

Article

The Health and Climate Benefits of the Integration of Plant-Based Nutrition in One Inpatient Hospital Setting: Applying Publicly Available Tools

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Abstract

Climate change is a threat affecting public health and healthcare systems, and the health sector accounts for nearly 10% of greenhouse gas emissions (GHGs) in the United States, including through food services. Reducing meat consumption in healthcare institutions presents solutions to reduce food-related GHGs and provide health benefits to patients. However, challenges in quantifying these benefits present barriers for implementation. We aimed to use publicly available tools to quantify the magnitude of climate, economic, and health benefits associated with integrating a plant-based protein “swap” of current menu options at one hospital institution. On average, modeled plant-based protein swaps cost \$0.159/ounce less, reduce trans fats (0.102 g/ounce) and cholesterol (19.0 mg/ounce), and decrease 721 g of CO₂/ounce compared to meat-based counterparts. However, the swap analysis yielded variable results on meal protein content and caloric intake that require additional consideration. If plant-based alternatives were implemented across half of the inpatient dining service at this institution, equivalent to 206,000 meals annually, there could be a potential annual value of \$920,240 in food cost savings and \$973,028 in avoided GHGs. Healthcare decision-makers can leverage publicly available tools to implement evidence-based climate change mitigation solutions, helping hospitals battle climate change and reduce the burden of chronic disease.

Keywords: sustainability; food services; greenhouse gas emissions; health co-benefits



Academic Editor: Jose L. Domingo

Received: 7 May 2026

Revised: 9 June 2026

Accepted: 21 June 2026

Published: 30 June 2026

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1. Introduction

The climate crisis is a significant public health threat affecting human health and healthcare systems. The health sector, which aims to heal and prevent illness, accounts for nearly 10% of greenhouse gas emissions (GHGs) in the United States [1]. Food procurement and dietary services contribute to these healthcare GHGs [2], as traditional food service models emphasizing animal-based products, like meat and ultra-processed foods, have negative environmental impacts [3,4], such as land use changes, freshwater depletion, deforestation, and enteric fermentation [5,6]. Livestock also emits 14.5% of total global GHGs, including methane, a short-lived but potent greenhouse gas [7,8], with cattle raised for beef and dairy products contributing nearly two-thirds of these emissions [7].

A shift towards plant-based (PB) nutrition, a dietary pattern that focuses on low-to-no consumption of animal foods and instead is rich in whole grains, fruits, vegetables, and

nuts [9], and prioritizes whole, minimally processed plant foods as the foundation of meals, has presented a promising solution to reduce food-related GHGEs [10,11]. PB nutrition is associated with a range of health benefits, including a lower risk of chronic conditions such as diabetes, cardiovascular disease, and certain types of cancer [12,13]. Additionally, PB diets are typically rich in essential nutrients, like fiber, vitamins, and antioxidants, that promote immune function and digestive health.

As U.S. hospitals serve upwards of 100 million meals daily to an estimated over 100,000 admitted inpatients each day [14], PB nutrition serves as a pathway for hospitals to reduce their climate damage as large-scale food service providers. Integrating PB nutrition can also support patient health, reduce readmission rates, and improve quality of care [12,15]. Despite the clear benefits of PB diets, significant challenges remain in transitioning away from traditional, meat-centric menus, as the transition requires systemic organizational change, policy support, and education. Many hospital food services are structured around standardized, cost-efficient systems that prioritize familiarity and convenience [16].

Despite favorable health and economic drivers, barriers remain. In countries where meat and dairy consumption is central to culture, changing public attitudes can require time and effort. However, hospitals can influence public behavior and set a precedent for climate-conscious eating. Initiatives such as “Meatless Mondays,” launched globally in 2003 to address health and environmental concerns, have already been implemented with success in some hospitals [17]. This initiative draws upon the concept of “nudging”, which has been a commonly used and successful technique in promoting healthier behaviors in the diet and nutrition space [18]. In this kind of public health approach, a variety of choices are offered; however, one or some are given greater exposure in order to make them more likely to be chosen; using a default option is one example of this [19]. Trials that offered PB meals as the default option demonstrated positive patient receptions, particularly when meals were designed with attention to cultural and dietary preferences [20]. Identifying PB menus as the default meal option for patients can encourage swapping of traditional meat-centric meals with PB options by leveraging behavioral economics to benefit individual health and the planet [21]. New York City (NYC) Health + Hospitals has tried this approach with success: by making PB choices the default option for inpatients, they reduced carbon emissions by 36% and reduced food costs, while still achieving over 95% patient satisfaction [22]. Patients eating PB meals during their hospital stay also significantly improved their weight and blood sugar levels [20].

The economics of PB nutrition options may also present barriers to implementation in the short-term. While the upfront costs of instituting these meal changes can deter institutions, plant-based meals can be more cost-effective in the long run. For example, one study revealed that plant-based protein meals cost \$0.59 less per serving than their animal-based counterparts [22]. Additionally, the long-term health benefits associated with plant-based diets can reduce healthcare costs related to chronic disease treatment and management [16].

Despite demonstrated successes, there is still limited information on the magnitude of localized climate and health benefits a hospital may accrue by integrating PB meals as a default food service option. There is also limited information available on how to utilize publicly available tools to evaluate these benefits at a time when the healthcare industry is increasingly required to reduce GHGEs through state regulations [23], insurance programs [24], or certification programs [25]. These gaps can present barriers in healthcare institutions implementing PB nutrition on various scales.

Here, we aim to leverage publicly available tools to quantify the magnitude of climate and health benefits associated with integrating PB meals across multiple scales of food

services provided by a hospital institution. We demonstrate this through multiple tiered protein “swap” scenario analyses at one academic medical hospital, showing what changes could be made to the current menu offerings and the resulting benefits of PB nutrition on the institution’s GHGEs, costs, and potential health implications. This study can demonstrate how healthcare decision-makers can implement PB meals as an evidence-based climate change mitigation solution, which may ease healthcare institutions’ adoption of PB nutrition as a default in clinical settings, helping hospitals battle the climate crisis and reduce the burden of chronic disease while maintaining their mission to protect and promote the health of patients.

2. Materials and Methods

We conducted a “protein swap” analysis, in which animal-based proteins were substituted with common plant-based alternatives, to demonstrate the benefits and possible areas for consideration of a default plant-based meal system, aligned with the approach developed by the organization Menus of Change, which aims to equip chefs and foodservice operators with healthy and sustainable menu options to achieve environmental and nutrition goals [26]. This “protein swap” analysis was conducted for one New York academic hospital that is currently required to reduce GHGEs through state Executive Order Number 22 [23]. Each dinner option in the seven-day menu was modified by replacing the primary meat-based protein with a PB alternative. Substitutions were made on a per-ounce basis and assumed a 4-ounce serving of protein. For example, in the Monday meal “Meat Lasagna”, the ground beef was substituted with green lentils. The PB alternatives were selected to closely resemble the original meat-based proteins in function and texture, based on the experience of the authors and common recipe replacements. Variety was also prioritized when selecting swaps to showcase the range of options available. The change in proteins for each meal is summarized in Table 1.

Table 1. Plant-based protein swap substitutions modeled in this analysis.

Day of Week	Original Menu Option	Current Protein	Plant-Based Swap
Sunday	Baked Tomato Basil Chicken Breast	Chicken Breast	White Beans
Monday	Meat Lasagna	Ground Beef	Green Lentils
Tuesday	Pasta and Meatballs with Sauce	Ground Beef	Cremeni Mushrooms
Wednesday	Asian Beef and Broccoli Stir Fry over Rice	Flank Steak	Garbanzo Beans
Thursday	Chicken Marsala with Rice	Chicken Breast	Portabello Mushroom
Friday	Maple Rosemary Roasted Salmon	Salmon	Tofu
Saturday	Baked Ziti with Meat Sauce	Ground Beef	Plant-Based Beef Alternative

While there may be other smaller food services, hospital dining services can be divided into inpatient meals (i.e., food for admitted patients), cafeteria services (i.e., food for families and staff), and event catering (i.e., buffet-style services for ceremonies, benefits, etc.). Three scalable protein swap analyses were done, focused on inpatient meals specifically at this academic hospital. These scenarios were informed by the successful implementation of a scaled inpatient PB meal approach at NYC Health + Hospitals in collaboration with their catering provider Sodexo Healthcare and the non-profit Greener By Default [22,27].

The first scenario analyzed here focused on implementing the protein swap within the cardiac care unit for inpatients admitted to the service for treatment and management of heart conditions. This service typically manages patients with recent conditions like myocardial infarction, arrhythmias, infections of heart tissue, or who have undergone recent heart surgery like valve replacement, coronary artery bypass graft, or stenting. These

patients are typically placed on a “Cardiac Diet” or “Heart Healthy Diet” while on this service; this typically includes low-sodium, low-fat, low-cholesterol foods and emphasizes proteins. As many of these cardiac conditions are life-threatening, hospitalization may be a time to engage with lifestyle-related causes of cardiac pathology, especially heart attacks and atherosclerosis; this life-changing event may allow patients to “recognize the connection between their diet, lifestyle, and chronic illness that brought them into the hospital [28,29].” Scenario 1 evaluated the protein swap for all 33 cardiac care patient beds available at this institution.

Scenario 2 focused on an expanded implementation with all 752 inpatient beds at the primary site of our academic hospital. Scenario 3 expanded the PB protein swap to all other inpatients at affiliate hospitals within our academic hospital network, including a nearby community hospital with 306 inpatient beds and a children’s hospital with 71 beds.

For each original protein and PB swap, we estimated nutrition information, cost to purchase, and GHGEs (Figure 1). Pricing information was collected for each protein and the PB protein swap option. Wholesale pricing was estimated through online listings at a popular wholesale retailer based on the location of the institution [30]. All prices were calculated on 5 December 2025. Pricing based on available packaging options and quantities was recorded and then standardized to determine a per-ounce cost.

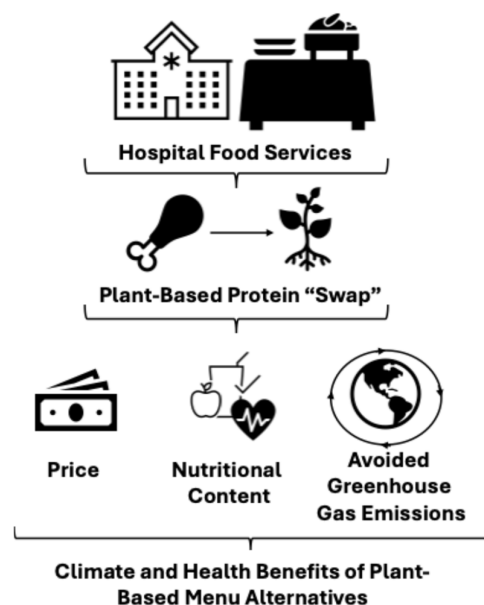


Figure 1. Schematic of methodology demonstrating the use of separate publicly available tools to estimate climate and health benefits of plant-based menu alternatives within hospital food services.

Nutritional content, including protein, cholesterol, sodium, energy, carbohydrates, calcium, iron, magnesium, and potassium, as well as trans, saturated, and total fat were all estimated using the U.S. Department of Agriculture’s Food and Nutrition FoodData Central Food Search (Washington, DC, USA) [31]. Fiber was estimated using Dietary Guidelines for Americans (Washington, DC, USA) [32], except for lentils, which were not available and instead were estimated from the University of Rochester Medical Center (Rochester, NY, USA) [33].

GHGEs were estimated in metric grams of CO₂ for each protein using a publicly available website, “My Emissions: Food Carbon Calculator” (London, England) [34]. This specific calculator may not represent all foods available in a specific context, but other calculators that are available may also be utilized, such as CleanMetrics (Portland, OR, USA), Harvard Foodprint Calculator (Cambridge, MA, USA), and Oxford University’s Diet Car-

bon Footprint (Oxford, England). We then further extrapolated this data to calculate the social cost of carbon (SCC) of each protein evaluated. SCC represents the average monetized avoided social damages from CO₂ emissions. This value was adjusted based on the 2020 value of \$190 per metric ton of CO₂ by calculating a 2% discount rate [35] and then adjusting for inflation using the U.S. Bureau of Labor Statistics Inflation Calculator (Washington, DC, USA) [36], yielding a 2025 SCC estimate of \$233.97 per metric ton of CO₂.

All estimates were calculated on a per-ounce basis and rounded to three significant figures. In the absence of an exact match, the best approximate match of food was chosen across all data sources (i.e., GHGE estimates available for mushrooms broadly, instead of different types of mushrooms). For each of these metrics, the difference between the original protein and the plant-based protein swap option was calculated. The average nutritional differences between scenarios were calculated.

Per-ounce cost and GHGE reduction estimates were then extrapolated to our three implementation scenarios. All three scenarios assumed that all modeled beds were full and that there was 50% uptake (a more conservative estimate than prior work showing a 95% patient satisfaction rating [22]) of the protein swap for 1 dinner per day, 7 days a week, for 52 weeks. This assumption allows for the use of the publicly available estimation tools while recognizing that some patients (e.g., pediatric patients, labor and delivery patients, patients on restricted diets, those who refuse PB options) may not be able to or interested in participating in the PB protein swap. Each subsequent scenario included the beds from the scenario prior.

3. Results

3.1. Price

On average, the original protein options cost \$0.349/ounce (range: \$0.0725/ounce for flank steak, \$0.565/ounce for salmon), while the PB protein swap options cost \$0.190/ounce (range: \$0.0275/ounce for garbanzo beans, \$0.475/ounce for PB ground beef alternative). All PB replacements were cheaper per ounce than the original meat alternative, except for replacing ground beef with a PB ground beef alternative. Across all swap scenarios, the PB protein swap saved \$0.16 per ounce of protein replaced (Table 2). This is equivalent to an approximate \$0.64 of cost savings per meal, assuming a 4-ounce portion of protein is replaced.

Table 2. Differences between meat-based protein and plant-based protein swap estimates of price, nutritional content, and greenhouse gas emissions (GHGE). Changes (Δ) are calculated as the original meat-based protein value minus the plant-based protein swap, so positive values indicate a reduction by the plant-based swap item (i.e., reduction in price, reduction in sodium) and negative values indicate an increase by the plant-based swap items (i.e., increase in price, increase in sodium). All estimates are on a per-ounce basis. Costs are shown in 2025 United States Dollars (\$). Current meat-based protein and plant-based protein values are available in Supplementary Table S1.

	Meal 1 Chicken Breast → White Beans	Meal 2 Ground Beef → Lentils	Meal 3 Ground Beef → Cremini Mushrooms	Meal 4 Flank Steak → Garbanzo Beans	Meal 5 Chicken Breast → Portabella Mushroom	Meal 6 Salmon → Tofu	Meal 7 Ground Beef → Plant-Based Beef Alternative	Average
Price (\$ per 1 oz)	0.462	0.202	0.0393	0.045	0.177	0.393	−0.201	0.160
Protein (g per 1 oz)	0.255	−1.73	4.09	−0.340	5.60	2.66	−0.0567	1.50
Total Fat (g per 1 oz)	−0.0765	4.96	5.44	0.887	0.459	2.53	1.98	2.31
Total Saturated Fat (g per 1 oz)	0.0989	1.94	1.94	1.01	0.0989	0.445	0.686	0.888

Table 2. *Cont.*

	Meal 1 Chicken Breast → White Beans	Meal 2 Ground Beef → Lentils	Meal 3 Ground Beef → Cremini Mushrooms	Meal 4 Flank Steak → Garbanzo Beans	Meal 5 Chicken Breast → Portabella Mushroom	Meal 6 Salmon → Tofu	Meal 7 Ground Beef → Plant-Based Beef Alternative	Average
Sodium (mg per 1 oz)	18.0	14.9	14.2	11.9	17.3	4.54	−82.2	−0.203
Energy (kcal per 1 oz)	−67.8	−33.2	60.4	−62.1	21.0	31.8	11.1	−5.55
Calcium (mg per 1 oz)	−39.4	−15.6	0.851	−30.3	0.284	−39.7	−18.1	−20.3
Iron (mg per 1 oz)	−1.79	−1.74	0.468	−0.924	0.0595	−0.405	−0.349	−0.631
Magnesium (mg per 1 oz)	−36.2	−25.7	1.76	−32.9	4.88	7.20	4.65	−10.9
Potassium (mg per 1 oz)	−3.09	−192	−30.3	−212	−5.39	107	24.7	−88.0
Fiber (g per 1 oz)	−1.33	−2.22	−0.96	0.0	−0.54	−0.26	0.0	−0.758
GHGE (g CO ₂ e per 1 oz)	109	1210	1190	1204	93	83	1160	721
Avoided Carbon Costs (\$ per 1 oz)	0.0255	0.283	0.278	0.282	0.0218	0.0194	0.271	0.169

3.2. Nutrition

The nutritional comparisons between the original protein and the PB swap option were more mixed. While some PB proteins (e.g., white beans, lentils, garbanzo beans, plant-based beef alternatives) had similar or more protein than their counterparts, there was an average 1.50 g/ounce reduction in protein across the PB swap menu as a whole. Swaps featuring mushrooms had the greatest decrease in protein, with a decrease of 4.09 to 5.60 g/ounce of protein substituted (Table 2).

The PB protein swaps had an average of 2.31 g of fat and 0.888 g of saturated fat per ounce of protein replaced. Most PB replacements had no saturated fats, and none of these PB options had trans fats or cholesterol. The PB replacements removed an average of 0.102 g of trans fats per ounce of protein replaced, and 19.0 mg of cholesterol per ounce of protein swapped.

On average, the PB swap options were higher in calcium, iron, magnesium, and potassium than their meat counterparts across the menu (Table 2). Legume-based options, like beans, lentils, and tofu, consistently had higher levels of calcium and iron than their original meat protein choice.

Original meat-based protein choices had an average of 52.7 kcal of energy per ounce of meat, while the PB replacements had 58.3 kcal per ounce. While there was a slight decrease in energy level, it was only an average 10.6% across the menu. Several PB swaps had more energy, including white beans, lentils, and garbanzo beans. The meat options on the original menu had no carbohydrates or dietary fiber. The PB replacements increased carbohydrates by 8.03 g per ounce and dietary fiber by 0.758 g per ounce of the protein replaced.

3.3. Climate Emissions

We estimate that the PB replacements reduced the average GHGE by 721 g of CO₂e per ounce of protein replaced (Table 2). The greatest GHGE reductions were observed when replacing beef, as this protein had GHGEs that were 10 times higher than those of the other proteins analyzed. Swapping salmon with tofu only reduced GHGEs by 83 g of CO₂e per

ounce of protein replaced. All the PB replacements had GHGEs that were at least one order of magnitude lower than their counterparts. Overall, the reductions in GHGEs translated to avoided climate damages, valued at \$0.169 per ounce of protein replaced (Table 2).

3.4. Scalable Implementation Scenarios

Per-ounce cost and GHGE reduction estimates were extrapolated to our three implementation scenarios. In Scenario 1, if the PB protein swap was implemented across half of the 33 cardiac inpatient unit beds, there was an estimated total savings of \$26,900 across more than 6000 meals delivered annually. A similar value of avoided climate damages, \$28,443, was also estimated from the reduction in GHGEs associated with the PB protein replacements (Table 3). These results continued to scale linearly with each expanded scenario (Table 3). If the PB alternative dinner menu was implemented across all inpatient dining services (still assuming 50% uptake) across this academic medical system, there could be a potential annual value of \$920,240 in food cost savings and \$973,028 in avoided GHGEs.

Table 3. Scaled extrapolation scenarios of a plant-based protein swap.

	Scenario 1: Cardiac Inpatient Unit	Scenario 2: Primary Hospital Inpatient	Scenario 3: Whole-Health System Inpatient
Number of Inpatient Beds Included	33	752 **	1129 ***
Number of Meals Modeled Annually *	6023	137,240	206,043
Annual Food Cost Savings with the Protein-Based Protein Swap (\$)	\$26,900.22	\$612,948.15	\$920,239.55
Avoided Greenhouse Gas Emissions Savings (\$)	\$28,443.32	\$648,109.10	\$973,027.86

* Assuming 1 dinner per day with 50% uptake of each plant-based protein swap, rounded to the next whole number. ** The primary hospital houses 719 inpatient beds, which, combined with the 33 beds of Scenario 1, yield 752 beds. *** The affiliate hospitals house 377 inpatient beds, which, combined with the 752 beds of Scenario 2, yield 1129 beds.

4. Discussion

Using publicly available tools, we examined the magnitude of climate and health benefits associated with integrating PB nutrition across multiple tiered scenarios of inpatient food services provided by a hospital institution. On average, PB replacements provided improved nutritional value compared to their meat counterparts and saved approximately \$0.64 per meal. When scaled across the inpatient ecosystem of this academic hospital, half of the inpatient individuals modeled to switch from meat to PB dinner options could potentially yield \$920,240 in food cost savings and \$973,028 in avoided GHGEs across more than 206,000 meals annually.

We demonstrate this through tiered protein swap analysis changes that could be made to the current menu offerings and the resulting potential benefits of PB meals on the institution's GHGEs, costs, and potential nutritional implications for patients. Our findings are similar to a successful PB default menu project implemented within NYC Health + Hospital, which found a savings of \$0.59 per replaced meal on average across 800,000 meals served in 2023 [22]. In this project, an annual savings of \$318,000 was reported [22], which is a similar order of magnitude but less than the savings we estimate from fewer meals. This difference may be explained by food prices being approximately 10% greater in 2025 as compared to 2023, with the greatest impacts among meat-based products [37]. Additionally, the NYC Health + Hospital study implemented a fully PB

menu, where we estimated savings based on swapping meat-based proteins for PB alternatives, which we feel may present a more approachable entry point into PB nutrition transitions for some individuals. Prices will continue to fluctuate and vary over time and space, but we aim to demonstrate how these tools can be leveraged to provide estimates for a hospital's specific geographical and temporal context.

The transition to PB nutrition may also help improve the health of patients. The PB protein swaps analyzed here demonstrated reductions in trans fats and cholesterol, and increases in dietary fiber, calcium, iron, magnesium, and potassium per ounce of protein that was replaced. This is coupled with the prior evidence documenting the health benefits of PB nutrition on cardiovascular health [9]. While hospital stays may be short, exposure to PB meal options while in the hospital, especially if coupled with nutrition guidance by providers, may expose individuals to healthier options that they may be more willing to integrate into their daily lives upon leaving the hospital. While some of the specific swaps resulted in reductions in protein or increased carbohydrates, protein swap design in collaboration with nutrition and dietary experts should adapt these swaps to be nutritionally equivalent and comparably palatable to their meat-based counterparts. These options also help hospitals demonstrate a commitment to patient health through their food menus and reducing GHGEs.

Additionally, avoiding GHGEs decreases climate damages, which will decrease climate change-related health harms that individuals would incur in the future. There is a growing number of voluntary and mandated initiatives within the healthcare sector to mitigate GHGEs. For example, from 2022 to 2024, nearly 1000 hospitals had signed a voluntary pledge to reduce GHGEs by 50% by 2030 (this program was ended in 2025 [38,39], and an executive order in New York State requires that all state agencies, which include some hospital facilities and academic medical centers, must reach 100% zero-emission electricity by 2030 [23]. Hospital investments in PB nutrition can further support reaching these voluntary and mandatory goals.

Previous work has also demonstrated the capabilities of publicly accessible tools in helping stakeholders implement sustainability-related programs. Similar tools were recently used to quantify the health and climate benefits of hospitals implementing renewable energy and improving energy efficiency [40]. Additionally, food and catering have been integrated into multiple national healthcare climate mitigation plans [41]. A systematic review on healthcare GHGE mitigation identified the use of tools in informing decision-making on GHGE within healthcare [42], but there seems to be limited application of bridging the use of these tools in food-related decision-making as part of the healthcare carbon footprint.

While our findings demonstrate the potential benefits possible with a protein swap, going from a modeled scenario to implementation can face barriers for widespread adoption related to patient satisfaction, institutional habits, staff training, cultural dietary preferences, and logistics. Here, we aim to demonstrate how publicly available tools can be utilized to quantify the benefits for healthcare decision-makers to aid their implementation of PB options, but addressing these barriers will be critical to the success of PB nutrition integration. Making PB meals the default option, if implemented with care and education, can improve the overall satisfaction of patients. The NYC Health + Hospital project found a 95% acceptance rate of PB options among eligible patients [22]. In this analysis, we selected PB protein replacements that provided greater variety and closely resembled the original meat-based proteins in function and texture. Successful real-world implementation would require collaboration with dietitians and culinary professionals to inform context-specific replacements that ensure nutritional adequacy and patient appeal, especially for those on specific diets, such as texture-modified or therapeutic diets, nutritionally vulnerable

populations, or specific populations, such as children. To best achieve these goals and leverage PB benefits, nutritionists and culinary professionals may also aid in creating PB menu options that go beyond “swapping” a protein or that utilize other substitutions than described here; however, our goal here was to show how these tools can be leveraged in an approach starting with a simplified “swap” option.

Many PB proteins, such as lentils, contain comparable amounts of protein to meat-based proteins. However, certain PB alternatives are lower in protein and may require additional protein supplementation, such as through the addition of nuts, nutritional yeast, or whole grains to increase nutritional content. Additionally, protein quality and completeness should be considered in PB alternatives, especially for nutritionally vulnerable populations or for those on specific nutritional diets. Also, plants are the only source of fiber in the human diet, and as such, the use of these alternatives increases the amount of fiber consumed in each meal relative to its meat-based counterpart. Expanding PB meals would require additional considerations for specific populations, such as pediatric patients. The Plantrician Project’s Pediatric Plant-Based Nutrition Quick Start Guide could serve as a valuable resource for this work, as well as a tool to provide education for parents on why these offerings are available and the default for their admitted children [43].

Within healthcare institutions, successful implementation will be dependent on collaboration across departments, including nutritionists, chefs, hospital providers, and hospital leadership. Food service staff need to be equipped with the skills to prepare nutritionally balanced, appealing PB meals, while providers need the tools to counsel patients on the health benefits of these dietary options. Institutional policymakers play a critical role through the implementation of incentives and guidelines that promote sustainable food procurement practices in hospitals, and in implementation, hospital leaders can demonstrate a commitment to their community’s health by making decisions that reduce their contributions towards climate damage and their community’s health.

A transition to PB nutrition can also provide alignment with the Institute for Healthcare Improvement’s (IHI) Triple, Quadruple, and now Quintuple Aims, first shared in 2007, and developed to transform healthcare. PB nutrition supports the Triple Aim to improve patient experiences, health outcomes, and costs [44]. In addition to the approximate cost savings of \$0.64 per meal across PB menu swaps, the provision of PB meals in inpatient settings may be of some benefit to healing and the reduction in inflammation in the short term [45], and patients may be open to adopting more PB diets following their discharge. Nutrition education is a growing part of health empowerment; in this context, a hospital can be a leader in supporting its community members and patients in taking charge of their health [46]. The IHI’s Quadruple and Quintuple Aims consider clinician wellbeing and health equity, respectively [44]. Nonwhite Americans are roughly three times more likely than white Americans to identify as vegetarian [47], and the implementation of this initiative may better connect with disenfranchised communities of color to improve health and patient satisfaction with marginalized communities, including refugee and immigrant populations [48]. As food waste is a contributor to healthcare GHGs, it is important to consider how a nudge approach, such as shown here by making the PB option a default option, from which patients can opt out, can potentially impact food waste. Offering PB items, which may be preferred by some communities, may help to reduce food waste; however, additional research is needed to further elucidate the food waste implications of PB replacements in tandem with patient satisfaction and acceptability metrics.

While this is a simplified method for swapping the existing meat-based protein for a PB alternative, the analysis highlights how a stepwise integration of PB meals within a hospital setting can positively impact climate sustainability, patient nutrition, and meal cost. However, this study does face several limitations. While we demonstrated a methodology

for estimating wholesale costs, the exact wholesale distributor, availability of products, and prices will vary over time and space. Here, we aim to present a relative comparison of costs, though a hospital decision-maker may use different or multiple suppliers based on their needs and budgets, and costs will be variable over time. We demonstrated swapping a meat-based protein for a PB alternative, prioritizing similar texture, taste, and function. However, some popular PB swaps, like mushrooms, may not provide adequate nutritional content on their own as they are not rich in protein. Successful implementation will require collaboration across departments, including nutritionists, chefs, and hospital providers. Partnerships with organizations like Greener by Default can also allow teams to customize their approach to integrating PB meals on their menus. Additionally, costs and damages associated with food waste and acquisition practices, which can exacerbate negative environmental impacts if sustainability is not prioritized [49], are not included in this analysis. Importantly, the quantitative results here are informed by several publicly available tools. While a multitude of tools are available, each may derive metrics differently or be applicable to specific foods and/or contexts, yielding different specific estimates for price, nutrition, or GHGE. We aim to demonstrate here how these tools can be used in conjunction with each other by hospital leaders to inform positive changes. However, additional work is needed to inform the successful implementation of such efforts.

5. Conclusions

Using publicly available tools, we found that the integration of PB protein swaps within an existing hospital food service menu can save money, improve the nutritional quality of meals, and offset GHGEs. This simulated analysis shows how hospitals can demonstrate leadership in healthcare, sustainability, and climate action, while also reinforcing their mission of healing. This initiative offers a systemic shift that advances health, health equity, and climate resilience through the lens of hospitals as large food-service providers. We demonstrate the potential for one hospital and other institutions to promote public health with large systemic change in the nutrition system that aligns practice with supporting climate science backed by nutritional evidence. The application of publicly available tools to evaluate these costs and benefits can serve as a tool for informing change and encourage larger conversations about the role of health systems and other institutions as leaders in sustainability.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/greenhealth2030018/s1>, Table S1: Estimates of current meat-based protein and plant-based protein swap estimates of price, nutritional content, and greenhouse gas emissions (GHGE).

Author Contributions: Conceptualization, J.S.B., E.S. and A.A.W.; methodology, J.S.B., E.S. and A.A.W.; software, E.S. and A.A.W.; validation, E.S. and A.A.W.; formal analysis, J.S.B., E.S., E.L., P.C., J.D.B., A.A. and A.A.W.; investigation, J.S.B., E.S. and A.A.W.; resources, J.S.B., E.S. and A.A.W.; data curation, J.S.B., E.S., E.L., P.C., J.D.B., A.A., E.S. and A.A.W.; writing—original draft preparation, J.S.B., E.L., P.C., J.D.B. and A.A.; writing—review and editing, J.S.B., E.S. and A.A.W.; visualization, E.S. and A.A.W.; supervision, A.A.W.; project administration, J.S.B., E.S. and A.A.W. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data output files are available at <https://github.com/williaau/pbn> (accessed on 20 June 2026). All other data is publicly available from the references included in Section 2.

Acknowledgments: The authors thank Natalie Vinton, for her assistance in initial data curation and contributions to original draft preparations.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

GHGE	Greenhouse gas emissions
NYC	New York City
PB	Plant-based
SCC	Social cost of carbon

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