulnerable populations.

Policy recommendations

Based on the findings from this review, the following recommendations are proposed to facilitate treatment outcomes in PLHIV:

1. Coverage of Nutritional Supplements by the Social Health Insurance Fund (SHIF)

Recommendation: Ensure all nutritional supplements for HIV-positive individuals are fully covered under the Social Health Insurance Fund (SHIF), eliminating financial barriers to access.

Justification: Research indicates that food-based interventions significantly improve health outcomes in people living with HIV. Supplements like micronutrient-fortified yoghurt have increased CD4 cell counts (19) and lipid-based energy-dense pastes have improved BMI and fat-free body mass in wasted HIV-infected adults (30).

Expanding SHIF coverage would ensure equitable access to these critical interventions.
Additional Support: Government subsidies should be allocated to SHIF to reduce the financial burden on patients and make therapeutic nutrition interventions universally accessible.

2. Advocacy and Promotion of Indigenous Food Consumption

Recommendation: Launch national awareness campaigns and educational programs to promote the use of indigenous, nutrient-rich foods in HIV care, focusing on traditional grains, legumes, and vegetables.

Justification: Indigenous foods such as moringa and amaranth leaves have shown positive effects on HIV treatment outcomes (23)(38). These foods are readily available and culturally appropriate, making them sustainable alternatives to imported supplements.

Additional Support: The Ministry of Health and Agriculture should collaborate with media outlets and local influencers to disseminate culturally sensitive nutrition messages through radio, television, and community-based programs.

3. Policy for Mainstreaming Locally Available Foods in Health Facilities and Institutions

Recommendation: Develop and implement policies that integrate locally available foods into meal plans for health facilities, schools, and colleges, ensuring consistency with national nutritional guidelines.

Justification: Locally prepared cereal-lentil mixtures have been shown to support recovery during tuberculosis treatment (28) demonstrating their potential for inclusion in institutional feeding programs for broader health benefits.
Additional Support: Government procurement policies should prioritize locally sourced ingredients, providing funding for farm cooperatives to supply health institutions and educational facilities.

4. Incentives for Manufacturers of Food Supplements and Fortified Foods

Recommendation: Provide tax incentives, grants, and infrastructure support for local manufacturers producing therapeutic and fortified foods.

Justification: Ready-to-use therapeutic Foods (RUTF) have proven to be effective in promoting weight gain in malnourished HIV-positive patients (14). However, high production costs and reliance on imports limit accessibility. Offering incentives would encourage domestic production, ensuring affordability and availability.

Additional Support: Policymakers should create business-friendly regulations that support innovation and efficiency in the local food supplement industry.

5. Clinical Studies to Determine Herbal Food Supplementation Dosing

Recommendation: Fund research to establish standardized dosing protocols for herbal foods used in HIV nutrition therapy, ensuring efficacy and safety.

Justification: Sutherlandia frutescens has demonstrated mental and social health benefits in HIV-positive individuals, although its effects on CD4 counts and viral load were not significant (24). Further research is needed to determine optimal dosing and integrate plant-based solutions into HIV care.

Additional Support: Research grants should be allocated through national health research institutions, with findings incorporated into national treatment guidelines.

6. Review of National Guidelines for Plant-Based Foods and Fortified Foods

Recommendation: Conduct a comprehensive review of existing national guidelines to include evidence-based recommendations on plant-based food and fortified foods tailored to PLHIV.

Justification: Many dietary interventions such as probiotics and synbiotics have shown significant effects on gut health and immune function (18) (27) but their inclusion in standard treatment protocols remains limited.

Additional Support: A task force comprising nutritionists, medical researchers, and policymakers should be formed to assess current guidelines and propose updates based on scientific evidence.

7. Infrastructure Development for Local RUTF Production

Recommendation: Establish local production facilities for Ready-to-Use Therapeutic Foods (RUTF) to reduce reliance on imports and lower costs.

Justification: Studies show that supplementary feeding with lipid-based energy-dense products significantly improves BMI and fat-free body mass (30), yet accessibility remains a challenge due to import dependency. Local infrastructure development would strengthen supply chains and improve sustainability.

Additional Support: Public-private partnerships should be promoted to encourage investment in local production plants, with government subsidies for startups in the field.

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08 Appendices

Appendix 1. Steps of conducting systematic reviews

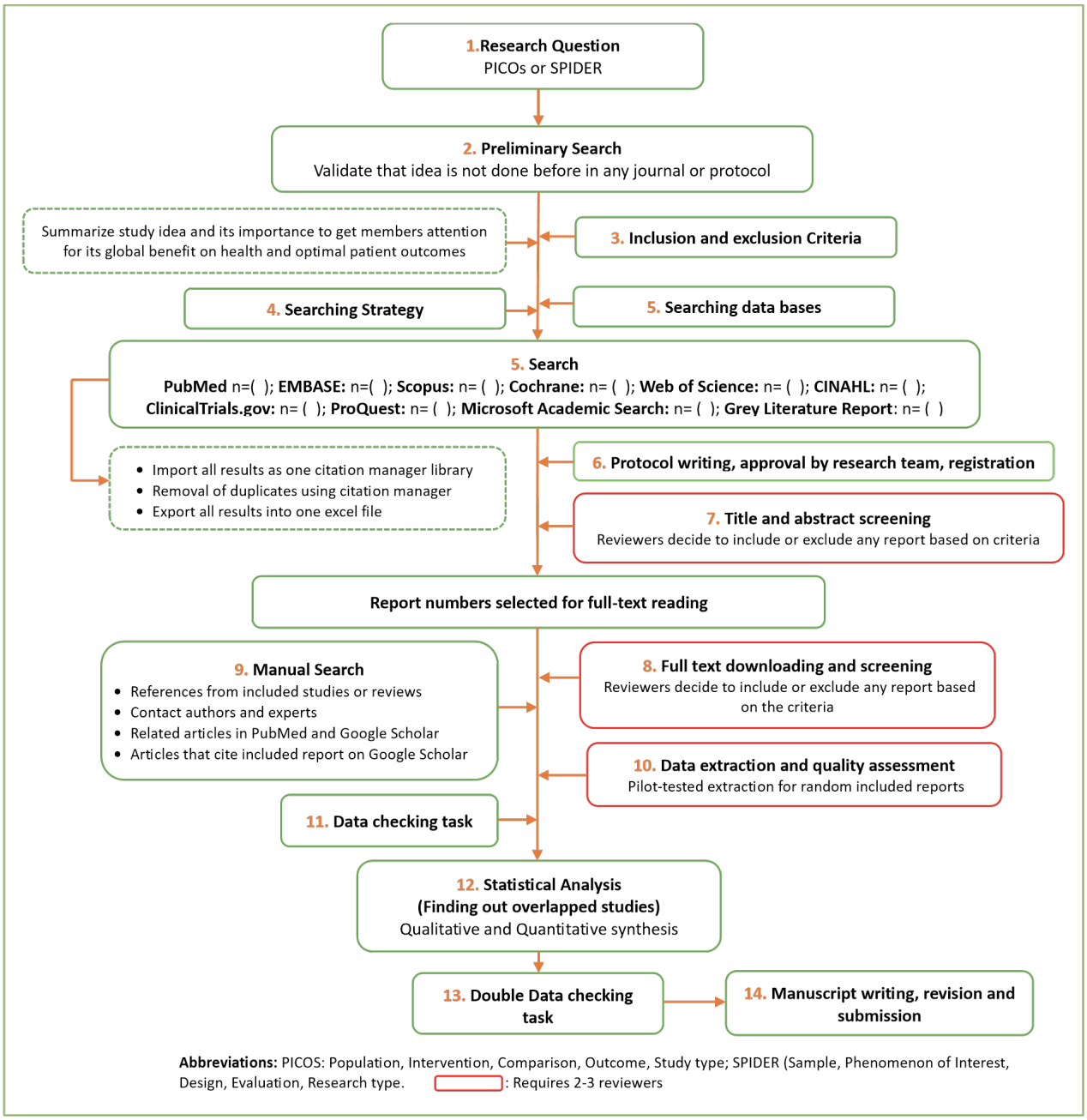

Figure 2: Step-by-step process of conducting a systematic review. Adopted from Tawfik et al (13) .

Appendix 2. Detailed Search Strategy

1. PubMed

(HIV[tw] OR “HIV Disease”[tw] OR “HIV and AIDS”[tw] OR HIV[Mesh]) AND (Food[tw] OR Diet*[tw] OR “Functional Food”[Mesh] OR “Diet Therapy”[Mesh] OR “Plants, Medicinal”[Mesh] OR “Diet, Food, and Nutrition”[Majr:NoExp] OR
“Diet Therapy”) AND (“Health Outcom*”[tw] OR “Outcome Assessment”[tw] OR “Viral Load”[Majr] OR “viral load”[tw] OR “Quality of life”[tw] OR “Opportunistic infection*”[tw] OR “AIDS-Related Opportunistic Infections”[Majr])

2. OVID Medline

(HIV.mp. OR “HIV Disease”.mp. OR “HIV and AIDS”.mp. OR exp HIV/) AND (Food.mp. OR Diet*.mp. OR exp “Functional Food”/ OR exp “Diet Therapy”/ OR exp “Plants, Medicinal”/ OR *”Diet, Food, and Nutrition”/ OR
“Diet Therapy”) AND (“Health Outcom*”.mp. OR “Outcome Assessment”.mp. OR exp *”Viral Load”/ OR “viral load”.mp. OR “Quality of life”.mp. OR “Opportunistic infection*”.mp. OR exp *”AIDS-Related Opportunistic Infections”/)

3. Cochrane Library

(HIV:ti,ab,kw OR “HIV Disease”:ti,ab,kw OR “HIV and AIDS”:ti,ab,kw OR [mh HIV]) AND (Food:ti,ab,kw OR Diet*:ti,ab,kw OR [mh “Functional Food”] OR [mh “Diet Therapy”] OR [mh “Plants, Medicinal”] OR [mh ^”Diet, Food, and Nutrition”] OR “Diet Therapy”) AND ((“Health” NEXT Outcom*):ti,ab,kw OR “Outcome Assessment”:ti,ab,kw OR [mh “Viral Load”] OR “viral load”:ti,ab,kw OR “Quality of life”:ti,ab,kw OR (“Opportunistic” NEXT infection*):ti,ab,kw OR [mh “AIDS-Related Opportunistic Infections”])

4. CINAHL (Ebsco)

(HIV OR “HIV Disease” OR “HIV and AIDS” OR (MH HIV+)) AND (Food OR Diet* OR (MH “Functional Food+”) OR (MH “Diet Therapy+”) OR (MH “Plants, Medicinal+”) OR (MM “Diet, Food, and Nutrition”) OR
“Diet Therapy”) AND (“Health Outcom*” OR “Outcome Assessment” OR (MM “Viral Load+”) OR “viral load” OR “Quality of life” OR “Opportunistic infection*” OR (MM “AIDS-Related Opportunistic Infections+”))

5. Web of Science Advanced

(ALL=HIV OR ALL=”HIV Disease” OR ALL=”HIV and AIDS” OR ALL=HIV) AND (ALL=Food OR ALL=Diet* OR ALL=”Functional Food” OR ALL=”Diet Therapy” OR ALL=”Plants, Medicinal” OR ALL=”Diet, Food, and Nutrition” OR “Diet Therapy”) AND (ALL=”Health Outcom*” OR ALL=”Outcome Assessment” OR ALL=”Viral Load” OR ALL=”viral load” OR ALL=”Quality of life” OR ALL=”Opportunistic infection*” OR ALL=”AIDS-Related Opportunistic Infections”)

6. Scopus (advanced search)

(TITLE-ABS-KEY(HIV) OR TITLE-ABS-KEY(“HIV Disease”) OR TITLE-ABS-KEY(“HIV and AIDS”) OR INDEXTERMS(HIV)) AND (TITLE-ABS-KEY(Food) OR TITLE-ABS-KEY(Diet*) OR INDEXTERMS(“Functional Food”) OR INDEXTERMS(“Diet Therapy”) OR INDEXTERMS(“Plants, Medicinal”) OR INDEXTERMS(“Diet, Food, and Nutrition”) OR “Diet Therapy”) AND (TITLE-ABS-KEY(“Health Outcom*”) OR TITLE-ABS-KEY(“Outcome Assessment”) OR INDEXTERMS(“Viral Load”) OR TITLE-ABS-KEY(“viral load”) OR TITLE-ABS-KEY(“Quality of life”) OR TITLE-ABS-KEY(“Opportunistic infection*”) OR INDEXTERMS(“AIDS-Related Opportunistic Infections”)

Appendix 3: Study Settings of the included studies

Country	Number of articles
Kenya	4
Uganda	3
Malawi	3
South Africa	3
USA	5
Brazil	1
Mexico	1
Zambia	1
Tanzania	1
Botswana	1
Canada	1
Spain	1
Cameroon	1
Argentina	1
Portugal	1
Ethiopia	1
Thailand	1
UK	3
Australia	1
Total	**34**

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