

Assessing ChatGPT's effectiveness in designing personalized diet plans for secondary stroke prevention: preliminary reports

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Stroke is one of the leading causes of morbidity and mortality worldwide, and secondary prevention, including dietary modifications and a healthy lifestyle, is essential to reduce the risk of recurrence. This study evaluates the effectiveness of ChatGPT, an artificial intelligence model, in creating personalized dietary plans for secondary stroke prevention. Patient data, including vital signs and biomarkers, belong to the ambulatory patients, who have been treated at the First Neurology Clinic at the University Hospital St. Marina in Varna, Bulgaria. Five patients with a history of ischemic stroke were selected based on age (less than 65 years), minimal comorbidity, and no prior stroke incidents. Based on data from their scans, ChatGPT generated personalized seven-day, five-meal-a-day diet plans for each patient, providing accurate data on the amount of food, calories, protein, carbohydrates, fat, and fiber in each meal. The plans were evaluated against the principles of the Mediterranean diet, DASH, and the European Food Pyramid using the Alternative Healthy Eating Index 2010, which emphasizes food groups associated with reducing the risk of chronic diseases. ChatGPT-generated diets are tailored to patients' medical needs, but further studies with larger numbers of participants are needed for full personalization. The plans are healthy and provide an adequate intake of energy (1800-2000 kcal), protein (70-90 g), carbohydrates (200-250 g), fat (60-70 g), fiber (25-35 g), vitamins, and minerals.

Keywords: stroke, meal plans, secondary prevention, ChatGPT, personalized nutrition

INTRODUCTION

Stroke is one of the leading causes of morbidity, mortality, and disability worldwide [1-4]. According to the World Health Organization (WHO), about 15 million people have a stroke each year; five million die, and another five million are left permanently disabled [5]. The Stroke Action Plan for Europe (SAP-E) 2018-2030 has been developed for stroke prevention [6]. Stroke survivors are a high-risk group, and for them, a healthy lifestyle is a key strategy for effective secondary prevention. It is recommended that they follow these basic principles: healthy eating, regular physical activity, spiritual relaxation, and adequate rest. Their diet should include low salt, potassium-rich foods, plenty of vegetables and fruits, whole grains, unsaturated fats, moderate fish consumption, and a low intake of lean meats [7, 8].

In such cases, the Mediterranean diet [9], Dietary Approaches to Stop Hypertension (DASH) [10], and diets that emphasize the intake of more fruits and vegetables, whole grains, plant-based proteins, and lean meats are strongly recommended [11, 12]. The Healthy Eating Pyramid also organizes the principles of a balanced diet. These three approaches

are used to assess the overall quality of a diet [10, 12, 13]. Another assessment approach is the Healthy Eating Index (HEI) [14] and the Alternative Healthy Eating Index (AHEI) [15], both developed to evaluate the nutritional quality of diets in American citizens. AHEI emphasizes food groups and ingredients directly linked to reducing the risk of chronic diseases such as heart disease, type 2 diabetes, and cancer. Studies indicate that the impact of diet on disease occurrence can also vary based on gender [15-17].

Stroke is a life-threatening condition, and the role of diet in its prevention is the focus of extensive research [18-20]. For effective secondary prevention, national stroke plans are essential. These plans should include patient follow-up, access to key preventive strategies for a healthy lifestyle, and prescription medications such as antihypertensives, lipid-lowering agents, antiplatelets, anticoagulants, oral hypoglycemic agents, and insulin. Secondary prevention strategies also encompass physical activity, a healthy diet, limited or safe alcohol consumption, smoking cessation, and management of mood and psychological stress [21].

The integration of artificial intelligence (AI) into our daily lives enables consultations on a variety of

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issues, including health. AI has the potential to provide relevant information related to nutrition, identify causes of diseases such as cardiovascular conditions, diabetes, cancer, and obesity, and offer guidance on potential treatments [22]. However, it always recommends consulting a doctor. Numerous studies [23-27] have evaluated the capabilities of ChatGPT and other AI models in medicine, although research in this area is still developing. Based on this, we aim to investigate and assess ChatGPT-4's ability to create personalized dietary plans for secondary stroke prevention.

MATERIALS AND METHODS

The study began with a review of published research on the impact of healthy diets on the secondary prevention of stroke. We searched Scopus, Web of Science, PubMed, and Google Scholar databases using the keywords "healthy diet and stroke." The review indicated that a healthy diet positively affects stroke survivors in secondary prevention. We then explored the role of artificial intelligence in nutrition using the keywords *nutrition* and *AI*. We found that AI is primarily used to evaluate dietary plans, while areas such as designing personalized plans, predicting malnutrition, and understanding the relationship between nutrition and disease are less developed. The evaluation of customized diet plans by ChatGPT is still in progress. To appropriately assess the generated diets, we continued our study using the keywords *dietary plans* and *assessment*. We selected the Mediterranean diet, Dietary Approaches to Stop Hypertension (DASH), the European Food Pyramid, and the Alternative Healthy Eating Index (AHEI) for comparison and evaluation.

For the study, we selected data from five ambulatory patients with a history of ischemic stroke, who have been treated at the First Neurology Clinic at the University Hospital St. Marina in Varna, Bulgaria. We selected patients based on the following criteria:

- Age under 65 years;
- No gender discrimination – both men and women;
- History of ischemic stroke;
- Minimal number of concomitant diseases;
- First stroke for each patient.

ChatGPT was used to generate personalized seven-day diet plans by inputting the data and test results (Table 1) for each patient and requesting a seven-day healthy menu with five meals per day.

For each food item included in the menu, we required the following information: quantity in grams or number of servings, energy contribution in

calories, and the amounts of protein, carbohydrates, fat, and fiber in grams. The menu was tabulated, and a brief analysis of the nutritional content of the diet plans was conducted to ensure they met the patients' nutritional needs. The AI-generated menus are presented in Table 2. They were compared against the criteria of healthy diets – Mediterranean, DASH, and the European Food Pyramid. For clarity, the menus were evaluated according to the AHEI 2010 criteria (Table 3). The AHEI provides a more precise and current assessment of dietary patterns, emphasizing food groups and ingredients that directly reduce the risk of chronic diseases such as heart disease, type 2 diabetes, and cancer. The meal plans were assessed for energy intake, nutrient accuracy, and meal variability. Each food item was scored from 0 to 10 based on its quantity and servings. The scores were statistically analyzed using Microsoft Excel, and the results are illustrated in graphs (Figs. 1, 2).

DISCUSSION

In ChatGPT, we input some of the patients' health status indicators (Table 1) and requested a seven-day healthy diet plan, including five meals per day. As shown in the table, the patients range in age from 45 to 63 years, with three men and two women. All patients have experienced an ischemic stroke. Patient 2 has an accompanying condition of Type 2 diabetes, and Patient 4 is a heavy smoker; the remaining three patients have no reported accompanying diseases. All patients have higher-than-normal blood pressure. Heart rate data is available only for patients 1 and 2, while the data for the other patients are not reported. One indicator, CRP (C-reactive protein), as shown in Table 1, was within the normal range only for patient 3, while in the other patients, it was elevated. Elevated CRP levels can indicate an increased risk of cardiovascular disease [29], inflammatory conditions such as rheumatoid arthritis and Crohn's disease, and various infections. These levels can often be regulated through diet and exercise if the patient is able [30-32]. Foods with antioxidant properties, such as fruits and vegetables, and those rich in vitamin C, such as citrus fruits, can help reduce and prevent inflammation and lower CRP levels.

Additionally, foods high in omega-3 fatty acids, such as fatty fish (e.g., salmon, mackerel, sardines), certain vegetable fats found in avocados and olive oil, nuts (e.g., almonds, walnuts), and seeds (e.g., chia, flaxseed) also help reduce inflammation [33].

Table 1. Patient information entered into the ChatGPT

Patient №	1	2	3	4	5	Normal Range
Age	63	52	49	45	54	-
Gender	Female	Female	Female	Male	Male	-
Final Diagnosis	Ischemic stroke in the vertebrobasilar system	Ischemic stroke in the vertebrobasilar system	Ischemic stroke in the vertebrobasilar system	Ischemic stroke in the territory of the left middle cerebral artery	Ischemic stroke in the vertebrobasilar system	-
Accompanying Diseases	None	Type 2 Diabetes Mellitus	Not reported	Use of one pack of cigarettes per day	Not reported	-
Arterial Pressure	160/95	130/70	130/80	140/90	130/80	90/60 - 120/80 mmHg
Heart Rate	98/min	78/min	Not reported	Not reported	Not reported	60-100 beats/min
CRP	6.25 mg/l	13,9 mg/l	0,60 mg/l	7.72 mg/l	9,3 mg/l	0.0-5.0 mg/l
HDL	1.35 mmol/l	Not reported	Not reported	1.12 mmol/l	1,09 mmol/l	1.0-1.6 mmol/l
LDL	4.53 mmol/l	Not reported	Not reported	3.80 mmol/l	4,46 mmol/l	0-2.6 mmol/l
ALT	98.4 U/l	69 U/l	19,1 U/l	14.0 U/l	90 U/l	10-49 U/l
AST	74.4 U/l	52 U/l	21 U/l	19.8 U/l	92 U/l	0-34 U/l
Glucose	6.4 mmol/l	8,6 mmol/l	9,3 mmol/l	6.0 mmol/l	6,9 mmol/l	4.1-5.9 mmol/l
Creatinine	72 mcmol/l	56 mcmol/l	61 mcmol/l	99 mcmol/l	65 mcmol/l	62-115 µmol/l
Triglycerides	2.62 mmol/l	4,49 mmol/l	3,38 mmol/l	1.35 mmol/l	3,02 mmol/l	0-1.7 mmol/l
Urea	12.7 mmol/l	4,7 mmol/l	5,1 mmol/l	5.6 mmol/l	4,9 mmol/l	3.2-8.2 mmol/l
Cholesterol	7.07 mmol/l	5,30 mmol/l	7,69 mmol/l	5.53 mmol/l	6,94 mmol/l	2.70-5.20 mmol/l
Sodium	141 mmol/l	142 mmol/l	140 mmol/l	138 mmol/l	138 mmol/l	132-146 mmol/l
Potassium	3.8 mmol/l	4,5 mmol/l	4,0 mmol/l	3.6 mmol/l	4,3 mmol/l	3.50-5.50 mmol/l
Chloride	99 mmol/l	104 mmol/l	100 mmol/l	100 mmol/l	99 mmol/l	99-109 mmol/l

Fiber and plant-protein-rich legumes (e.g., lentils, beans, chickpeas) and whole grains (e.g., oats, brown rice, quinoa) contribute to reducing inflammatory processes. Due to their beneficial effects, these foods are recommended by doctors and are included daily in the generated diets, suggesting that ChatGPT has adhered to this criterion.

Another important indicator is HDL (high-density lipoprotein), often referred to as "good" cholesterol. HDL's role is to transport cholesterol from the blood to the liver, where it is broken down and eliminated from the body. This process helps remove accumulated plaques from the arterial walls in atherosclerosis, thereby reducing the risk of heart attacks and strokes. Consequently, HDL is considered a "cleaner" of the blood vessels. Foods that help increase HDL levels include omega-3 fatty acids found in fish, flaxseeds, chia seeds, nuts, and olive oil. These foods are an essential part of the menu recommended by ChatGPT. For patients 2 and 3, there are no data on HDL levels, but for the other patients, HDL levels are within the normal range, though close to the lower limit (Table 1). The diet

includes the aforementioned foods, which contribute to increasing HDL levels.

LDL (low-density lipoprotein), often referred to as "bad" cholesterol, also transports cholesterol in the blood. However, high levels of LDL lead to cholesterol buildup in artery walls, forming plaques that narrow the arteries (atherosclerosis) and increase the risk of heart disease and stroke. Table 1 indicates that LDL data are missing for two patients, while for patients 1, 4, and 5, LDL levels are above the permissible values. To regulate LDL, it is important to avoid foods high in saturated fats (such as red meat, full-fat dairy products, and processed foods), increase the consumption of foods rich in omega-3 fatty acids, and eat more fiber-rich foods (such as oats, legumes, fruits, and vegetables). Avoiding smoking, maintaining a normal weight, engaging in aerobic exercise (such as walking, running, or swimming), and managing stress through methods like meditation, yoga, or deep breathing can also be beneficial. Table 2 shows that fish, which is high in omega-3 fatty acids, is frequently recommended in the dietary plan, likely due to the elevated LDL levels.

ALT (alanine aminotransferase) is an enzyme primarily found in the liver and plays a crucial role in amino acid metabolism. Elevated levels of ALT in the blood can indicate liver damage or disease, such as hepatitis, cirrhosis, alcohol-related damage, use of hepatotoxic drugs, muscle damage, or other conditions. Normal ALT levels in adults range from 7 to 56 U/L (units per liter). To regulate ALT levels, a healthy diet is essential, including avoiding alcohol, consuming foods rich in antioxidants, steering clear of saturated fats and processed foods, achieving weight loss, and engaging in physical activity. Nutritional supplements such as vitamin E and silymarin (milk thistle extract) are known for their liver-protective properties and may help lower ALT levels. Table 1 shows that ALT levels were within the normal range for patients 3 and 4, while the remaining three patients had elevated levels. These patients require a healthy diet and appropriate physical activity to manage their condition.

Another liver indicator used in the study is AST (aspartate aminotransferase), an enzyme found in various tissues of the body, including the liver, heart, muscles, kidneys, and brain. Its primary role is to support amino acid metabolism. Normal levels of AST in adults range from 10 to 40 U/L (units per liter). Table 1 shows that AST levels are within the normal range for patients 3 and 4, while the levels are elevated in the other patients. Regulating AST levels involves maintaining a healthy diet that includes antioxidant-rich foods, omega-3 fatty acids, and limiting alcohol intake. It is also important to avoid hepatotoxic drugs, manage chronic conditions such as diabetes or metabolic syndrome, and consider antioxidant supplements like silymarin (under medical supervision). Increasing physical activity can also aid in regulating AST levels.

Glucose levels were elevated in all patients. Normal glucose levels range from 4.1 to 5.9 mmol/L. Patients should avoid simple carbohydrates, such as sugar, sweets, and carbonated drinks. Table 2 indicates that these items are not included in the diet plans. Instead, the diet should focus on complex carbohydrates, such as whole grains, vegetables, and legumes, which are broken down more slowly and help maintain stable blood glucose levels. Eating smaller portions more frequently, as in a five-meal-a-day plan, is beneficial. Additionally, it is important to consume an adequate amount of water to support normal metabolic processes, which is currently lacking in the diet plans and the analysis [34-41].

Creatinine levels were normal in all patients. Creatinine is a byproduct of normal muscle metabolism and plays a crucial role in energy production within muscle cells. It is synthesized in

the liver and kidneys and stored in the muscles. During muscle activity, creatinine breaks down into various metabolites, which are then excreted through urine. Therefore, creatinine levels in the blood and urine are important indicators of kidney function.

Triglyceride levels were within the normal range only for patient 4; in all other patients, they were elevated. Triglycerides are a type of fat (lipid) found in the blood and serve as a primary energy source. After eating, excess calories are converted into triglycerides and stored in fat cells. These triglycerides are used as an energy reserve to support basic bodily functions and the absorption of fat-soluble vitamins (A, D, E, and K). To manage elevated triglyceride levels, it is essential to follow a healthy diet, avoid sugar and sugary products, engage in physical activity, and maintain a healthy weight.

Urea levels were above normal only for patient 1. Urea is a chemical compound produced in the liver from ammonia, which is released during protein breakdown. It is transported *via* the blood to the kidneys, where it is filtered and excreted in urine. Normal urea levels range from 3.2 to 8.2 mmol/L. Elevated urea levels can indicate kidney disease, dehydration, or excessive protein intake, while low levels may suggest liver disease or malnutrition. Urea plays a crucial role in detoxifying the body by helping to eliminate waste products from nitrogen metabolism.

All patients exhibited elevated cholesterol levels, indicating hypercholesterolemia (high cholesterol). Cholesterol is a type of lipid (fat) that plays a crucial role in various bodily processes. Produced in the liver, cholesterol is present in cell membranes, where it helps maintain their structural integrity and is essential for synthesizing hormones (such as estrogen and testosterone), vitamin D, and bile acids that aid in fat digestion. While the body produces sufficient cholesterol, it is also obtained from dietary sources, particularly animal products like meat, eggs, and dairy. High cholesterol levels can be managed through dietary changes and, if necessary, cholesterol-lowering medications. In the recommended diets, red meat, dairy products, and eggs are included very cautiously (Table 2).

The levels of sodium, potassium, and chloride are within the normal range for all patients. Sodium is crucial for fluid regulation and maintaining normal nerve and muscle function. Potassium supports proper heart, muscle, and nervous system function. Chloride helps maintain acid-base balance and proper body hydration. Normal values of these electrolytes indicate a well-balanced electrolyte status in the patients.

The analysis of health indicators highlights the need for a healthy lifestyle among stroke survivors. Recommended diets for stroke prevention emphasize low salt intake and include more fruits, vegetables, whole grains, legumes, seeds, nuts, low-fat dairy products, and lean white meats. Conversely, red and processed meats, sweets, and alcohol are not

recommended. Following a stroke, dietary intervention should be viewed as a crucial strategy for preventing recurrence. Table 2 presents the diet plans generated by ChatGPT, and it can be concluded that these plans meet the criteria for stroke prevention.

Table 2. Diet plans generated by ChatGPT.

Days	Meals	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
1	Breakfast	Oatmeal (100g), fresh berries (50g), ground flaxseed (15g), herbal tea (unsweetened)	Whole grain cereal (50g) with low-fat milk (200ml), a small apple (100g)	Oatmeal (100g), fresh strawberries (100g), chia seeds (1 tbsp), green tea (unsweetened)	Oatmeal (100g), fresh strawberries (50g), chia seeds (1 tbsp), herbal tea (unsweetened)	Oatmeal (100g), fresh blueberries (50g), ground flaxseed (1 tbsp), herbal tea (unsweetened)
	Morning snack	Apple (150g), almonds (15g)	Carrot sticks (100g), hummus (50g)	Orange (150g)	Apple (150g), walnuts (10, 15g)	Orange (150g), almonds (10, 15g)
	Lunch	Grilled chicken breast (100g), quinoa salad with mixed vegetables (200g), whole grain bread (30g)	Grilled chicken breast (120g), quinoa salad with mixed vegetables (200g)	Grilled chicken breast (120g), mixed vegetable salad (200g), quinoa (100g)	Grilled chicken breast (100g), quinoa salad with mixed vegetables (200g), whole grain bread (1 slice, 30g)	Grilled chicken breast (100g), quinoa salad with mixed vegetables (200g), whole grain bread (1 slice, 30g)
	Afternoon snack	Low-fat yogurt (150g), walnuts (20g)	Greek yogurt (150g), mixed berries (50g)	Greek yogurt (150g), a handful of almonds (15g)	Greek yogurt (150g), mixed berries (50g)	Greek yogurt (150g), mixed berries (50g)
	Dinner	Baked salmon (120g) with lemon and dill, steamed broccoli and carrots (200g), brown rice (100g)	Baked salmon (120g) with steamed broccoli and carrots (200g), brown rice (100g)	Baked cod (150g), roasted Brussels sprouts (150g), brown rice (100g)	Baked salmon (120g) with lemon and dill, steamed green beans and carrots (200g), brown rice (100g)	Baked salmon (120g) with lemon and dill, steamed green beans and carrots (200g), brown rice (100g)
2	Breakfast	Whole grain toast (30g) with avocado spread (50g), boiled egg (1), herbal tea (unsweetened)	Whole grain toast (30g) with avocado spread (50g), boiled egg (1)	Whole grain toast (30g) with avocado spread (50g), boiled egg (1)	Whole grain toast (30g) with avocado spread (50g), boiled egg (1), herbal tea (unsweetened)	Whole grain toast (30g) with avocado spread (50g), boiled egg (1), herbal tea (unsweetened)
	Morning snack	Carrot sticks (100g), hummus (50g)	Apple (150g), almonds (15g)	Apple (150g)	Carrot sticks (100g), hummus (50g)	Carrot sticks (100g), hummus (50g)
	Lunch	Lentil soup (250ml), mixed green salad with olive oil and lemon dressing (200g)	Lentil soup (250ml), mixed green salad with olive oil and lemon dressing (200g)	Lentil soup (250ml), mixed green salad with olive oil dressing (200g)	Lentil soup (250ml), mixed green salad with olive oil and lemon dressing (200g)	Lentil soup (250ml), mixed green salad with olive oil and lemon dressing (200g)
	Afternoon snack	Blueberries (100g), hazelnuts (15g)	Blueberries (100g), hazelnuts (15g)	Carrot sticks (100g), hummus (50g)	Apple (150g), almonds (10, 15g)	Apple (150g), cashews (10, 15g)
	Dinner	Grilled turkey breast (120g), quinoa (100g) with sautéed spinach and garlic (200g), steamed green beans (150g)	Grilled turkey breast (120g), quinoa (100g) with sautéed spinach and garlic (200g)	Grilled turkey breast (120g), baked sweet potato (150g), steamed green beans (150g)	Grilled turkey breast (120g), quinoa (100g) with sautéed spinach and garlic (200g), steamed green beans (150g)	Grilled turkey breast (120g), quinoa (100g) with sautéed spinach and garlic (200g), steamed green beans (150g)
3	Breakfast	Smoothie (200ml almond milk, 1 banana, 50g spinach), chia seeds (15g)	Smoothie (200ml almond milk, 1 banana, 50g spinach), chia seeds (15g)	Smoothie (200ml almond milk, 1 banana, 50g spinach), flaxseeds (1 tsp)	Smoothie (200ml almond milk, 1 banana, 50g spinach), chia seeds (1 tsp)	Smoothie (200ml almond milk, 1 banana, 50g spinach), chia seeds (1 tsp)
	Morning snack	Celery sticks (100g), peanut butter (20g)	Celery sticks (100g), peanut butter (20g)	Celery sticks (100g), peanut butter (20g)	Celery sticks (100g), peanut butter (20g)	Celery sticks (100g), peanut butter (20g)
	Lunch	Baked cod (120g) with tomato and basil sauce, barley salad with cherry tomatoes and parsley (200g)	Baked cod (120g) with tomato and basil sauce, barley salad with cherry tomatoes and parsley (200g)	Baked salmon (120g), quinoa salad with cherry tomatoes and cucumbers (200g)	Baked cod (120g) with tomato and basil sauce, barley salad with cherry tomatoes and parsley (200g)	Baked cod (120g) with tomato and basil sauce, barley salad with cherry tomatoes and parsley (200g)
	Afternoon snack	Greek yogurt (150g), mixed berries (50g)	Greek yogurt (150g), mixed berries (50g)	Mixed berries (100g), walnuts (20g)	Greek yogurt (150g), mixed berries (50g)	Greek yogurt (150g), mixed berries (50g)
	Dinner	Stuffed bell peppers (200g) with quinoa, vegetables, and lean ground beef, mixed green salad (150g) with balsamic vinaigrette	Stuffed bell peppers (200g) with quinoa, vegetables, and lean ground beef, mixed green salad (150g)	Stuffed bell peppers (200g), with quinoa and lean ground beef, mixed green salad (150g)	Stuffed bell peppers (200g) with quinoa, vegetables, and lean ground beef, mixed green salad (150g) with balsamic vinaigrette	Stuffed bell peppers (200g) with quinoa, vegetables, and lean ground beef, mixed green salad (150g) with balsamic vinaigrette
4	Breakfast	Greek yogurt (150g), oats (30g), honey (10g)	Greek yogurt (150g), oats (30g), honey (10g)	Greek yogurt (150g), oats (30g), honey (10g)	Greek yogurt (150g), oats (30g), honey (1 tsp), herbal tea (unsweetened)	Greek yogurt (150g), oats (30g), honey (1 tsp), herbal tea (unsweetened)

				tsp), green tea (unsweetened)		
	Morning snack	Kiwi (100g), almonds (15g)	Kiwi (100g), almonds (15g)	Kiwi (100g), almonds (15g)	Kiwi (100g), walnuts (10, 15g)	Kiwi (100g), walnuts (10, 15g)
	Lunch	Grilled chicken salad (250g) with mixed greens, tomatoes, cucumbers, olive oil dressing, whole grain bread (30g)	Grilled chicken salad (250g) with mixed greens, tomatoes, cucumbers, olive oil dressing	Grilled chicken breast salad (200g) with mixed greens, cherry tomatoes, and olive oil dressing	Grilled chicken salad (250g) with mixed greens, tomatoes, cucumbers, olive oil dressing, whole grain bread (1 slice, 30g)	Grilled chicken salad (250g) with mixed greens, tomatoes, cucumbers, olive oil dressing, whole grain bread (1 slice, 30g)
	Afternoon snack	Cottage cheese (100g) with pineapple chunks (50g)	Cottage cheese (100g) with pineapple chunks (50g)	Cottage cheese (100g) with pineapple chunks (50g)	Cottage cheese (100g) with pineapple chunks (50g)	Cottage cheese (100g) with pineapple chunks (50g)
	Dinner	Baked trout (120g) with lemon and herbs, steamed asparagus (150g), wild rice (100g)	Baked trout (120g) with lemon and herbs, steamed asparagus (150g), wild rice (100g)	Baked trout (120g) with lemon, steamed asparagus (150g), wild rice (100g)	Baked trout (120g) with lemon and herbs, steamed asparagus (150g), wild rice (100g)	Baked trout (120g) with lemon and herbs, steamed asparagus (150g), wild rice (100g)
5	Breakfast	Whole grain toast (30g) with almond butter (15g), banana (100g), herbal tea (unsweetened)	Whole grain toast (30g) with almond butter (15g), banana (100g)	Whole grain toast (30g) with almond butter (15g), a small banana (100g)	Whole grain toast (30g) with almond butter (15g), banana (1 small, 100g), herbal tea (unsweetened)	Whole grain toast (30g) with almond butter (15g), banana (1 small, 100g), herbal tea (unsweetened)
	Morning snack	Cucumber slices (100g), tzatziki dip (50g)	Cucumber slices (100g), tzatziki dip (50g)	Cucumber slices (100g), tzatziki dip (50g)	Cucumber slices (100g), tzatziki dip (50g)	Cucumber slices (100g), tzatziki dip (50g)
	Lunch	Chickpea and vegetable stew (250ml), mixed green salad (150g)	Chickpea and vegetable stew (250ml), mixed green salad (150g)	Chickpea and vegetable stew (250ml), mixed green salad (150g)	Chickpea and vegetable stew (250ml), mixed green salad (150g)	Chickpea and vegetable stew (250ml), mixed green salad (150g)
	Afternoon snack	Strawberries (100g), cashews (15g)	Strawberries (100g), cashews (15g)	Strawberries (100g), cashews (15g)	Strawberries (100g), cashews (10, 15g)	Strawberries (100g), cashews (10, 15g)
	Dinner	Grilled turkey breast (120g), sweet potato mash (150g), steamed broccoli (150g)	Grilled turkey breast (120g), sweet potato mash (150g), steamed broccoli (150g)	Grilled turkey breast (120g), sweet potato mash (150g), steamed broccoli (150g)	Grilled turkey breast (120g), sweet potato mash (150g), steamed broccoli (150g)	Grilled turkey breast (120g), sweet potato mash (150g), steamed broccoli (150g)
6	Breakfast	Smoothie (200ml almond milk, 50g berries, 50g spinach, 15g flaxseed)	Smoothie (200ml almond milk, 50g berries, 50g spinach, 1 tbsp flaxseed)	Smoothie (200ml almond milk, 50g berries, 50g spinach, 1 tbsp flaxseeds)	Smoothie (200ml almond milk, 50g berries, 50g spinach, 1 tbsp flaxseed, chia seeds (1 tsp))	Smoothie (200ml almond milk, 50g berries, 50g spinach, 1 tbsp flaxseed, chia seeds (1 tsp))
	Morning snack	Bell pepper slices (100g), hummus (50g)	Bell pepper slices (100g), hummus (50g)	Bell pepper slices (100g), hummus (50g)	Bell pepper slices (100g), hummus (50g)	Bell pepper slices (100g), hummus (50g)
	Lunch	Baked chicken breast (120g), quinoa and vegetable stir-fry (200g)	Baked chicken breast (120g), quinoa and vegetable stir-fry (200g)	Baked chicken breast (120g), quinoa and vegetable stir-fry (200g)	Baked chicken breast (120g), quinoa and vegetable stir-fry (200g)	Baked chicken breast (120g), quinoa and vegetable stir-fry (200g)
	Afternoon snack	Greek yogurt (150g), sliced strawberries (50g)	Greek yogurt (150g), sliced strawberries (50g)	Greek yogurt (150g), sliced strawberries (50g)	Greek yogurt (150g), sliced strawberries (50g)	Greek yogurt (150g), sliced strawberries (50g)
	Dinner	Baked mackerel (120g) with herbs, steamed Brussels sprouts and carrots (200g), brown rice (100g)	Baked mackerel (120g) with herbs, steamed Brussels sprouts and carrots (200g), brown rice (100g)	Baked mackerel (120g), steamed Brussels sprouts and carrots (200g), brown rice (100g)	Baked mackerel (120g) with herbs, steamed Brussels sprouts and carrots (200g), brown rice (100g)	Baked mackerel (120g) with herbs, steamed Brussels sprouts and carrots (200g), brown rice (100g)
7	Breakfast	Whole grain cereal (50g) with low-fat milk (200ml), small apple (100g)	Whole grain cereal (50g) with low-fat milk (200ml), a small apple (100g)	Whole grain cereal (50g) with low-fat milk (200ml), small apple (100g)	Whole grain cereal (50g) with low-fat milk (200ml), small apple (100g)	Whole grain cereal (50g) with low-fat milk (200ml), small apple (100g)
	Morning snack	Radishes (100g), low-fat cheese (50g)	Radishes (100g), low-fat cheese (50g)	Radishes (100g), low-fat cheese (50g)	Radishes (100g), low-fat cheese (50g)	Radishes (100g), low-fat cheese (50g)
	Lunch	Lentil and vegetable stew (250ml), mixed green salad (150g)	Lentil and vegetable stew (250ml), mixed green salad (150g)	Lentil and vegetable stew (250ml), mixed green salad (150g)	Lentil and vegetable stew (250ml), mixed green salad (150g)	Lentil and vegetable stew (250ml), mixed green salad (150g)
	Afternoon snack	Mixed nuts (20g), blueberries (100g)	Mixed nuts (20g), blueberries (100g)	Mixed nuts (20g), blueberries (100g)	Mixed nuts (20g), blueberries (100g)	Mixed nuts (20g), blueberries (100g)
	Dinner	Baked chicken breast (120g), steamed mixed vegetables (200g), whole grain couscous (100g)	Baked chicken breast (120g), steamed mixed vegetables (200g), whole grain couscous (100g)	Baked chicken breast (120g), steamed mixed vegetables (200g), whole grain couscous (100g)	Baked chicken breast (120g), steamed mixed vegetables (200g), whole grain couscous (100g)	Baked chicken breast (120g), steamed mixed vegetables (200g), whole grain couscous (100g)

- One of the most suitable diets for stroke prevention is the Mediterranean diet which emphasizes consuming fresh seasonal foods. Its main principles include: Frequent consumption of dairy products like yogurt and cheese;

- Daily consumption of a large variety of vegetables, antioxidant-rich fruits, legumes, raw nuts, whole grains, and olive oil;

- Weekly intake of fish, eggs, and poultry;

- Limited intake of red meat, refined sugar, and saturated fats;

- Adequate water intake.

Comparing the generated diet plans with the Mediterranean diet shows a significant match. However, there is a difference in the recommended fish consumption. The Mediterranean diet suggests a weekly intake of fish, poultry, and eggs – meaning once a week – whereas the ChatGPT-generated diets recommend fish and white meats more than once a week. This adjustment may align with the elevated indicators noted in the previous studies. Red meat intake is limited to just one occurrence, specifically lean beef. The daily meals include whole grains, nuts (up to 20 grams), seeds, fresh fruits, and vegetables. Additionally, the milk included in the diet is low-fat, which is appropriate for managing elevated triglyceride levels.

Another suitable diet is the DASH diet. While it shares many principles with the Mediterranean diet, it is specifically designed to regulate and prevent high blood pressure. Its main principles include:

- Increased consumption of foods rich in magnesium, potassium, calcium, fiber, and protein;

- Reducing intake of foods high in sugar, saturated and trans fats, and sodium;

- Increased consumption of fruits, vegetables, legumes, nuts, low-fat and skim dairy products, poultry, and fish;

- Limited consumption of processed foods and fatty red meats;

- Restricting daily sodium intake to 2,300 mg, and in some cases, to 1,500 mg per day.

Comparing the ChatGPT-generated diets to the DASH diet criteria also shows a high level of concordance. The recommended sodium intake in the generated diets falls within the range of 1,500-2,000 mg per day. The menu includes foods such as mackerel, salmon, brown rice, oats, chickpeas, lentils, almonds, and flaxseed, which are rich in magnesium. Potassium is provided by bananas, avocados, beans, and lentils, while dairy products, broccoli, and almonds supply calcium. Whole grains, a key component of the DASH diet, are also recommended daily by ChatGPT.

The European food pyramid for a healthy diet emphasizes the importance of consuming a varied and balanced diet. Its main principles include:

- Frequent consumption of foods from the base of the pyramid, such as cereals, vegetables, and fruits, which are rich in vitamins, minerals, fiber, and other essential nutrients;

- Moderate consumption of foods from the middle of the pyramid, including proteins, dairy products, and fats;

- Very limited and cautious consumption of foods from the top of the pyramid, such as processed and refined foods, as well as other high-calorie, low-nutrient items.

Table 2 shows that the menu includes foods from the base of the pyramid, with moderate consumption of those from the middle, and no processed or refined foods are present.

Based on the comparisons made, we can conclude that the diets generated by ChatGPT adhere to the criteria of all three types of healthy eating plans.

Although the dietary plans generated by artificial intelligence follow the established principles, we calculated the health index using the AHEI-2010 criteria for greater accuracy (Table 3) [43-47].

Table 3. The AHEI-2010 scoring method. [43]

Component	Minimum Score (0)	Maximum Score (10)
Vegetables	0 servings/d	≥5 servings/d
Fruits	0 servings/d	≥4 servings/d
Whole grains	0 servings/d	≥4 servings/d
Sugar-sweetened beverages and fruit juice	≥1 servings/d	0 servings/d
Nuts and legumes	0 servings/d	≥1 servings/d
Red/processed meat	≥1.5 servings/d	0 servings/d
Trans fat	≥4% of energy	≤0.5% of energy
Long-chain (n-3) fats (EPA + DHA)	0 mg/d	≥250 mg/d
PUFA	≤2% of energy	≥10% of energy
Sodium	Highest decile	Lowest decile
Alcohol	Women: ≥2.5 drinks/d Men: ≥3.5 drinks/d	Women: 0.5-1.5 drinks/d Men: 0.5-2.0 drinks/d

The AHEI-2010 is a tool designed to assess diets and their association with the risk of chronic diseases. It was developed as an alternative to traditional dietary guidelines to evaluate nutrition

quality and its impact on the risk of cardiovascular disease, diabetes, and cancer. In this regard, it provides a more precise assessment of the quality of AI-generated diets.

The AHEI-2010 [43] focuses on the types of foods and food groups linked to better health:

- Encourages increased intake of fresh fruits, which are major sources of vitamins, minerals, and fiber.
- Includes a variety of vegetables, emphasizing leafy greens and avoiding potatoes.
- Assesses consumption of whole grain products such as brown rice, oatmeal, and whole grain bread.
- Encourages regular consumption of nuts and legumes, which are excellent sources of plant-based protein and healthy fats.
- Measures intake of fish and other sources of omega-3 fatty acids, such as flaxseed and walnuts, for their cardiovascular protective effects.
- Promotes replacing saturated and trans fats with polyunsaturated fats found in vegetable oils, nuts, and fish.
- Evaluates the presence of trans fats, long-chain (n-3) fats (EPA + DHA), and polyunsaturated fatty acids (PUFA) in the diet.
- Reduces consumption of red and processed meats, which are associated with higher risks of chronic diseases.
- Limits intake of sweetened beverages and high-sugar fruit juices that contribute to obesity and metabolic diseases.
- Assesses moderate alcohol consumption (up to 1 drink per day for women and 2 for men) for its potential heart-protective effects.
- Recommends limiting sodium intake to reduce the risk of high blood pressure and cardiovascular disease.

Each component of the diet is rated on a scale from 0 to 10 points based on how well it aligns with healthy eating recommendations. The maximum score for a diet according to the AHEI-2010 criteria is 110 points. A diet scoring above 65 points is considered healthy, with higher scores indicating a better alignment with healthy eating practices and a lower risk of chronic diseases. Based on these criteria [43] and the quantities of each food in the diet plans, we calculated the number of servings and points for each component, as well as the total score for each day (Fig. 1). The graph shows that all the diet plans received more than 65 points, indicating that the ChatGPT-generated diets are healthy.



Figure 1. AHEI-2010 scores for daily menus ranged from 71.5 to 88.6 across all five patients

For each diet plan, we calculated the average number of points for each food component and displayed these on a radar chart (Fig. 2) to assess differences in the recommended food quantities for different patients. The chart indicates that there is consistency for some foods (such as whole grains and red meats), while differences exist for others (such as nuts, foods with trans fats, and PUFA). Although fruits and vegetables are included daily, their quantities often fall short of meeting the AHEI-2010 health criteria. The distribution of vegetables and fruits throughout the week is suboptimal, with some days not meeting the minimum recommendations set by the World Health Organization. Fish oils, a major source of polyunsaturated fatty acids (PUFA), are included, but consumption of other PUFA-rich foods (like nuts and flaxseeds) could be higher. Additionally, ChatGPT's diet plans show limited variety, as the same foods are repeated across different meals. While the overall scores for all diet plans exceed 65 points, indicating they are healthy, there is room for improvement in food variety and nutrient distribution.

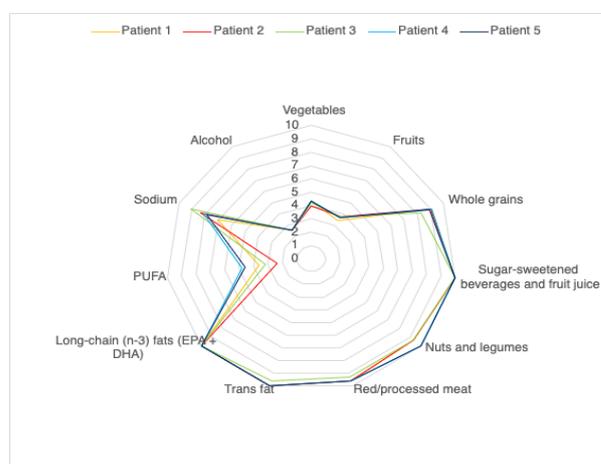


Figure 2. Average distribution of AHEI-2010 component scores throughout the week for all patients' diets.

CONCLUSIONS

A healthy and balanced diet is crucial for maintaining physical and psychological well-being, particularly for stroke survivors. Large language models like ChatGPT offer a valuable tool for generating dietary plans. This study provides a comprehensive analysis of ChatGPT's potential to create personalized dietary plans aimed at stroke prevention, highlighting both the advantages and limitations of the generated diets.

While databases such as Scopus, PubMed, and Web of Science contain numerous studies on healthy eating recommendations and preventive diets for recurrent stroke, no studies were found specifically addressing personalized stroke prevention dietary plans generated by ChatGPT. Therefore, this study is unique in evaluating ChatGPT's capability to deliver customized dietary plans for secondary stroke prevention.

ChatGPT has successfully generated healthy diet plans that align with patients' nutritional needs and medical conditions. However, to definitively establish these plans as personalized, further research involving larger patient cohorts is necessary. The current plans provide an adequate intake of energy (1800 to 2000 kcal per day), protein (70 to 90 g per day), carbohydrates (200 to 250 g per day), fat (60 to 70 g per day), fiber (25 to 35 g per day), vitamins, and minerals.

The developed plans align with current healthy dietary recommendations; however, additional follow-up is essential to ensure their appropriateness for stroke survivors.

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