

DIET AND LIFESTYLE GUIDELINES FOR DIABETES: EVIDENCE BASED AYURVEDIC PERSPECTIVE

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received: September 13, 2014 accepted: October 24, 2014

available online: December 15, 2014

Abstract

Background and Aims: Ayurveda strongly emphasize on preventive and promotive aspects of health rather than curative. Centuries ago, Ayurveda laid the concepts of Dinacharya (daily regimen for healthy living), Ritucharya (seasonal regimen for healthy living), Sadvaritta (moral conducts) and Achara Rasayana (social conducts) as well established guidelines for healthy diet and lifestyle; but in current era, hardly anyone aptly follow it. As a result, there is tremendous rise in lifestyle disorders as pandemics, diabetes being the most menacing among them. The aim of this review is to bring into the limelight the Ayurvedic dietary and lifestyle guidelines for prevention of type 2 diabetes and available factual research evidence validating it. **Materials and methods:** Ayurvedic recommendations for prevention of diabetes were rationally reviewed in light of published information from several articles. Publications in Pubmed, Scopemed, Dhara online and other allied databases covering fields of therapeutics, pharmacology, biomedicine and health were also screened and taken into study for the report. **Conclusion:** Ayurvedic lifestyle guidelines of adopting a healthy dietary pattern together with physical activity are valuable tools in the prevention of type 2 diabetes.

key words: Ayurveda, Diabetes Mellitus, Diet, Lifestyle, Madhumeha.

Introduction

All polyuric diseases in Ayurveda are described under 'Prameha', and Madhumeha is one amongst them, equated to Type 2 Diabetes Mellitus. The description of the acquired form of Prameha; referred to as Apathyanimittaja Prameha, is very similar to type 2 diabetes. Apathya Ahara (dietetic incompatibilities/unwholesome diet) and Apathya Vihara (lifestyle incompatibilities) both are the major risk factors for Madhumeha [1].

Diabetes Mellitus is the most threatening endemic lifestyle disorder, having social, medical and economic ramifications globally. As per a recent report of the International Diabetes Federation, each year 3.8 million deaths are attributable to diabetes and related complications; at least 50% of diabetics are unaware of their condition (indicating lack of awareness); and up to 80% of type 2 diabetes is preventable by adopting a healthy diet and increasing physical activity [2]. Studies have proved that active participation of the patients in the form of lifestyle changes can result in less

expense for the management of diabetes and ensure good glycemic control also [3].

Each person needs an individualized treatment. Insulin or oral hypoglycemic agents are only prescribed for Type 2 diabetics if diet and exercise alone fail to lower the glycemic level. Ironically, drug approach could not cure disease condition or prevent further progress of disease and in spite of good glycemic control, patient lands into life threatening complications. Besides that, conventional antidiabetic drugs are either expensive or often associate adverse effects. Therefore the key for management is to consult a doctor and a dietician, which means adjusting one's diet, activity, and sometimes taking medication [4].

Substantial evidence now exist to suggest that diabetes is strongly associated with increasing urbanization, population growth, aging, patient's unhealthy lifestyle choices, reduced physical activity, obesity, behavioral patterns, socioeconomic changes and perhaps most importantly a 'Western style' diet [5,6]. Type 2 diabetes is a largely preventable disease and intensive lifestyle interventions are not only highly effective but cost-effective too. Here, Ayurvedic *Pathya Ahara* (wholesome diet) and *Pathya Vihara* (wholesome lifestyle) can play a major role in disease prevention.

Taking these facts into consideration, the present review was undertaken to bring into the limelight the role of suitable Ayurvedic dietary and lifestyle guidelines to prevent diabetes in view of the available evidence based supporting data.

Materials and methods

Search strategy and Inclusion criteria

Diet and lifestyle related etiologies accountable for diabetes as mentioned in Ayurvedic treatises were rationally reviewed along with recommendations of *Pathya Ahara*

(wholesome diet) and *Pathya Vihara* (wholesome lifestyle) as preventive strategies. The search was conducted in light of contemporary scientific supporting data available in electronic and internet media for possible justification and validation of these Ayurvedic principles. Publications in Pubmed, Scopemed, Dhara online and other allied databases covering fields of therapeutics, pharmacology, biomedicine and health were also screened and taken into study for the report. Information extracted from original articles, review works, randomized control trials (RCTs) and meta-analyses including reports of experiments on humans and animal model systems and cross references were collected. Searches were not limited by date or place of publications but to publications in English language.

Results

Diet related etiologies and contraindicated Apathya Ahara in Ayurveda

Excessive use of curds, flesh of animals of domestic, aquatic and marshy places, use of dairy preparations, new water (water of rivers and tanks during rains and floods), new grains, puddings made of jaggery/sugar and using more similar factors (heavy diets, fatty foods that increase body weight, cholesterol and causes obesity etc.) which increase *Kapha Dosha* [7]. In addition, the foods / drinks which increase *Medas* (adipose tissue), *Mutra* (urine), and diets which are sweet, sour, salty, fatty, not easily digestible, slimy, cold, drinks like beer and molasses were also considered as the causative factors [1,8]. In another context it is said that excessive intake of dry substances (*Ruksha Ahara*), light food (*Laghu Ahara*), excessive use of pungent, bitter, cool items, excessive fasting etc. increase *Vata* and also cause *Madhumeha* [9]. According to Ayurveda, there are mainly

two types of diabetic persons: *Sthula* (obese) and *Krishha* (lean and thin), both having different etiology and lifestyle intervention.

Contraindicated *Apathya Ahara* for diabetes are: alcohols like *Sauveera*, *Sukta*, *Maireya* and *Sura*, milk, milk products, oil, ghee, sugarcane juice or sugar, jaggery, alkaline, curd, grain cakes (*Pishta*), sour substances, sweet drinks (*Panakas*), and meats of domestic, aquatic and swamp animals [10].

Contemporary supporting data

Evidences have proved that high fat (total and saturated) and meat intake were associated with a higher risk of type 2 diabetes. High fat or oil intake is reported to decrease the favorable high-density lipoprotein (HDL) cholesterol levels in the blood and may adversely affect the lipid profile [11,12]. This supports Ayurvedic claims on the role of fatty items, marshy animals, aquatic animals (which are heavy with fats) and milk items in diabetes.

It is reported that, bakery and dairy products, sugar/sugar items, jaggery, molasses, alcohol (wine, beer) and sugar added foods are predisposing factors for diabetes [13-16]. These foods immediately burden the beta cells of Langerhans, can lead to insulin resistance, etc [17]. Reports linking bovine serum albumin (BSA) antibodies and diabetes suggest that milk protein have a strong diabetogenic effect. In some cases, bovine serum albumin may cross-react with a protein (P.69) which can be induced on pancreatic beta cells membrane by the inflammatory mediator interferon gamma [18]. This study also supports the Ayurvedic concept that the excessive use of milk and milk products may cause diabetes.

In the current era, people are fond of flour preparations, sweetened drinks, refrigerated, preserved and reheated food items, due to the busy schedules of society today, wherein they

hardly have time to eat at home. Such food is low in fiber, high in glycemic loads and is associated with increased risk of diabetes [19]. *Adhyashana* (over eating) is also proved as a risk factor for DM [20]. These dietary irregularities further contribute to disturb the carbohydrate and lipid metabolism and result in *Madhumeha* in susceptible individuals. These studies confirm the Ayurvedic etiology for diabetes.

WHO identified one particular type of Diabetes as 'Malnutrition Related Diabetes Mellitus', which is common in India. Most of these patients are lean and thin young adults between 15 to 35 years age and more often reported in Kerala and Orissa states [21,22]. This type can be correlated to *Krishha Pramehi*. It is presumed that diabetes is mainly caused by heavy food which increases *Kapha*, *Medas* etc. But Ayurveda also emphasized that excessive starvation and intake of dry substances can also cause another variety of *Prameha* (diabetes).

In Northern Europe and North America Ice lands, the unusual rise of type 1 diabetes in children born in the month of October was hypothesized to be explained by the high Nitrosamine content of smoked mutton traditionally used at Christmas. In mice experiments it was proved that, this effect was mediated via the parental germ cell rather than by direct effect on pancreatic beta cells of fetus [23]. The Ayurvedic literature cautioned that, mutton of marshy lands might cause *Prameha* hence to be restricted. Nevertheless, more confirmative studies are required.

Ayurvedic Diet and lifestyle protocols for diabetes

(1) First and foremost guideline is to avoid the diet and lifestyle related etiological factors involved in type 2 diabetes (*Nidanaparivarjana*) [7]. (2) *Sthula Madhumehi* person diet should be *Apatarpanaguna* and heavy for digestion, while *Krishha Madhumehi* persons diet should be

Santarpanaguna and light for digestion. *Krishna* patients diet should be such that it doesn't increase *meda* [7]. (3) Octafactor guidelines for proper use of diet like *Prakriti*, *Karan*, *Sanyoga*, *Rashi*, *Desha*, *Kala*, and the user, must be taken into consideration [24]. (4) According to *Ritu* (seasons), various diets and activities should be prescribed depending upon the nature of *prakriti* and *doshas* [25].

Pathya Ahara for diabetics in Ayurveda

Ayurveda has given utmost emphasis for the maintenance of *Pathya Ahara*. Ayurveda stated that if one take wholesome diet and activities suitable to all *Dhatus* (tissues), he can never suffer from *Madhumeha* [9]. It is said that, like bird reaches its nest on the tree, in the same way *Prameha* reaches the person who eats more, unhygienic (even by not taking bath) and lazy [9]. Quantity and quality of diet should be decided on the basis of *Agnibala* (digestive power). The recommended diet for *Madhumehi* is detailed in Table 1 [7,26].

Table 1. Recommended *Pathya Ahara* for diabetics (adapted after [7,26]).

Group	Name of items
Grains	<i>Yava</i> (barley)- <i>Hordeum vulgare</i> , <i>Godhuma</i> (Wheat)- <i>Triticum sativum</i> , <i>Shashtika Shali</i> (rice)- <i>Oryza sativa</i> , <i>Kodrava</i> (grain variety)- <i>Paspalum Scrobiculatum</i> , <i>Uddalaka</i> , <i>Shyamaka</i> , <i>Bajara</i>
Pulses	<i>Chanaka</i> (bengal gram)- <i>Cicerarietinum</i> , <i>Adhaki</i> (toor dal)- <i>Cajanus cajan</i> , <i>Mudga</i> (green gram)- <i>Phaseolus aureus</i> , <i>Kulattha</i> (Horse gram)- <i>Dolichos biflorus</i>
Vegetables (bitter and astringent)	<i>Methika</i> (fenugreek)- <i>Trigonella foenum</i> , <i>Patola</i> (pointed gourd)- <i>Trisanthus dioica</i> , <i>Karvellaka</i> (bitter gourd)- <i>Momordica charantia</i> , <i>Tanduleyaka</i> (<i>Choulayee</i>)- <i>Amaranthus spinosus</i> , <i>Vastukam</i> (<i>Bathuva</i>), <i>Shobhanjana</i> (drum stick)- <i>Moringa oleifera</i> , <i>Karkotaka</i> – <i>Momordica dioica</i> , <i>Rasona</i> (garlic)- <i>Alium sativum</i> , <i>Kadali</i> (raw banana)- <i>Musa paradisiaca</i> .
Fruits	<i>Jambu</i> (Jamun)- <i>Eugenia jambolana</i> , <i>Talaphala</i> - <i>Borassus flabellifer</i> , <i>Amalaki</i> (goose berry)- <i>Emblica officinalis</i> , <i>Kapittha</i> (monkey fruit)- <i>Limonea acidissima</i> , <i>Dadima</i> (pomegranate) – <i>Punica granatum</i> , <i>Tinduka</i> – <i>Disospyros embroyoptesis</i> .

Seeds	<i>Methika</i> , <i>Kamala</i> - <i>Nelumbo nucifera</i> , <i>Utpala</i> – <i>Nymphaea stellate</i> ,
Flesh (fat free meat; forest animals, forest birds)	<i>Harina</i> (deer flesh), <i>Shashaka</i> (rabbit), Birds likes – <i>Kapota</i> (pigeon), <i>Titira</i> , <i>Lavaka</i> .
Fermented or alcoholic liquids	<i>Madhveeka Sura</i> , <i>Madhvasava</i> (in <i>Kapha Pittaja Prameha</i>), <i>Purana Sura</i> - old wine
Other natural products	<i>Madhu</i> (honey), <i>Madhudaka</i> (honey mixed with water)
Oils	<i>Nikumba</i> (<i>Danti</i> - <i>Baliospermum montanum</i>), <i>Ingudi</i> (<i>Balanitis egyptica</i>), <i>Atasi</i> (<i>Linum usitatisimum</i>), <i>Sarshapa</i> (<i>Mustard</i>)
Others food articles and spices	<i>Dhani</i> (pop corn of jowar), <i>Laja</i> /Murmura (puffed rice), <i>Maricha</i> – (<i>Piper nigrum</i>), <i>Saindhava</i> – (rock salt), <i>Hingu</i> - (<i>asafoetida</i>), <i>Haridra</i> - (<i>Turmeric</i>), <i>Ardraka</i> - (<i>Ginger</i>)

The indigenous diet may not be useful in lowering the blood sugar to the same extent as insulin and other hypoglycemic agents. However, by acting as Ayurvedic nutraceuticals, it supplements and improves the quality of life; therefore, may be useful as adjunct to manage the disease and its complications. Ayurvedic dietary plans comprise a wide range of multivalent actions as health promoting dietary additives as well as putative therapeutic agents, which is of considerable importance to diabetic health.

Contemporary supporting data

Researchers have proved that simple carbohydrates are broken down easily and increases blood glucose levels fast. Hence simple sugars like table sugar, honey, candy, jam, cakes and pastries etc. are contraindicated, while complex carbohydrates like cereals, whole grains, and vegetables are recommended at least to 50% of diabetic diet. Another study suggest to avoid high fat, salt, alcohol, caffeine and refined (white) foods such as white sugar, white flour, white bread, pastries, and so on. These have high glycemic index (GI) and will cause the blood sugar levels to spike [27].

Ayurveda suggests increased intake of fiber rich green vegetables and cereals (*Patola*, *Tanduleyakam*, *Vastukam*, *Yava*, etc.). *Yava* (barley) is high in fiber content (4 g in 100 g) and is highly recommended in 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 was recorded in rice, followed by wheat while the minimum rise in the case of *Yava* which surpasses all cereals and pulses. Thus barley proved to be the best diet for patients with *Prameha* [28].

Comparatively, whole green gram, bengal gram have more fiber content (4 g) than green gram dal and bengal gram dal (1 g). Whole horse gram and Toor dal also have rich fiber content (5 g) [29]. *Hordeum vulgare*, *Oryza sativa*, *Triticum sativum*, Green gram, Toor dal, fenugreek, onion, garlic, gooseberry, Jamun etc. are recommended to diabetics by modern researchers too [30]. Of interest, many reports proved the advantages of vegan diet for reduction in diabetes incidence [31,32], its ability to improve insulin resistance being well established [33].

Honey is a sweet but highly nutritive natural product. Is it beneficial or detrimental in diabetes? 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 [34,35]. This supports the Ayurvedic recommendation to use it alone or mixed with water in diabetes.

Role of fruits, vegetables, spices and seeds 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 (sulphur-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). Avoid fruits with high GI like Banana, Cheekoo, Grapes, and Mango etc. but Orange, Watermelon, and Apple Guava etc. can be advised. Although watermelon has a high GI, the Glycemic Load (GL) per food serving is low and it will not have a big effect on glucose levels. Try to avoid fruit juices; instead opt for whole fruits, as they contain more fiber and are more filling. Consume cooked or uncooked vegetables with little or no dressing. Opt for fat-free or low fat dressings on salads, as well as uncooked vegetables.

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 antidiabetic effects like short term blood glucose decrease and long term improved glucose tolerance. A number of

condiments and spices advocated in Ayurveda including 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.

Vegetable and fruit fibers reduce the risk of diabetes, delay sugar digestion and absorption, improve the insulin sensitivity and glucose utilization and relieve constipation. Along with rich fiber content, fruits contain considerable amount of phytates, which modulate glycemia and produce a different GI of foods. Phytates affects the digestability 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 benefits of chromium supplementation for glycemic control in diabetes. Trivalent chromium is found in whole grains, seeds/nuts (almond, walnut), green beans, cereals etc [36-39].

Conventional approach to diet therapy

Given the heterogeneous nature of type 2 diabetes, diversified diet with a judicious choice from a variety of food groups is essential to provide the necessary nutrients. However, overeating should be avoided. Meal plans and diet modifications are generally individualized by a registered dietitian to meet patient needs and lifestyle. A typical conventional approach would recommend a diet composed of 60-65 percent carbohydrate, 25-35 percent fat, and 10-20 percent protein, with limited or no alcohol consumption [40]. The dietary choices ought to be practical, dynamic and flexible, based on the prevailing situation. Food related approaches, both in qualitative and quantitative terms, should be well planned.

Diabetic meal plan

A diabetic meal plan matches calories from foods to individual physical activity and insulin levels. In a balanced diet, 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 a range of chronic degenerative illnesses. WHO recommends intake of whole grain foods, with a minimum consumption of 5-10 portions of fruits and vegetables per day [41,42]. A 1500 calories Diabetic Diet chart suggested by the National Institute of Nutrition, India, is detailed in Table 2 [43].

Table 2. 1500 calories diabetic diet chart
(Adapted after [43]).

Food stuff	Amount (g)	
	Vegetarian	Non-vegetarian
Cereals	225	250
Pulses	60	20
Green leafy vegetables	200	200
Other vegetables	200	200
Fruits	100	100
Milk	300	150
Oil	15	20
Flesh foods	--	70
This diet provides	Grams	% calories
Protein	60	15.5
Fats	37	21.5
Carbohydrates	244	63.0

Lifestyle related etiologies of diabetes in Ayurveda

Asayasukha (habituation to sitting on soft cushions for long periods) and *Swapanasukha/Atinidra* (prolonged sleeping) are suggested as key predisposing factors for diabetes [1]. *Divasvapna* (day sleeping) is also one of the causes of *Prameha* [44,45]. *Charaka* has also emphasized that anxiety, anger, worry, grief, and similar other stress producing factors lead to the development of *Prameha* in susceptible individuals. *Madyapana* (alcohol consumption) has a significant role in the

etiology of *Madhumeha* [46]. *Vyavayi*, *Vikasi* etc. ten *Guna* (properties) of *Madya* (alcohol) are opposite to *Ojas*, causes *Tridoshadushti* (vitiation) and *Kshubdhata* (altered state) in *Ojas* [46] which in turn can hamper *Vyadhikshamatava* (immunity); it may be one of the predisposing factors of *Madhumeha*.

Contemporary supporting data

Machines have made us sluggish. In parallel with lifestyle changes, walking habits have changed, supported by the increased use of automobiles and two wheelers. The prevalence of type 2 diabetes is raising much more rapidly because of sedentary lifestyle or reduced activity levels [20,47]. A pathway through which obesity causes insulin resistance has recently been discovered in mice, in the form of an adipose tissue derived hormone named resistin – an important link between the adipocyte and diabetes [47-49]. Hyperinsulinemia and insulin resistance factors are insidious features of obesity, having direct correlation with BMI [50]. Although BMI and physical activity are independent predictors of incident diabetes and mortality, the magnitude of the association with BMI is much greater than with physical activity [51].

Day napping and short night sleep are reported as a potential risk factor for diabetes [52]. Though much evidences are not available on the role of *Ratrijagarana* (vigil) in diabetes development, a report of the University of Chicago Medical Center showed that sleep deprivation severely affects the body ability to metabolize glucose, which can lead to early stage type 2 diabetes. It was observed that both short-term (<6 h) and long term (>8 h) sleep, as well as sleep loss, are related to glucose intolerance and to increased risk of type 2 diabetes [53-55].

Stress related anxiety has been shown as a major contribution factor for type 2 diabetes [56]. Middle to old age is the common age group of type 2 diabetics and this is the period in life in which persons get exposed to a variety of stress. Further stress causes imbalance in hormonal and nervous regulation of the body and makes the person susceptible to different disorders including diabetes. A high risk of complications of diabetes is associated with influence of psycho-stressors and depressive disorders [57]. This is supported by a study wherein diabetes was induced by stress in albino rats and their blood examination showed increase rate of catalase activity, suggesting the acceleration rate of cell injury and free radical generation, which in turn is a precursor to diabetes [58]. Addiction may also adversely affect the diabetic health. Tobacco chewing, smoking and alcoholism are considered as risk factors for diabetes [59].

Pathya Vihara for diabetics in Ayurveda

For preventing *Prameha*, *Sushruta* has recommended walking of 100 *yojan* in 100 days i.e. 1 *yojan* per day (1 *yojan* is ~ 7.5 km) [10]. A quotation '*Nihsukhatva Sukhaya cha*' in *Kaphasya upakrama* mentioned by *Vagbhata* is very appropriate for preventing type 2 diabetes [8], which means withdrawing of luxury to create happiness. *Sthula Pramehi* are advised to do exercises like wrestling, horse riding, vigorous walking etc but *Krishna Pramehi* are advised to protect their strength and not to do exercises [7].

Contemporary scientific supporting data

A study reported that a daily brisk walk of 7.5 km (brisk is walking with speed of at least 5 km/hr) for 100 days can reverse Glucose Tolerance Test to normal [60,61]. Lack of exercise may be one of the main factors for the bad glycemic control in chronic cases. Risk of getting diabetes can be reduced by regular

exercises and maintaining ideal body weight. Physical activity has been shown to reduce hyperinsulinemia and improve peripheral insulin activity in 65 year old subjects [62], which shows that even at this age, chronic diseases can be fought through a better lifestyle. Exercise improves insulin sensitivity and glucose absorption, transport and uptake are increased in perfused skeletal muscle, which reduces the insulin requirement. Exercising also increases blood flow through distal muscle groups increasing oxygenation to tissues in the feet and hands. Distal extremity blood flow is decreased primarily in a stocking and glove pattern. This increase in oxygenation lessens the chances of tissue ischemia and neuropathy and increases capillary blood flow. Aerobic exercise also increases stroke volume and heart muscle contractibility, thus increasing vascular efficiency [63]. Though Ayurveda cautions sedentary life styles as a factor for diabetes it also cautions excessive starvation and excessive exercises which may also lead to another variety of Diabetes. This may be either Type-I or Malnutrition Diabetes.

Earlier, exercise was considered as a major tool to control diabetes to a certain extent and it was recommended to each and every diabetic patient. But as mentioned in Ayurveda, *Krishna Pramehi* are suggested not to do high intensity exercises and advised to protect their strength. Similarly in type 1 diabetes, there are risks of hypoglycemia during or after high exercises or of worsening metabolic control if insulin deficiency is present; therefore, well planned exercises regimens are suggested for them [64].

Evidences from lifestyle intervention RCTs and Meta-analyses

Recently conducted randomized control trials and systematic reviews showed that progression to type 2 diabetes in high risk individuals can be prevented/delayed by

adopting a lifestyle intervention program (increasing physical activity, dietary modification, and weight loss). It reduced the rate of conversion from Impaired Glucose Tolerance (IGT) or pre-diabetes to type 2 diabetes [65-68]. Lifestyle intervention reduced or delayed the risk of diabetes by ~ 60% over a 3-year period in people at high risk (IGT). These interventions included intensive lifestyle modifications, with goals of > 7% loss of body weight and 150 minutes of physical activity per week. Both emphasized restriction of energy, lower fat intake, and higher fiber intake.

No exercise or less exercise may cause insulin resistance and reduce glucose utilization or insulin sensitivity. A recent meta-analysis showed that exercise reduces HbA1c levels by an amount that is expected to reduce diabetic complications, without a mean effect on body weight [69].

In the Nurses' Health Study, the combination of a high GL and a low cereal fiber intake further increased the risk of diabetes (relative risk = 2.5) when compared with a low GL and high cereal fiber intake [70]. Refined starch could be more important in this context than refined sugars because, weight for weight, starch yields twice as much glucose than sucrose, and can be rapidly digested and absorbed. Glycemic excursions appear to be similar between starches and sucrose (table sugar). White bread intake may be one of the best single food predictors of type 2 diabetes [71]. A stronger association has been observed between total fat and saturated fat intake and type 2 diabetes [72,73]. Intakes of both whole grains [74,75] and dietary fiber (in particular, cereal fiber) are associated with lower risk of type 2 diabetes [76].

Need of society awareness and self care strategies for diabetics

The rapid rise in the incidence of diabetes is attributable to the social change. Initiation of

prevention strategies to develop preventive measures is strongly needed. Community awareness is required to improve knowledge and attitudes about the role of physical activity, nutrition, and healthy eating behavior in disease prevention. Increased community skills to change behaviors and adopt a healthy lifestyle through community-based interventions in a variety of settings such as schools, worksites, churches, community centers is needed.

Self-care coping strategies in patients with diabetes are needed and these would be more achievable if they are well aware and advised to follow suitable dietary and lifestyle recommendations mentioned in Ayurveda. According to the literature, neither the curative model nor the compliance/adherence model is rigorously effective in diabetes care. An alternative paradigm is needed that recognizes the patient is in control of, and responsible for, the daily self management of their diabetes.

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*, *Pranayama* etc) over a period of time. It is also postulated that rejuvenation or regeneration of beta cells of pancreas may be taking place, which may increase utilization and metabolism of glucose in peripheral tissues, liver and adipose tissues through enzymatic processes. It is effectively proven to improve quality of life in diabetics and should be adopted in daily routine [77-79].

Conclusion

Disorderly lifestyle plays an important role in the development of type 2 diabetes. Along with drug interventions, emphasis must be given to socioeconomic, behavioral and nutritional issues and to promote a healthier lifestyle (in order to increase compliance to the lifestyle modifications) especially for high risk individuals. Dietary and lifestyle plans should be made in accordance with the day-to-day requirement of an individual. Due importance must be given to adopt Yoga in daily routine. Maintaining physical wellbeing, mental tranquility and sanctity is equally crucial.

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