# Results

# RESULTS

Thirty patients of NIDDM randomly selected, clinically examined and fully investigated where all patients subjected to tests of autonomic neuropathy then the results of these tests classified the whole patients into the following groups: -

**Group1:**

Eighteen patients of NIDDM with positive autonomic neuropathy including the following subgroups:

*Early autonomic neuropathy: 4 patients.
*Definite autonomic neuropathy: 8 patients.
*Sever autonomic neuropathy: 6 patients.

**Group2:**

Twelve Patients of NIDDM without autonomic neuropathy as a control group.

Ventilatory function tests and blood glucose level were done for all patients before and after exercise. The results of these tests were as follows:

**Clinical data of the diabetic patients (Table 1)**

As regard to the age of patients, it was ranged from 40 to 60 years with (mean ± S.D.) age 51.8 ± 7.9 .

The duration of the disease was from 1 to 18 years and mean (mean ± S.D.) was 33.1 ± 6.4 .

Fasting and 2h.p.p. blood glucose were done. The range was 130 to 246 mg/dl for fasting and 160 to 340 mg/dl for 2h.p.p. The mean fasting bl.G. was 191.4 ± 61.9 and mean 2h.p.p. bl.G. was 255.2. ± 88.4 .

**Number and percent of symptoms in relation to autonomic neuropathy ("Table 2","Figure 1")**

These symptoms were postural hypotension, gustatory sweating, gastroparesis, urinary problems and hypoglycemia. Each symptom either absents or present. These symptoms studied in both autonomic neuropathy positive group and autonomic neuropathy negative group (the control group).

***#As regards to negative autonomic neuropathy group (12 patients)***
**("Table 2", "Figure 1")**

-*Postural hypotension* was present in 7 patients with percent (58.3% of total number of patients in this group) and absent in 5 patients with percent (41.7% of total group).

-*Gustatory sweating* was present in 5 patients (41.7% of total group) and absent in 7 patients (58.3% of total group).

-*Gastroparesis* was present in 4 patients (33.3% of total group) and absent in 8 patients (66.7% of total group).

- *Urinary problems* were present in 8 patients (66.7% of total group) and absent in 4 patients (33.3% of total group).

-*Hypoglycemia* was absent in all patients of the group of negative neuropathy (100% of total group).

* From the previous result we observed that absence of history of any attack of hypoglycemia in diabetic patients without autonomic neuropathy while the symptom of highly rate of occurrence regardless presence of autonomic neuropathy was urinary problems followed by postura hypotension.

***#As regards to positive autonomic neuropathy group (18 patients)***
**("Table2", "Figure 1")**

-*Postural hypotension* was present in 10 patients with percent (55.6% of total number of patients in this group) and absent in 8 patients (44.4% of total positive group).

-*Gustatory sweating* was present in 11 patients (61.1% of total positive group) and absent in 7 patients (38.9% of total positive group).

-*Gastroparesis* was present in 11 patients (61.1% of total positive group) and absent in 7 patients (33.3% of total group).

-*Urinary problems* were present in 10 patients (55.6% of total positive group) and absent in 8 patients (44.4% of total group).

-*Hypoglycemia* was present in only 4 patients (22.2% of total positive group) and absent in 14 patients (77.8% of total group).

* From the previous result we observed that the most frequant symptom were gastroparesis and gustatory sweating by same number and percent and least frequent was hypoglycemia.

## Number and percentage of presence of different tests done for autonomic neuropathy (Table 3)

# *The heart rate response to deep breathing* was present in 11 patient 8 in positive neuropathy group with high percentage (44.4% of total positive group) and 3 in negative neuropathy with percent (25% of total negative group).

# *The heart rate response to standing up* was present in a small number of patients' only 6 patients three in each group with percent (25% of total negative group) and (16.7% of total positive group).

# *The heart response to Valsalva maneuver* was present in 11 patient 8 of them in positive neuropathy with high percent (44.4% of total negative group) and 3 patients in negative neuropathy group with percent (25% of total positive group).

# *Blood pressure response to standing up* was present in a very few number only 3 patients 2 of them in positive neuropathy group with percent (11.1% of positive group) and one patient in negative neuropathy group with percent (8.3% of negative group).

# *Blood pressure response to sustained handgrip* was present in a little number 6 patients, 4 in positive neuropathy group with percent (22.2% of positive group) and 2 in negative neuropathy group with percent (16.7% of negative group).

## The correlation between the age and different ventilatory functions before and after exercise (table 4)

As shown in this table, the age was negatively correlated to the predicted values of FVC, $FEV_1$, $FEV_1/FVC$, $FEF_{25-75\%}$ and MVV and the correlation coefficient ($r^2$) were - 0.541, 0.642, -0.798, - 0.790 and - 0.550 in the same order.

*The p-value was significant for the predicted values of all functions it was <0.05 meaning that with advancement of age all the predicted values of all functions decreased to different levels.

As regard to each function and the percent of predicted values before and after exercise the correlation coefficient (r) for FVC were 0.113 pre-exercise & 0.169 post-exercise, for $FEV_1$ were 0.123 before-exercise & 0.170 after-exercise, for $FEV_1/FVC$ were 0.049 before-exercise & 0.145 after-exercise, for $FEF_{25-75\%}$ were 0.027 before-exercise & 0.194 after-exercise, and for MVV were -0.291 before-exercise & -0.239 after-exercise.

*P-value for all functions decreased toward the significant side after exercise than before exercise but still statistically non-significant for all functions they were >0.05 .

## Correlation between B.M.I. and different ventilatory functions before and after exercises (Table 5).

The B.M.I. was negatively correlated to the predicted values of FVC, $FEV_1$, $FEF_{25-75\%}$ and MVV. The correlation coefficient ($r^2$) were -0.433, -0.422, -0.371 and -0.389 for these function in the same order.

*The p-value was significant for all these 4 function they were < 0.05.

The predicted value of $FEV_1/FVC$ was not correlated with B.M.I., as the correlation coefficient was 0.009 and the p-value non-significant value > 0.05.

As regard to the percent of predicted values before and after exercise, The correlation coefficient ($r^2$) for FVC before exercise was 0.081 and after exercise was 0.057, for $FEV_1$ were -0.039 before-exercise & 0.111 after-exercise, for $FEV_1/FVC$ were 0.091 before-exercise & 0.057 after-exercise, for $FEF_{25-75\%}$ were -0.047 before-exercise & 0.181 after-exercise and for MVV were 0.018 before-exercise & 0.167 after-exercise.

*P-value for $FEV_1$, $FEF_{25-75\ \%}$ and MVV decreased after-exercise toward the significant side than before-exercise but still statistically non-significant the values were >0.05.

While in case of FVC and $FEV_1/FVC$ the values were not decreased after-exercise. All were >0.05 non- significant.

**Statistical analysis of obese and non-obese diabetic patients in relation to ventilatory functions before and after exercise ("Table 6" & "figure 2, 3").**

This table shows the mean and standard deviation (M ± SD) of each group for each ventilatory function, predicted values and percent of predicted values before and after exercise and their P-values.

For obese group (M ± S.D.) of all the predicted values were as follows:

The (M ± S.D.) of predicted value of FVC was 2.95 ± 0.51, for $FEV_1$ was 2.45 ± 0.43, for $FEV_1/FVC$ was 82.38 ± 2.56, for $FEF_{25-75\%}$ was 2.75 ± 0.52 and for MVV was 89.12 ± 12.54

For non-obese group (M ± S.D.) of all the predicted values were as follows:

The (M ± S.D.) of predicted value of FVC was 3.39 ± 0.72, for $FEV_1$ was 2.77 ± 0.60, for $FEV_1$/FVC was 81.64 ± 2.34, for $FEF_{25-75\%}$ was 3.03 ± 0.62 and for MVV was 102.22 ± 25.30

As regard to the percent of predicted values before and after exercise, there was a significant relation in case of $FEV_1$ as the (M ± SD) before and after-exercise in obese group were 55.50 ± 18.69 before-exercise & 59.13 ± 18.05 after-exercise and for non-obese were 70.18 ± 17.74 before-exercise & 73.09 ± 15.22 after-exercise.

*P-value before exercise for both groups were <0.05 and after exercise <0.05 which both were significant. **(Figure 2)**

Also for $FEF_{25-75\%}$ the (M ± S.D) before and after-exercise:

-In the obese group (M ± S.D.) was 80.00 ± 53.79 before-exercise and become 69.13 ± 30.15 after-exercise.

- In the non-obese group (M ± S.D.) was 89.77 ± 38.98 before-exercise and become 92.14 ± 34.74 after-exercise.

* P-value before and after-exercise were <0.05 which were both significant were <0.05 which were both significant. **(Figure 3)**

For obese group (M ± S.D.) of FVC before-exercise 62.61 ± 31.57 and 54.75 ± 15.25 after-exercise, for $FEV_1$/FVC before-exercise 104.63 ± 29.94 and after-exercise 110.87 ± 8.13 and for MVV before-exercise 46.62 ± 20.78 and 52.13 ± 22.10 after-exercise.

For non-obese group (M ± S.D.) of FVC before-exercise 64.64 ± 21.41 and 65.32 ± 13.81 after-exercise, for $FEV_1$/FVC before-exercise 111.45 ± 14.83 and after-exercise 112.68 ± 12.77 and for MVV before-exercise 56.09 ± 26.03 and 54.68 ± 27.34 after-exercise.

* P-value for FVC, $FEV_1$/FVC and MVV were > 0.05 non-significant value.

**The correlation between the duration of diabetes mellitus and different ventilatory functions before and after-exercise (Table 7).**

The duration of diabetes was negatively correlated with the predicted values of all functions with correlation coefficient ($r^2$) = -0.108 for FVC, -0.147 for $FEV_1$, -0.313 for $FEV_1$/FVC, 0.271 for $FEF_{25-75\%}$ and -0.104 for MVV. All are non-significant correlation as the P- value were >0.05 for all function.

The percent of predicted values before and after exercise of all functions were 0.273 & 0.136 for FVC, 0.100 & 0.101 for $FEV_1$, -0.235 & 0.060 for $FEV_1$/FVC, -0.245 & 0.084 for $FEF_{25-75\%}$ and -0.062 & 0.023 for MVV.

*P-value for all functions were >0.05 non-significant.

**The changes of the different ventilatory functions in relation to presence and absence of autonomic neuropathy before and after-exercise (Table 8).**

As shown in the table 8 the autonomic neuropathy negative number was 12 patients & autonomic neuropathy positive was 18 patients and (M ± SD) of the predicted values of all functions were as follows:

- For FVC the M ± SD for negative group was 3.23 ± 0.64 and positive group 3.30 ± 0.74 with P-value > 0.05 non-significant value.
- For $FEV_1$ (M ± S.D.) was 2.65 ± 0.54 in negative neuropathy group and 2.71 ± 0.61 in positive neuropathy group.
- For $FEV_1$/FVC (M ± S.D.) was 81.83 ± 2.89 in negative neuropathy group and 81.83 ± 2.07 in positive neuropathy group.
- For $FEF_{25-75\%}$ (M ± S.D.) was 2.97 ± 0.62 in negative neuropathy group and 2.94 ± 0.60 in positive neuropathy group.

- For MVV (M ± S.D.) was 96.68 ± 20.83 in negative neuropathy group and 100.09 ± 25.08 in positive neuropathy group.

*# In negative neuropathy group.*

* The percent of predicted values before and after-exercise for all functions as follows: -

- FVC (M ± S.D.) was 67.58 ± 29.03 before-exercise and 61.08 ± 12.47 after-exercise.
- $FEV_1$ (M ± S.D.) was 64.00 ± 14.57 before-exercise and 69.00 ± 15.69 after-exercise.
- $FEV_1/FVC$ (M ± S.D.) was 106.58 ± 2.89 before-exercise and 112.92 ± 8.38 after-exercise.
- $FEF_{25-75\%}$ (M ± S.D.) was 96.33 ± 54.19 before-exercise and 87.33 ± 38.41 after-exercise.
- MVV (M ± S.D.) was 52.33 ± 22.58 before-exercise and 53.08 ± 26.04 after-exercise.

*# In positive neuropathy group.*

* The percent of predicted values before and after-exercise for all functions as follows: -

- FVC (M ± S.D.) was 61.78 ± 20.45 before-exercise and 43.44 ± 16.34 after-exercise.
- $FEV_1$ (M ± S.D.) was 67.78 ± 21.53 before-exercise and 69.61 ± 18.12 after-exercise.
- $FEV_1/FVC$ (M ± S.D.) was 111.67 ± 11.88 before-exercise and 111.72 ± 13.56 after-exercise
- $FEF_{25-75\%}$ (M ± S.D.) was 81.06 ± 33.20 before-exercise and 85.11 ± 33.03 after-exercise.
- MVV (M ± S.D.) was 54.39 ± 26.73 before-exercise and 54.61 ± 26.21 after-exercise.

*The p – values of the percent of predicted values before and after exercise for FVC, $FEV_1/FVC$, $FEF_{25-75\%}$ and MVV were >0.05 all these values are non-significant.

**Statistical comparison of ventilatory functions according to severity of autonomic neuropathy before and after-exercise ("Table 9" & " figure 4").**

As shown the autonomic neuropathy positive group was classified into early, definite and severs subgroups. The numbers of patients were 4, 8 and 6 in the same order.

The (M ± SD) of all predicted values of ventilatory functions were as follows: -

# For FVC

It was 3.48 ± 0.49 for early neuropathy, 3.25 ± 0.95 for definit neuropathy and 3.25 ± 0.66 for sever neuropathy.

# For $FEV_1$

It was 2.86 ± 0.39 for early neuropathy, 2.66 ± 0.78 for definit neuropathy and 2.70 ± 0.53 for sever neuropathy.

# For $FEV_1/FVC$

It was 81.50 ± 2.08 for early neuropathy, 81.38 ± 1.60 for definit neuropathy and 82.67 ± 2.66 for sever neuropathy.

# For $FEF_{25-75\%}$

It was 3.37 ± 0.38 for early neuropathy, 2.85 ± 0.76 for definit neuropathy and 2.96 ± 0.55 for sever neuropathy.

# For MVV

It was 100.50 ± 10.99 for early neuropathy, 100.43 ± 33.76 for definit neuropathy and 99.38 ± 21.68 for sever neuropathy.

* P-value >0.05 non-significant for all functions.

- As regard to percent of predicted for the 3 groups before and after- exercise change variably in the all functions.

* For example for $FEV_1/FVC$: -

- In early neuropathy, they were 115.25 ± 9.98 before exercise and 108.25 ± 16.66 after-exercise.
- In definit neuropathy, they were 100.13 ± 12.12 before exercise and 108.38 ± 15.97 after-exercise.
- In sever neuropathy, they were 111.33 ± 14.15 before exercise and 118.50 ± 5.32 after-exercise.

* For the other 4 functions (M ± S.D.) showed variable change to either side.

*Also the p-values of the percent of predicted before and after exercise of all ventilatory functions slightly changed to either side except in $FEV_1/FVC$ decreased more after exercise but still statistically non-significant P-value >0.05 .

**Statistical analysis of fasting blood glucose in autonomic and non-autonomic neuropathy patients before and after-exercise ("Table 10" & "figure 5").**

With autonomic neuropathy group the (M ± SD) before exercise was 173.2 ±49.3 and decreased after exercise to 165.4 ± 43.0 while with non-autonomic neuropathy group (the control group) before exercise was 211.0 ± 105.9 and also decreased after exercise to be 205.4 ± 92.2 .

This decrease in blood glucose level was not so marked to become statistically significant as the repeated measure analysis of variants (ANOVA) shows non-significant change to time effect either before or after exercise (p-value >0.05), or to group variant in both positive or negative neuropathy (p-value >0.05).

**Correlation between blood glucose level and age of the patients with or without D.A.N. before and after exercises (Table11a).**

This table shows the correlation coefficient was in negative neuropathy group -0.60 before exercise and -0.32after exercise

while in the positive group was 0.08 before exercise and 0.70 after exercise.
*P-value of all of them was non-significant > 0.05 so there is no change in any D.A.N. groups.

**Statistical analysis of blood glucose in age below and above 45 years before and after-exercise ("Table 11b" & "figure 6").**

Below 45 years the M ± SD fasting blood glucose before exercise was 224.6 ± 130.2 and decreased after exercise into 206.1 ± 114.2.

Above 45 years the M ± SD blood glucose before exercise was 177.3 ± 52.7 and after exercise decreased to 173.9 ± 49.0.

The repeated measure analysis for variants shows significant correlation with advancement of age after exercise (P-value <0.05) but there was an insignificant correlation with any specific age group (P-value >0.05).

*So there was significant correlation between blood glucose after exercise in relation to age.

**Correlation of blood glucose level and obesity before and after exercises (Table 12a).**

This table shows the correlation coefficient was in negative neuropathy group -0.55 before exercise and -0.45after exercise while in the positive group was -0.19 before exercise and -0.30 after exercise.
*P-value of all of them were non-significant > 0.05.

**Statistical analysis of between blood glucose in obese and non-obese groups before and after exercise ("Table 12b" & "figure 7").**

In obese group the M ± SD was before exercise 147.5 ± 45.6 and increased after exercise to 155.5 ± 51.2 while in non – obese

group the M ± SD was 203.2 ± 82.3 and decreased after exercise to 190.8 ± 71.8.

The repeated measure analysis of variant in relation to time factor was non-significant correlation (P-value was 0.58) but it was significantly correlated to group effect (P-value <0.05) which meaning that there was interaction among different group where it decreased after exercise in non-obese patients and increase after exercise in obese patients.

**Correlation of blood glucose level and duration of diabetes before and after exercises ("Table 13a", "Figure 8").**

This table shows the correlation coefficient was in negative neuropathy group -0.05 before exercise and -0.35 after exercise while in the positive group was 0.32 before exercise and 0.52 after exercise.

*P-value is significant <0.05 in positive group after exercise meaning that with D.A.N. the blood glucose level decrease after exercise.

**Statistical analysis of blood glucose in-group of patients below and above 7 years of diabetes before and after exercise ("Table 13b" & "figure 9").**

The (M ± SD) of fasting blood glucose in the group with diabetes below 7 years before exercise was 194.7 ± 96.8 and after exercise decreased to 184.5 ± 86.1 while in group above 7 years diabetes the M ± SD before exercise was 182.8 ± 58.8 and decreased after exercise to 178.7 ± 51.7.

The repeated measure analysis of variant shows significant correlation after exercise with the duration of diabetes mellitus P-value <0.05 but it was non-significant with any specific group P-value >0.05.

## Table ( 1 ) : -

**Clinical data of the diabetic patients.**

| | Age "years" | B.M.I | Duration Of D.M. "years" | Fasting BL.G. "mg/dl" | 2h.P.P. BL.G. "mg/dl" |
|---|---|---|---|---|---|
| Range | 40-60 | 23.7 - 41.2 | 1 – 18 | 130 - 246 | 160 - 340 |
| Mean | 51.8 | 33.1 | 7.3 | 191.4 | 255.2 |
| S.D. | 7.9 | 6.4 | 3.3 | 61.9 | 88.4 |

Bl.G. = Blood glucose.
B.M.I. = Body mass index.
D.M. = Diabetes mellitus.
2h. P.P. = 2 hours postprandial.
S.D. =Standard deviation.

## Table ( 2 ) : -

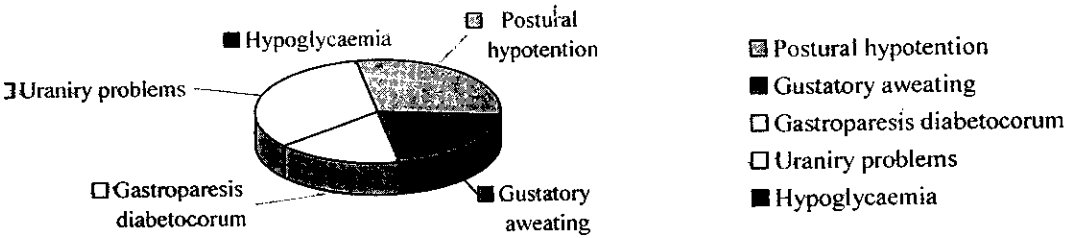
Number and percent of symptoms in relation to autonomic neuropathy.

| | | Postural hypotension | | Gustatory sweating | | Gastroparesis diabetocorum | | Uranity problems | | Hypoglycaemia | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Absent | Present | Absent | Present | Absent | Present | Absent | Present | Absent | Present |
| Negative D.A.N. patients (No=12) | No. | 5 | 7 | 7 | 5 | 8 | 4 | 4 | 8 | 12 | - |
| | % | 41.7 | 58.3 | 58.3 | 41.7 | 66.7 | 33.3 | 33.3 | 66.7 | 100 | - |
| Positive D.A.N. patients (No=18) | No. | 8 | 10 | 7 | 11 | 7 | 11 | 8 | 10 | 14 | 4 |
| | % | 44.4 | 55.6 | 38.9 | 61.1 | 38.9 | 61.6 | 44.4 | 55.6 | 77.8 | 22.2 |

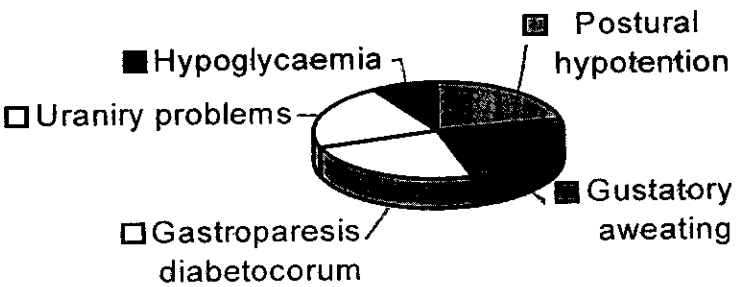
**D.A.N** **Diabetic autonomic neuropathy.**
**No.** **Number**
**%** **Percent**

## Fig.(1): Number and percent of symptoms on relation to autonomic neuropathy

### "Negative D.A.N. patients"




### "Positive D.A.N. patients"



## Table ( 3 ) : -

Number and percent of presence of different tests done for autonomic neuropathy.

| | | Heart rate response to deep breathing | | Heart rate response to standing up | | Heart rate response to Valsalva maneuver | | Blood pressure response to standing up | | Blood pressure response to sustained handgrip | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Absent | Present | Absent | Present | Absent | Present | Absent | Present | Absent | Present |
| Negative D.A.N. Patients (No=12) | No. | 9 | 3 | 9 | 3 | 9 | 3 | 11 | 1 | 10 | 2 |
| | % | 75 | 25 | 75 | 25 | 75 | 25 | 91.7 | 8.3 | 83.3 | 16.7 |
| **Positive D.A.N. Patients (No=18)** | **No.** | **10** | **8** | **15** | **3** | **10** | **8** | **16** | **2** | **14** | **4** |
| | **%** | **55.6** | **44.4** | **83.3** | **16.7** | **55.6** | **44.4** | **88.9** | **11.1** | **77.8** | **22.2** |

**D.A.N** **Diabetic autonomic neuropathy.**
**No.** **Number**
**%** **Percent.**

## Table ( 4 ) : -

### Correlation of age and different ventilatory functions before and after exercise.

| | FVC | | | $FEV_1$ | | | $FEV_1$ / FVC | | | $FEF_{25-75\%}$ | | | MVV | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | |
| | | Before exercise | after exercise | | Before exercise | after exercise | | before exercise | After exercise | | Before exercise | after exercise | | before exercise | after exercise |
| Correlation coefficient ($r^2$) | -0.541 | 0.113 | 0.169 | - 0.642 | 0.123 | 0.170 | - 0.798 | 0.049 | 0.145 | - 0.790 | 0.027 | 0.194 | - 0.550 | - 0.291 | - 0.239 |
| P-value | <0.05 | >0.05 | >0.05 | <0.05 | >0.05 | >0.05 | <0.05 | >0.05 | >0.05 | <0.05 | >0.05 | >0.05 | <0.05 | >0.05 | >0.05 |
| Significance | S. | N.S. | N.S. | S. | N.S. | N.S. | S. | N.S. | N.S. | S. | N.S. | N.S. | S. | N.S. | N.S. |

**P- value**

* **P > 0.05 is non-significant (N.S.).**
* **P < 0.05 is significant (S.).**

## Table ( 5 ) : -

Correlation between B.M.I. and different ventilatory functions before and after exercise.

| | FVC | | | $FEV_1$ | | | $FEV_1$ / FVC | | | $FEF_{25-75\%}$ | | | MVV | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | |
| | | Before exercise | After exercise | | Before exercise | after exercise | | before exercise | After exercise | | Before exercise | after exercise | | before exercise | after exercise |
| Correlation coefficient ($r^2$) | - 0.433 | 0.081 | - 0.057 | - 0.422 | - 0.039 | - 0.112 | 0.009 | - 0.091 | - 0.057 | - 0.371 | - 0.047 | - 0.181 | - 0.389 | - 0.018 | 0.167 |
| P-value | <0.05 | >0.05 | >0.05 | <0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | <0.05 | >0.05 | >0.05 | <0.05 | >0.05 | >0.05 |
| Significance | S. | N.S. | N.S. | S. | N.S. | N.S. | N.S. | N.S. | N.S. | S. | N.S. | N.S. | S. | N.S. | N.S. |

**P-value**

* **P > 0.05 is non-significant (N.S.).**
* **P < 0.05 is significant (S.).**

## Table ( 6 ) : -

**Statistical analysis of ventilatory functions in obese and non-obese diabetic patients in relation to exercise:**

| | FVC "M ± S.D" | | | $FEV_1$ "M ± S.D" | | | $FEV_1$ / FVC "M ± S.D" | | | $FEF_{25-75\%}$ "M ± S.D" | | | MVV "M ± S.D" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % of Predicted | | | % of Predicted | | | % of Predicted | | | % of Predicted | | | % of Predicted | |
| | Predicted | Before exercise | After exercise | Predicted | Before exercise | after exercise | Predicted | Before exercise | After exercise | Predicted | before exercise | after exercise | Predicted | before exercise | after exercise |
| Obese diabetic patients | 2.95 ± 0.51 | 62.61 ± 31.57 | 54.75 ± 15.25 | 2.45 ± 0.43 | 55.50 ± 18.69 | 59.132 ± 18.05 | 82.38 ± 2.56 | 104.63 ± 29.94 | 110.87 ± 8.13 | 2.75 ± 0.52 | 80.00 ± 53.79 | 69.13 ± 30.15 | 89.12 ± 12.54 | 46.62 ± 20.78 | 52.13 ± 22..10 |
| Non-Obese diabetic patients | 3.39 ± 0.72 | 64.64 ± 21.41 | 65.32 ± 13.81 | 2.77 ± 0.60 | 70.18 ± 17.74 | 73.09 ± 15.22 | 81.64 ± 2.34 | 111.45 ± 14.83 | 112.68 ± 12.77 | 3.03 ± 0.62 | 89.77 ± 38.98 | 92.14 ± 34.74 | 102.22 ± 25.30 | 56.09 ± 26.03 | 54.68 ± 27.34 |
| P-value | >0.05 | >0.05 | >0.05 | >0.05 | <0.05 | <0.05 | >0.05 | >0.05 | >0.05 | >0.05 | <0.05 | <0.05 | >0.05 | >0.05 | >0.05 |
| Significance | N.S. | N.S. | N.S. | N.S. | *S. | *S. | N.S. | N.S. | N.S. | N.S. | *S. | *S. | N.S. | N.S. | N.S. |

M = Mean
S.D. = Standard deviation.

**P-value**

P < 0.05 is significant (S.).
P > 0.05 is non-significant (N.S).

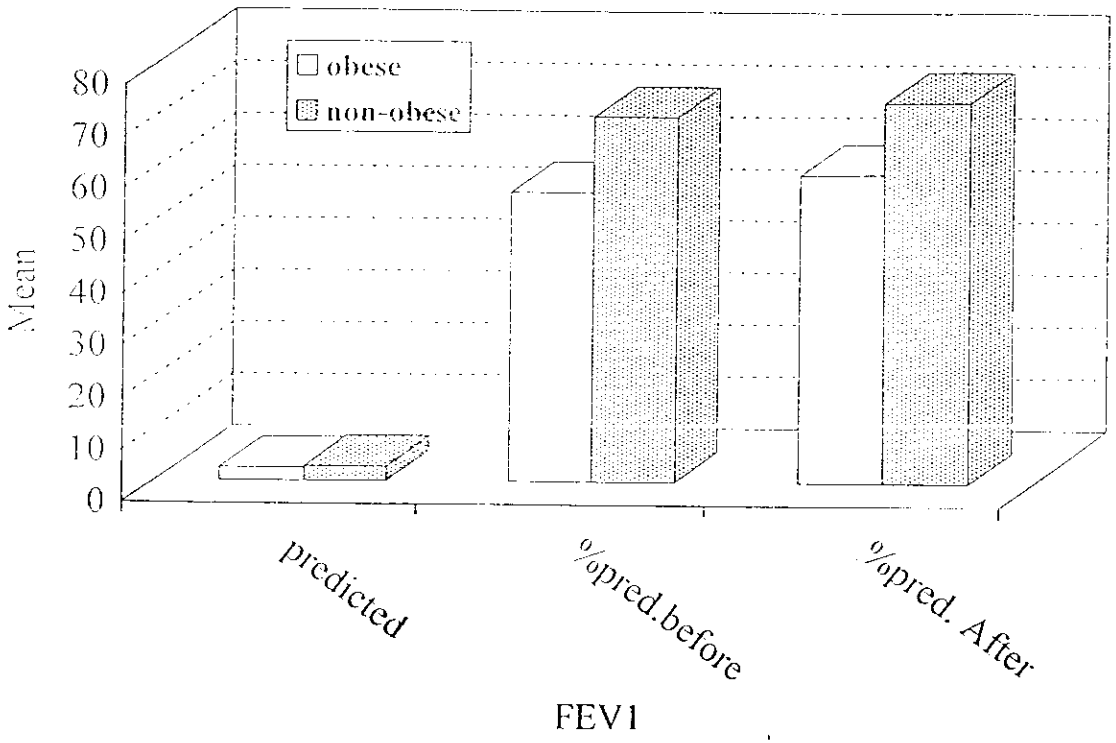



**Fig (2) Study of FEV1 according to B.M.I. in obese and non-obese patients before and after exercise**

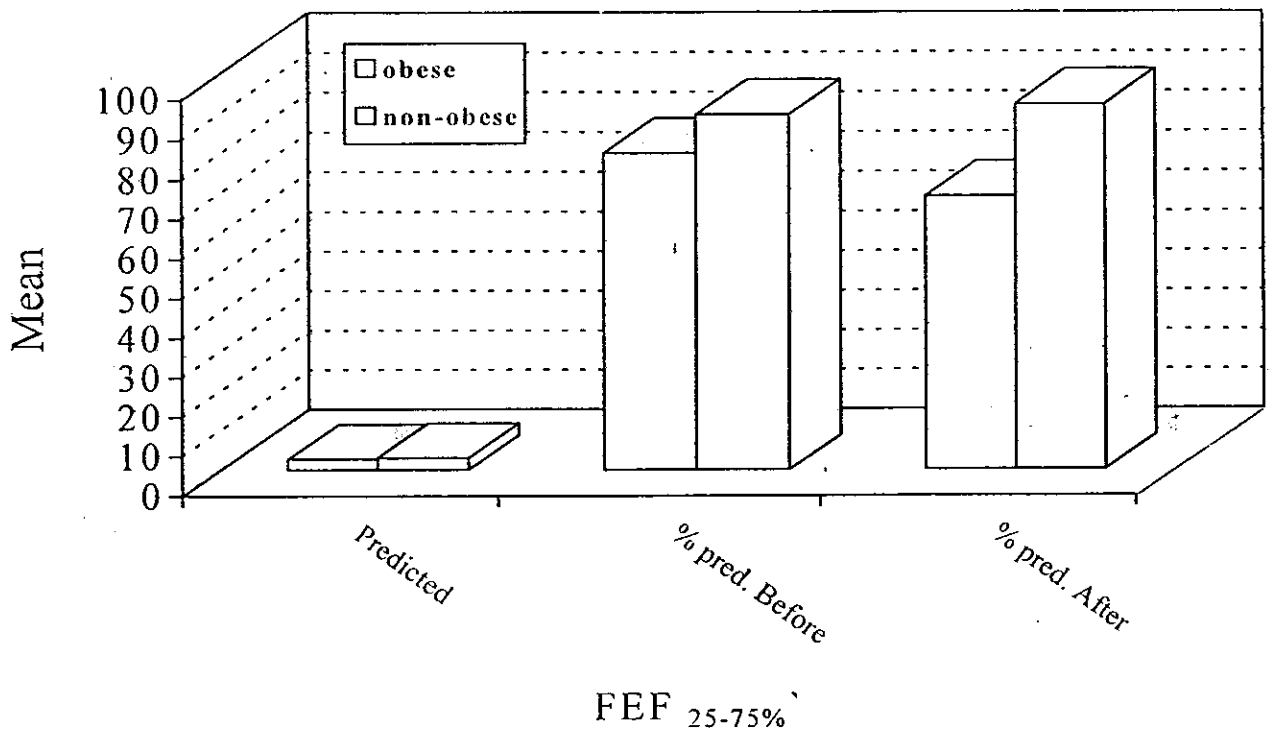



**Fig. (3) Study of $FEF_{25-75\%}$ according to B.M.I. in obese and non-obese patients before and after exercise**

## Table ( 7 ) : -

Correlation between duration of diabetes mellitus with different ventilatory functions before and after exercise.

| | FVC | | | $FEV_1$ | | | $FEV_1$ / FVC | | | $FEF_{25-75\%}$ | | | MVV | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | | Predicted | % of Predicted | |
| | | Before exercise | after exercise | | Before exercise | after exercise | | Before exercise | After exercise | | Before exercise | after exercise | | before exercise | after exercise |
| Correlation coefficient ($r^2$) | - 0.108 | 0.273 | 0.136 | - 0.147 | 0.100 | 0.101 | - 0.313 | - 0.235 | - 0.060 | - 0.271 | - 0.245 | 0.084 | - 0.104 | - 0.062 | 0.023 |
| P-value | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 |
| Significant | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |

**P-value**

**P < 0.05 is significant (S.).**

**P > 0.05 is non-significant (N.S).**

## Table ( 8 ) : -

**Statistical analysis of ventilatory functions according to presence of autonomic neuropathy before and after exercise.**

| | FVC "M ± S.D" | | | $FEV_1$ "M ± S.D" | | | $FEV_1$ / FVC "M ± S.D" | | | $FEF_{25-75\%}$ "M ± S.D" | | | MVV "M ± S.D" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % of Predicted | | | % of Predicted | | | % of Predicted | | | % of Predicted | | | % of Predicted | |
| | Predicted | Before exercise | after exercise | Predicted | Before exercise | after exercise | Predicted | Before exercise | After exercise | Predicted | before exercise | after exercise | Predicted | before exercise | after exercise |
| Negative D.A.N. patients (No=12) | 3.23 ± 0.64 | 67.58 ± 29.03 | 61.08 ± 12.47 | 2.65 ± 0.54 | 64.00 ± 14.57 | 69.00 ± 15.69 | 81.83 ± 2.89 | 106.58 ± 2.89 | 112.92 ± 8.38 | 2.97 ± 0.62 | 96.33 ± 54.19 | 87.33 ± 38.41 | 96.68 ± 20.83 | 52.33 ± 22.58 | 53.08 ± 26.04 |
| Positive D.A.N. patients (No=18) | 3.30 ± 0.74 | 61.78 ± 20.45 | 43.44 ± 16.34 | 2.71 ± 0.61 | 67.78 ± 21.53 | 69.61 ± 18.12 | 81.83 ± 2.07 | 111.67 ± 11.88 | 111.72 ± 13.56 | 2.94 ± 0.60 | 81.06 ± 33.20 | 85.11 ± 33.03 | 100.09 ± 25.08 | 54.39 ± 26.73 | 54.61 ± 26.21 |
| P-value | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 | >0.05 |
| Significant | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |

**P-value**

**P < 0.05 is significant (S.).**

**P > 0.05 is non-significant (N.S).**

## Table ( 9 ) : -

**Statistical comparison of ventilatory functions according to severity of autonomic neuropathy before and after exercise.**

| | FVC "M ± S.D" | | | $FEV_1$ "M ± S.D" | | | $FEV_1$ / FVC "M ± S.D" | | | $FEF_{25-75\%}$ "M ± S.D" | | | MVV "M ± S.D" | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % of Predicted | | | % of Predicted | | | % of Predicted | | | % of Predicted | | | % of Predicted | |
| | Predicted | Before exercise | after exercise | Predicted | before exercise | After exercise | Predicted | Before exercise | after exercise | Predicted | before exercise | after exercise | Predicted | before exercise | after exercise |
| Early autonomic neuropathy ( No. 4 ) | 3.48 ± 0.49 | 48.50 ± 24.45 | 59.50 ± 16.76 | 2.86 ± 0.39 | 55.50 ± 28.41 | 64.50 ± 21.30 | 81.50 ± 2.08 | 115.25 ± 9.98 | 108.25 ± 16.66 | 3.307 ± 0.38 | 86.00 ± 39.29 | 85.50 ± 40.27 | 100.50 ± 10.99 | 55.75 ± 39..37 | 58.00 ± 36.60 |
| **Definite Autonomic neuropathy ( No. 8)** | **3.25 ± 0.95** | **66.63 ± 23.01** | **66.00 ± 19.36** | **2.66 ± 0.78** | **70.50 ± 22.42** | **70.00 ± 19.29** | **81.38 ± 1.60** | **110.13 ± 12.12** | **108.38 ± 15.97** | **2.85 ± 0.76** | **78.25 ± 36.73** | **77.63 ± 36.59** | **100.43 ± 33.76** | **49.25 ± 18.20** | **53.25 ± 21.51** |
| **Sever autonomic neuropathy ( No. 6 )** | **3.25 ± 0.66** | **64.17 ± 11.70** | **62.17 ± 13.79** | **2.70 ± 0.53** | **72.33 ± 15.17** | **72.50 ± 17.10** | **82.67 ± 2.66** | **111.33 ± 14.15** | **118.50 ± 5.32** | **2.96 ± 0.55** | **81.50 ± 30.02** | **94.83 ± 21.68** | **99.38 ± 21.68** | **60.33 ± 30.79** | **54.17 ± 29.51** |
| **P-value** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** | **>0.05** |
| **Significant** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** | **N.S.** |

**P-value**

**P < 0.05 is significant (S.).**

**P > 0.05 is non-significant (N.S).**

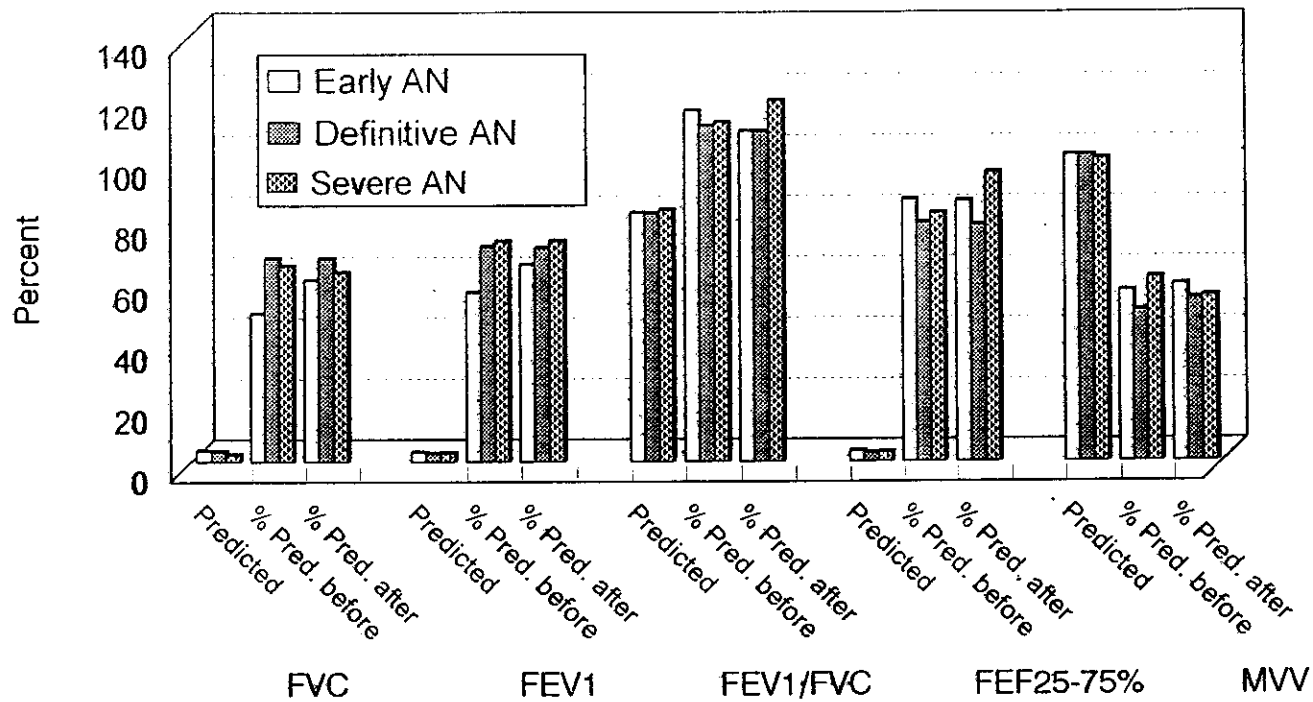



Fig. (4) Comparison of pulmonary function tests according to severity of autonomic neuropathy (AN) before and after exercise.

## Table ( 10 ) : -

**Statistical analysis of fasting blood glucose in autonomic and non-autonomic neuropathy patients before and after exercise**

| Blood glucose | Positive D.A.N. patients M ± SD (No = 18) | Negative D.A.N. patients M ± SD (No = 12) |
|---|---|---|
| Before Exercise | 173.2 ± 49.3 | 211.0 ± 105.9 |
| After Exercise | 165.4 ± 43.0 | 205.4 ± 92.2 |
| P-value | >0.05 | >0.05 |
| Significance | N.S. | N.S. |

* *Repeated measure analysis of variants:*

| Effect : | P – Value | Significance |
|---|---|---|
| Time | 0.10 | N.S. |
| Groups | 0.78 | N.S. |

**D.A.N.= Diabetic autonomic neuropathy**

**M. = Mean.**

**SD. = Standard deviation.**

**N.S. = Non significant.**

P-value

P-value < 0.05 is significant.

P-value > 0.05 is non-significant.

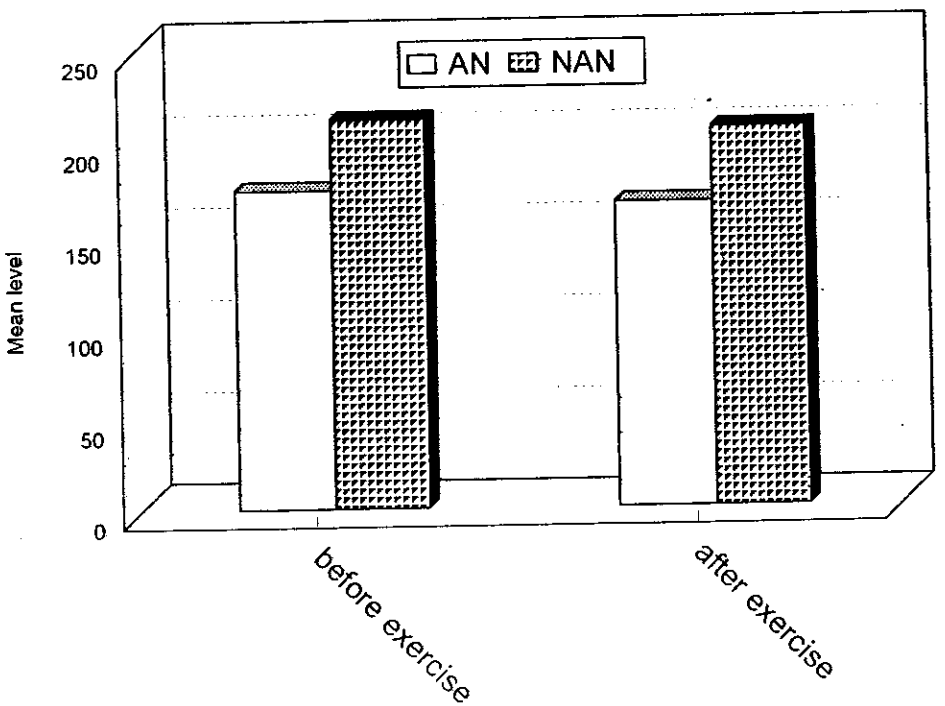



Fig. (5) Comparison of blood glucose level before and after exercise in autonomic and non-autonomic neuropathy groups.

## Table ( 11a ) : -

**Correlation of blood glucose level and age of the patients before and after-exercise.**

| | Negative D.A.N. Patients | | Positive D.A.N. Patients | |
|---|---|---|---|---|
| | Before exercise | After exercise | Before exercise | After exercise |
| Correlation Coefficient ($r^2$) | -0.60 | -0.32 | 0.08 | 0.70 |
| P-value | >0.05 | >0.05 | >0.05 | >0.05 |
| Significance | N.S. | N.S | N.S | N.S |

## Table ( 11b ) : -

**Comparison between blood glucose before and after exercise in age groups below and above 45 years.**

| Blood glucose | Age below 45 y. M ± SD | Age above 45 y. M ± SD |
|---|---|---|
| Before Exercise | 224.57 ± 130.21 | 177.30 ± 52.71 |
| After Exercise | 206.14 ± 114.15 | 173.87 ± 49.01 |

* *Repeated measure analysis of variants:*

| Effect : | P – Value | Significance |
|---|---|---|
| Time | <0.05 (Post-ex.) | Significant |
| Groups | >0.05 | N.S. |

P-value

Ex. = Exercise
N.S.= Non significant

*P> 0.05 is significant
*P< 0.05 is non-significant

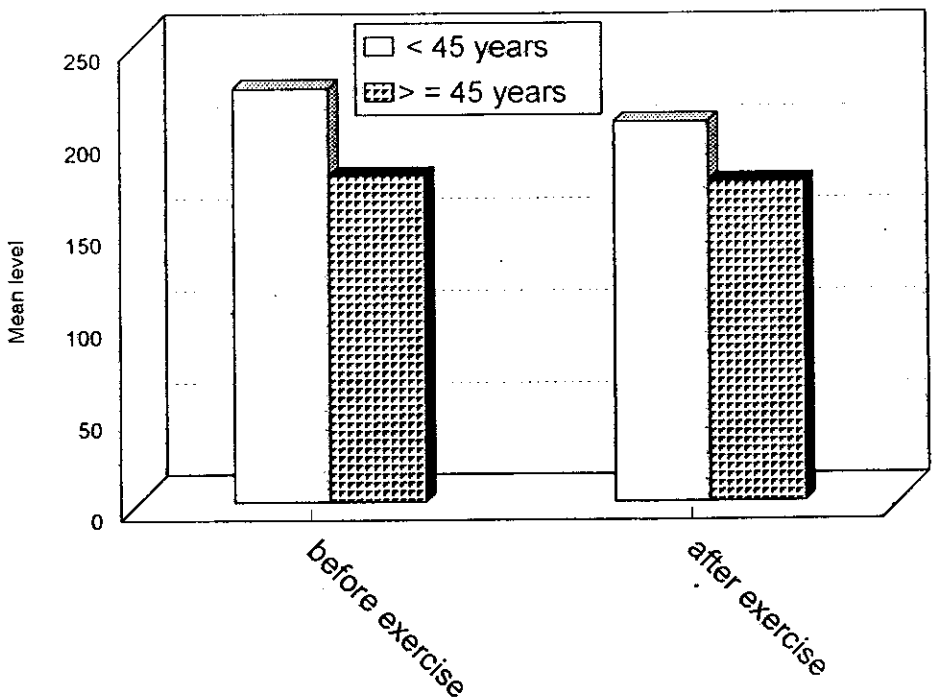



Fig. (6) Comparison of blood glucose level before and after exercise in age groups below and above 45 years

## Table ( 12a ) : -

**Correlation of blood glucose level and obesity in diabetic patients before and after-exercise.**

| | Negative D.A.N. Patients | | Positive D.A.N. Patients | |
|---|---|---|---|---|
| | Before exercise | After exercise | Before exercise | After exercise |
| Correlation Coefficient ($r^2$) | -0.55 | -0.45 | -.019 | -0.30 |
| P-value | >0.05 | >0.05 | >0.05 | >0.05 |
| Significance | N.S. | N.S. | N.S. | N.S. |

## Table ( 12b ) : -

**Comparison between blood glucose before and after exercise in obese and non-obese groups.**

| Blood glucose | Obese | Non obese |
|---|---|---|
| Before Exercise | 147.5 ± 45.6 | 203.2 ± 82.3 |
| After Exercise | 155.5 ± 51.2 | 190.8 ± 71.8 |

* *Repeated measure analysis of variants:*

| Effect : | P – Value | Significance |
|---|---|---|
| Time | >0.05 | N.S. |
| Groups | <0.05 | Significant |

**N.S. = Non significant**

P-value

* P-value < 0.05 is significant

*P< 0.05 is non-significant

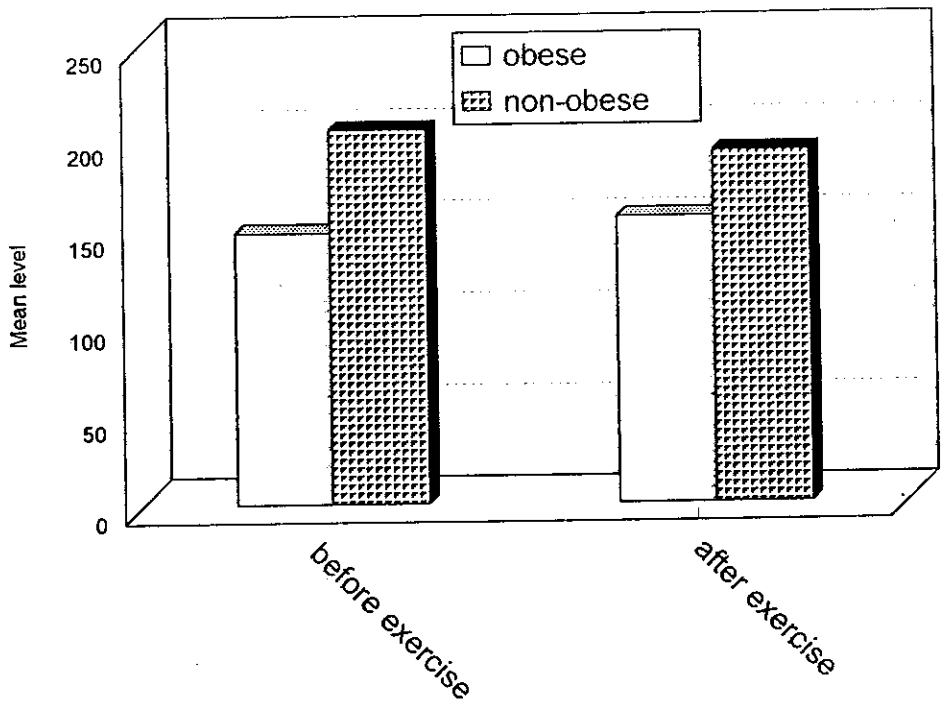



Fig. (7) Comparison of blood glucose level before and after exercise in obese and non-obese groups

## Table ( 13a ) : -

**Correlation of blood glucose level and duration of diabetes before and after-exercise.**

| | Negative D.A.N. Patients | | Positive D.A.N. Patients | |
|---|---|---|---|---|
| | Before exercise | After exercise | Before exercise | After exercise |
| Correlation Coefficient ($r^2$) | -0.05 | -0.35 | 0.32 | 0.52 |
| P-value | >0.05 | >0.05 | >0.05 | <0.05 |
| Significance | N.S. | N.S. | N.S. | N.S. |

## Table ( 13b ) : -

**Comparison between blood glucose in groups of patients below and above 7 years duration of diabetes before and after exercise.**

| Blood glucose | Duration < 7 y. M ± SD | Duration ≥ 7 y. M ± SD |
|---|---|---|
| Before Exercise | 194.71 ± 96.84 | 182.75 ± 58.79 |
| After Exercise | 184.50 ± 86.05 | 178.69 ± 51.71 |

* *Repeated measure analysis of variants:*

| Effect : | P – Value | Significance |
|---|---|---|
| Time | <0.05 | Significant |
| Groups | >0.05 | N.S. |

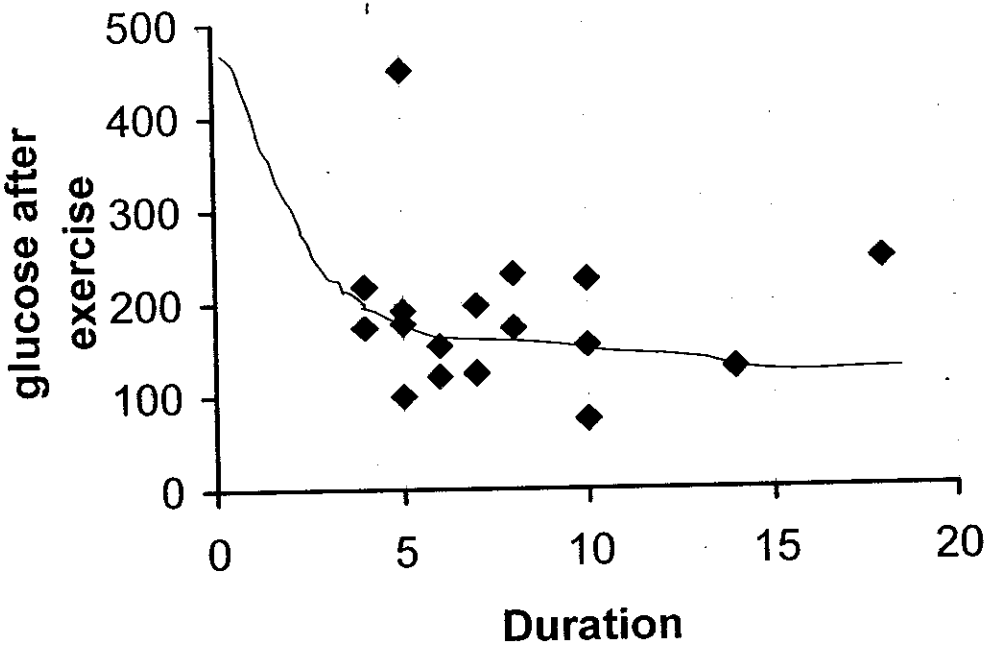
**N.S. = Non significant**

P-value

P < 0.05 is significant

P > 0.05 is non-significant

Fig.(8):Correlation of blood glucose level with the duration of diabetes before and after exercise



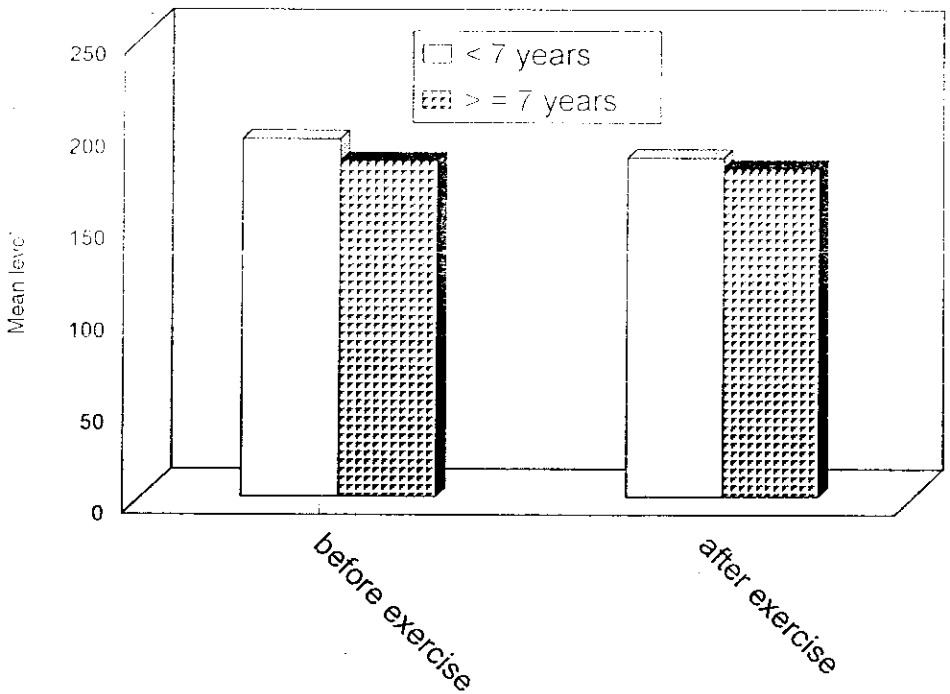



Fig. (9) Comparison of blood glucose level before and after exercise in groups according to duration of diabetes mellitus below and above 7 years