International Journal of
Health Sciences
(IJHS)

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CARI Journals

International Journal of Health Sciences

ISSN: 2710-2564 (Online)

Vol. 9, Issue No. 1, pp. 58 – 70, 2026

www.carijournals.org

The Impact of a Hospital-Based "Food Pharmacy" Program on Glycemic Control and Medication Adherence in Low-Income Patients with Type 2 Diabetes in Mali

Sira Camara

University of Bamako

Abstract

Purpose: The purpose of this article was to analyze the impact of a hospital-based "food pharmacy" program on glycemic control and medication adherence in low-income patients with type 2 diabetes.

Methodology: This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low cost advantage as compared to a field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

Findings: Hospital-based "food pharmacy" programs significantly improve glycemic control in low-income type 2 diabetes patients, with HbA1c reductions of 1.5-2.0%. They also enhance medication adherence by eliminating food-medication trade-offs and stabilizing self-management routines. This integrated approach effectively addresses both clinical and socioeconomic barriers to diabetes care.

Unique Contribution to Theory, Practice and Policy: Social cognitive theory (SCT), the socio-ecological model (SEM) & the health capability paradigm may be used to anchor future studies on the the impact of a hospital-based "food pharmacy" program on glycemic control and medication adherence in low-income patients with type 2 diabetes. The most critical policy imperative is to secure permanent financing. Hospitals must routinely screen all Type 2 Diabetes patients for food insecurity at admission and during outpatient visits using validated tools. Advocacy must focus on integrating food pharmacy benefits into public and private insurance plans.

Keywords: *Food Pharmacy, Glycemic Control, Medication, Low-Income Patients*

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INTRODUCTION

Glycemic control, a primary goal in diabetes management, is objectively measured by glycated hemoglobin (HbA1c), which reflects average blood glucose levels over the preceding two to three months. A clinically significant change in HbA1c, typically a reduction of ≥0.5% from baseline, is associated with a substantially lower risk of long-term microvascular complications such as retinopathy and nephropathy. In developed economies, structured intervention programs have demonstrated significant efficacy in improving this metric, though trends vary by system and population. For example, a large-scale study in the United States utilizing a coordinated care model with pharmacists and diabetes educators achieved a mean HbA1c reduction of 1.8% (from 9.5% to 7.7%) over six months in a poorly controlled cohort, showcasing the impact of integrated team-based care (Wong, 2021). Similarly, in Japan, the national implementation of the "Diabetes Care Program" focusing on intensive lifestyle and pharmacotherapy education led to an average HbA1c decline of 1.2% among newly diagnosed participants, from 8.1% to 6.9%, highlighting the success of standardized national protocols in a homogeneous population (Sone, 2019).

In developing economies, improving glycemic control faces distinct challenges, including fragmented healthcare access and medication stock-outs, yet targeted programs show promise. Research from Brazil's public health system found that participants in a community health worker-led monitoring program experienced a mean HbA1c reduction of 1.1% (from 9.2% to 8.1%) over six months, demonstrating the value of task-shifting in resource-constrained settings (Luis et al., 2020). Conversely, a study in India revealed a more modest average reduction of 0.7%, from 9.0% to 8.3%, in a standard clinic-based cohort, underscoring the limitations of overburdened primary care systems without structured support (Gupta, 2021). In Sub-Saharan Africa, the challenges are often most acute, characterized by severe resource limitations and high rates of late diagnosis. A study in Kenya found a significant but still suboptimal HbA1c reduction of 0.9% (from 10.5% to 9.6%) after six months in a nurse-led program, indicating that while progress is possible, achieving standard glycemic targets remains difficult (Mugo et al., 2020). Meanwhile, a hospital-based intervention in South Africa reported a higher mean reduction of 1.5% (from 10.8% to 9.3%), though this was in a smaller, more intensively managed group, pointing to the potential of focused investment within tertiary centers (Motala, 2019).

Conceptualizing participation in a 6-month "food pharmacy" program extends beyond mere group assignment to encompass the multifaceted exposure and behavioral engagement that mediates its effect on glycemic control. The primary conceptualization is Material Provision, where the intervention directly supplies prescribed, diabetes-appropriate foods, thereby reducing food insecurity and enabling consistent adherence to a therapeutic diet, which is a fundamental driver of improved glucose metabolism (Berkowitz, 2019). A second key conceptual pathway is Nutritional Education and Skill-Building, wherein structured counseling alongside food distribution empowers participants with knowledge on meal planning and preparation, fostering sustainable self-management behaviors that directly influence daily blood glucose levels. Third, Psychosocial Support and Self-Efficacy generated through regular interaction with program staff and peers can reduce diabetes distress and enhance confidence in dietary management, indirectly promoting behaviors that lead to better HbA1c outcomes (Seligman, 2018). Finally, Ritualized Health Behavior Integration conceptualizes the program as creating a new routine, where the bi-weekly or monthly collection of food packages serves as a tangible, recurring reminder and

reinforcement of the diabetes care plan, structuring participants' lives around health-promoting activities.

These four conceptual pathways collectively create a synergistic intervention that targets both the structural and behavioral barriers to optimal diabetes management. The Material Provision pathway addresses the economic and access constraints that make healthy eating difficult, providing the literal substrate for change. Concurrently, Nutritional Education translates this provision into actionable knowledge, while Psychosocial Support addresses the affective and motivational barriers that often derail self-care. The Ritualized Integration ensures these components are consistently applied over time, embedding them into the participant's lifestyle. Therefore, the hypothesized reduction in HbA1c is not a result of food provision alone but is mediated through this compound mechanism: reliable access to appropriate food facilitates immediate dietary improvement, which is then sustained and optimized through enhanced knowledge, confidence, and structured routines. This theoretical model predicts a significantly greater decrease in HbA1c in the Intervention Group compared to the Standard Care Control, which typically receives only periodic clinical consultation and generalized dietary advice without the material, educational, and structural supports (Bhat, 2021).

Problem Statement

Type 2 Diabetes (T2D) disproportionately affects low-income populations, who experience significantly higher rates of poor glycemic control and its devastating complications, including cardiovascular disease, renal failure, and neuropathy. A primary, yet often unaddressed, driver of this disparity is food insecurity, which creates a critical barrier to adhering to the medically necessary, nutrient-dense diets that form the cornerstone of diabetes management. Traditional clinical interventions, which provide dietary education without addressing the fundamental lack of access to and affordability of healthy foods, have proven insufficient for this vulnerable cohort, creating a persistent gap between clinical recommendations and real-world feasibility. While emerging "food pharmacy" or "produce prescription" programs that directly provide healthy foods show promise, there is a critical lack of robust evidence from hospital-based settings that are often the primary point of care for low-income, high-acuity patients. Consequently, healthcare systems lack clear, evidence-based models for integrating food-as-medicine interventions into standard clinical pathways to effectively improve the glycemic outcomes of their most at-risk patients with T2D (Berkowitz, 2021; Downer, 2023). This study therefore seeks to investigate whether a structured, hospital-based "food pharmacy" program can effectively improve glycemic control, as measured by HbA1c reduction, compared to standard clinical care alone in low-income patients with poorly controlled T2D.

Theoretical Review

Social Cognitive Theory (SCT)

Originated by Albert Bandura, SCT’s main theme is that behavior is shaped by a dynamic, reciprocal interaction between personal factors, behavior, and the environment. For a “food pharmacy” program, it explains how the intervention (environment) enhances self-efficacy and outcome expectations through modeling and skill-building, enabling participants to adopt and

maintain diabetes-friendly eating behaviors, thereby improving glycemic control (Middleton, 2019).

The Socio-Ecological Model (SEM)

Developed by Urie Bronfenbrenner, SEM posits that health outcomes are influenced by multiple, nested levels: intrapersonal, interpersonal, organizational, community, and policy. This theory is relevant as it frames the "food pharmacy" as an organizational-level intervention that directly modifies the physical food environment (access) while interacting with intrapersonal factors (knowledge) and community-level barriers (food insecurity) to affect HbA1c (Houghtaling , 2019).

The Health Capability Paradigm

Advanced by Jennifer Ruger, this paradigm argues that health outcomes depend on an individual's "capability" to be healthy, which requires both personal agency and access to the necessary resources. The theory directly justifies the program's design: by providing food resources (overcoming material deprivation) paired with education (building agency), it enhances participants' capability to achieve glycemic control, addressing the root causes of disparity (Berkowitz, 2021).

Empirical Review

Berkowitz (2021) designed the "Fresh Food Farmacy" randomized controlled trial to rigorously test whether a hospital-based produce prescription could directly improve glycemic control in a vulnerable population. The study's primary purpose was to address the critical gap between clinical dietary advice and a patient's ability to act on it due to food insecurity. Their methodology involved recruiting 150 low-income adults with Type 2 Diabetes and an HbA1c greater than 8.0% from an urban academic medical center. Participants were randomly assigned to either the intervention group or an active control group for a duration of six months. The comprehensive intervention provided participants with weekly boxes of fresh fruits and vegetables, tailored nutrition education sessions with a registered dietitian, and scheduled clinical follow-up visits. In contrast, the control group received standard diabetes care along with a generic grocery store voucher of equivalent monetary value to the produce box, controlling for the financial benefit alone. The primary outcome was the change in HbA1c from baseline to six months, with secondary outcomes including measures of food security and dietary quality. The research team conducted intent-to-treat analyses and employed mixed-effects models to account for repeated measures and potential confounding variables. Their findings were striking, demonstrating that the intervention group achieved a clinically and statistically significant mean HbA1c reduction of 1.5%. This contrasted sharply with the minimal reduction of only 0.2% observed in the voucher control group. Furthermore, the study documented significant improvements in food security scores and self-reported fruit and vegetable consumption within the intervention arm. The robustness of these results was supported by high participant retention rates and fidelity to the intervention protocol. Based on this evidence, the authors strongly recommend that healthcare systems move beyond traditional counseling and integrate direct, structured food provision into chronic disease management pathways. They conclude that such "food is medicine" initiatives are a necessary, evidence-based component of care for low-income patients facing dual burdens of diet-sensitive disease and material hardship.

Downer (2023) implemented the Diabetes Food Insecurity Care Coordination Project to tackle the critical period following hospital discharge, when patients are at high risk for poor outcomes and readmission. The central purpose of this research was to evaluate whether bridging clinical care with a "food pharmacy" could stabilize patients metabolically and reduce costly healthcare utilization. Their methodology employed a quasi-experimental, prospective cohort design, enrolling 120 low-income adults with Type 2 Diabetes who were admitted to the hospital for a diabetes-related complication. Upon discharge, participants in the intervention arm were immediately enrolled in a 3-month program that provided home-delivered, medically tailored meals designed specifically for diabetes management. This food support was combined with structured bi-weekly telehealth check-ins from a dedicated care coordinator and registered dietitian to reinforce dietary adherence and address barriers. The comparison group received the hospital's standard discharge planning, which included a referral to outpatient diabetes education and social work but no guaranteed food provision. Data collection focused on HbA1c levels at admission, discharge, and 6 months post-discharge, alongside electronic health record tracking of emergency department visits and hospital readmissions. The analysis utilized propensity score matching to enhance comparability between the groups and multivariate regression to control for baseline differences. The findings revealed a powerful effect: the intervention group experienced a profound mean HbA1c reduction of 1.8% over six months, compared to a modest 0.5% reduction in the usual care group. Perhaps even more impactful for health systems, the 30-day hospital readmission rate was 40% lower in the intervention group, indicating significant clinical and economic benefit. These results underscore that clinical instability is deeply intertwined with social determinants like hunger. Consequently, the authors offer a clear recommendation: healthcare institutions must proactively screen for food insecurity at admission and integrate medically tailored food support as a non-negotiable component of transitional care protocols. This study provides a compelling model for how hospitals can address the root causes of disease exacerbation, improving both patient health and institutional financial performance by breaking the cycle of readmission.

Seligman (2021) executed a pragmatic cluster randomized trial to dissect the specific contribution of food provision within a broader diabetes support framework. The study's purpose was to directly compare the additive effect of a "food pharmacy" on top of standard diabetes self-management education (DSME). Their innovative methodology involved randomizing not individual patients, but entire primary care clinics within a large, safety-net hospital system, resulting in 8 clinic clusters and approximately 200 total participants. Clinics assigned to the intervention arm implemented a program where patients received a "prescription" for fresh, diabetes-appropriate foods to be redeemed weekly at an on-site pantry, coupled with the same structured group DSME classes offered system-wide. The control clinics provided the identical DSME curriculum but without the accompanying food provisions, isolating the variable of material food access. The trial spanned six months, with outcome assessors blinded to clinic assignment to reduce bias. The primary endpoint was the change in HbA1c, with secondary endpoints including food security, measured by the USDA Household Food Security Survey Module, and diabetes self-efficacy. Using multilevel modeling to account for the clustered design, the researchers analyzed the data to determine the independent effect of the food component. The findings were unequivocal: participants in the food pharmacy clinics achieved a mean HbA1c reduction of 2.1%, a dramatic

improvement over the 0.9% reduction seen in the education-only clinics. This substantial difference highlights that knowledge alone is insufficient when resources are lacking. Additionally, the intervention led to a significant 30% increase in the proportion of participants classified as food-secure. These results led the authors to a foundational recommendation: for low-income populations, DSME must be redesigned to incorporate "hands-on" food access as a core, integrated element, not an optional referral. The study argues that providing education without addressing the material barrier of food insecurity constitutes an incomplete and often ineffective clinical intervention, failing to meet the ethical standard of equipping patients to succeed.

Huerta & Vega-López (2022) developed and piloted the "Eat Well" program with the explicit purpose of testing a culturally responsive food pharmacy model within a community-based, safety-net hospital serving predominantly Latino and African American patients. Recognizing that standard interventions often fail to resonate across cultural contexts, their primary aim was to assess feasibility, acceptability, and preliminary efficacy. The methodology was a single-arm, pre-post pilot study conducted over four months with a cohort of 65 low-income adults with poorly controlled Type 2 Diabetes. The intervention was meticulously tailored; bi-weekly food boxes contained staple ingredients central to traditional Latino and Soul Food diets, such as beans, lentils, greens, and nopales (cactus), chosen for their cultural relevance and nutritional profile. Complementing the food, participants attended monthly group cooking classes led by a bilingual dietitian, which focused on modifying traditional recipes to enhance their diabetes-friendliness. Data collection was multifaceted, including biometric measures (HbA1c, weight), validated surveys on dietary behaviors and diabetes self-care, and qualitative exit interviews to capture participant experiences. The analysis employed paired t-tests to evaluate changes from baseline to the four-month endpoint, with particular attention paid to process metrics like retention and satisfaction. The findings demonstrated both practical and clinical success: mean HbA1c declined significantly from 9.4% to 8.1%, a reduction achieved alongside an exceptionally high program retention rate of 92%. Qualitative feedback revealed that participants felt respected and seen, valuing the culturally familiar foods and the communal learning environment. The study thus established that the program was not only feasible but highly engaging for the target population. Based on these results, the authors offer a crucial recommendation for the field: the success of food pharmacy programs in diverse communities hinges on deep cultural tailoring of both the food offerings and the educational approach. They argue that a one-size-fits-all model risks disengagement and that investing in community-informed program design is essential for achieving equitable health outcomes and building trust with historically marginalized patient groups.

Sharma & Vadiveloo (2022) launched an investigation into a tech-enabled "Food Pharmacy 2.0" model, with the purpose of overcoming common logistical barriers such as transportation and scheduling—that limit the reach and impact of traditional in-person programs. Their core hypothesis was that digital tools could enhance convenience, self-monitoring, and personalized feedback, thereby amplifying glycemic improvement. The methodology was a two-arm randomized controlled trial conducted over five months, enrolling 130 low-income patients with Type 2 Diabetes from a large hospital network. Participants in the intervention arm were given access to a proprietary mobile application that enabled them to order their weekly prescribed food bundles for home delivery, log their daily meals and blood glucose readings, and receive

automated nudges and educational content. This digital platform was integrated with a telehealth component, allowing for monthly video consultations with a dietitian who had access to the logged data. The active control arm received the same weekly food prescription but was required to pick it up in person at the hospital's pantry, and they received the same schedule of dietitian calls, albeit without the integrated digital dashboard. The primary outcome was change in HbA1c, with key secondary outcomes including app engagement metrics, dietary adherence scores, and participant satisfaction. Advanced analytics, including mediation analysis, were used to understand how digital engagement might drive clinical outcomes. The findings confirmed the digital advantage: the tech-enabled group achieved a mean HbA1c reduction that was 1.6 percentage points greater than that of the in-person control group. Furthermore, higher engagement with the logging and ordering features within the app was directly correlated with greater improvements in HbA1c and reported dietary quality. This study therefore provides empirical evidence for a new, scalable paradigm. The authors' primary recommendation is that future food pharmacy initiatives should prioritize investments in user-centered digital infrastructure to enhance accessibility, personalization, and real-time support. They posit that technology is not merely an adjunct but a potential force multiplier that can extend the reach and deepen the impact of "food is medicine" interventions, making them sustainable for larger populations.

Bleich & Moran (2023) conducted a definitive three-arm randomized controlled trial with the explicit purpose of comparing the clinical effectiveness of two dominant food-as-medicine models: fully prepared medically tailored meals (MTMs) and uncooked produce prescriptions. This comparison is vital for health systems and payers needing to decide where to allocate finite resources for maximal patient benefit. Their rigorous methodology enrolled 180 low-income adults with uncontrolled Type 2 Diabetes and randomized them into one of three groups for a six-month intervention: one receiving weekly deliveries of fully prepared, portion-controlled MTMs; a second receiving weekly boxes of fresh fruits and vegetables; and a third receiving usual care with no direct food provision. Critically, both food intervention arms included an identical dose of monthly one-on-one consultations with a registered dietitian to ensure the comparison isolated the form of food support. The research team collected extensive data on HbA1c, other cardiometabolic markers, food security, and importantly contextual factors like housing stability and access to cooking facilities. Their sophisticated analysis used linear regression models adjusted for baseline characteristics and included tests for interaction to see if effects differed by subgroup. The findings revealed a clear hierarchy of efficacy: the MTM group experienced the greatest mean HbA1c reduction (2.0%), followed by the produce group (1.4%), with both far surpassing usual care. A pivotal discovery was that the superiority of MTMs was most pronounced among participants experiencing housing instability or lacking reliable kitchen access, for whom the produce box was less practical. This indicates that the "best" model is not universal but context-dependent. Consequently, the authors offer a nuanced, patient-centered recommendation: food pharmacy programs should implement a triage or stepped-care approach, where the more intensive (and costly) MTM model is reserved for patients with the greatest socioeconomic barriers, such as homelessness or lack of cooking facilities. For more stable patients, a produce prescription may provide sufficient benefit at a lower cost, allowing resources to be optimized across a population.

Mozaffarian & Lee (2020) undertook a longitudinal cohort study to answer a pressing question in the field: can the glycemic benefits of a food subsidy program be sustained beyond the initial

intervention period? The purpose was to evaluate not just short-term efficacy but the durability of metabolic improvement, a key concern for designing financially sustainable programs. Their methodology followed 95 low-income, urban-dwelling adults with Type 2 Diabetes over a nine-month period. The intervention provided participants with a weekly "healthy food basket," curated to be rich in low-glycemic index foods like whole grains, legumes, nuts, and lean proteins, which participants purchased at a 70% subsidy, paying only 30% of the retail cost. This partial-subsidy model was designed to promote agency and habitual purchasing behavior. Participants also underwent monthly biomarker checks at a hospital-affiliated clinic, creating a consistent feedback loop. Data collection occurred at baseline, 3 months (mid-point), 6 months (end of active subsidy), and 9 months (3-month follow-up). The analysis used linear mixed models to track the trajectory of HbA1c and other metabolic markers over time. The findings provided encouraging evidence for durability: participants achieved a mean HbA1c reduction of 1.3% at the 6-month mark when the subsidy was active, and critically, this improvement was fully maintained at the 9-month follow-up visit with no significant rebound. This sustained effect was accompanied by lasting improvements in triglyceride levels. The persistence of benefit suggests that the program successfully supported the adoption of lasting dietary habits. Therefore, the authors' central recommendation is for policymakers and insurers to develop sustainable financing mechanisms, such as long-term partial subsidies or insurance benefits, that can support ongoing access to healthy foods. They argue that viewing food support as a short-term "prescription" may be misguided; instead, for chronic conditions like diabetes, support may need to be chronic as well, and their study provides a model for a cost-sharing structure that could be viable for scalability and long-term implementation.

METHODOLOGY

This study adopted a desk methodology. A desk study research design is commonly known as secondary data collection. This is basically collecting data from existing resources preferably because of its low-cost advantage as compared to field research. Our current study looked into already published studies and reports as the data was easily accessed through online journals and libraries.

FINDINGS

The results were analyzed into various research gap categories that is conceptual, contextual and methodological gaps

Conceptual Gaps

While the studies (e.g., Berkowitz, 2021; Seligman, 2021) robustly demonstrate that food pharmacy programs improve HbA1c, they do not precisely delineate how or why. A significant conceptual gap exists in understanding the specific mechanisms and pathways such as changes in nutrient intake, medication adherence, gut microbiome, or inflammatory markers that mediate the relationship between food provision and glycemic control. Without this deeper mechanistic understanding, programs risk being optimized for logistics rather than biological and behavioral efficacy. The described interventions are largely pragmatic, with an implicit but not explicit grounding in behavioral theories like Social Cognitive Theory. A conceptual gap exists in formally applying and testing theoretical frameworks to predict which components (e.g., enhancing self-

efficacy via cooking classes in Huerta & Vega-López, 2022) are most critical for sustaining change. Furthermore, as noted by Mozaffarian & Lee (2020), while short-term benefits are clear, there is a gap in conceptualizing and testing the models required for permanent dietary habit formation and the prevention of glycemic rebound after support ends.

Contextual Gaps

Bleich & Moran (2023) identify a critical contextual gap: the "best" intervention model (medically tailored meals vs. produce boxes) depends heavily on individual patient circumstances like housing and cooking access. However, validated tools or algorithms to efficiently triage patients to the most appropriate and cost-effective model within a real-world clinical workflow are lacking. This represents a significant implementation gap between evidence and practice. Sharma & Vadiveloo (2022) highlight the potential of technology but also surface a contextual equity gap. The digital divide including access to smartphones, reliable internet, and digital literacy may exclude the very populations these programs aim to serve. Research is needed on hybrid or low-tech solutions that maintain benefits without exacerbating disparities, ensuring that "Food Pharmacy 2.0" does not create a new tier of access.

Geographical Gaps

All cited studies (Berkowitz, 2021; Downer, 2023; etc.) are conducted in urban settings within high-income countries, primarily the United States. A major geographical gap exists in understanding the efficacy and feasibility of hospital-based food pharmacies in rural areas (where food deserts and hospital access differ) and in low- and middle-income countries (LMICs). The models, which often rely on complex supply chains and digital infrastructure, may not be transferable to resource-constrained settings with different food systems and health infrastructures. While Huerta & Vega-López (2022) begin to address cultural tailoring within a U.S. context, a vast geographical gap remains in adapting the "food pharmacy" concept to the distinct cultural diets, agricultural systems, and public health policies of other developed nations (e.g., Japan, the UK) and developing regions. Research is absent on how such programs could be integrated into single-payer health systems or community health worker networks common in many parts of the world, representing a critical gap for global health equity.

CONCLUSION AND RECOMMENDATIONS

Conclusions

In summary, the collective evidence underscores that hospital-based "food pharmacy" programs represent a transformative and clinically effective intervention for improving glycemic control in low-income patients with Type 2 Diabetes. By directly addressing the fundamental barrier of food insecurity, these programs consistently demonstrate significant reductions in HbA1c often between 1.5% and 2.0% that exceed the outcomes of standard care alone, which typically provides education without material support (Berkowitz , 2021; Seligman, 2021). The efficacy of these programs is amplified when they are integrated into specific clinical pathways, such as post-hospitalization transitional care, where they also yield substantial reductions in costly hospital readmissions (Downer et al., 2023). Furthermore, research indicates that success is not achieved through a one-size-fits-all model; rather, it requires thoughtful adaptation, including cultural tailoring of food offerings, the strategic use of technology to overcome access barriers, and the

matching of intervention intensity such as medically tailored meals versus produce boxes to individual patient needs and contexts (Huerta & Vega-López, 2022; Bleich & Moran, 2023; Sharma & Vadiveloo, 2022).

Therefore, the implementation of food pharmacy programs moves beyond a novel pilot concept to an essential, evidence-based component of ethical diabetes management for vulnerable populations. It bridges the critical gap between clinical advice and practical feasibility, aligning healthcare delivery with the socioeconomic realities of patients' lives. To realize their full potential, future efforts must focus on developing sustainable financing models, such as insurance reimbursement or long-term subsidies, to ensure these interventions are not merely short-term prescriptions but durable components of chronic disease care (Mozaffarian & Lee, 2020). Ultimately, adopting the "food is medicine" paradigm within hospitals is a necessary step toward achieving health equity, improving long-term outcomes, and addressing the root causes of metabolic disease disparities.

Recommendations

Theory

Future research must move beyond pragmatic efficacy trials to explicitly ground interventions in robust theoretical models. We recommend employing the Socio-Ecological Model (SEM) to design and evaluate how the program interacts across individual, interpersonal (family), organizational (hospital), and community levels. Concurrently, the Health Capability Paradigm should be used to measure how the intervention enhances both the agency (knowledge, skills) and the opportunity (material resources) of patients to achieve health. Testing these frameworks will generate a nuanced understanding of the mechanisms of change, explaining why and for whom the intervention works, thereby refining theoretical models of health behavior in low-resource contexts. Develop a Middle-Range Theory of "Food is Medicine": The field requires a dedicated middle-range theory that synthesizes the active ingredients of successful food pharmacy programs. Researchers should theorize and empirically test the specific relationships between program components (e.g., food provision, culinary education, social support), mediating variables (e.g., dietary self-efficacy, food security, medication adherence), and the primary outcome of glycemic control. This will transform the intervention from a "black box" into a defined model with testable pathways, enhancing scientific rigor and replicability.

Practice

Hospitals must routinely screen all Type 2 Diabetes patients for food insecurity at admission and during outpatient visits using validated tools. For those who screen positive, a structured triage protocol should be activated. Following the evidence from Bleich & Moran (2023), this protocol should match patients to the most appropriate and cost-effective intervention: Medically Tailored Meals (MTMs) for those with severe barriers like homelessness or lack of cooking facilities, and produce prescriptions for those with stable housing. This patient-centered approach optimizes resource allocation and clinical impact. To overcome logistical barriers and enhance scalability, practice leaders should invest in hybrid delivery models that blend human touch with technology. Building on Sharma & Vadiveloo (2022), programs should offer a core in-person or telehealth dietitian support system coupled with a user-friendly digital platform for prescription management,

home delivery ordering, and dietary self-monitoring. Crucially, low-tech options (e.g., phone-based check-ins) must be preserved to ensure equitable access and prevent the digital divide from exacerbating health disparities.

Policy

The most critical policy imperative is to secure permanent financing. Advocacy must focus on integrating food pharmacy benefits into public and private insurance plans. Policymakers should pursue Medicaid 1115 waivers and Medicare Advantage pilot programs that reimburse for medically tailored food and nutrition counseling as essential preventive services for diabetes. Additionally, value-based payment models should be designed where savings from reduced hospitalizations (as demonstrated by Downer et al., 2023) are reinvested to fund the food program, creating a sustainable financial loop. To ensure systemic adoption, food security intervention must be elevated from an optional pilot to a standard of care. Policy bodies (e.g., The Joint Commission, the Centers for Medicare & Medicaid Services) should incorporate food insecurity screening and management into hospital accreditation standards and quality performance metrics for diabetes care. Furthermore, national clinical guidelines from organizations like the American Diabetes Association should be updated to explicitly recommend "food is medicine" interventions as a core component of comprehensive diabetes management for food-insecure individuals, providing a powerful mandate for practice change.

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