



Assessment of blood pressure in the population with impaired glucose tolerance in Bangladesh

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Abstract

The regulation of blood pressure in population with IGT is a substantial issue although not characterized well. Therefore, the purpose of the present study is to clarify the role of dietary modification and physical exercise in subjects with impaired glucose tolerance on the regulation of cardiovascular homeostasis. Thirty three newly detected otherwise healthy subjects aged 35-63 years, were randomly selected to participate in a 12 weeks diet and exercise program and blood pressure was monitored and recorded from each participants. Mean systolic B.P (mm Hg) was recorded 118.83 ± 3.3 at base line with a range of 85-160 mm Hg. At the end of 12 weeks, systolic B.P. 117.36 ± 2.84 was demonstrated by the total group. Diastolic B.P was reduced significantly from 84.23 ± 2.33 at base line to 80.4 ± 2.07 mm Hg at follow-up. For men, both systolic and diastolic B.P were 116.87 ± 4.78 and 84.06 ± 3.71 at base line while 114.68 ± 2.9 and 82.62 ± 2.35 were recorded for follow-up respectively. For women, systolic and diastolic B.P were 121.07 ± 4.6 and 84.42 ± 2.79 at baseline and 120.42 ± 5.11 and 77.85 ± 3.5 at follow up respectively. In 35-40, 41-50 and 51-63 years group, the systolic pressures were recorded; similarly, the diastolic pressures for the respective groups were also monitored at baseline and follow-up. In different BMI groups, 118.5 ± 6.14 vs. 114.5 ± 3.76 (BMI 20-25) and 119.0 ± 4.0 vs. 118.8 ± 3.85 (BMI >25) systolic pressures were observed while 85.5 ± 4.91 vs. 81.0 ± 3.4 (BMI 20-25) and 83.6 ± 2.58 vs. 80.1 ± 2.66 (BMI >25) diastolic pressures for baseline and follow-up populations were demonstrated respectively. Although a significant role on lowering of diastolic pressure for individuals including women and middle aged people was noted however other groups were remained to be unchanged. The results would give a new insight on the characterization of IGT and the programme may play the critical role in this respect.

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Introduction

Impaired glucose tolerance (IGT) is a strong predictor of not only of type 2 diabetes (Boyko *et al.*, 2000) but also of cardiovascular disease and other complications of diabetes (Tominaga *et al.*, 1999; Schnell and Standl, 2006;. The glucose tolerance of hypertensive patients should be determined as precisely as possible in daily clinical practice in order to identify problems at an early stage (Christ *et al.*, 2003; Saad *et al.*, 2004). In its seventh report, the 2003 Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC-7) defined a new set of guidelines for the prevention and management of hypertension. According to the JNC-7, normal blood pressure (BP) is defined as systolic BP less than 120 mmHg and a diastolic BP less than 80 mmHg; a BP of 120-139/80-89 mmHg is defined as prehypertension (PHT) (Chobanian *et al.*, 2003). Prehypertension is not currently categorized as a disease; however, prehypertensive individuals have double the risk for developing hypertension of those with normal BP (Vasan *et al.*, 2001) and even slightly elevated BP is known to increase cardiovascular risk (Lewington *et al.*, 2002; Tsai *et al.*, 2005; Anan *et al.*, 2007; Shinzato *et al.*, 2007). Therefore, it is substantial to regulate the alteration of BP in the populations with IGT.

Planned physical activity, according to the age and physical status, is considered a useful part of treatment (Reitman *et al.*, 1984). Exercise improves metabolism and has been shown to enhance insulin action on target tissues and contribute to weight loss. Over the past decade, several studies (Schneider *et al.*, 1984; Koivisto *et al.*, 1986) have demonstrated significantly improved glycemic control in patients with type 2 diabetes (NIDDM) treated with regular exercise. Dietary change is part of most weight control programs, and caloric restriction decreases hyperglycemia dramatically (Savage *et al.*, 1979). Thus, intervention in the form of dietary modification and physical exercise in individuals with impaired glucose tolerance (IGT) could significantly improve metabolic control,

reduce the incidence of diabetes mellitus and thereby may have a major impact on the public health burden of diabetes in the near future.

Type 2 diabetes is characterized by the higher blood glucose level associated with other vascular complications although its remedy is yet to be done. Because of the higher glucose level caused by the impaired cellular uptake and by the insulin resistance, the effects regarding the higher blood pressure are observed. However, increased glucose level in IGT subjects also causes increased blood pressure (Falkner *et al.*, 1999), therefore, proper diagnosis and its remedy are substantial and dietary intervention together with physical exercise may play the role in this respect. Therefore, the present study has been undertaken to clarify the influence of the above mentioned program on the regulation of blood pressure in the subjects with impaired glucose tolerance.

Materials and methods

Subjects

137 persons (men 67 and women 70) with impaired glucose tolerance (IGT) were registered at Rajshahi Diabetic Clinic aged 35-63 years were recruited for the study and were made questionnaire to obtain relevant information on the socio-demographic data. Of these individuals, fifty otherwise healthy subjects (i.e., apart from minor, unconnected ailments or mild hypertension) aged 35-63 years, were invited to participate in a 12 weeks diet and exercise intervention program. Thirty three subjects (men 17 and women 16) agreed to participate in the program and they were selected by the following criteria:

1. Subjects who met the revised criteria for IGT (FBS <7.0 mmol/L and 2hPG \geq 7.8 mmol/L but <11.1 mmol/L).
2. Middle aged men and women without evidence of coronary heart disease (CHD), stroke or other major illness.
3. Subjects taking drugs that may impair glucose tolerance at baseline or during the follow up period were excluded. With a dropout rate less than 10%, the remaining subjects were 30 (men 16 and women 14).

Baseline examination

A baseline examination was conducted on each participant after a 10 to 12h overnight fast. Blood pressure of the study participants before and after diet and exercise intervention was recorded. Body mass index (BMI) was calculated using the formula $BMI = (\text{weight in kg})/(\text{height in meter}^2)$. After a fasting blood sample was taken, each subject was ingested 75g of glucose monohydrate dissolved in 300 ml water within a 2 minute period. Blood glucose was monitored in fasting sample and also in the sample obtained 2h after the glucose load.

Interventions

Appropriate dietary advice was given to the subjects and participants were encouraged to increase the amount of their leisure physical activities.

Diet

Participants with $BMI < 25 \text{ kg/m}^2$ were prescribed a "prudent diet" containing 30 kcal/kg body weight. Subjects with $BMI \geq 25 \text{ kg/m}^2$ were encouraged to reduce their calorie intake so as to gradually lose weight at a rate of 0.5 to 1.0 kg per month until they achieved a BMI 23 kg/m^2 . The recommended proportion of calorie intake was 55-65% carbohydrate (preferably complex carbohydrate e.g., starches), 10-20% protein and 20-30% fat (increasing the ratio of polyunsaturated fat to saturated fat). The participants were encouraged to consume more food with high fiber content, e.g., whole grains, fresh fruits, vegetables and reduce the intake of simple sugars. Individual's goals were set for total calorie consumption, and daily quantities of cereals, vegetables, meat, milk, and oils. This was accomplished by providing a list to each individual of the recommended daily intake of commonly used foods and a substitution list to allow exchange within food groups. In addition, participants were received an individual counseling by physician.

Exercise

Participants were taught and encouraged to increase the amount of leisure physical activities. The rate of increase and type of exercise were recommended on participant's interest, age, past exercise patterns and

fitness. Participants were encouraged to exercise at least two units per day and five days in each week. Appropriate indoor activities were suggested for winter. Physical activity was ascertained in minutes per day for major activities, such as walking, running, cycling, ball playing, aerobics, gardening and swimming etc. and converted to units per day as shown below.

Blood sampling

With all aseptic precautions, 5 mL of venous blood was taken in a clean dry test tube, and allowed to stand at room temperature until it had clotted. It was then centrifuged at a speed 2500 rpm for 5 minutes. Serum was separated within 30 minutes.

Assay of serum metabolite

Serum glucose was estimated by enzymatic-colorimetric (GOD-PAP) method (Trinder, 1969) using reagent kit, glucose liquicolor (Human-GMBH, Germany).

Statistical analysis

Results of the experiments were expressed as mean and standard error of different groups. The differences between the mean values were evaluated by ANOVA followed by paired *t*-test using SPSS software.

Results

Socio-demographic characteristics of the participants

Mean age (years) of the participants was 45 ± 1.35 with a range of 35-63 years, nine participants (30%) were within 35-40 years while majority fifteen participants (50%) aged 41-50 years and rest six participants (20%) were above 50 (51-63) years (Table 2). A male preponderance was observed among the study participants where 53.3% of the total participants were male ($n=16$) and 46.7% were female ($n=14$) (Table 2). Much diversity in education level was observed among the participants and is shown in Table 2 where two peoples (6.7%) were illiterate while primary, secondary and higher secondary educated peoples were four (13.4%), eleven (36.6%) and six (20%) respectively.

The graduate and post graduate participants were five (16.6%) and two (6.7%) respectively.

Family history of diabetes

Relevant history of diabetes in the family was found in fourteen participants (46.7%). Diabetes was not known in the family of others (n=16, 53.3%).

Effects of diet and exercise intervention on blood pressure

Effects of diet and exercise on blood pressure of diverse individuals with IGT were performed.

Subjects with IGT as a whole (n=30) had systolic blood pressure 118.83 ± 3.3 mm Hg at baseline and mean diastolic pressure was 84.23 ± 2.33 mm of Hg while in follow-up individuals induced by diet and physical exercise, the systolic and diastolic blood pressures were 117.36 ± 2.84 mm and 80.4 ± 2.07 mm Hg respectively (Fig.1). Although slight variations in systolic blood pressure were observed among the groups, diastolic pressure was found to be significant ($p < 0.05$).

Table 1. Activities required for one unit of exercise.

Intensity	Time (min)	Exercise
Mild	30	Slow walking, Shopping, House cleaning, Gardening.
Moderate	20	Faster walking, Walking down stairs, Cycling, Doing heavy laundry.
Strenuous	10	Slow running, Climbing stairs, Playing basket ball, Tennis, Swimming.

However, physical exercise and dietary manipulations seem to be involved in reducing the blood pressure, thereby improve IGT in subjects. As slight increase in blood pressure may cause severe effects on

cardiovascular abnormalities e.g., prehypertension etc, therefore, the follow-up program might be involved in reducing such complications.

Table 2. Distribution of the participants by age, sex and education.

Age (Yrs)	No. of participants	Percentage (%)
35-40	9	30
41-50	15	50
51-63	6	20
Sex		
Male	16	53.3
Female	14	46.7
Education		
Illiterate	2	6.7
Primary	4	13.4
Secondary	11	36.6
Higher Secondary	6	20
Graduate	5	16.6
Post Graduate	2	6.7
Total=	30	100

To find the role of diet and physical exercise performed by the subjects on the regulation of blood pressure, systolic and diastolic pressure of different sex groups were determined. Fig.2 shows the effects of diet and exercise intervention on blood pressure for men (Fig.2A) and women (Fig.2B). Mean systolic blood pressure was recorded 116.87 ± 4.78 mm of Hg

at base line and at the end of 12 weeks, a reduced mean blood pressure (116.87 ± 4.78 vs. 114.68 ± 2.9) was demonstrated by men. Diastolic blood pressure was reduced from 84.06 ± 3.71 mm at base line to 82.62 ± 2.35 mm of Hg at follow-up however, both differences were failed to reach the level of significance.

For women exposed to diet and exercise for 12 weeks had systolic blood pressure 120.42 ± 5.11 mm Hg while at baseline, the individuals showed blood pressure 121.07 ± 4.6 mm of Hg. The diastolic pressure for this group 84.42 ± 2.79 mm of Hg at baseline was demonstrated, however, at follow-up, the value 77.85 ± 3.5 mm of Hg was noted. The results appeared to indicate that the blood pressures both systolic and diastolic were slightly reduced in response to 12 weeks follow-up program, however, diastolic pressure for women was found to be significantly ($p < 0.05$) altered when compared to the baseline parameters.

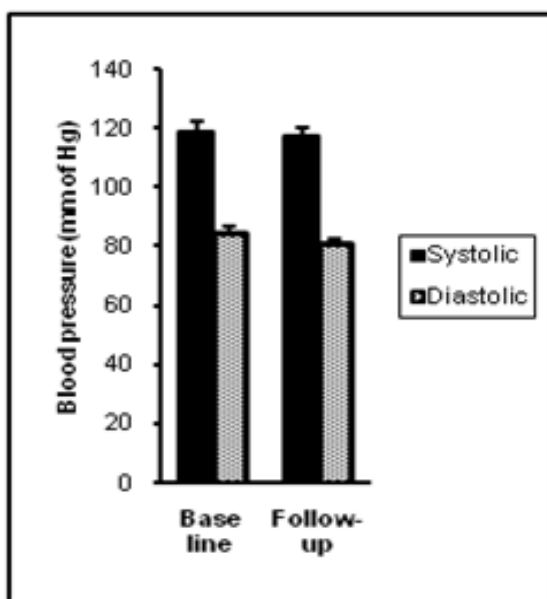


Fig. 1. Effects of intervention on blood pressure for the entire study participants. Values are mean \pm standard deviation. Using paired student's t-test, $p < 0.05$ and $p < 0.01$ were considered significant compared to the respective baseline parameters.

Different age related blood pressure was monitored during this program and compared with the baseline groups because age is the important determinant for characterization of the cardiovascular complications. Fig. 3A shows the blood pressures (systolic and diastolic) among the individuals ranging 35-40 years age. The systolic and diastolic pressures at baseline for this group were 114.44 ± 5.74 mm and 79.11 ± 4.98 mm of Hg respectively. After 12 weeks follow-up program, the systolic and diastolic pressures 108.44 ± 3.84 mm and 70.77 ± 3.6 mm of Hg respectively were

observed. For 41-50 years group (shown in Fig.3B), different blood pressures were monitored for the baseline and follow-up individuals.

The systolic blood pressures for baseline and follow-up groups were 120.66 ± 5.27 mm and 121.33 ± 4.64 mm of Hg while the values were 88.33 ± 3.07 mm and 84.53 ± 2.14 mm of the above groups for the diastolic pressures respectively. Similar but slightly reduced pressures in response to diet and physical exercise were noted for the participants joined in the program however, diastolic pressure for middle aged people was recorded to be significantly altered ($p < 0.05$). Therefore, it is assumed that the follow-up program may have the role on the regulation of vascular complications.

As shown in Fig.3C, the blood pressures were recorded to determine the effect of diet and physical exercise in IGT subjects with age 51-63 years. After 12 weeks of follow-up, the systolic and diastolic pressures were 120.83 ± 3.74 mm and 84.56 ± 4.64 mm of Hg respectively. On the other hand, the baseline subjects showed the systolic and diastolic pressures 120.84 ± 5.83 mm and 81.66 ± 3.8 mm of Hg respectively. Compared to baseline blood pressure values, although not significant, slightly reduced pressures were observed whenever the subjects joined the follow-up program.

Subjects with different BMI groups were considered for monitoring blood pressures during the follow up program. Since the index recognizes and characterizes the energy balance of the subjects, therefore, it is reasonably argued that blood pressures might be altered in response to dietary management and physical exercise.

As shown in Fig.4A, subjects with BMI 20-25 had systolic and diastolic pressures 118.5 ± 6.14 mm and 85.5 ± 4.91 mm Hg respectively for the baseline population while 114.5 ± 3.76 and 81.0 ± 3.4 mm of Hg systolic and diastolic blood pressures were recorded respectively for the follow-up individuals. On the other hand, the systolic and diastolic pressures for the groups with BMI > 25 were 118.8 ± 3.85 and

80.1 ± 2.66 mm Hg respectively for follow-up populations with impaired glucose tolerance while for the base line populations for this group, the systolic and diastolic blood pressures were 119.0 ± 4.0 mm and 83.6 ± 2.58 mm Hg

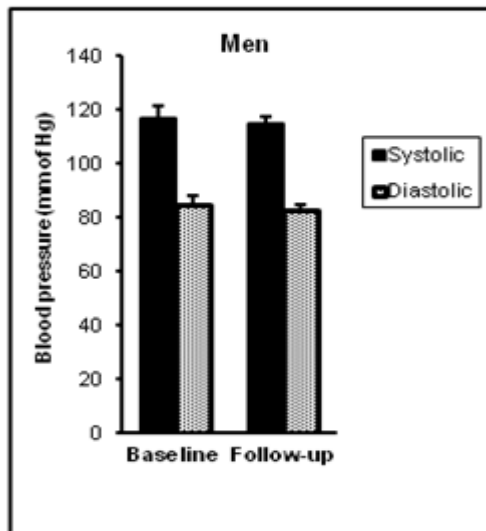


Fig. 2A.

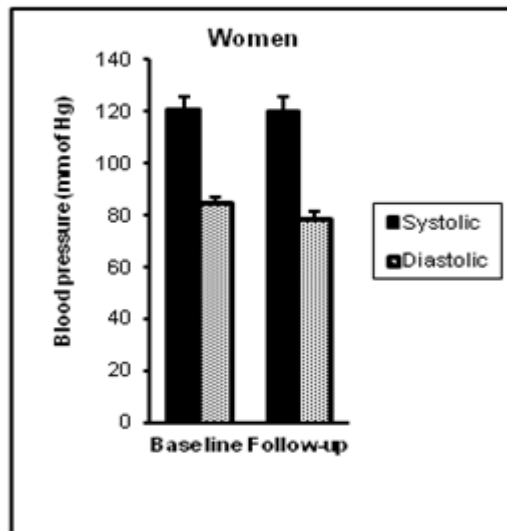


Fig. 2B.

Fig. 2. Effects of diet and exercise on blood pressure for different sex groups. Values are mean ± standard deviation. Values are mean ± standard deviation. Using paired student's t-test, $p < 0.05$ and $p < 0.01$ were considered significant compared to the respective baseline parameters.

Discussion

The present study reveals the effect of diet and physical exercise on the regulation of blood pressure of diverse populations with impaired glucose tolerance. Although measurement of blood pressure in the populations shows no significant differences among the groups however dietary management and physical exercise in follow-up groups were assumed to be involved in reductions particularly for women and middle aged peoples in this respect. The recorded blood pressure was not considered for hypertensive patients. It is well known that regular physical exercise is considered an effective strategy to prevent and treat hypertension (Chobanian *et al.*, 2003; Pescatello *et al.*, 2004). Therefore, over the last year, the increase in the number of people getting regular physical exercise has been considered one of the major achievements in the public health area, which indicates that the general public is more aware of the health benefits gained by physical exercise.

The results are consistent with the general concept that if the population was hypertensive then the diet and physical exercise might be involved in reducing the effect and regulate the enhancement of blood pressure. Moreover, it has been demonstrated that hypertension is associated to the impaired glucose tolerance (Rao *et al.*, 2004). Therefore, the results are compatible and reasonable for the individuals considered for the current investigation.

In this study, blood pressure was monitored in different populations particularly age, sex and BMI groups with impaired glucose tolerance (IGT). It was found that the 12 weeks follow-up program for the entire populations did not significantly alter the systolic and diastolic pressures of the subject although seem to be reduced slightly by this approach. For men, the blood pressure of the populations was reduced slightly and for women, the value was reduced significantly in response to the dietary management and exercise.

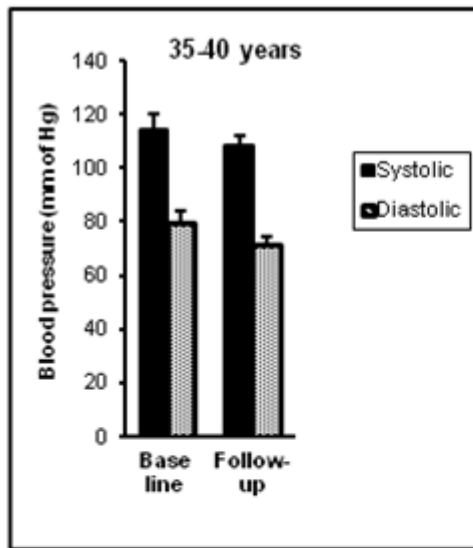


Fig. 3A.

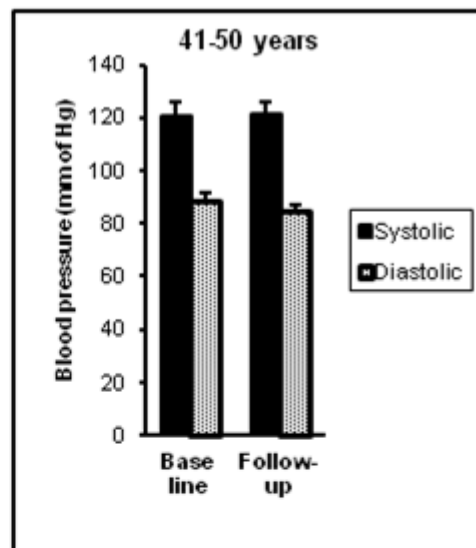


Fig. 3B.

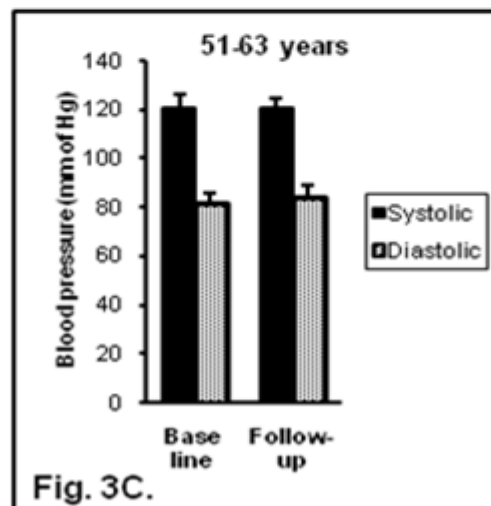


Fig. 3C.

Fig. 3. Blood pressure of the study participants before and after diet and exercise intervention for different age groups. Values are mean \pm standard deviation. Using paired student's t-test, $p < 0.05$ and $p < 0.01$ were considered significant compared to the respective baseline parameters.

Therefore, it is reasonably considered to accept the role of the undertaken follow-up program in this respect. In populations with high prevalence of type 2 diabetes, hypertension is an especially important cause of morbidity and mortality because the risk of diabetic macrovascular and microvascular complications is strongly related to the level of blood pressure (Mahroos *et al.*, 2000). Because of the higher glucose concentration in blood in response to glucose tolerance, increased blood pressure is a normal phenomena and it is well known that physical exercise and dietary manipulation play the critical

role on reducing the glucose concentration in blood of population.

Therefore, it is argued that blood pressure of the IGT subjects might be modified by the intervention program. Because the dietary advice and physical exercise offered according to BMI, leading to the possibility of effects of the interventions on blood pressure in lean and overweight individuals, no significant differences was observed in those who had BMI at baseline 20-25 or follow-up kg/m^2 . Similar effects on blood pressure between baseline and follow-up were found for BMI > 25 having the higher

body weight. The results indicate that these groups did not show the incidence of hypertension. Hypertension and diabetes mellitus (DM) are both conditions that contribute to an increased risk and expression of cardiovascular disease. The risk for cardiovascular disease, as well as cardiovascular disease morbidity and mortality, are markedly augmented when hypertension and diabetes occur together. Both hypertension and non-insulin-

dependent diabetes mellitus (NIDDM) occur at higher rates among black Americans, who also suffer a higher prevalence of cardiovascular disease. (Falkner *et al.*, 1999). The insulin-resistance syndrome, which consists of high blood pressure (BP), obesity, glucose intolerance (or DM), and dyslipidemia, is strongly associated with cardiovascular disease (Chobanian *et al.*, 2003; Pescatello *et al.*, 2004).

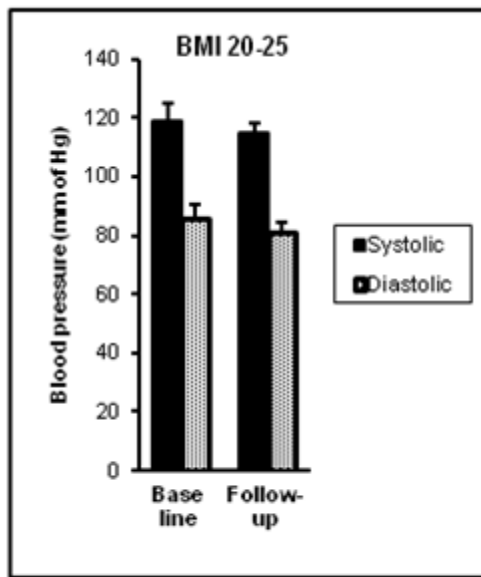


Fig. 4A.

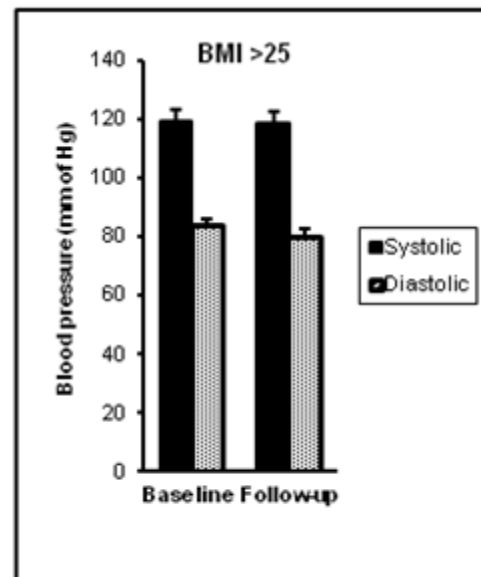


Fig. 4B.

Fig. 4. Blood pressure of the study participants before and after diet and exercise intervention for different BMI groups. Values are mean \pm standard deviation. Using paired student's t-test, $p < 0.05$ and $p < 0.01$ were considered significant compared to the respective baseline parameters.

Proper management of diet and physical exercise are the effective approaches to regulate different complications of the populations particularly, hypertension, diabetes, abnormal growth of body and abnormal weight. Recent investigations reveal and suggest that improvement of cardiovascular abnormalities caused by excess consumption of calories, environmental factors and other effectors has been observed (Hansson, 2005; Johnson *et al.*, 2009;). However, the diagnosis and remedy are essential requirements for these complications. Impaired glucose tolerance is associated with greatly increased risk of cardiovascular disease risk in prehypertensive people (Zhang *et al.*, 2006) showing higher blood pressure. Furthermore, IGT is a strong

predictor not only of type 2 diabetes (Boyko *et al.*, 2000) but also of cardiovascular disease and other diabetes complications (Tominaga *et al.*, 1999; Schnell and Standl, 2006;). The glucose tolerance of hypertensive patients should be determined as precisely as possible in daily clinical practice in order to identify problems at an early stage (Christ *et al.*, 2003; Saad *et al.*, 2004).

The important aspect of present study was that a group of middle aged (mostly sedentary and overweight) glucose intolerant subjects successfully participated in a 12 weeks diet and exercise intervention program, with a dropout rate less than 10%. Middle aged people although having mild reduction in blood pressure (diastolic B.P) of follow-

up group however diet management and exercise did not show the effective approach on lowering blood pressure indicating the peoples were not included to the hypertensive group. During the 12 weeks period, majority of the participants were able to make their life style changes and achieved the recommended dietary intake and physical activities. Mean age of the total participants was recorded 45 years with a range of 35-63 years. 50% of the total participants aged 41-50 years, 30% aged 35-40 years and rest 20% was between 51-63 years. These findings support the view that age is an important determinant of the course of the impaired glucose tolerance and the risk of NIDDM increases with age (Saad *et al.*, 1988). The preponderance of the middle class subjects could be attributed to fact that rapid changes in life style are more marked among this group of people. Measurement of blood pressure of the study participants indicates that hypertension may not be an association of glucose intolerance. Contrary to this view, several epidemiological studies have found a positive correlation between hyperinsulinemia and hypertension (Modan *et al.*, 1985). The results are the good agreement with the hypothesis that impaired glucose tolerance could be modulated by dietary modification, physical exercise and a variety of factors however regulation of blood pressure is mediated by different mechanisms.

Conclusion

Dietary modification and physical exercise have been employed to clarify its role on the regulation of blood pressure of the IGT subjects. Although the significant alterations on blood pressure of diverse populations concerning age, sex, BMI groups were not observed in response to modified diet and physical exercise, however, minor reductions and modifications on blood pressure were found. Since diastolic pressure for the total populations including women and middle aged people has been effectively altered during the intervention, the programme may play the pivotal role in this respect. The measurement of blood pressure might be a useful tool for characterization of the impaired glucose tolerance and will give a new

insight for the development of strategy for finding the causes and etiology of diabetes and related disorders.

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