A clinical survey to evaluate the role of diet, lifestyle and stress as etiological factors in pathogenesis of type 2 diabetes mellitus

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Abstract

Diabetes is a global epidemic with devastating human, social and economic consequences. For the first time, a non-infectious disease has been seen as posing as serious a global health threat as infectious epidemics such as HIV/AIDS. The prevalence of type 2 diabetes is rising at alarming rates worldwide because of increased urbanization, high prevalence of obesity, sedentary lifestyles and stress. Survey of 151 type 2 diabetes mellitus patients revealed that rice, potato, bajra, curd, milk, krishara, ghee are most potent followed by banana, parotha, and butter, bhajiya, puri, chiku, mango, masha etc to cause the disease. Most of the patients indulged in sedentary life style like abstinence of physical and mental work, excessive sleep, and day sleep. These diabetic subjects were feeling unhappy and depressed, constantly under strain, lost sleep over worry, feeling of not overcoming difficulties, loss of concentration, incapable of making decisions, inability to face problems, loss of confidence, cannot enjoy day-to-day life. On brief psychiatry rating scale, psychological factors affected at various levels include; tension, somatic concern, anxiety, depressed mood, suspiciousness, guilt feeling, emotional withdrawal. The data reflects that defective diet and lifestyle including stress and obesity play an important role in aetiopathogenesis of diabetes mellitus.

Introduction

Diabetes mellitus (DM) is a chronic disease marked by elevated blood glucose levels. It affects 5-6% of the global adult population. Type 2 diabetes prevalence is rising at alarming rates worldwide because of increased urbanization, high prevalence of obesity, sedentary lifestyle and stress, among other factors. Up to 80% of type 2 diabetes is preventable by adopting a healthy diet and increasing physical activity. High status of life, less labour, stressful jobs, junk-frozen-fried foods, irregular meals and distorted life style together have made a fatal cock tail named diabetes mellitus. Every 10 seconds a person dies from diabetes-related causes. Every 10 seconds two people develop diabetes. Seven of the 10 countries with the highest number of people living with diabetes are in the developing world. India has the largest diabetes population in the world with an estimated 41 million people, amounting to 6% of the adult population. India is the kingdom of diabetes, having more than 5 crore diabetic patients. Among them 11.8% Indian diabetics are residing in Gujarat which is a matter of great concern.

The pathogenesis of type 2 diabetes has been attributed variably to defects in insulin action or to defects in insulin secretion and it is likely that both defects are usually involved [1]. When insulin secretion is sufficient to meet insulin requirements, whether large or small, normal glucose homeostasis will be maintained and glucose intolerance will be avoided. An area of active research in cell culture and transgenic mouse models suggests that abnormalities in the insulin receptor signaling pathway, in both pancreatic beta-cells and muscle cells, may be involved [2]. For the glucose intolerant, lifestyle changes can also prevent the onset of diabetes through weight loss [3]. Physical activity is recommended for diabetics because of its importance in weight loss management and due to its acute and chronic effects on glucose controls [4, 5]. It reduces the risk for developing Type 2 diabetes through the years [6]. Even non vigorous physical activity such as bowling, gardening, and house hold work has been shown to reduce insulin resistance [7]. Physical activity has been shown to reduce hyperinsulinemia and improve insulin peripheral activity in 65 year old subjects [8], which shows that even at this age, chronic diseases can be fought through a better lifestyle. As central obesity is a major contributor to insulin resistance, reduction of former is of utmost importance. Even without weight loss, physical activity reduces abdominal fat in men [9].

When combined with weight loss, physical activity reduces insulin resistance. 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 [10].

Stress is a potential contributor to chronic hyperglycemia in diabetes as it has major effects on metabolic activity. Energy mobilization is a primary result

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of the fight or flight response. Stress stimulates release of various hormones which can result in elevated blood glucose level. In diabetes, as a result of relative or absolute lack of insulin, stress-induced increases in glucose cannot be metabolized properly. Furthermore, regulation of these stress hormones may be abnormal in diabetes. In contrast, more consistent evidence supports the role of stress in type 2 diabetes. Although human studies on the role of stress in the onset and course of type 2 diabetes are few, a large body of animal study supports the notion that stress reliably produces hyperglycemia in this form of disease. Furthermore, there is mounting evidence of autonomic contributions to the pathophysiology of this condition in both animals and humans [11].

Anger (krodha), grief (shoka), and anxiety (udvega) are described amongst the etiological factors of Pittaja and Vataja Prameha in the Ayurvedic classics [12,13]. The objective of this study was to evaluate the role of diet, life style and stress as etiological factors in pathogenesis of type 2 diabetes.

Materials and Methods

Total 151 patients of type 2 diabetes, attending the O.P.D. / I.P.D. of Institute for Post Graduate Teaching and Research in Ayurveda Hospital, Gujarat Ayurved University, Jamnagar, were selected irrespective of their sex, caste for survey study. The sample is from the Saurashtra region of Gujarat in India.

Inclusion Criteria: Patients of type 2 diabetes fulfilling the standard diagnostic criteria of World Health Organization (W.H.O.) for diabetes mellitus. Symptoms of diabetes mellitus plus random blood glucose > 200 mg/dl or fasting blood glucose > 126 mg/dl or two-hour blood glucose > 200 mg/dl during an oral glucose tolerance test.

The detailed examination of patients was done on the basis of specially prepared proforma incorporating classical symptoms; daily dietetics with their frequency and quantity approximately to assess the Hetu Skandha (causative factors).

Table 1: Scoring pattern adopted for assessing the dietary habit of the patients [14]

Frequency of consumption	*Score*
Never consumes the item	0
Very occasionally (Two or three monthly once)	1
Monthly once	2
Monthly twice or thrice (Seasonal consumption)	3
Weekly once	4
Weekly twice, thrice or more	5
Daily once	6
Daily more than once	7

Quantity of Consumption	*Score*
Regular quantity	add 0
Slightly over in quantity	add 1
Significantly over in quantity	add 2
In much more quantity	add 3

Mean score of consumption (M.S.C.): The total score of consumption is done by summing up both the scores of frequency and quantity.

Correction of M.S.C. [14]

Quantity of Consumption	*Score*
The classical reference or indirect classical reference for hetutva in Prameha	+1
Satmya (congenial) but harmful if consumed in bulk for long duration	-1
Pathya and Aharya but not Vyadhivirodhi	-2
Hitatama and Vyadhivirodhi also	-3

Likely etiological factor (L.E.F.) = corrected M.S.C. % of patients consuming the Nidana

Highly Significant L.E.F. = >350

Significant L. E. F. = between - 250 - 350

Mild L.E.F. = between - 150 - 250

Observation and Results

Data of 151 type 2 diabetic patients surveyed revealed that maximum number of patients (40.4%) belonged to the age group of 50-60 yrs. Majority of patients (58.94%) belonged to middle class followed by upper middle class (19.87%). Positive family history of diabetes was reported in 48.34% patients. Family history of obesity was positive in 51% of patients. The 41.06% patients were addicted to tea, tobacco (30.12%) smoking (27.71%), beetle (7.23%), beetle nut (4.82%), Alcohol (2.41%). The 31.79% patients were secondary educated followed by primary (18.54%) whereas 19.2% patients were uneducated. Maximum numbers of patients (43.71%) were housewives followed by service men (24.5%) and businessmen (17.88%).

Symptoms reported includes: Polyuria (62.25%), polyphagia (9.27%), polydypsia (48.34%), burning sensation in palm and sole (50.33%), numbness in hand

and leg (59.60%), fatigue (51.65%), weakness (37.69%), Leg cramps (50.33%), excessive sweating (43.05%), dryness in mouth (28.48%).

The data on dietary habits revealed that majority of the patients (83.44%) were vegetarian. The 78% patients were afflicted towards Madhura rasa followed by Katu rasa (49.67%), Amla rasa (47.68%) and Lavana rasa (27.15%). As far as Agni is concerned maximum number of patients (36.42%) had Vishamagni followed by Mandagni (23.84%) and Tikshnagni (11.28%). Maximum patients (47.02%) had habit of Adhyashana followed by Ajirnashana (41.72%) and Vishamagni (25.16%).

Highly significant L.E.F. group: Rice (630), Potato (503), Bajra (491), Curd (471), Milk (432), Krishara (425), Ghee (403).

Significant L.E.F. group: Green leafy vegetables (281), Banana (275), Parotha (268).

Mild L.E.F. Group: Buttermilk (239), Bhajiya (224), Puri (207), Chiku (203), Butter (195), Bread (192), Mango (191), Pavbhaji (162), Masha (161).

The data on life style revealed that most of the patients indulged in sedentary life style like not doing any exercise (83.44%), Tyakta Chinta (33.11%), habit of day sleep (84.1%). Among them 37.09% patients were sleeping for 1 hr., 28.48% patients for 1-2 hrs. in day time. The 29% patients had disturbed sleep whereas 17.22% had excessive sleep.

To determine the influence of stress on an individual as per General Health Questionnaire (GHQ) – 12; significant level of stress (score ≥3) was observed in 24.50% of patients. Among them maximum number of patients (40%) were feeling unhappy and depressed, constantly under strain (26%), lost sleep over worry (19%), feeling of not overcoming difficulties (19%), loss of concentration (19%), incapable of making decisions (16%), inability to face problems (16%), loss of confidence (12%), cannot play useful part in the things (11%), cannot enjoy day-to-day life (10%) more than usual or much more than usual which can be taken as acute stress. While evaluating GHQ it was observed that patients had loss of confidence (73%), feeling of not overcoming difficulties (70%), feeling of worthlessness (70%), constantly under strain (66%), feeling unhappy and depressed (49%) same as usual which shows this trait in their nature. Though intensity is less they are not at all healthy feelings rather chronic in nature so can be taken as chronic stress (n=151).

The 20% patients had overweight and 70% patients were obese. Among them 58% patients had grade II obesity followed by grade I (11%) and grade III (1%) obesity (n=100). Serum cholesterol, serum triglyceride, serum LDL and serum VLDL levels were found abnormally high in 39.22%, 62.75%, 73.53% and 36.27% of patients, respectively while S.HDL level was low in 30.39% of patients (Tables 2 and 3).

Table 2: Blood and urine sugar level

FBS (n=121)			*PPBS (n=127)*			*Urine Sugar (n=102)*		
Range (mg %)	*No. of pts.*	*%*	*Range (mg %)*	*No. of pts.*	*%*	*Range*	*No. of pts.*	*%*
>200	44	36.36	>275	46	36.22	++++	8	7.84
125-199	57	47.11	200-275	38	29.92	+++	19	18.63
105-129	14	11.57	140-199	36	28.35	++	14	13.73
<105	6	4.96	<140	7	5.51	+	11	10.78
						Trace	15	14.71
						Nil	35	34.31

Table 3: Lipid profile of 102 patients

S.Cholesterol		*S. Triglyceride*		*S. LDL*		*S. VLDL*		*S. HDL*	
Range (mg %)	*%*	*Range (mg %)*	*%*	*Range (mg %)*	*%*	*Range (mg %)*	*%*	*Range (mg %)*	*%*
>300	1.96	>500	3.92	160-189	58.82	>140	1.96	<40	30.39
240-299	8.82	200-499	31.37	130-159	11.76	90-140	1.96	40-60	65.69
200-239	28.43	150-199	27.45	100-129	2.94	40-90	32.35	>60	3.92
<200	60.78	<150	37.25	<100	26.47	<40	63.73		

Discussion

Majority of patients (87.42%) were above 40 yrs with chronicity of>1 yr. (60.26%) which shows maturity onset nature of disease. Maximum patients were male. "The female is dominant sex at Global Platform but for India it is M>F" (API, 1999). Majority of patients belonged to middle class and upper middle class. Once known luxuries now with advancing technologies they have converted into necessities due to which physical activity has lessen at significant level and struggling for gaining these facilities middle class has invited stress in their lives which has a great impact on initiation, progression and exacerbation of the disease. Positive family history for DM (48.34%) showed genetic background of the disease. Majority of patients were addicted to tea, smoking, tobacco chewing which decreases natural immunity and makes person susceptible for any disease. Smoking has been shown to increase the incidence of diabetes in several cohort studies. The magnitude of this effect is moderate; smoking is estimated to increase the incidence of diabetes by 1.5-3 fold [15, 16]. The mechanism of this effect is not known but may be that smoking contributes to upper body obesity, which is associated with the metabolic syndrome of central obesity, insulin resistance, glucose intolerance or overt diabetes, hypertension and dyslipidemia. Moreover smoking increases oxidative stress which antagonize the insulin action and leads to diabetes mellitus. The 2.41% patients were addicted to alcohol. There is some evidence of a 'U' or 'J' shaped curve relating alcohol consumption and the risk of developing diabetes [17,18,19]. This may reflect increased insulin sensitivity [20]. That is, person consuming moderate amounts of alcohol may be slightly less likely than non-drinkers to develop type 2 diabetes, whereas heavy alcohol users are more likely than non-users or moderate drinkers to develop diabetes.

Alcohol may improve insulin sensitivity when consumed in small amounts. At higher levels of intake, alcohol may interfere with insulin-mediated glucose disposal, causing insulin resistance [21]. Majority of the patients were secondary educated followed by primary and uneducated which denotes that they may be less cautious about the causes and complication of the disease therefore not managing their dietary regimen properly. Most of the housewives indulge sedentary life style and have habit of Adhyashana. They are also less cautious about following or managing proper diet and lifestyle regimen due to less education. Servicemen either due to sedentary lifestyle or/and increased level of stress at work place are more prone to develop this disease. Businessmen are also affected more due to sedentary life style and increased level of stress. Most of the patients were indulging sedentary life style like abstinence of physical and mental work, excessive sleep which are direct causative factors of the disease. Disturbed sleep illustrates the disequilibrium of mental faculty due to stress and anxiety or fear. These factors may cause insulin resistance and decreases insulin sensitivity. The present study also supports the fact that ~90% of people with type 2 diabetes are overweight or obese [22].

Hyperinsulinemia and insulin resistance are pervasive features of obesity, increasing with weight gain and diminishing with weight loss. Insulin resistance is more strongly linked to intra abdominal fat than to fat in other depots [23].

On the basis of uncontrolled FBS (95.04%) and PPBS (94.49%) it can be said that the disease cannot be controlled only with oral antihyperglycemic agents until their dietary habits are corrected and disturbed psychological factors are brought to physiological limits. Positive urine sugar (65.69%) in diabetic patients can be correlated with the Ayurvedic term *'Mutre Abhidhavanti Pipilika'*. In patients of type 2 diabetes abnormal lipid profile like: high level of S. cholesterol (39.22%), S. Triglyceride (62.75%), S. low density lipid (73.53%), S. very low density lipid (36.27%) and low level of S. high density lipid (30.39%) showed the *Bahu* (excessive) and *Abaddha* meda is the main *dushya in* Prameha as well abnormally high level of lipid in blood stream because of stress induced lipolysis.

Conclusions

This study establishes that excessive consumption of potato, rice, curd and other milk products like ghee, oily foods like puri - parotha, lack of exercise, day sleep and chronic stress leading to anxiety and depression play a significant role in causation of the disease. Physical inactivity is the result of a progressive shift of lifestyle towards more sedentary patterns leading to obesity coupled with genetic back ground is responsible for type 2 diabetes with disturbance in blood glucose and lipid profile. Hence avoidance of such dietary factors, sedentary lifestyle and stress can contribute significantly for prevention of disease as well as promotion of health of diabetic subjects.

References

1. Lebovitz HE. Type 2 diabetes – an overview. *Clinical Chem* 1999; 48: 1339-45.
2. Sreenan SK, Zhou YP, Otani K, et al. Calpains play a role in insulin secretion and action. *Diabetes* 2001; 50: 2013-20.
3. Tuomilehto J, Lindstrom J, Erikkson JG, et al. Prevention of type 2 diabetes mellitus by changes in life style among subjects with impaired glucose tolerance. *N Engl J Med* 2001; 344: 1343-50.
4. American College of Sports Medicine Position Stand. Exercise and type 2 diabetes. *Med Sci Sports Exer* 2001; 32: 1345-60.
5. American Diabetes Association. Diabetes mellitus and exercise (position statement). *Diabetes Care* 2000; 24: S51-S55. See also www.diabetes.org, Clinical Practice Recommendation, accessed in Sept 2001.
6. Manson JE, Rimm EB, Stampfer MJ, et al. Physical activity and incidence of non-insulin dependent diabetes mellitus in women. *Lancet* 1991; 338: 774-8.

7. Mayer-Davis EJ, D'Agostino R, Karter AJ, et al. Intensity and amount of physical activity in relation to insulin sensitivity. *JAMA* 1998; **279**: 669-74.

8. Kirwan JP, Kohrt WM, Wojta DM, et al. Endurance exercise training reduces glucose stimulated insulin levels in 60 to 70 year old men and women. *J Gerontol* 1993; **48**: M84-90.

9. Ross R, Dagnone D, Jones PJH, et al. Reduction in obesity and related co morbid conditions after diet induced weight loss or exercise induced weight loss in men. *Ann Intern Med* 2000; **133**: 92-103.

10. Boule NG, Haddad E, Kenny GP, et al. Effects of exercise on glycemic control and body mass in type 2 diabetes. *JAMA* 2001; **286**: 1218-27.

11. Department of Psychiatry, Duke University Medical Center, Durham, North Carolina 27710. doi: 10.2337/diacare.15.10.1413. *Diabetes Care* 1992; **15**: 1413-22.

12. Agnivesha, Charaka samhita, Nidana sthana 4/24, edited by Vaidya Yadavji Trikamji Acharya, Chaukhambha Surbharati Prakashan,Varanasi, India, 2008, p. 214.

13. Agnivesha, Charaka samhita, Nidana sthana 4/36, edited by Vaidya Yadavji Trikamji Acharya, Chaukhambha Surbharati Prakashan,Varanasi, India, 2008, p. 215.

14. Shrirang Galgali, R R Dwivedi. A clinical study of of Caraka Nidana sthana with special reference to Prameha. M.D. (Ayu) thesis; I.P.G.T. & R.A., Jamnagar, India, 2000.

15. Kerr D, Sherwin RS, Pavalkis F, et al. Effect of caffeine in the recognition of and responses to hypoglycemia in humans. *Ann Intern Med* 1993; **119**: 799-804.

16. Rimm EB, Chan J, Stampfer MJ, et al. Prospective study of cigarette smoking, alcohol use, and the risk of diabetes in men. *BMJ* 1995; **310**: 555-59.

17. Bergrem H, Kalo I, Staehr Johansen K. The St Vincent Declaration activities. *The SVD Newsletter* 10th Anniversary 1999; **14**: 8.

18. Krans HMJ, Porta M, Keen H, Staehr Johansen K. Diabetes care research in Europe: St Vincent Declaration action programme. Copenhagen: WHO Office, EUR/ICT/CLR 055/3; 1995.

19. Krans HMJ, Porta M, Keen H, Staehr Johansen K. Diabetes care research in Europe: St Vincent Declaration action programme. Implementation document. *Giornale Italiano di Diabetologia* 1995; **15**: 1.

20. Rosenquist U. Implementation of the St Vincent Declaration in Stockholm country, Sweden. *Giornale Italiano di Diabetologia* 1993; **13**: 75-6.

21. Backlund LB, Algvere PV, Rosenquist U. New blindness in diabetes reduced by more than one third in Stockholm Country. *Diabet Med* 1997; **14**: 732-40.

22. Dr. Ajay Gopalani G, Dr. Bhushana. Obesity, Sarmandal, Kottakkal Ayurveda Series - 67, Vaidyaratnam P.S.Varier's Arya Vaidya Sala, Kottakkal, First edition, India, 2007, p. 84.

23. Ascaso JF, et al. *Eur J Intern Med* 2003; **14**: 101-6.