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THE DOUBLE BURDEN OF MALNUTRITION IN PEOPLE LIVING WITH HIV: GLOBAL EVIDENCE IN AN INTEGRATIVE REVIEW WITH META-ANALYSIS

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ABSTRACT

Infection with the human immunodeficiency virus remains associated with relevant nutritional changes, even after expanding access to antiretroviral therapy. Historically, people living with HIV have been affected by malnutrition, low weight, wasting, weight loss, micronutrient deficiencies, and food insecurity—conditions related to poorer immune response, higher morbidity, and increased mortality. However, over the past decades, greater survival, clinical recovery after starting treatment, population aging, metabolic changes, and prolonged exposure to antiretroviral therapy have contributed to the growth of overweight, obesity, and cardiometabolic risk in this population. In this context, this study aimed to analyze global evidence on the double burden of malnutrition in people living with HIV, considering the coexistence of nutritional deficits and excess weight in the contemporary era of HIV care.This is an integrative literature review with a meta-analytic component, based on 40 selected scientific studies from recognized databases, including observational studies, cohorts, systematic reviews, meta-analyses, and nutritional intervention studies. The findings showed that malnutrition remains significant in vulnerable populations, especially in contexts marked by food insecurity, poverty, limited access to health services, and a higher infectious disease burden. At the same time, overweight has become increasingly common, associated with weight gain after antiretroviral therapy, changes in body composition, obesity, hypertension, diabetes, and other metabolic conditions. The integrated analysis revealed that malnutrition in people living with HIV should not be understood only through the body mass index, but as a multifactorial phenomenon that involves chronic inflammation, lean mass, adiposity, diet quality, micronutrients, food security, and social determinants.It is concluded that the double burden of malnutrition represents a persistent and emerging challenge in HIV care, requiring expanded nutritional surveillance, ongoing metabolic assessment, individualized interventions, food security policies, and interdisciplinary action.

Keywords:HIV infections; malnutrition; nutritional status; obesity; food security.

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INTRODUCTION

Infection with the human immunodeficiency virus (HIV) remains a condition of high relevance for global public health, not only because of its infectious and immunological burden, but also due to the complex metabolic, nutritional, and social repercussions that accompany disease progression and prolonged use of antiretroviral therapy (ART). In recent decades, expanded access to antiretroviral treatment has profoundly changed the clinical course of infection, reducing mortality, increasing survival, and transforming HIV into a largely manageable chronic condition across many care settings. However, this epidemiological transition has not eliminated nutritional vulnerabilities associated with HIV; rather, it has produced a more complex scenario characterized by the coexistence of classic forms of undernutrition, such as low body weight, wasting, loss of lean mass, micronutrient deficiencies, and food insecurity, alongside the progressive increase in overweight, obesity, and cardiometabolic disorders in people living with HIV (PLHIV) (1,8,9,31,32) .

Historically, malnutrition associated with HIV has been characterized by progressive weight loss, wasting syndrome, and immune deterioration, often observed in advanced stages of infection. Classic studies have shown that weight loss and low body mass index (BMI) are associated with disease progression, increased risk of opportunistic infections, worse clinical response, and higher mortality (1, 10, 11, 14). The pathophysiology of this process involves interconnected mechanisms, including chronic systemic inflammation, increased resting energy expenditure, hormonal changes, reduced food intake, intestinal malabsorption, chronic diarrhea, coinfections, and deterioration of lean body mass (13-17). In addition, malnutrition impairs immune response, reduces functional capacity, and may limit the overall effectiveness of care, especially in regions marked by food insecurity, poverty, and barriers to access to health services (4,7, 19,39,40).

Despite therapeutic advances, malnutrition remains significant in PLHIV, especially in low- and middle-income countries. Studies conducted in African settings show relevant prevalences of low body weight

and nutritional impairment among adults under clinical follow-up or receiving ART (2,20,21,24,25). In a systematic review and meta-analysis conducted in Sub-Saharan Africa, the combined prevalence of malnutrition among adults living with HIV remained high, showing that although the expansion of ART is essential, it is not sufficient to neutralize the social and biological determinants of nutritional vulnerability (24). In addition, malnutrition represents not only a marker of clinical frailty, but also a factor associated with worse outcomes, including higher morbidity and mortality, which reinforces its importance as a prognostic indicator and as a target for integrated interventions (1,25,26).

Alongside this, contemporary literature has demonstrated a substantial change in the nutritional profile of people living with HIV (PLHIV), with an increase in the prevalence of overweight, obesity, and weight gain after the start of ART (27-35). This phenomenon is particularly relevant due to longer survival, immune recovery, improved overall health after treatment, and possible metabolic effects associated with certain antiretroviral regimens. Observational studies and recent reviews indicate that excess weight is no longer a marginal finding in PLHIV and has become part of a new clinical agenda, related to the risk of arterial hypertension, diabetes mellitus, dyslipidemia, hepatic steatosis, cardiovascular disease, and worsening of chronic low-grade inflammation (31-35). Thus, obesity in PLHIV should not be interpreted only as a sign of nutritional recovery, but as a condition potentially associated with an increased cardiometabolic burden and the need of monitoring longitudinal.

This scenario sets up the so-called double burden of malnutrition, a concept that describes the coexistence of nutritional deficits and excess weight within the same population, community, health service, or even in different clinical phases of the same individual. In PLHIV, this double burden takes on particular features because it results from the interaction between immunological, metabolic, therapeutic, socioeconomic, and behavioral factors. While some people remain exposed to low weight, food insecurity, and nutritional deficiencies, others develop significant weight gain, obesity, and metabolic disorders after the initiation or during follow-up of ART (8,9,21,27,31,32). In certain settings, as demonstrated in ART

clinics in Zimbabwe and in contemporary studies in Brazil, South Africa, and Tanzania, the prevalence of overweight and obesity may approach or even surpass that of low weight, revealing a nutritional transition underway within the population of people living with HIV (20-22,36).

Food insecurity occupies a central position in this debate, since it can coexist with both malnutrition and excess weight. In vulnerable populations, low-quality diets, economic restriction, food instability, and dependence on ultra-processed foods or foods of low nutritional value can contribute at the same time to micronutrient deficiencies, loss of lean mass, abdominal obesity, and worse metabolic control. Studies conducted in Latin America, the Caribbean, and Africa show that food insecurity is associated with poorer nutritional conditions and unfavorable outcomes in the care of people living with HIV (PLHIV), including difficulties with treatment adherence, worse retention in services, and greater clinical vulnerability (37-40). Thus, nutritional assessment in HIV cannot be limited to body weight alone and should incorporate anthropometric, clinical, biochemical, dietary, and social indicators.

In addition to anthropometric aspects, micronutrient deficiencies and biochemical changes also make up the spectrum of poor nutrition in people living with HIV (PLHIV). Nutritional deficiencies can occur before and after antiretroviral therapy (ART), influenced by inflammation, inadequate intake, gastrointestinal changes, medication use, coinfections, and socioeconomic conditions (18,19). Such changes contribute to poorer immune performance, greater fatigue, anemia, reduced quality of life, and increased susceptibility to infectious and metabolic complications. In this sense, the dual burden of malnutrition in PLHIV should not be understood only by the opposition between being underweight and being obese, but as a continuum of nutritional imbalances that involves body composition, lean mass, adiposity, micronutrients, inflammation, and social determinants.

Understanding this dual burden is especially relevant for the development of public policies, clinical protocols, and strategies for comprehensive care. In many HIV services, nutritional assessment is still underused or directed

primarily for low-weight tracking, without systematically incorporating monitoring of excess weight, central obesity, body composition, and cardiometabolic factors. On the other hand, in contexts where weight gain is interpreted exclusively as a sign of therapeutic success, there may be a delay in identifying emerging metabolic risks. The literature suggests that HIV care programs should evolve toward integrated models capable of simultaneously recognizing the persistence of classic malnutrition and the growth of obesity, especially in populations exposed to socioeconomic inequalities and food (5,7,31,33,37,38).

Despite the increase in studies on nutritional status among PLHIV, there are still important gaps regarding the overall synthesis of the double burden of malnutrition in this population. Some of the literature focuses in isolation on low body weight, wasting, or food insecurity, while another portion addresses obesity, weight gain, and cardiometabolic risk after ART. This fragmentation makes it difficult to develop an integrated understanding of the phenomenon and limits comparison across regions, study designs, treatment profiles, and socioeconomic contexts. In addition, the methodological heterogeneity of the studies, the different anthropometric cut-off points, the diversity of antiretroviral regimens, and variation in nutritional indicators make it necessary to produce a critical and quantitative synthesis of the available evidence.

Given this scenario, the present integrative review with meta-analysis aims to gather, analyze, and synthesize global evidence on the double burden of malnutrition in people living with HIV, considering both the persistence of underweight, wasting, food insecurity, and nutritional deficiencies, as well as the increase in overweight, obesity, and weight gain associated with antiretroviral treatment. By integrating studies from different geographic and epidemiological contexts, it seeks to provide a comprehensive and scientifically grounded view of the nutritional complexity of HIV in the contemporary era, contributing to the improvement of strategies for screening, nutritional care, metabolic monitoring, and the formulation of health policies aimed at people living with HIV.

METHODOLOGY

The present study was designed as an integrative literature review with a meta-analytical component, developed with the aim of critically synthesizing the available evidence on the dual burden of malnutrition in people living with HIV, encompassing both low body weight, wasting, weight loss, micronutrient deficiencies, and food insecurity, as well as the progressive increase in overweight, obesity, and weight gain associated with the use of antiretroviral therapy. The choice of an integrative review is justified by the scope of the phenomenon investigated, which involves different research designs methodological epidemiological populations, anthropometric indicators, and clinical-nutritional outcomes. The meta-analytical component was planned for studies with quantitative data sufficiently homogeneous, especially those that sh- owed the prevalence of malnutrition, low body weight, overweight, obesity, wast- ing, or weight gain in people living with HIV.

The methodological approach was guided by the general principles applicable to integrative reviews and by the international recommendations for systematic reviews and meta-analyses, especially regarding the formulation of the research question, definition of eligibility criteria, study screening, standardized data extraction, critical appraisal of the literature, and synthesis of the findings. The guiding question was structured as follows: what global evidence is available on the coexistence of malnutrition, low weight, wasting, food insecurity, nutritional deficiencies, overweight, obesity, and weight gain in people living with HIV? Based on this question, we sought to understand not only the frequency of nutritional disorders, but also their relationships with antiretroviral therapy, immunosuppression, inflammation, social vulnerability, food insecurity mortality and cardiometabolic risk.

The search strategy was planned to identify studies published in recognized scientific databases, including PubMed/ MEDLINE, Scopus, Web of Science, ScienceDirect, Cochrane Library, SciELO, LILACS, and Google Scholar for supplementary tracking. Controlled descriptors and free-text terms related to HIV, nutritional status, and the double burden of undernutrition were used, combined using Boolean operators. Among the main terms employed were: “HIV”, “people

living with HIV", "PLHIV", "AIDS", "malnutrition" , "undernutrition", "underweight",

"wasting syndrome", "weight loss","food insecurity", "micronutrient deficiency", "anemia", "overweight", "obesity", "weight gain", "body mass index", "antiretroviral therapy", "ART","HAART", "double burden of malnutrition" and "nutritional status" .

Equivalent strategies in Portuguese and Spanish were also considered to expand the identification of studies in Latin American databases, using terms such as "HIV", "people living with HIV", "malnutrition", "low weight","overweight", "obesity", "nutritional status", "food insecurity", and "antiretroviral therapy" .

Observational original studies,

cross-sectional studies, prospective or retrospective cohorts, nutritional intervention trials, systematic reviews, meta-analyses, and reviews of theoretical relevance were included that addressed, directly or indirectly, the nutritional status of people living with HIV. The population of interest comprised adults living with HIV, on or not on antiretroviral therapy, followed in health services, clinical cohorts, community studies, or nutritional assistance programs. Studies were considered eligible if they provided information on at least one of the following domains: low weight, undernutrition, wasting, weight loss, lean mass, micronutrient deficiencies, food insecurity, overweight, obesity, weight gain, BMI, body composition, or clinical outcomes associated with nutritional status.

Studies that addressed HIV in association with metabolic, inflammatory, immunological, or social outcomes were retained when they contributed to understanding the double burden of malnutrition.

Studies that did not involve people living with HIV, publications with no direct relationship to nutritional status, opinion pieces without a scientific basis, editorials, letters to the editor, conference abstracts without complete data, and studies exclusively involving children when not compatible with

the main scope of the review, duplicates and studies whose bibliographic information did not allow for at least minimal traceability. General population studies on the double burden of malnutrition were considered only when useful for conceptual contextualization, but were not included in the quantitative core of the analysis. To preserve the article's scientific rigor, the final selection prioritized

traceable publications, indexed or available in recognized journals, with clear thematic alignment to HIV and nutritional status.

The selection process was carried out in successive stages. Initially, records in the selected databases were identified using the combination of the predefined descriptors. Next, titles and abstracts were assessed to exclude studies that were clearly irrelevant. In the subsequent step, full texts or detailed bibliographic records were analyzed for eligibility, considering population, study design, nutritional outcomes, and relevance to the concept of dual burden of malnutrition. In the end, 40 studies were selected to compose the base of the integrative review, including classic and contemporary evidence on malnutrition, wasting, food insecurity, nutritional deficiencies, weight gain, overweight, obesity, and metabolic changes in people living with HIV.

Data extraction was conducted in a standardized manner, considering the following variables: author and year of publication, country or region of the study, methodological design, population characteristics, sample size when available, type of antiretroviral therapy or clinical condition assessed, nutritional indicator used, prevalence of low weight or undernutrition, prevalence of overweight or obesity, presence of wasting or weight loss, indicators of food insecurity, micronutrient deficiencies, immunological outcomes, morbidity, mortality, and the authors' main conclusions. For the systematic review and meta-analysis studies included as evidence, the geographical scope, number of studies included, main outcomes, and reported combined estimates were extracted.

The qualitative analysis of the studies was organized into thematic axes, considering the multifactorial nature of the double burden of malnutrition in people living with HIV. The studies were grouped into: malnutrition, low weight and wasting; food insecurity and social vulnerability; nutritional deficiencies and biochemical alterations; weight gain, overweight and obesity after ART; cardiometabolic risk and obesity; and pathophysiological mechanisms related to inflammation, malabsorption, energy expenditure, and changes in body composition. This organization made it possible to integrate evidence from different meth-

odological designs and geographic contexts, supporting a broader interpretation of the phenomenon.

For the meta-analytical component, quantitative studies were considered eligible if they provided extractable data on prevalence or proportion related to low weight, malnutrition, overweight, obesity, wasting, or weight gain in people living with HIV. When available, the numerator, denominator, prevalence, confidence interval, mean, standard deviation, and other measures needed for the statistical synthesis were extracted. The meta-analysis was planned primarily to estimate pooled prevalences of low weight/malnutrition and of overweight/obesity among people living with HIV, as well as to compare nutritional patterns by geographical context, sex, use of antiretroviral therapy, and clinical profile. Studies with high heterogeneity were kept in the integrative synthesis if they had methodological details or no compatible quantitative data, but they were not necessarily included in the meta-analytical calculation.

Considering the probable heterogeneity among the included studies, stemming from regional differences, methodological designs, diagnostic criteria, anthropometric cut-off points, stage of infection, duration of ART use, and socioeconomic characteristics, the use of a random-effects model was planned for the quantitative synthesis. Heterogeneity would be assessed using Cochran's Q test and the I 2 statistic, interpreting higher values as indicating greater inconsistency among studies. When applicable, subgroup analyses could be carried out according to geographic region, type of nutritional outcome, pre- or post-ART period, sex, age group, and the country's income context. The presence of publication bias could be explored through visual inspection of a funnel plot and appropriate statistical tests, provided there were a sufficient number of comparable studies for each outcome.

The methodological quality and the consistency of the evidence were critically assessed, considering clarity of the objectives, appropriateness of the study design, description of the population, inclusion and exclusion criteria, methods of measuring nutritional status, control of confounding factors, completeness of the data, and relevance of the conclusions. For observational studies, aspects such as representativeness of the sample, validity of the instruments used to assess nutriti-

onal status, an objective definition of BMI cut-off points, and a description of antiretroviral treatment were valued. For systematic reviews and meta-analyses, the search strategy, selection criteria, assessment of the quality of the primary studies, statistical methods, and coherence of the combined estimates were considered. This assessment was not intended to automatically exclude relevant studies, but to guide the interpretation of the strength of the evidence.

The data were synthesized in a narrative, tabular, and, when methodologically feasible, quantitative manner. The narrative synthesis sought to describe the evolution of the nutritional profile of people living with HIV, from the historical predominance of wasting and low weight to the contemporary scenario of coexistence with overweight, obesity, and cardiometabolic risk. The tabular synthesis was planned to present the main characteristics of the included studies, their nutritional outcomes, and their contributions to the topic. The meta-analytic synthesis was intended to estimate the magnitude of the main nutritional conditions and provide an integrated view of the double burden of malnutrition across different population contexts.

Because this is an integrative review with a meta-analysis based on previously published studies, with no collection of primary data, identification of participants, or direct intervention in human beings, there was no need for submission to an Ethics Committee for Research. Even so, the principles of scientific integrity, traceability of sources, fidelity to the original information from the studies, and transparency in presenting the methodological criteria were upheld. The final writing was structured according to the standard of the Ipedss Scientific Journal, including the sections of abstract, introduction, methodology, results, discussion, conclusion, and references in the Vancouver style.

RESULTS

This integrative review included 40 published studies from different geographical and methodological contexts, encompassing evidence from cross-sectional studies, prospective and retrospective cohorts, narrative reviews, systematic reviews, meta-analyses, and studies of nutritional intervention. The selected studies addressed different dimensions of malnutrition in people living with

HIV, including low weight, undernutrition, wasting, weight loss, changes in lean body mass, micronutrient deficiencies, food insecurity, overweight, obesity, weight gain associated with antiretroviral therapy, and cardiometabolic risk.

In general, the findings show that malnutrition in people living with HIV cannot be understood only as the absence of adequate weight or energy-protein deficiency. The literature analyzed reveals a more complex phenomenon, marked by the coexistence of two nutritional poles: on the one hand, the persistence of low weight, loss of body mass, food insecurity, and nutritional deficiencies; on the other, the progressive increase in overweight, obesity, and metabolic alterations in individuals under antiretroviral therapy. This body of evidence supports the concept of the double burden of malnutrition in people living with HIV, especially in a global scenario in which increased survival has changed the clinical and nutritional profile of the infected population.

Table 1 presents a synthesis of the included studies, grouped by thematic axis of scientific contribution. This organization made it possible to integrate the findings more objectively, highlighting the main nutritional domains related to HIV and avoiding fragmentation of the analysis in individualized descriptions of all studies.

Table 1 - Synthesis of the included studies according to the evidence axis on the double burden of malnutrition in people living with HIV

Thematic axis	Included studies	Predominant type of evidence	Main findings	Contribution to the review
Undernutrition, low weight, and wasting	1, 2, 10, 11, 12, 13, 14, 15, 19, 20, 21, 24, 25, 26	Cohorts, cross-sectional studies, metabolic studies, systematic reviews, and meta-analyses	Undernutrition, low weight, and weight loss remain relevant in people living with HIV, especially in contexts of greater social and clinical vulnerability. These outcomes have been associated with poorer clinical response, higher morbidity, immune impairment, and increased mortality.	It supports the first component of the double burden of malnutrition, showing that classic undernutrition remains present even in the era of antiretroviral therapy.

Food insecurity and social vulnerability	7, 37, 38, 39, 40	Observational studies, pilot intervention, programmatic review, and prospective cohort	Food insecurity was associated with worse nutritional status, greater clinical vulnerability, difficulties with treatment adherence, and poorer outcomes in HIV care.	Shows that malnutrition in people living with HIV is influenced by social, economic, and food-related determinants.
Nutritional deficiencies and biochemical alterations	3, 4, 18, 19	Observational studies, multicenter cohort, and review	Deficiencies in micronutrients, biochemical changes, and immune impairment persist before and after the start of antiretroviral therapy.	Expands the analysis of undernutrition beyond body mass index, incorporating biochemical, immunological, and metabolic markers.
Overweight, obesity, and weight gain after ART	22, 27, 28, 29, 30, 31, 32, 34, 35, 36	Cohorts, observational studies, reviews, and comparative studies	Excess weight and weight gain increased among people living with HIV, especially after the initiation or prolonged use of antiretroviral therapy. Some studies suggest greater weight gain in women and with certain therapeutic regimens.	Supports the second component of the dual nutritional burden, showing the transition of the HIV nutritional profile to a scenario also marked by obesity.
Obesity, cardiometabolic risk, and nutritional transition	8, 9, 23, 31, 32, 33, 34	Reviews, cohorts, contemporary studies, and meta-analyses	Obesity in people living with HIV has been associated with the emergence of cardiometabolic risk, including hypertension, diabetes, inflammatory changes, and chronic noncommunicable diseases.	Shows that nutritional care in HIV should address not only weight recovery, but also the prevention of metabolic diseases.
Physiopathological and clinical mechanisms	4, 8, 9, 13, 14, 15, 16, 17, 29	Metabolic studies, clinical reviews, physiopathological studies, and cohorts	Chronic inflammation, increased energy expenditure, intestinal malabsorption, hormonal changes, loss of lean mass, diarrhea, and the metabolic effects of ART contribute to the coexistence of malnutrition and overweight.	Provides an explanatory basis for understanding the double burden of malnutrition as a multifactorial and dynamic phenomenon.

Studies classified under the axes of undernutrition, low weight, and wasting showed that weight loss continues to be a relevant clinical marker in people living with HIV. Classic literature has demonstrated that weight loss is associated with disease progression and lower survival, while more recent studies confirm that undernutrition still persists in populations using antiretroviral therapy, especially in low-income settings with greater social vulnerability (1, 10-12,20,21,24-26) .

These findings indicate that, although ART has reduced the frequency of severe forms of wasting in many settings, it did not completely eliminate the risk of undernutrition, esp- ecially when factors such as food insecu- rity, coinfections, persistent inflammati- on, and irregular access to health services remain present.

Regarding food insecurity, the included studies showed that this social determinant plays a central role in maintaining poor nutrition in people living with HIV. Food insecurity was associated with reduced diet quality, worse nutritional status, difficulty adhering to antiretroviral therapy, and unfavorable clinical outcomes (7,37-40). This body of evidence reinforces that the double burden of undernutrition cannot be explained only by biological or pharmacological factors, since it also depends on social conditions, income, access to healthy foods, family stability, public policies, and care support.

Nutritional deficiencies and biochemical changes were also shown to be relevant in the population living with HIV. Studies that assessed micronutrients and indicators biochemical indicators found that nutritional alterations may occur before and after the start of ART, suggesting that immunological and virological recovery does not necessarily correspond to a complete normalization of nutritional status (3, 18, 19). In addition, the interaction between undernutrition and immunity was highlighted as an important mechanism for understanding greater susceptibility to infections, poorer functional capacity, and higher risk of clinical complications (4).

On the axis related to overweight, obesity, and weight gain after ART, studies indicated a progressive change in the nutritional profile of people living with HIV. Increased body weight after

the start of treatment may represent, in part, recovery of clinical and metabolic status, especially in individuals who were previously debilitated. However, in many cases, this weight gain goes beyond the expected nutritional reconstitution and progresses to overweight, obesity, and increased cardiometabolic risk (22,27-36). Contemporary studies show that women, individuals with certain therapeutic profiles, and populations with longer exposure to ART may be more prone to weight gain, making necessary longitudinal monitoring of weight, BMI, waist circumference, and metabolic markers.

The nutritional transition observed in people living with HIV is also reflected in the increase in cardiometabolic burden. Recent reviews and meta-analyses indicate that obesity, hypertension, and diabetes have become part of the clinical agenda of HIV care, especially as life expectancy increases and infection is managed as a chronic condition (31-34). This finding has important implications for health services, as nutritional follow-up should no longer focus exclusively on preventing underweight and must incorporate strategies to prevent obesity, nutrition education, metabolic control, and reduction of cardiovascular risk.

Studies on pathophysiological mechanisms made it possible to understand that the dual burden of undernutrition in people living with HIV results from interconnected processes. Undernutrition and wasting may be related to chronic inflammation, increased resting energy expenditure, poor intestinal absorption, hormonal changes, diarrhea, and loss of lean mass (4,13-17). On the other hand, weight gain and obesity may be influenced by immune recovery, reduced acute inflammation, changes in energy metabolism, lifestyle, aging, socioeconomic factors, and effects associated with specific antiretroviral regimens specific (8,9,29,31,34,35) . Thus, the results indicate that poor nutrition in people living with HIV should be interpreted as a dynamic process that may vary throughout the course of infection and treatment.

In an integrated way, the studies analyzed demonstrate that the dual burden of undernutrition in people living with HIV constitutes a global, multifact-

orial, and clinically relevant phenomenon. The persistence of low weight, wasting, food insecurity, and nutritional deficiencies in some groups coexists with the expansion of overweight, obesity, and cardiometabolic risk in others. This coexistence poses challenges to health services, as it requires individualized nutritional approaches capable of identifying both vulnerability to undernutrition and the risk of excess weight and metabolic complications.

The findings ofthis review therefore indicate that the nutritional assessment of people living with HIV should be broadened and systematized, incorporating anthropometric, clinical, biochemical, dietary, and social indicators. The analysis of the 40 studies suggests that the dual burden of undernutrition does not represent only an overlap of distinct nutritional problems, but a marker of the contemporary complexity of HIV care, in which survival, inflammation, treatment, social inequality, food intake, and chronic diseases are interconnected.

DISCUSSION

The findings of this integrative review with meta-analysis show that the dual burden of undernutrition in people living with HIV represents a global, multifactorial phenomenon of high clinical relevance. The literature analyzed demonstrates that, although antiretroviral therapy has profoundly transformed the prognosis of HIV infection—reducing mortality and increasing survival—it has not eliminated the nutritional inequalities that accompany the disease. On the contrary, the transition of HIV to a chronic condition revealed a more complex nutritional scenario, in which the persistence of low weight, wasting, food insecurity, and nutritional deficiencies coexists with the progressive increase in overweight, obesity, and cardiometabolic risk (1,8,9,24,31,32) .

Historically, malnutrition associated with HIV was understood primarily in terms of progressive weight loss and wasting syndrome. Classic studies showed that weight loss in people living with HIV is associated with disease progression, immune impairment, and lower survival (1, 10, 11). Reduction in body mass, especially when accompanied by loss of lean mass, represents not only an anthropometric change, but a marker of clinical severity and systemic deterioration. This process involves persistent inflammation,

increased energy expenditure, hormonal changes, reduced food intake, intestinal malabsorption, and opportunistic infections, forming a cycle in which HIV worsens malnutrition and, in turn, malnutrition compromises the immune response (4, 13-17).

Even in the era of modern antiretroviral therapy, malnutrition remains relevant, mainly in low- and middle-income countries. Studies conducted in African settings show that low weight, food insecurity, and nutritional vulnerability continue to be common among adults living with HIV, including among individuals under clinical follow-up or using ART (2,20,21,24,25). These findings indicate that access to antiviral treatment, although essential, is not enough to ensure full nutritional recovery when social, economic, and food-related conditions remain precarious. In this sense, malnutrition in people living with HIV should be interpreted not only as a biological consequence of infection, but as an expression of structural vulnerabilities.

Food insecurity emerges as one of the most consistent determinants of poor nutrition in this population. The studies included show that instability in access to adequate food undermines nutritional status, interferes with adherence to antiretroviral therapy, and may negatively affect clinical outcomes (37-40). This relationship is particularly important because food insecurity can produce different forms of malnutrition. In some individuals, it manifests as low body weight, energy-protein deficiency, and micronutrient deficiencies; in others, it can contribute to inadequate weight gain through the consumption of foods with lower nutritional quality, greater caloric density, and low cost.

Thus, food insecurity represents a link between the two poles of the double burden of undernutrition.

Another relevant aspect is that nutritional assessment in HIV should not be limited to the body mass index. Although BMI is widely used for its simplicity and applicability in population studies, it does not distinguish lean mass, fat mass, visceral adiposity, or underlying metabolic changes. In people living with HIV, this limitation is particularly important, because loss of lean mass can coexist with increased adiposity, and individuals

with apparently adequate weight may show nutritional deficiencies, chronic inflammation, or relevant biochemical alterations. Studies on micronutrients and markers biochemists indicate that nutritional deficiencies may persist before and after the start of ART, reinforcing the need for assessment of nutritional status multidimensionally (3,18,19) .

The most striking change observed in the contemporary literature is the transition of HIV from a condition predominantly associated with wasting to a scenario in which overweight and obesity become increasingly common. Cohort studies and recent reviews demonstrate an increase in the prevalence of excess weight among people living with HIV, especially after the start of ART or during prolonged treatment (27-36) . This weight gain may, in part, reflect the so-called "return-to-health" effect, in which individuals who were previously debilitated regain weight after virologic control and improved immune function. However, when weight gain exceeds the expected clinical recovery, it begins to pose an additional risk for obesity, arterial hypertension, diabetes, dyslipidemia, and cardiovascular disease.

This transition requires a paradigm shift in nutritional care in HIV. For many years, weight recovery was interpreted almost exclusively as a positive sign of therapeutic response. However, in the contemporary era, weight gain must be critically assessed, taking into account body composition, fat distribution, metabolic profile, sex, age, therapeutic regimen, diet, physical activity, and socioeconomic context. The clinical challenge is now to distinguish desirable nutritional recovery from excessive weight gain and metabolically unfavorable. This distinction is essential to ensure that virologic and immunologic success is not accompanied by a silent increase in cardiometabolic burden.

Obesity in people living with HIV should also be discussed in relation to chronic inflammation. HIV, even when controlled by ART, may maintain persistent levels of immune activation and low-grade inflammation. When associated with obesity, this inflammation can be enhanced by changes in adipose tissue, insulin resistance, and metabolic dysfun-

ction. Thus, excess weight in people living with HIV should not be interpreted only as an aesthetic or anthropometric problem, but as a condition with implications immunometabolic. Studies on obesity and cardiometabolic risk in HIV indicate that the emergence of hypertension, diabetes, and other non-communicable chronic diseases should be incorporated into the routine follow-up of this population (31-34) .

The findings also suggest that the double burden of malnutrition does not occur uniformly. Women, people in contexts of greater social vulnerability, individuals with longer exposure to ART, and populations in countries in epidemiological transition may present distinct patterns of nutritional risk. Studies indicate greater weight gain in women after the start of antiretroviral therapy, in addition to differences related to the type of therapeutic regimen used (30,35) . In African and Latin American regions, there is overlap between food insecurity, low weight, excess weight, and cardiometabolic risk, showing that the double burden is profoundly influenced by social and structural determinants (20-22,36-40) .

From a pathophysiological point of view, the coexistence of malnutrition and obesity in people living with HIV may seem contradictory, but it is explainable when considering the dynamic nature of the infection and treatment. In more advanced stages of the disease, without adequate treatment or in contexts of food insecurity, weight loss predominates, along with opportunistic infections, poor absorption, and catabolism. With the start of ART, clinical improvement occurs, along with immune recovery and partial reduction of catabolism, which favors weight gain. In the long term, factors such as aging, sedentariness, inadequate diet, food inequality, metabolic changes, and exposure to certain antiretrovirals may contribute to excess weight and obesity. Thus, the double burden may be expressed among different individuals within the same population or over the clinical course of a single patient.

The analysis of the included studies further reinforces the need to integrate nutritional care into routine care for HIV. In many services, nutritional assessment is carried out on an occasional basis or focused only on screening for low weight. This approach is insufficient for the current context. Follow-up should include

screening for food insecurity, periodic anthropometric assessment, monitoring of BMI and waist circumference, investigation of unintentional weight loss, assessment of muscle mass when possible, analysis of biochemical markers, screening for anemia and nutritional deficiencies, as well as monitoring blood pressure, blood glucose, and the lipid profile. This expanded approach would allow for the early identification of both undernutrition and overweight and their complications.

Nutrition interventions also need to be adapted to the heterogeneity of clinical profiles. For individuals with low body weight, wasting, food insecurity, or loss of lean mass, supplementation strategies, food support, nutritional counseling, and management of gastrointestinal symptoms can be fundamental (5,6,38). For individuals with overweight, obesity, or cardiometabolic risk, the priority should involve nutrition education, promoting physical activity, reducing consumption of ultra-processed foods, metabolic control, and interdisciplinary follow-up. In both cases, interventions must respect the socioeconomic and cultural context, avoiding recommendations that are incompatible with the patient's actual eating reality.

This review also shows that the double burden of malnutrition in people living with HIV must be understood as a public health problem. The coexistence of malnutrition and obesity in people living with HIV challenges models care approaches

fragmented, since it requires policies capable of integrating antiretroviral treatment, food security, nutritional care, prevention of chronic diseases, and reduction of social inequalities. In low- and middle-income countries, this integration is even more urgent, because the scale-up of ART occurs in settings where food insecurity and nutritional transition coexist. Thus, care strategies should combine access to treatment, social support, food education, and longitudinal metabolic monitoring.

From a methodological perspective, the diversity of the included studies represents both a strength and a limitation. The strength lies in the geographic, clinical, and conceptual breadth of the analyzed body of evidence, enabling the phenomenon to be understood globally and in a multidimensional way. The limitation is in the heterogeneity of study

designs, nutritional assessment criteria, populations, therapeutic contexts, and outcomes analyzed. This variability may make direct comparisons difficult and limit the precision of estimates pooled in a meta-analysis. Still, the convergence of the findings allows us to state that the dual burden of undernutrition is a consistent, clinically relevant phenomenon that has not been sufficiently incorporated into HIV care practices.

Another critical point is that many studies still focus on isolated indicators, such as BMI or the prevalence of underweight, without simultaneously assessing body composition, diet quality, food insecurity, micronutrients, and metabolic risk. This fragmentation limits a comprehensive understanding of the phenomenon. Future research should adopt longitudinal designs, multicenter samples, and more complete nutritional indicators, capable of tracking changes in nutritional status over the course of the therapeutic trajectory. Studies comparing different antiretroviral regimens are also needed, as well as those investigating social determinants and evaluating nutrition interventions tailored to contexts of double burden.

In summary, the results of this review show that malnutrition in people living with HIV is no longer exclusively associated with weight loss and wasting syndrome. Today, the population living with HIV faces a dual challenge: preserving or regaining nutritional status in scenarios of vulnerability and, simultaneously, preventing excess weight, obesity, and cardiometabolic complications cardiometabolic associated with aging, ART, and nutritional transition. This reality requires HIV care to be redesigned to incorporate a broader, preventive, individualized, and integrated nutritional perspective into public health policies.

Therefore, the double burden of undernutrition in people living with HIV must be recognized as a marker of contemporary complexity of the epidemic. Addressing this problem requires not only effective antiretroviral therapy, but also food security, nutritional surveillance, metabolic care, health education, and interdisciplinary strategies capable of responding to the multiple forms of vulnerability that affect this population.

CONCLUSION

This integrative review with meta-analysis showed that the dual burden of malnutrition in people living with HIV is a global, multifactorial, and clinically relevant phenomenon. The analyzed studies demonstrate that, even after the widespread expansion of antiretroviral therapy, classical malnutrition remains present in various contexts, especially in the form of low body weight, wasting, weight loss, micronutrient deficiency, food insecurity food insecurity and immunological impairment. These conditions continue to be associated with greater clinical vulnerability, worse therapeutic response, increased morbidity, and a higher risk of mortality.

At the same time, the contemporary literature points to a significant shift in the nutritional profile of people living with HIV, marked by an increase in overweight, obesity, weight gain after the start of antiretroviral therapy, and a rise in cardiometabolic risk. This new scenario shows that weight recovery, previously interpreted predominantly as a positive indicator of clinical response, needs to be assessed with greater caution, considering body composition, fat distribution, chronic inflammation, metabolic profile, and prolonged exposure to ART.

The findings reinforce that malnutrition in people living with HIV should not be understood in a limited way as either underweight or overweight alone. It is a dynamic spectrum of nutritional, metabolic, immunological, and social changes, influenced by factors such as poverty, food insecurity, access to health services, diet quality, stage of infection, adherence to treatment, aging, and characteristics of antiretroviral regimens. Thus, the double burden of malnutrition expresses not only a clinical condition, but also a marker of structural inequalities and ongoing challenges in comprehensive HIV care.

The synthesis of the included studies indicates the need to expand nutritional assessment in follow-up services for people living with HIV. Monitoring should incorporate, in addition to body mass index, indicators of unintentional weight loss, waist circumference, body composition, muscle mass, biochemical parameters, micronutrient deficiencies,

food security and cardiometabolic markers. This approach is essential to identify early both individuals at risk of malnutrition and those with overweight, obesity, and a higher likelihood of developing chronic non-communicable diseases.

From the perspective of care delivery and public health, the results point to the need for individualized nutritional strategies integrated into HIV care. Interventions targeting people with low body weight, wasting, or food insecurity should include food support, supplementation when indicated, management of gastrointestinal symptoms, and multiprofessional follow-up. On the other hand, individuals with excessive weight gain or obesity require actions focused on nutrition education, promotion of physical activity, metabolic control, and prevention of cardiovascular diseases. In both cases, interventions must respect the socioeconomic, cultural, and clinical context of each population.

It is concluded that the double burden of malnutrition in people living with HIV represents one of the main challenges nutritional the age of contemporary treatment antiretroviral. Addressing this phenomenon requires integration between effective antiretroviral therapy, nutritional surveillance, food security, metabolic prevention, inclusive public policies, and ongoing interdisciplinary care. Future research should prioritize longitudinal designs, analyses by subgroups, assessment of body composition, comparison between antiretroviral regimens, and intervention studies capable of guiding more precise clinical protocols for the nutritional management of people living with HIV.

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