IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

lifestyle Intervention For Prediabetic Patients In Ayurveda; Review

1Chetan Pawar, 2Ashish Agrawal

1Assistant Professor, 2Assistant Professor

1SMBT Ayurved college & Hospital,Nandi Hills, Dhamangoan Ghoti Ta Igatpuri Dist Nashik State Maharashtra.,

2SMBT Ayurved college & Hospital,Nandi Hills, Dhamangoan Ghoti Ta Igatpuri Dist Nashik State Maharashtra.

INTRODUCTION: Prediabetes is an intermediate state of hyperglycemia with glycemic parameters above normal but below the diabetes threshold.[1] Observational evidence suggests an association between prediabetes and complications of diabetes such as early nephropathy, small fiber neuropathy, early retinopathy, and risk of macrovascular disease. Several studies have shown the efficacy of lifestyle interventions with regards to diabetes prevention with a relative risk reduction of 40%-70% in adults with prediabetes. There is increasing evidence to prove the efficacy of pharmacotherapy in the prevention of diabetes in adults with prediabetes, Pharmaceutical treatment options other than metformin are associated with adverse effects that limit their use for prediabetes. Long term cost-effectiveness of such interventions and the endpoint of therapy remains unclear.

India has approximately 73 million people living with diabetes and another 37 million with prediabetes while nearly 47% of the diabetes cases are undiagnosed.[2][3] There have been reports of increased mean fasting plasma glucose and prevalence of diabetes in developed as well as developing countries. The worldwide prevalence of impaired glucose tolerance in 2010 was estimated to be 343 million (7.8%) ranging from 5.8% in South East Asia to 11.4% in North American and Caribbean Countries of the nation's population.[4] International Diabetes Federation projects an increase in the prevalence of prediabetes to 471 million globally by 2035.

Various organizations have defined prediabetes with criteria that are not uniform. The World Health Organization (WHO) has defined prediabetes as a state of intermediate hyperglycemia using two specific parameters, impaired fasting glucose (IFG) defined as fasting plasma glucose (FPG) of 6.1-6.9 mmol/L (110 to 125 mg/dL) and impaired glucose tolerance (IGT) defined as 2 h plasma glucose of 7.8-11.0 mmol/L (140200 mg/dL) after ingestion of 75 g of oral glucose load or a combination of the two based on a 2 h oral glucose tolerance test (OGTT).[5] The American Diabetes Association (ADA), on the other hand, has the same cut-off value for IGT (140-200 mg/dL) but has a lower cut-off value

for IFG (100-125 mg/dL) and has additional hemoglobin A1c (HbA1c) based criteria of a level of 5.7% to 6.4% for the definition of prediabetes.[6]

Matting of hairs of the head, sweet taste in the mouth, loss of sensation (numbness), and burning sensation in hands (palms) and feet (soles); dryness of the mouth, palate, and throat; increased thirst, laziness, accumulation of waste products in the body, coating of the orifices of the body with wastes, burning sensation and numbness in body parts; flies and ants swarm on the body and urine, turbid urine, foul smell; excessive sleep and stupor at all time, are premonitory symptoms mentioned in Ayurvedic literature as Prameha Purvarupa and can be correlated with prediabetes.[7] Purvarupa is the earliest symptom of the disease. When Purvarupa gets manifested, the disease is still in developing form. This is the best time to intervene in the disease process by the administration of comprehensive treatment. Though Ayurveda, a heritage of Indian medical science is full of illustration of dietetic code and lifestyle intervention for healthy and diseased; but very little is known to the Indian society regarding the utmost importance of following these conducts of food and daily routine. A faulty diet like excessive consumption of fatty diet along with a lack of physical and mental exertion along with heavy day sleep had contributed a significant role in the rise of prediabetic and diabetic patients and the incidence of diabetes along with other noncommunicable disease and is increasing at an alarming rate.

Awareness among prediabetic patients, regarding the deleterious effects of an unhealthy diet (high intake of fat, sugar, and salt) along with the effects of sedentary lifestyle is the need of the hour. As risk factors like dietary choices, overweight and sedentary lifestyle are modifiable, it is needed for providing a prone case of diabetes with knowledge regarding following a good lifestyle where various aspects regarding daily regime including of dietetic habits, sleep habits, bowel habits, the importance of consumption of different low fat (Kapha and Medohara), high fiber recipes (Apatarpana diet) and daily physical exercises may be introduced. Awareness among cases who have a strong tendency to develop diabetes due to genetic predisposition or Kapha predominant person regarding this may urge them to adopt other means through which the patients can follow a healthy diet which may help to prevent diabetes. This regimen of diet and lifestyle intervention can be adopted in community-based health education programs so that maximum people in the society who are prediabetes can get benefited.

OBJECTIVES

The objective of this review is to bring into focus the role of Ayurvedic dietary and lifestyle guidelines for prevention and management of prediabetes.

MATERIAL AND METHODS

To fulfill the objectives relevant Ayurveda books Charak Samhita, Sushruta Samhita, and modern literature books Harrison principle of internal medicine, API and available research updates and information on Google Scholar, Pub Med, Science Direct, Sciene.gov were searched and analyzed with keywords prediabetes, lifestyle modification, diabetes, Prameha.

RESULTS AND DISCUSSION Nourishment of the body with proper diet is the basic need of human but when this goes unbalanced, either extra accumulation or depletion of tissue occurs resulting in metabolic disorders. As per Ayurveda, Prameha is a disorder of Kapha dominance and hence a Kapha dominant individual when indulges in a heavy fatty diet with no calories burning; then it slowly progresses towards the accumulation of Meda (fatty tissues),ultimately impairing the digestion and metabolism resulting into insulin deficiency or insulin resistance. Similarly, in other individuals who have poor digestion or impaired metabolism, the above pathogenesis starts causing diabetes. Hence as per the principle of Ayurveda faulty diet and lifestyle becomes the root cause of diabetes. So, awareness regarding diet especially, diet habits and lifestyle modification plays a critical role in

controlling blood sugar levels in a known case of diabetes or to prevent the disease in susceptible subjects i.e. cases of prediabetes.

Unless people with prediabetes change their lifestyle, most will have type 2 diabetes within the next 10 years, according to the National Institute of Diabetes and Digestive and Kidney Diseases. Lifestyle changes such as weight loss (7% of body weight) and moderate physical activity (150 minutes per week) can reduce the risk of diabetes by as much as 58%. To prevent the case of diabetes for 3 years, persons would have to participate in the lifestyle intervention program.[8]

A total of 14 articles from Google scholar were pooled. The results of 16 randomized controlled trials showed that people with prediabetes who received lifestyle intervention had a lower rate of progression to type 2 diabetes after one and three years of follow-up. The majority of the studies also showed a greater weight loss in lifestyle intervention participants, with a great variation between studies. Costs per quality-adjusted life year were lower when the benefits of lifestyle intervention were analyzed over a life-long time horizon compared to only the period of a lifestyle intervention (three years) or modeling over ten years.[9]

The Diabetes Prevention Program Research Group has published several studies showing that type 2 diabetes may be preventable by diet and exercise.[9] The DPP lifestyle intervention was based on empirical literature in nutrition, exercise, and behavioral weight control, especially as it applied to the prevention of type 2 diabetes in diverse ethnic groups. The intervention was designed to achieve and maintain at least a 7% weight loss and 700 calories/week of physical activity in all lifestyle participants.

Various etiological factors of diabetes have been mentioned in the texts of Ayurveda which are mainly Kapha Meda vitiating. As per the principles of Ayurveda, Nidana Parivarjana (avoidance of causative factors) is the first and most important step of treatment; hence the causative factors for Prameha or type 2 diabetes can be taken as the don'ts for the patients of prediabetes.

Ayurveda has given utmost emphasis for the maintenance of Pathya Ahara. It is stated that if one follows a wholesome diet and activities suitable to all Dhatus (tissues), the person can never suffer from Madhumeha (a type of Prameha).[10] Prameha encroaches the person who eats more excessively, and remain unhygienic (even by not taking bath) and lazy.[11] And hence as per Ayurveda quantity and quality of diet should be decided based on Agnibala (digestive power).

Hence it can be said that the primary focus in prediabetes care is glucose control where three main principles of nutritive therapy are applied- Total energy balance, nutrient balance, and food distribution balance. Careful distribution of food and snacks is especially important for the prediabetic patient. To achieve this following diet chart recommended.

Table 1: Recommended Pathya Ahara for prediabetes.[12]

Group	Name of items
Grains	Yava (barley)- Hordeum vulgare, Godhuma(wheat)- Triticumsativum, Shashtika Shali (rice)- Oryzasativa , Kodrava (grain variety)- Paspolum Scrobiculatum, Bajara (pearl millet)- Pennisetum glaucum
Pulses	Chanaka (bengal gram)- Cicer arietinum L , Adhaki (pigeon pea)- Cajanus cajan , Mudga (green gram)-Phaseolus aureus, Kulattha (horse gram)- Dolichos biflorus
Vegetables (bitter and Astringent)	Methika (fenugreek)- Trigonella foenum, Patola (pointed gourd)- Trisanthus dioica, Karvellaka (bitter gourd)- Momordic acharantia, Tanduleyaka – (Spiny amaranth) Amaranthus spinosus, Vastukam – (Sowbane) Chenopodium murale, Shobhanjana (drum stick)- Moringa oleifera, Karkotaka (spine gourd) – Momordica dioica , Rasona (garlic)- Alium sativum, Kadali (raw banana)- Musapara disiaca
Fruits	Jambu (Java plum) -Eugenia jambolana, Talaphala (tala palm)- Borassus flabellifer, Amalaki(gooseberry)-Emblica officinalis, Kapittha(monkey fruit)- Limonea acidissima , Dadima (pomegranate) – Punica granatum , Tinduka – (Indian persimon)- Disospyros embrayoptesis
Seeds	Methika (fenugreek seeds)-Trigonella foenum-graecum, Kamala-(Lotus) Nelum bonucifera, Utpala –(Water lily) Nymphoea stellate

Flesh (fat-free meat; Forest animals, forest birds)	Harina (deer flesh), Shashaka (rabbit) Birds likes–Kapota (pigeon), Titira-(Himalayan quail)
Fermented or alcoholic liquids	Madhveeka Sura, Madhvasava (in Kapha Pittaja Prameha), Purana Sura- old wine

Other natural products	Madhu (honey), Madhudaka (honey mixed with water)
Oils	Nikumba (Wild castor) -Danti- Baliospernum montanum,, Ingudi (Desert date) - Balanitis egyptica, Atasi (Flax)-Linum usitatisimum, Sarshapa (Mustard)- Brassica campastris
Others food articles and spices	Dhani (popcorn of jowar), Laja/Murmura (puffed rice), Maricha–Black pepper- (Piper nigrum), Saindhava– (rock salt), Hingu- (asafoetida)- Ferula asafoetida Haridra- (Turmeric)- Curcuma longa, Ardraka- (Ginger)- Zingiber officinalis

Ayurveda suggests increased intake of fiber-rich green vegetables and cereals (Patola, Tanduleyakam, Vastukam, Yava, etc.). Yava (barley) which is high in fiber content (4 g in 100 g) and is highly recommended in the diabetic diet in different forms. In a primary clinical trial in normal subjects, blood sugar pattern was recorded after giving different types of food such as wheat chappati, barley chappati, bajra chappati, maize chappati, gram chappati and rice with Patola curry separately. Three blood samples were taken at hourly intervals. The maximum rise in blood sugar level was recorded in rice, followed by wheat, while it was least in the case of barely which surpassed all cereals and pulses. Thus, barley proved to be the best diet for patients with Prameha.[13] Comparatively, whole green gram, whole bengal gram have more fiber content (4 g) than green gram dal and bengal gram dal (1 g). Whole horse gram and adhaki dal also have rich fiber content (5g). Hordeum vulgare, Oryza sativa, Triticum sativum, green gram, adhaki dal, fenugreek, onion, garlic, gooseberry, blueberry, etc. are recommended to diabetics by modern physicians too.[14] Of interest, many reports proved the advantages of a vegan diet for the reduction in diabetes incidence, it's the ability to improve insulin resistance is being well established.

Honey is a sweet but highly nutritive natural product. Honey supplementation alone or in combination with antidiabetic drugs has been found to reduce hyperglycemia in rodents and humans with diabetes mellitus. However, the mechanisms of the hypoglycemic effect of honey remain unclear. The possible roles of fructose, mineral ions (such as zinc, copper, and vanadium), phenolic acids, and flavonoids have been suggested. The protection of the pancreatic beta cells against oxidative stress and damage (via honey antioxidant molecules such as organic acids and phenolic compounds) is one such potential mechanism. This supports the Ayurvedic recommendation to use honey alone or mixed with water in diabetes. Fruits, vegetables, and spices are micronutrient-rich; influence various systems in the body with diverse metabolic and physiological functions, and enable elderly diabetics to be fit and active. They provide nutritional substances like dietary fiber, vitamins, minerals, phytonutrients such as flavonoids (antioxidants), saponins, polyphenols (antioxidants), carotenoids (vitamin A-like compounds), isothiocyanates (sulfur-containing compounds) and so on, which are essential to ensure a balanced diet. Type 2 diabetics can enjoy fruits except those containing high carbohydrate and sugar levels (i.e. avoid high GI items). Such persons can avoid fruits with high GI like banana, chikoo, grapes, and mango, etc. Patients can be asked to avoid fruit juices, instead opt for whole fruits, as they contain more fiber.

Spices are food adjuncts that have been used as flavoring and coloring agents and as preservatives. They are recognized to possess medicinal properties too, and their therapeutic role is highly appreciated in Ayurveda. They exert several beneficial physiological effects including some anti-diabetic effects like short term blood glucose decrease and long term improved glucose tolerance. Pepper, asafetida, fenugreek seeds, cumin seeds, curry leaves, Ocimum, rock salt, turmeric, cinnamon, mustard, garlic, onion, ginger, and coriander are reported to possess potential antidiabetic substances and have been ascribed hypoglycemic activities, both experimentally and clinically.[15]

Vegetable and fruit fibers reduce the risk of diabetes, delay sugar digestion, and absorption, improve insulin sensitivity and glucose utilization, and relieve constipation.[16] Along with rich fiber content, fruits contain a considerable amount of phytates, which modulate glycemia and produce a different GI of foods. Phytates affects the digestibility of starch by combining with protein or digestive enzymes. Chromium is a critical cofactor in insulin action and its deficiency can lead to hyperglycemia. Some studies have reported the benefits of chromium supplementation for glycemic control in diabetes. Trivalent chromium is found in whole grains, seeds/nuts (almond, walnut), green beans, cereals, etc.[17]

Pathya Vihara for prediabetics in Ayurveda

For preventing Prameha, Sushruta has recommended walking of 100 yojans in 100 days. e.i. 1 yojan per day (1 yojan is ~ 7.5 km).[18] A quotation ‘Nihsukhatva Sukhaya cha’ as the management of Kapha mentioned by Vagbhata is very appropriate for preventing type 2 diabetes[19], which means withdrawing of luxury to create happiness. Yoga provides an appropriate lifestyle intervention that would be greatly helpful in preventing or postponing the diabetes prevalence. Significant physical, physiological, psychological, and endocrine changes have been reported by following various Yoga regimens (Asana like Mayurasana, Bhujangashana, Pranayama, etc) over a period. It is also postulated that rejuvenation or regeneration of beta cells of the pancreas may be taking place, which may increase the utilization and metabolism of glucose in peripheral tissues, liver, and adipose tissues through enzymatic processes. It is effectively proven to improve the quality of life in diabetics and should be adopted in daily routine.[20] Lifestyle intervention for prediabetes consists of increased physical activity, dietary modification, and weight loss. It has been reported such changes in lifestyle reduce the rate of conversion from Impaired Glucose Tolerance (IGT) or pre-diabetes to type 2 diabetes.[21] Lifestyle intervention reduced or delayed the risk of diabetes by ~ 60% over 3 years in people at high

risk[22] (IGT). These interventions included intensive lifestyle modifications, with goals of > 7% loss of body weight and 150 minutes of physical activity per week.

Table 2: Diet chart for the Prediabetic patients.[23]

Diet	Early Morning	A glass of Yava mantha[24] Method of preparation: soak 2 to 3 teaspoon of powdered roasted yava in a glass of warm water for half an hour and then churn this liquid, filter, and drink
	Morning Breakfast	1-2 dry chapatti made from Yava/barely (Hordeum vulgare L.) or 1 bowl of a boiled green gram or split Bengal gram with slight rock salt, turmeric, and pepper
	Midday meal	Before commencing the meal, a cup of warm vegetable soup specially prepared from Gourd or bitter gourd or green leafy vegetables that contain manganese may be taken. Other preferable vegetables for preparing soup are cabbage, radish, spinach, drumstick, pumpkin, Amla (gooseberry). Salad: cabbage, cucumber, radish with rock salt & black pepper powder 2 – 3 small chapattis made from barley flour or mixed flour of wheat & barley or a cup of brown rice with Moong Dal. 1 small bowl of vegetables prepared with Fenugreek seeds, ginger, garlic, and onions. Vegetables advised to be taken are bitter gourd, cabbage, drum sticks, bottle guard, ridge gourd, Parval, brinjal, kankoda, methi (fenugreek leaves) Afternoon / Early evening 1 glass of yavamantha or 1-2 khakhara made from barley flour
	Dinner	1 small cup of Moong dal Soup Khichadi made from Samo / Kodaro with moong dal or Tuvara dal or 2 -3 small chapattis made from barley flour 1 bowl of any vegetable as advised for lunch
Lifestyle change	Exercise[25]	30 minutes brisk walking in the fresh air in the morning + Sooryanamaskara in the gradual increasing manner as 3 times for 3 days, 5 times for 3 days, 7 times for 3 days, 9 times for 3 days, 11 times for 3 days, 12 times for remaining 15 days then continued also after therapy. 30 minutes brisk walking in the evening Avoid day sleep
Psychological	Yoga is an antistress and antianxiety measure. Asana practiced may be reducing the stress of the daily life of modern society with moderate physical exercise[26]	In Madhumeha specific asana is indicated which stimulate endocrinal gland vitalized and improve its functions and secret pancreatic secretion properly shall be done like, Mayurasana, Bhujangashana, Matsyendrasana, Gomukhasana, Chakarasana, Halasana, under the supervision

CONCLUSION

Disorderly lifestyle plays an important role in the development of prediabetes and types 2 diabetes. Judicious use of medicine in the management of diseases is a well-known concept but as per Ayurveda, avoidance of causes and maintenance of diet and lifestyle is the major part of the treatment of any disease. Prediabetes being a lifestyle disorder, lifestyle intervention becomes a critical part of its management and hence awareness about lifestyle modification should be spread in the society. Due importance must be given to adopting a healthy lifestyle and appropriate performing of yoga in daily routine. Lifestyle modifications if adopted can reverse prediabetes, control blood sugar level, prevent complications, and can improve quality of life. A diet containing a wide variety of selected vegetables, fruits, cereals, spices, and minimally processed foods would be expected to help maintain the glycemic level and BMI within limits and reduce the risk of diabetes. Physical activity such as daily brisk walk and weight loss plays an important role in the prevention of diabetes.

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