Body Mass Index, Physical Activity, High Normal Fasting Plasma Glucose levels and the risk of Diabetes Mellitus Type 2

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Abstract

Background: To find out the relationship between obesity, sedentary lifestyle and fasting plasma glucose (FPG)levels in apparently healthy individuals belonging to the paramedical staff of the Liaqat University of Medical and Health Sciences, Jamshoro.

Methods: 50 healthy individuals were included in the study. FPG levels were measured at baseline and after three years. Body mass index was calculated as weight in kilograms divided by the square of the height in meters, and the subjects were defined as obese if their BMI was 30 or greater. A specially designed questionnaire NICE guideline- PHI2 Physical activity: Implementation advice 2006 was filled at baseline & at the end of the study. Patients with known DM were excluded from the study.

Results: At baseline the mean FPG level was 88 ± 5.62 mg/dl which increased to 98.4 ± 4.22 mg/dl in a three year period. 41% of subjects had FPG of ≥100 when followed up after 3 years. There were two incident cases of DM Type 2. The study revealed that in men with FPG of 100 mg/dL or higher there was a progressively greater risk for type 2 diabetes as the FPG values rose, compared with men who had an FPG of less than 86 mg/dL, p <0.001. A similar large risk was detected in men with a BMI of 30 or more, compared with a BMI less than 25 .It was also observed that most of the subjects were among the moderately inactive group.

Conclusion: Persons with normal blood sugar at a given examination, who are over weight and living a sedentary life style; can develop diabetes in coming years as compared to people with less BMI and lower normal fasting plasma glucose levels.

Key Words: Diabetes Mellitus Type 2, Fasting plasma Glucose levels, Body mass index.

Introduction

Diabetes mellitus Type 2 is one of the fastest growing public health problems in the world. The prevalence of diabetes for all age groups worldwide was estimated to be 2.8% in 2000 and to rise to 4.4% in 2030.[1] The total number of individuals with diabetes is projected to rise from 171 million in 2000 to 366 million in 2030.[1] Cardiovascular disease accounts for more than 70% of total mortality among patients with DM type 2.[2] Both genetic and environmental factors have been implicated in the etiology of DM type 2.[3] Lifestyle factors, the main determinants of the disease, are physical inactivity and obesity.[4] Results from prospective studies and clinical trials have shown that moderate or high levels of physical activity or physical fitness, as well as changes in lifestyle (dietary modification and enhanced physical activity) can prevent type 2 DM. [5-11] Recent clinical trials in China, Finland, and the United States have demonstrated that lifestyle intervention (dietary modification and enhanced physical activity) reduced the risk of progressing from impaired glucose tolerance to type II diabetes.[12-14] Insulin resistance develops in response to decreased insulin secretion and plays a part in the development pathogenesis of DM type 2. Insulin resistance is a decrease in the endogenous sensitivity to insulin action. Endogenous insulin secretion suppresses hepatic glucose biosynthesis, increases glucose uptake and glycogen synthesis in target cells, and reduces the lipolysis of adiposities. Increased insulin resistance hinders normal insulin activity, leading to hyperinsulinemia and, eventually, DM type 2. In fact, decreased insulin secretion and increased insulin resistance precede the development of clinical hyperglycemia.[15]

Epidemiologic evidence has shown that physical activity and body fat loss are of medical benefit, not just for preventing diabetes but also for cardiovascular health and quality of life.[16] Regular physical activity is a crucial component of a healthy lifestyle. Healthcare professionals and policy makers should aggressively promote physical activity and weight control.[17] It is well known that increasing physical activity and losing weight can prevent 40 to 80 percent of adult onset diabetes in those with

elevated blood sugar levels. In a Finnish study physical activity and weight has been weighed in promoting or protecting from diabetes in those with normal blood sugar and those with high blood sugars, but not high enough to be called diabetes.[18]

Subjects and Methods

After taking informed consent, 50 men aged between 30 to 57 years were included in the study. At the end two patients were dropped, one because of long leave and the other due to retirement from the job. The study period was three years (March 2006 through March 2009). We obtained blood measurements for fasting plasma glucose levels, BMI and physical lifestyle information from apparently normal individuals of paramedical staff, belonging to Liaqat University of Medical and Health Sciences, Jamshoro. FPG levels were measured at baseline and at the end of the study. Body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in meters. BMI was calculated at start of the study and after three years and the subjects were defined as obese if their BMI was 30 or greater. A specially designed questionnaire NICE guideline - PHI2 Physical activity: Implementation advice 2006 was filled at start and end of the study. NICE (National Institute for Health and Clinical Excellence) has developed tools to help organizations implement the NICE public health intervention guidance on physical activity. NICE recommends that primary care practitioners should take the opportunity, whenever possible, to identify inactive adults and advise them to aim for 30 minutes of moderate activity on 5 days of the week (or more).[19]

Inclusion Criteria: Apparently healthy males with no history of DM, Hypertension or renal problem.

Exclusion Criteria: Patients were excluded from the study if they had confirmed type 1 or type 2 diabetes at the time of enrolment.

Results

The men included in the study belonged to the lower socio-economic class, with the mean age of 42±7.23. At baseline the mean fasting glucose level was 88 ± 5.62 mg/dl which increased to 98.4 ± 4.22 mg/dl in a three year period. 41% 0f subjects had FBS of ≥100 as they were followed up after three years. (Table 1)

BMI when calculated, it was noted that 38 (76%) subjects were having BMI between 25-29 at start of the study and 12 (24%) were having BMI of ≥ 30 but when they were followed after three years 28(58.3%) were having BMI of 25-29 and 20(41%) were found to be obese i.e. having BMI of 30 or more (Table 1, Figure 1).

The general practice physical questionnaire was filled twice at baseline. It showed that 22 (44%) men were among the moderately inactive group, 16(32%) in moderately active group, and 12(24%) in active group, while at three years 24(50%) in moderately inactive, 18(37.5%) in moderately active group, 6(12.5%) in active group. (Table 1, Figure 3).

Table 1: Characteristics of patients at baseline and at three years

Characteristic	Baseline n=50	After 3years n=48
Age (Years)		
Mean Age	42 (±7.23)	44(±6.84)
Range	30-57	33-58
Fasting plasma glucose level(mg/dl)	88 ± 5.62	98.4 ± 4.22
Mean	77-97	84 -130
Range		
Body mass index(BMI)		
25-29	38(76%)	28(58.3%)
≥ 30	12(24%)	20(41%)
Family history of DM*	08	08
Physical activity (%) **		
Moderately inactive	22 (44%)	24(50%)
Moderately active	16(32%)	18(37.5%)
Active	12(24%)	06(12.5%)
Inactive	00	00

Plus–minus values are mean SD.
*A family history of diabetes indicates the presence of type 2 diabetes in a first degree relative.
** Physical activity denotes engagement in physical activity for a minimum of 20 min at least three times per week.
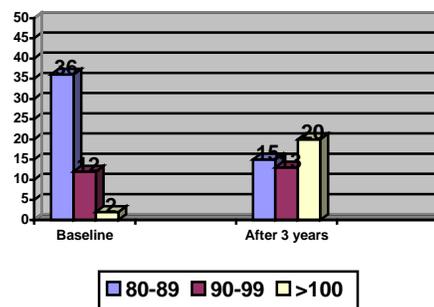
Figure 1: Fasting Plasma Glucose Levels at baseline and after 3 years

During follow-up (from 2006 through 2009), there were two incident cases of DM Type 2, the study revealed that in men with FPG of 100 mg/dL or higher there was a progressively greater risk for DM Type 2 as the FPG values rose, as compared with men who had an FPG of less than 86 mg/dL p value <0.001. A similarly large risk was detected in men with a BMI of 30 or more compared with a BMI less than 25-29.
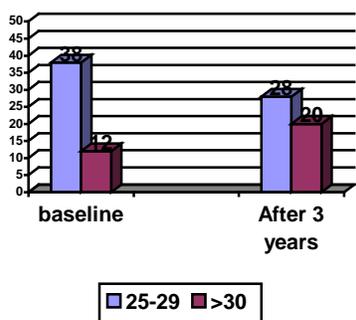

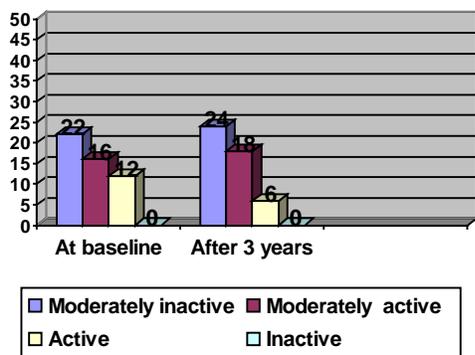### Figure 2: BMI at Baseline and after 3 Years

Figure 3: Grouping of patients according to General Practice Physical Activity Questionnaire

Discussion

It is often seen that sedentary life style and obesity go together, but the problem is that more people are adopting such lifestyle. This study highlights those persons whose fasting plasma glucose levels were within normal range but at upper limit of the normal range. The definition of a normal fasting plasma glucose level has recently been revised by the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus of the American Diabetes Association. An impaired fasting plasma glucose level is now considered to include the range of 100 to 109 mg per deciliter (5.55 to 6.05 mmol per liter).[20] Obese persons who do not have diabetes consistently exhibit an enhanced rate of glucose production. This enhanced rate may emanate from elevated levels of free fatty acids that directly accelerate the rate of hepatic gluconeogenesis, combined with desensitization of the hepatic regulatory loop involving hypothalamic sensing of fatty acids.[21-22] Obesity-associated altered secretion of adipocytokines from adipocytes, macrophages in fat tissue, or both has been suggested as the mechanism involved in mediating such dysregulations between fatty tissue and the liver.[23-25]

Our study is in accordance with the study conducted by Tirosh et al, according to which a high normal FPG level is independent risk factor for DM Type 2 along with BMI and physical activity.[26]

Conclusions

1. A sedentary lifestyle, and being obese can lead to DM type 2 in coming years of individuals who are at risk.

2. Changes in lifestyle are effective in preventing both diabetes and obesity in high-risk adults with impaired glucose tolerance.

3. High normal FPG value alone may not be a detector of Type 2 Diabetes, so along with FPG, BMI, physical activity and eating habits questionnaires might serve as better screening methods.

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