A Prospective Study of Physical Activity and Its Role in Management and Prevention of Diabetes

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Abstract

Physical activity may be a therapeutic tool in a variety of patients with, or at risk for diabetes. Recent evidence has shown that increased physical activity in conjunction with dietary changes can prevent individuals heading towards diabetes. Physical activity plays an independent role in protection against diabetes. Present study indicates that in a total sample of 1000 subjects, 359 persons are performing physical activities and 641 are doing sitting type of work. Borderline, newly detected, known and total diabetic subjects are more in subjects performing sitting type of work than physical work. Men are more physically active than women. Physical activity is more in rural population in borderline and newly detected diabetic subjects but in known cases it is more in urban population. Hence the risk of developing diabetes is more in urban population. In the total population (1000) only 38 subjects (3.8%) were doing exercise daily. Similarly in the present study, borderline, newly detected, known and total diabetic subjects are more in physically inactive persons. The significance of this study, thus, lies in the fact that the individuals are unaware of their disease status and more having a sedentary life style. These findings indicate that promotion of physical activity is important in the prevention of diabetes mellitus.

Key Words: Diabetes, Physical activity, Sedentary, Borderline, Newly detected diabetics

Introduction

Diabetes is such a complex disease with many different forms. Physical activity is any bodily movement produced by skeletal muscles resulting in energy expenditure. Therefore this includes sports and leisure activities of all forms. Physical activity and exercise helps tune the "human machine" and help to make our organs, muscles, bones and arteries more efficient. This is our way of counter attacking and we can reduce the chances of getting an illness or a disease. Aristotle and the Indian physician, Sushruta, suggested the use of exercise in the treatment of diabetic patients as early as 600 B.C. and during late last century and early this century many physicians claimed that the need for insulin decreased in exercising patients.

During physical activity, whole-body oxygen consumption may increase by as much as 20-fold and even greater increases may occur in the working muscles. To meet its energy needs under these circumstances, skeletal muscle uses, at a greatly increased rate, its own stores of glycogen and triglycerides, as well as free fatty acids (FFAs) derived from the breakdown of adipose tissue triglycerides and glucose released from the liver. To preserve central nervous system function, blood glucose levels are remarkably well maintained during physical activity. The metabolic adjustments that preserve normoglycaemia during physical activity are in large part hormonally mediated. A decrease in plasma insulin and the presence of glucagons appear to be necessary for the early increase in hepatic glucose production during physical activity, and during prolonged exercise, increases in plasma glucagon and catecholamine appear to play a key role. These hormonal adaptations are essentially lost in insulin-deficient patients with type 1 diabetes. As a consequence, when such individuals have too little insulin in their circulation due to

inadequate therapy, an excessive release of counter insulin hormones during physical activity may increase already high levels of glucose and ketone bodies and can even precipitate diabetic ketoacidosis. Indeed, in patients with type 2 diabetes, physical activity may improve insulin sensitivity and assist in diminishing elevated blood glucose levels into the normal range (*American Diabetes Association, 2003*).

With the publication of new clinical reviews, it is becoming increasingly clear that physical activity may be a therapeutic tool in a variety of patients with, or at risk for diabetes, but that like any therapy its effects must be thoroughly understood. People at an increased risk of Type 2 diabetes are those with; impaired glucose tolerance, obesity, family history of diabetes or previous gestational diabetes. Recent evidence has shown that increased physical activity in conjunction with dietary changes can prevent individuals with impaired glucose tolerance from progressing to Type 2 diabetes (*Schneider and Ruderman, 1990; Wasserman and Zinman, 1994; Devlin and Ruderman, 2002; Diabetes Prevention Program Research Group, 2002*).

The main goal of any intervention in diabetes is to maintain blood glucose, blood pressure and lipid levels within a range that will either prevent or delay the onset of any diabetes complications. The health benefits of physical activity are well documented in the prevention of diabetes in individuals at high risk and in the management of Type 2 diabetes (*Zinman et al., 2004*).

The health benefits of physical activity are less well studied in diabetes and shows that regular physical activity is likely to confer cardiovascular benefits. Physical activity promotion needs to be given at least equal importance as advice regarding diet and medication by the diabetes team. Resources need to be made available so that people with diabetes have access to information and advice, which will help them to build regular physical activity into their lifestyle.

Material and Methods

The present epidemiological and biochemical study has been undertaken in the district Sangrur, Punjab (India). The samples survey has been undertaken from the area covered and 1000 subjects were selected randomly for questioning regarding the different aspects of epidemiology. Out of these 1000 samples, 500 are from urban population and 500 from rural population

The subjects were questioned personally, using a questionnaire which is designed for collection of data and general information regarding age, sex, socio-economic status, marital status, education, occupation, physical activity, dietary intake habits, and family history of diabetes, awareness and treatment taken for diabetes. But amongst them obesity, diet, family history and physical activity were found to highly correlated with the disease and in this paper the role of physical activity is explained in the management of diabetes. Fasting and random blood sugar levels, blood groups, blood pressure, urine sugar and urine protein (fasting and random), body mass index were also measured in the 1000 subjects.

Results

Table 1: Distribution of number of subjects of diabetes mellitus according to nature of work in different status of subjects

S. No.	Status	Nature of Work				Total
		Physical		Sitting		
		N	%	N	%	
I	N	272	41.65	381	58.35	653
II	BL	70	29.04	171	70.96	241
III	ND	4	7.27	51	92.73	55
IV	KD	9	23.68	29	76.32	38
V	TD	4	30.77	9	69.23	13
	Total	359	35.90	641	64.10	1000

Table 1a: Statistical Analysis

Status of subjects	χ^2	DF	p	HS/NS
N	22.964	1	<0.0001	HS
BL	6.877	1	<0.001	HS
ND	21.291	1	<0.0001	HS
KD	2.938	1	>0.05	NS
TD	0.365	1	>0.05	NS

χ^2 : Chi Square test, p : Probability, HS : Highly Significant, NS : Non significant, DF : Degree of Freedom,

Table 1b: Comparison of Fasting Blood Sugar Level in Relation to Actual Work Condition of occupation between Physical and Sitting Type of Jobs

Status	Physical		Sitting		't'	Sig
	N	Mean ±SD	N	Mean ±SD		
N	272	81.19 ± 8.76	381	81.61 ± 9.47	0.59	NS
BL	70	96.21 ±10.75	171	97.81 ±10.47	1.05	NS
ND	4	128.75 ±24.75	51	140.45 ±29.41	0.8	NS
KD	9	151.33 ±31.96	29	159.93 ±45.61	0.63	NS
TD	4	51.50 ± 7.53	9	51.00 ± 7.4	0.11	NS

In the total population (1000), 359 persons are observed to be performing physical activities and 641 are doing sitting type of work. Borderline (BL), newly detected (ND); known diabetic (KD) and total diabetic (TD) subjects are more in subjects performing sitting type of work than physical work (Table-1).

Men are more physically active than women. Difference between male and female according to their work conditions is given in table 2. Females are doing more sedentary type of jobs. When physical activity is compared between rural and urban populations then the following results have been obtained –

		Physical	Sitting
BL (241)	Urban (139)	42 (30.21%)	97 (69.78%)
	Rural (102)	28 (27.45%)	74 (72.54%)
ND (55)	Urban (28)	1 (3.57%)	27 (96.42%)
	Rural (27)	3 (11.11%)	24 (88.88%)
KD (38)	Urban (27)	8 (29.62%)	19 (70.37%)
	Rural (11)	1 (9.09%)	10 (90.90%)

TABLE 1c: Comparison of Random Blood Sugar Level in relation to actual work condition of their occupation between physical and sitting type of job

Status	Physical		Sitting		't'	
	N	Mean±SD	N	Mean±SD		
N	272	116.64 ± 12.96	381	116.26 ±15.77	0.33	NS
BL	70	156.32 ± 15.45	171	161.53 ±17.89	2.27	S
ND	4	272.50 ± 34.61	51	229.58±50.55	2.29	S
KD	9	256.11 ± 68.74	29	263.89± 68.34	0.29	NS
HG	4	84.00 ± 12.41	9	92.66 ±20.79	0.93	NS

Physical activity is more in rural population in borderline and

newly detected diabetic subjects but in known cases it is more in urban population. Hence the risk of developing diabetes is more in urban population as discussed earlier.

TABLE 2: Distribution of males and females according to their nature of work.

STATUS		PHYSICALLY ACTIVE		SEDENTARY	
		Male (226)	Female (133)	Male (329)	Female (312)
Normal (653)	N	177	95	226	155
	%	(78.3)	(71.4)	(68.69)	(49.67)
Bordeline (241)	N	40	30	66	105
	%	(17.69)	(22.55)	(20.06)	(33.65)
Newly detected (55)	N	2	2	16	35
	%	(0.88)	(1.5)	(4.8)	(11.2)
Known diabetic (38)	N	5	4	17	12
	%	(2.21)	(3.0)	(5.16)	(3.84)
Hypoglycemic (13)	N	2	2	4	5
	%	(0.88)	(1.50)	(1.21)	(1.60)
Total diabetic (93)	N	7	6	33	47
	%	(3.09)	(4.51)	(10.03)	(15.06)

Chi-square test is applied in which calculated values are more than tabulated values and highly significant for borderline ($p<0.001$) and newly detected ($p<0.0001$) categories but non-significant in known diabetic ($p>0.05$) and total diabetic ($p>0.05$) categories (Table-1a). Comparison is done between the fasting and random blood sugar levels of the subjects performing physical and sitting type of job (Table-1b and 1c) and significant results have been obtained for only random blood sugar levels of borderline (at 95% level) and newly detected ($p <0.05$) subjects (Table-1c). In the total population (1000) only 38 subjects (3.8%) were doing exercise daily.

Discussion

An endeavour has been made putting the present study along with the earlier studies to bring out the fact that physical exercise is a very important factor either to escape or delay the onset of this disease. This statement is supported by various workers who have done research from different parts of the globe.

Physical inactivity was found to be a risk factor for the incidence of diabetes mellitus (*Kriska et al., 2006*).

Similarly in the present study, borderline, newly detected, known and total diabetic subjects are more in physically inactive persons. These findings indicate that promotion of physical activity may be important in the prevention of diabetes mellitus.

The higher prevalence of diabetes mellitus and lower levels of physical activity was also observed among older persons by *Clark (1997)*. In the present study, prevalence of diabetes is also more in subjects of 70 years. The young individual in good metabolic control can safely participate in most activities. The middle-aged and older individual with diabetes should be encouraged to be physically active. The aging process leads to a degeneration of muscles, ligaments, bones, and joints, and disuse and diabetes may exacerbate the problem. Physical activity is known to reduce the risk of non-insulin dependent diabetes mellitus in younger and middle aged subjects. According to *Williams et al. (1999)* people with newly diagnosed diabetes were less

physically active than their counter parts.

In the study of *Baan et al. (1999)*, a significant inverse association between physical activity and presence of newly diagnosed diabetes was observed. The purpose of this past study was to estimate the association between physical activity and presence of risk for diabetes. The same relationship has been observed in the present study. Subjects who are borderline and newly detected diabetics are totally unaware of the diagnosis at the time of examination, and also of any physical activity which can change their status. On examination of the data regarding their habits, finds out that all such cases are not performing any physical activity or exercise which indicates fully unawareness in general population about their health. Thus, it makes very clear that the physical exercise has got a profound affect on this disease.

There is evidence that physical activity increases peripheral sensitivity to insulin, especially in skeletal muscle and adipose tissue (*Horton, 1991; Pescatello and Dipietro, 1993; Feskens et al., 1994*). Besides, physical activity may improve weight reduction by increasing the energy expenditure associated with exercise because obesity is a major risk factor for developing diabetes (*Horton, 1988*). In the present study, among total population, only 3.8% are doing the regular exercise. According to *Gopalan et al. (1991)* in Pondicherry found some of those subjects who took some form of exercise (50%) and less than a third did so daily. *Rema et al. (1997)* also found, that out of 304 diabetic patients only 85 (27.9%) were doing walking or jogging. These findings, therefore, serves to strengthen the grounds for encouraging physical activity and exercise.

According to *Taylor et al. (1984)*, there was an epidemiological evidence for the role of physical activity as an independent risk factor for type-II diabetes in Melanesian and Indian men in Fiji. Prevalence of diabetes was more than twice as high in those graded as sedentary or undertaking light activity than performing more physical activities.

Physical activity is a protective factor against the diabetes. Physical inactivity is found to be a risk factor for the development of diabetes. Various epidemiological studies of following workers have showed that more active individuals have a lower incidence of diabetes mellitus (*Gopalan et al., 1991; Helmrick et al., 1991; Horton, 1991; Manson, 1991; 1992; Pescatello and Dipietro, 1993; Feskens et al., 1994; Burchfiel et al., 1995; Perry et al., 1995; Crespo et al., 1996; Lynch et al., 1996; Clark, 1997; Rema et al., 1997; Will et al., 1997; Giacca et al., 1998; Harris et al., 1998; Wing et al., 1998; Baan et al., 1999; Williams et al., 1999*).

The increase in prevalence of diabetes in U.S. has shown

substantial increase in obesity together with the high frequency of sedentary life style in U.S. (*Crespo et al., 1996*). Rural urban shifts and migration are usually accompanied by change in levels of physical activity, almost invariably to a more sedentary pattern.

A major characteristic of type-II diabetes is insulin resistance at the level of target tissues - possibly a post receptor defect. A sedentary type of life could be one of the numbers of factors causing insulin resistance in an individual with genetic susceptibility to diabetes. Physical exercise had been recommended as a part of therapy for type II diabetes because of increased insulin sensitivity during the exercise (*Bjorntorp, 1982*). Hence the main finding of the present study is repeated encouragement to increase physical activity and to do exercise to prevent the diabetes and its complications.

A standard recommendation for diabetic patients, as for nondiabetic individuals, is that physical activity includes a proper warm-up and cool-down period. A warm-up should consist of 5–10 min of aerobic activity (walking, cycling, etc.) at a low-intensity level. The warm-up session is to prepare the skeletal muscles, heart, and lungs for a progressive increase in exercise intensity. After a short warm-up, muscles should be gently stretched for another 5–10 min. Primarily, the muscles used during the active physical activity session should be stretched, but warming up all muscle groups is optimal. The active warm-up can either take place before or after stretching. After the activity session, a cool-down should be structured similarly to the warm-up. The cool-down should last about 5–10 min and gradually bring the heart rate down to its pre-exercise level.

There are several considerations that are particularly important and specific for the individual with diabetes. Aerobic physical activity should be recommended, but taking precautionary measures for physical activity involving the feet is essential for many patients with diabetes. The use of silica gel or air midsoles as well as polyester or blend (cotton-polyester) socks to prevent blisters and keep the feet dry is important for minimizing trauma to the feet. Proper footwear is essential and must be emphasized for individuals. Individuals must be taught to monitor closely for blisters and other potential damage to their feet, both before and after physical activity. A diabetes identification bracelet or shoe tag should be clearly visible when exercising. Proper hydration is also essential, as dehydration can affect blood glucose levels and heart function adversely. Physical activity in heat requires special attention to maintain hydration. Adequate hydration prior to physical activity is recommended (e.g., 17 ounces of fluid consumed 2 h before physical activity). During physical activity, fluid should be taken early and frequently in an amount sufficient to compensate for losses in sweat reflected in body weight loss, or the maximal amount of fluid tolerated. Precautions should be taken when exercising in extremely hot or cold environments. High-resistance exercise using weights may be acceptable for young individuals with diabetes, but not for older individuals or those with long-standing diabetes. Moderate weight

training programs that utilize light weights and high repetitions can be used for maintaining or enhancing upper body strength in nearly all patients with diabetes (*American College of Sports Medicine, 2000*).

A great deal of evidence has been accumulated supporting the hypothesis that physical activity may be useful in preventing or delaying the onset of type 2 diabetes. There are now three published trials documenting that with lifestyle modification (weight loss, regular moderate physical activity), diabetes can be delayed or prevented (*Pan et al, 1997 and Tuomilehto et al, 2001*)

All levels of physical activity, including leisure activities, recreational sports, and competitive professional performance, can be performed by people with type 1 diabetes who do not have complications and are in good blood glucose control. The ability to adjust the therapeutic regimen (insulin and medical nutrition therapy) to allow safe participation and high performance has recently been recognized as an important management strategy in these individuals. (*Wasserman and Zinman, 1994*).

Patient should have both an adequate knowledge of the metabolic and hormonal responses to physical activity and well-tuned self-management skills. The increasing use of intensive insulin therapy has provided patients with the flexibility to make appropriate insulin dose adjustments for various activities. Such an approach frequently neutralizes the beneficial glycemic lowering effects of physical activity in patients with type 1 diabetes (*Schneider and Ruderman, 1990*).

Diabetes is associated with an increased risk of macro vascular disease; the benefit of physical activity in improving known risk factors for atherosclerosis is to be highly valued. This is particularly true for physical activity that can improve the lipoprotein profile, reduce blood pressure, and improve cardiovascular fitness These studies have valuable contribution in changing the focus for physical activity in diabetes from glucose control to that of an important life behavior with multiple benefits.

The significance of this study, thus, lies in the fact that the individuals are unaware of their disease status and more having a sedentary life style. This study therefore suggests that mild exercise as prescribed in various general information hand books should be undertaken to avoid the occurrence of this disease. The challenge is to develop strategies that allow individuals with diabetes or to prevent diabetes should participate in activities that are consistent with their lifestyle and culture in a safe and enjoyable manner.

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