

Clinical Research

Clinical assessment of dietary interventions and lifestyle modifications in *Madhumeha* (type- 2 Diabetes Mellitus)Archana Gupta, Neeraj Kumar Agarwal¹, Parameswarappa S. ByadgiDepartment of Vikriti Vigyan, Faculty of Ayurveda, ¹Department of Endocrinology, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

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Abstract

Background: India leads the world with maximum number of diabetes patients being termed as the “diabetes capital of the world.” Certain risk factors including unsatisfactory diet, overweight, and a sedentary lifestyle are potentially reversible. *Acharayas* have widely described the role of diet and activities to control *Madhumeha* (type 2 diabetes mellitus [T2DM]) along with medications. Habitual consumption of roasted or dry Barley (*Hordeum vulgare* L.) flour, *Mudga* (*Phaseolus aureus* Roxb.) and *Amalaki* (*Emblca officinalis* Gaertn.) prevents the manifestation of *Prameha*. **Aim:** To assess the clinical effects of dietary interventions and life style modifications in *Madhumeha* patients. **Materials and Methods:** Present study was carried out on 56 patients of *Madhumeha* from S.S. Hospital, Banaras Hindu University, Varanasi. Dietary interventions and life style modifications schedule was prepared based on Ayurvedic principles and patients were advised to follow this regimen. Three consecutive follow-ups were done for 3 months at the interval of one month each. **Results:** Significant improvement was observed in clinical signs and symptoms along with plasma glucose and glycosylated hemoglobin (HbA1c) in *Madhumeha* patients after these interventions ($P < 0.001$). **Conclusion:** Dietary interventions and life style modifications are two important tools by which adequate glycemic control can be obtained, especially in newly diagnosed T2DM patients and in patients who are on antidiabetic medication, but not properly controlled.

Key words: *Amalaki*, blood sugar, HbA1c, *Madhumeha*, *Mudga*, type 2 diabetes mellitus, *Yava*

Introduction

India leads the world with maximum number of diabetic patients being termed as the “diabetes capital of the world.” According to the Diabetes Atlas 2006 published by the International Diabetes Federation, the number of people with diabetes in India currently around 40.9 million is expected to rise to 69.9 million by 2025 unless urgent preventive steps are taken.^[1] The so called “Asian Indian Phenotype” refers to certain unique clinical and biochemical abnormalities in Indians which include increased insulin resistance, greater abdominal adiposity that is, higher waist circumference despite lower body mass index (BMI), lower adiponectin and higher high sensitive C-reactive protein levels. This phenotype makes Asian Indians more prone to diabetes and premature coronary

artery disease. At least a part of this is due to genetic factors.^[2] However, the primary driver of the epidemic of diabetes is the rapid epidemiological transition associated with changes in dietary patterns and decreased physical activity as evident from the higher prevalence of diabetes in the urban population.

Treatment prevents some of its devastating complications, but does not usually restore normoglycemia or eliminate all the adverse consequences. The diagnosis is often delayed until complications are present. Since current methods of treating diabetes remain inadequate, prevention is preferable.^[3] The hypothesis that type 2 diabetes is preventable is supported by observational studies and clinical trials of diet and exercise. Interventions that work in some societies may not work in others because social, economic, and cultural factors influence diet and exercise. This is of special concern in India, where there is great regional and ethnic diversity in dietary and lifestyle patterns.

Sahaja/Kulaja/Jataja and *Apathyanimittaja*^[4] (diabetogenic diet and activity) are the two important etiological factors that explain the heterogenous nature of this disease. Incidence of this disease increases with age due to natural dominancy

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of *Vata* in the old age.^[5] In Ayurveda treatment principle of *Madhumeha* includes bio-purification therapy, palliative care, rejuvenation therapy, dietary interventions and life style modifications. *Acharayas* have widely described the role of diet and activities to control *Madhumeha* along with medications. Habitual consumption of roasted or dry *Yava* (barley - *Hordeum vulgare* L.) flour, *Mudga* (*Phaseolus aureus* Roxb.) and *Amalaki* (*Emblica officinalis* Gaertn.) prevents the manifestation of *Prameha*.^[6] In new cases of diabetes, adequate glycemic control can be obtained by diet and life style advice alone in approximately 50%, only 20–30% will need oral antidiabetic drugs and 20–30% will require insulin.^[7] In a patient with suspected type 2 diabetes mellitus (T2DM), the first line of therapy involves advice about dietary and life style modifications. In this regard, present study had been under taken to assess the effect of dietary interventions and life style modifications in *Madhumeha* (T2DM) patients on clinical signs and symptoms with biochemical parameters.

Materials and Methods

Randomly 56 patients of *Madhumeha* (T2DM) from OPD and IPD of S.S. Hospital Ayurveda wing and Endocrine O.P.D were selected for the present study from August 2011 to November 2012. The study was approved by the ethical committee of the Institute of Medical Sciences, Banaras Hindu University, Varanasi (vide letter no Dean/2010-11/346 dated 21-12-2010). Informed consent was obtained from selected patients. Selection of patients was based on subjective and objective criteria.

Inclusion criteria

- Age of patients in between 25 and 75 years
- Patients with diagnostic features of *Madhumeha* (T2DM) clinically such as *Prabhuta Mutrata* (polyuria), *Bahuashee* (polyphagia), *Pipasa* (polydipsia), *Gal-Talu Shosha* (throat dryness), *Kara-Pada Suptata* (numbness/tingling hand and foot), *Daurbalya* (weakness), *Sayyasana-Swapna Sheela* (always desire to occupy bed), *Netra Upadeha* (more *Akshi Vit*), *Dantadinam Maladhyatvam* (dirty teeth), *Swedo-Anga Gandha* (sweating with smell) and *Asya Madhurya* (sweet taste in mouth)
- Fasting plasma glucose (FPG) level ≥ 120 mg/dl and/or 2-h (postprandial) plasma glucose level ≥ 200 mg/dl.^[8]

Exclusion criteria

- Patients with T1DM
- Patients with T2DM who were insulin dependent and with severe diabetic complications like cardiovascular diseases, nephropathy and retinopathy
- DM associated with systemic viral/bacterial infections like HIV, Hepatitis, Tuberculosis and Malignancy etc
- Diabetes due to endocrinopathies, e.g., phaeochromocytoma, acromegaly, Cushing's syndrome, hyperthyroidism, etc
- Patients with certain genetic syndromes, which are sometimes associated with DM, e.g. Down's syndrome, Klinefelter's syndrome, Turner's syndrome, etc.

Posology

Registered patients were advised to follow dietary interventions

and life style modifications strictly as per our advice and informed them to come to next follow-up at 1 one month interval for three consecutive months along with ancillary investigations to report the changes in biochemical parameters after following the dietary interventions and life style modifications.

Instructions for dietary interventions and life-style modifications

Diet and activities schedule was prepared, and the same was advised to the patients. Detail description of dietary interventions, which were advised to the patients [Table 1].

Life-style modifications

Details of life style modifications advised to the patient are as follows:

- Early morning awakening
- Brisk walking/light exercises for 30 min
- Massage/swimming
- Yoga - *Asana* (as *Padmasana*, *Pashchimottanasana*, *Suptavajrasana*, *Surya-Namaskar*, *Dhanurasana*)
- *Pranayama* (*Bhastrika*, *Anuloma-Viloma*)
- After lunch walking for 15 min
- After dinner slow walking for 15 min.

Patients were advised to sleep only 6–7 h during the night and avoid sleep during day time. Patients were totally prohibited to take sweet items, fried items, fast foods, *Urad*, meat, milk products, cold drinks, chocolates, alcohol substances, dry fruits, curd, pickles, potato, sweet-potato, bread, butter, fermented items, etc.

Assessment criteria

Subjective parameters

The assessment was done with cardinal symptoms of *Madhumeha* such as *Prabhuta-Mutrata* (polyuria), *Bahuashee* (polyphagia), *Pipasa* (polydipsia), *Gal-Talu Shosha* (polydipsia), *Daurbalya* (weakness), *Sayyasana-Swapna* (always desire to occupy bed), *Danteshu-Malotpatti* (teeth sensation/pyorrhoea), *Swedaadhikya-Anga-Gandha* (sweating with smell), *Netra-Updeha* (blurring vision) and *Asya-Madhurya* (sweet taste in mouth).

Objective parameters

Blood pressure, body weight, BMI, central obesity, plasma glucose (FPG); 2-h plasma glucose (2-hPG) and glycosylated haemoglobin (HbA1c).

Statistical analysis

Statistical analysis was performed using Statistical Package of Social Science (SPSS)-(IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.) Data was analyzed statistically in terms of mean score (M), standard deviation (S.D.). Paired *t*-test was carried out at the level of *P* values 0.05, 0.01 and 0.001.

Observations

Patients selected for study were in the range of 25–74 years of age. The present clinical study reveals that the age predominance of 45–54 years that is, 37.00% and then 55–64 years, 35–44 years,

Table 1: Specific low caloric diet chart (1400-1800 calories)

Day schedule	Diet management	Calories
Early morning (5-6 am)	Sprouted (Green <i>Mudga+Chana</i>) 50-80 g <i>Amalaki</i> powder 5 g (1 tsf) - twice a day or <i>Amalaki</i> powder+roasted <i>methi</i> powder (1:4) - 5 g, twice a day	50 calories
Breakfast (8-10 am)	1 cup Tea with milk - 60 calories 1 small bowel <i>Dalia</i> /Wheat flakes/Oats/2-3 Bread slice without Spreads/ Biscuits/1 <i>Roti</i> with vegetable - 180 calories or 1 Boiled egg (only white part) - 100 calories	200-300 calories
Fruits (11-12 am)	<i>Amla</i> /Cucumber/Orange/ <i>Mausambi</i> /Unripe Guavava/Pears or Small amount: Apple/Papaya/Plum/Peach	60 calories
Lunch (12-2 pm)	1 bowel <i>Dal</i> (<i>Mudga/Arahar+Mudga/Masura</i>) - 150 calories 1 bowel green leafy vegetables - 200 calories Rice (small amount) - 50 calories 2-3 <i>Roti</i> (wheat 1 part+oats 1/2 part and/or 1/4 part <i>Chana</i>) - 150-200 calories Salad (cucumber/onion/tomato etc.) - 20 calories Lemon water - 1/2 glass *After lunch, day time sleep contraindicated	500-600 calories
Breakfast (5-6 pm)	2 <i>Roti</i> +green leafy vegetables - 200 calories or <i>Saktu</i> (oat+ <i>Chana</i>) with water - 60 calories/1 cup Tea with milk/Biscuits - 50 calories/Fruits - 60 calories	150-250 calories
Dinner (8-9 pm)	Leafy vegetables+ <i>Dal</i> +2-3 <i>Roti</i> +Salad - 300-400 calories *Nonvegetarian - Chicken or small fish+2 <i>Roti</i> - 300-400 calories	300-400 calories
Milk (9-10 pm)	150 ml skimmed cow milk	100 calories

*Especially emphasis on *Amalaki*, *Yava* (barley/oats), and *Mudga*

65–74 years, 25–34 years were 24.00%, 23.00%, 9.00%, and 7.00% respectively. Of 56 patients, 62.50% of the patients were males and 37.50% of patients were females. In this clinical study, 91.00% of patients were belonging to Hindu religion while 8.93% of patients belonging to Muslim religion. Present study reveals that the education-wise majority of the patients as graduates 39.29%, 23.21% had completed their primary education, 19.64% of the patients had completed intermediate education, and 17.86% were uneducated. Of 56 patients, maximum no of patients, that is, 32.14. % are belonging to business category, and 26.79% patients were indulged in house hold work. 16.07%, 10.71%, 8.93%, and 5.36% patients were belonging to labour, retired (Government employee), farmer and service in field work respectively. Data shows that 94.64% of patients were married and 5.36% were unmarried. The present study covered a cross-section of the society. It was found that majority of the patients were belonging to middle income group, that is, 51.79% and 39.29% patients were from lower income group and 08.92% patients were from high income group. It was found that the majority of the patients were from urban habitat (52.79%) when compared to those from rural habitat are (48.21%). The present study reveals that brothers and sisters were maximum sufferers, that is, 32.14% followed by father, mother and both 14.29%, 14.29%, and 8.93% respectively. No family history observed in 30.35% of cases [Table 2].

Results

Effect of therapy on subjective parameters

Clinical improvement in signs and symptoms after dietary interventions and lifestyle modifications observed in the present clinical study indicated its utility in *Madhumeha* management [Table 3].

Effect of therapy on objective parameters

In present clinical study significant improvement was observed in blood pressure control, Weight reduction and BMI of *Madhumeha* patients after three consecutive follow-ups of dietary interventions and life style modifications.

Effect of therapy on blood pressure

The present study revealed that before dietary interventions and life style modifications, 64.29% patients were having normal systolic blood pressure, 25.00% patients were having raised systolic blood pressure in the range of 130–150 mm/Hg, while 10.71% patients belonged to hypertensive group in the range of 150–170 mm/Hg. None of the patient in this study has reported systolic blood pressure above 170 mm/Hg. After dietary interventions and life style modifications, above data was changed up to 87.50%, 10.71%, and 1.79% respectively. The data of the present clinical study indicated that before dietary interventions and life style modifications, 55.36% patients were having normal diastolic blood pressure, 32.14% patients were having had raised diastolic blood pressure in the range of 80–90 mm/Hg. 12.50% patients had raised to

hypertensive group in the range of 90–100 mm/Hg. None of the patients in this study have reported diastolic blood pressure above 100 mm/Hg. After dietary interventions and life style modifications, above data were changed up to 80.36%, 16.07%, and 3.57% respectively [Table 4].

Effect of therapy on body weight

The present clinical study reveals that before dietary interventions and life style modifications, the incidence of patients in the weight group of 41–50 kg, 51–60 kg, 61–70 kg, 71–80 kg, and >80 kg was 7.15%, 10.71%, 53.57%, 23.21%, and 5.36% respectively. After dietary interventions and life style modifications, the incidence of patients in the weight group was 14.29%, 57.14%, 19.64%, 08.93%, and 00%, respectively [Table 5].

Table 2: Demographic profile of Madhumeha patients (n=56)

Subjective criteria	Highest incidence (%)
Age	
45-54 years	37.50
Sex	
Male	62.50
Religion	
Hindu	91.07
Education	
Graduates	39.29
Occupational status	
Businessmen	32.14
Marital status	
Married	94.64
Socioeconomic status	
Middle grade (Rs. 10,000-20,000/month)	51.79
Habitat status	
Urban	52.79
Family history of diabetes mellitus	
Brother and sister	32.14

Effect of therapy on body mass index

The present study reveals that before dietary interventions and life style modifications, the incidence of patients in the overweight group of 25.0–29.9 kg/m² (60.71%) was the highest, followed by normal group of 18.5–24.9 kg/m² (17.86%), Obese group of 30.0–39.9 kg/m² (16.07%), and underweight group of <18.5 kg/m² (5.36%), respectively. After dietary interventions and life style modifications, the incidence of patient in the normal group of 18.5–24.9 kg/m² (67.85%) was the highest, followed by overweight group of 25.0–29.9 kg/m² (17.86%), underweight group of <18.5 kg/m² (8.93%), and obese group of 30.0–39.9 kg/m² (5.36%), respectively [Table 6].

Effect of therapy on central obesity

Data showed that the presence of central obesity mean range before treatment was 96.25 ± 10.54 and after dietary interventions and life style modifications it reduced to 76.57 ± 19.24 [Table 7].

Effect of therapy on plasma glucose

The present clinical study reveals that mean initial score for FPG was 211.42, which reduced to 103.13, after three consecutive follow-up was done for 3 months at the interval of 1-month. Mean score for 2-hPG was 332.76, which reduced to 140.06, after three consecutive follow-up was done for 3 months at the interval of 1-month [Table 8].

Effect of therapy on glycosylated hemoglobin

The present clinical data reveals that before dietary interventions and life style modifications HbA1c mean range was 9.91, which reduced to 6.72 after the 3 months regimen [Table 9].

Discussion

It is elaborately described since ages erratic lifestyle and diet lead to obesity, followed by *Madhumeha* (T2DM) along with its complications. Acharaya Sushurta^[9] and Vagbhata^[10] have similar opinion regarding the etiological factors that *Apathya-Nimittaja Prameha* may be due to intake of more foods, which aggravates *Kapha*, *Meda* and *Mutra*, lack of exercise and other sedentary life styles and it may be compared to T2DM.

Table 3: Effect of dietary interventions and life-style modifications in Madhumeha patients

Signs and symptoms	BT (n)		AT (n)	
	Present	Absent	Present	Absent
<i>Prabhuta-Mutrata</i> (polyuria)	51	05	08	48
<i>Bahuashee</i> (polyphagia)	42	14	06	50
<i>Pipasa</i> (polydipsia)	48	08	05	51
<i>Gal-Talu Shosha</i> (polydipsia)	47	09	02	54
<i>Daurbalya</i> (weakness)	52	04	14	42
<i>Sayyasana-Swapna</i> (always desire to occupy bed)	46	10	08	48
<i>Danteshu-Malotpatti</i> (teeth sensation/pyorrhoea)	30	26	19	37
<i>Swedaadhikya-Anga-Gandha</i> (sweating with smell)	32	24	15	41
<i>Netra-Updeha</i> (blurring vision)	26	30	06	50
<i>Asya-Madhurya</i> (sweet taste in mouth)	12	44	02	54

BT: Before treatment, AT: After treatment

Table 4: Effect of therapy on BP in Madhumeha patients

SBP	BT/n (%)	AT/n (%)	DBP	BT/n (%)	AT/n (%)
110-130	36 (64.29)	49 (87.50)	70-80	31 (55.36)	45 (80.36)
130-150	14 (25.00)	06 (10.71)	80-90	18 (32.14)	09 (16.07)
150-170	06 (10.71)	01 (1.79)	90-100	07 (12.50)	02 (3.57)

BP: Blood pressure, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, n: Number of patients, AT: After treatment, BT: Before treatment

Table 5: Effect of therapy on body weight in Madhumeha patients

Body weight (in kg)	BT/n (%)	AT/n (%)
30-40	00 (00.00)	00 (00.00)
41-50	04 (07.15)	08 (14.29)
51-60	06 (10.71)	32 (57.14)
61-70	30 (53.57)	11 (19.64)
71-80	13 (23.21)	05 (08.93)
>80	03 (05.36)	00 (00.00)

n: Number of patients, AT: After treatment, BT: Before treatment

Table 6: Effect of therapy on BMI in Madhumeha patients

BMI (in kg)	BT/n (%)	AT/n (%)
<18.5 (underweight)	03 (5.36)	05 (8.93)
18.5-24.9 (normal)	10 (17.86)	38 (67.85)
25.0-29.9 (overweight)	34 (60.71)	10 (17.86)
30.0-39.9 (obese)	09 (16.07)	03 (5.36)
>40 (severe obese)	00 (00.00)	00 (00.00)

BMI: Body mass index or body fat (in kg/m²), n: Number of patients, AT: After treatment, BT: Before treatment

Excessive sleep during day and night, lack of exercise, laziness and frequent and excessive use of new grains, use of new peas, black gram and other pulses along with *Ghritha*, *Tila*, *Tilapista* etc., and the use of sugar cane juice, milk and its products, fresh wine, *Dadhivikara*, meat soups of different animals, residing in water or near water and all other materials vitiating *Kapha*, results into *Prameha* in susceptible individuals. Consuming foods that are low in fiber and high in glycemic loads is associated with increased risk of DM. The overall metabolic deregulation associated with *Madhumeha* (DM) causes secondary patho-physiologic changes in multiple organ system that imposes a tremendous burden on the individual with DM and on the health care system. All the above etiological factors of *Prameha* are similar to the modern concept of DM, which is a major health hazard affecting millions of people all over the world. So *Prameha* patients must take diet, which nourish the body elements, but will not contribute to the pathogenesis by generating excessive *Kapha*, *Meda*, *Kleda* and *Mutra*.^[11] It must be planned according to *agni* of patient. According to Charaka, habitual consumption of roasted or/and dry barley (*Yava*) flour, *Mudga* and *Amalaki* prevents the manifestation of *Prameha*. *Yava* must constitute the major diet portion of *Prameha* patient. *Yava* causes *Santarpana* without vitiating *Doshas*. *Yava* possesses mutual properties, *Pittaghna* and *Kaphaghna* and bestowing stability. Earlier studies have shown that *Yava* has property of antihypertensive effect, gastrointestinal

Table 7: Effect of therapy on central obesity in Madhumeha patients (n=56)

Waist (in cm)	Minimum	Maximum	Mean±SD	t	P
BT	72.00	118.00	96.25±10.54	5.71	<0.001
AT	56.00	92.00	76.57±19.24		

AT: After treatment, BT: Before treatment, SD: Standard deviation

Table 8: Effect of therapy on plasma glucose level in Madhumeha patients (n=56)

Plasma glucose level	Mean±SD	Different	t	P
FPG				
Initial	211.42±64.17	-	-	-
1 st follow-up	154.91±45.15	56.51±46.28	9.77	<0.001
2 nd follow-up	122.79±28.01	88.63±50.07	14.16	<0.001
3 rd follow-up	103.13±17.22	108.29±55.88	15.50	<0.001
2-hPG				
Initial	332.76±84.65	-	-	-
1 st follow-up	239.18±67.60	93.59±61.54	12.17	<0.001
2 nd follow-up	180.88±48.16	151.88±68.33	17.78	<0.001
3 rd follow-up	140.06±26.96	192.69±77.02	20.01	<0.001

FPG: Fasting plasma glucose, 2-hPG: 2-h plasma glucose, SD: Standard deviation

Table 9: Effect of therapy on glycosylated hemoglobin in Madhumeha patients (n=56)

	Mean±SD	Different	t	P
BT	9.91±2.25			
AT	6.72±1.19	3.19±1.53	16.66	<0.001

AT: After treatment, BT: Before treatment, SD: Standard deviation

effects, sympathomimetic effects, glycemic/insulinemic effect, metabolic effects and lowers the serum cholesterol level.^[12-14] *Amalaki* is highly nutritious and is an important dietary source of Vitamin C, minerals and amino acids. Several studies have shown their antioxidant and antidiabetic properties and also useful in heart and eye disorders.^[15,16] *Mudga* contains 64.04% protein and fair source of calcium, iron, Vitamins A and B. Sprouts are a good source of Vitamin B which is important for proper functioning of nerve conduction and these increases *Kleda*. Several studies have also proved their hypolipidemic, hypotensive and chronotropic effects.^[17,18] *Apatarpana*, that is, weight reduction with the help of *Vihara* in the treatment of *Prameha* as described by all Acharyas. All these manoeuvre help to reduce *Meda* and *Kapha*, which are the culprits in *Prameha*. Sushruta has described different types of exercises helpful for *Prameha* patients.^[19]

Outcome measure of the present study

Dietary interventions and life style modifications improved glycemic control, insulin sensitivity and cardiovascular fitness. Hence, reduction of plasma glucose level, hyperlipidemia and hypertension were observed in the present study. Reduction of the signs and symptoms, weight and BMI also indicates that dietary interventions and life style modifications are important tools for the management of *Madhumeha* (T2DM).

Conclusion

It can be concluded that dietary interventions and life style modifications are two important tools by which adequate glycemic control can be obtained especially in newly diagnosed type-2 DM patients. These tools are also useful in patients, who are on antidiabetic medication, without proper control on glycemic index.

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हिन्दी सारांश

मधुमेही रूग्णों में आहारीय व्यवधान एवं जीवनशैली परिवर्तन का नैदानिक मूल्यांकन

अर्चना गुप्ता, नीरजकुमार अग्रवाल, परमेश्वरअप्पा एस. ब्याडगी

संसार मे मधुमेह रोगियों की अधिकतम संख्या के साथ भारत 'संसार की मधुमेह राजधानी' के रूप में कहा जा रहा है। असंतोषजनक आहार, अधिक अतिरिक्त वजन और एक आसीन जीवनशैली सहित कुछ जोखिमकारकतत्व, जो संभावित प्रतिवर्ती है। आचार्यों ने मधुमेह को नियमित करने के लिए औषधियों के साथ-साथ आहार और गतिविधियों की भूमिका का व्यापक वर्णन किया है। भुना हुआ या सुखा जौ का आटा, मूंग और आँवला का अभ्यस्त सेवन प्रमेह की अभिव्यक्ति को रोकता है। मधुमेह रोगियों में आहारिय व्यवधान और जीवन शैली संशोधनों के नैदानिक प्रभाव का आकलन करने के लिए, यह अध्ययन एस.एस. अस्पताल, काशी हिन्दू विश्वविद्यालय, वाराणसी से मधुमेह के ५६ मरीजों पर किया गया। आहार हस्तक्षेप और जीवन शैली संशोधनों की अनुसूची आयुर्वेदिक सिद्धान्तों के आधार पर तैयार की गयी थी और रोगियों को इन आहार का पालन करने की सलाह लगातार तीन अनुवर्ती प्रत्येक एक महीने अन्तराल पर तीन महीनों के लिए दी गयी थी। इन उपायों के बाद मधुमेह रोगियों में प्लाज्मा ग्लूकोज और ग्लायकोसायलेटेड हीमोग्लोबीन के साथ नैदानिक संकेत और लक्षणों में उल्लेखनीय सुधार पाया गया। आहार हस्तक्षेप और जीवन शैली संशोधन दो महत्वपूर्ण उपकरण है, जिनके द्वारा पर्याप्त ग्लाइसिमिक नियंत्रण, विशेष रूप से नवनिदान मधुमेह रोगियों से प्राप्त किया जा सकता है। ये उपकरण उन रोगियों में भी उपयोगी है, जो मधुमेह विरोधी औषधि पर है, लेकिन ठीक से मधुमेह नियंत्रण नहीं है।