Results

Constitutionals Data

The study included 50 patients; 29 males and 21 females with a male: female ratio of 1.3:1.

Table (1): Patients' age and gender distribution among studied groups

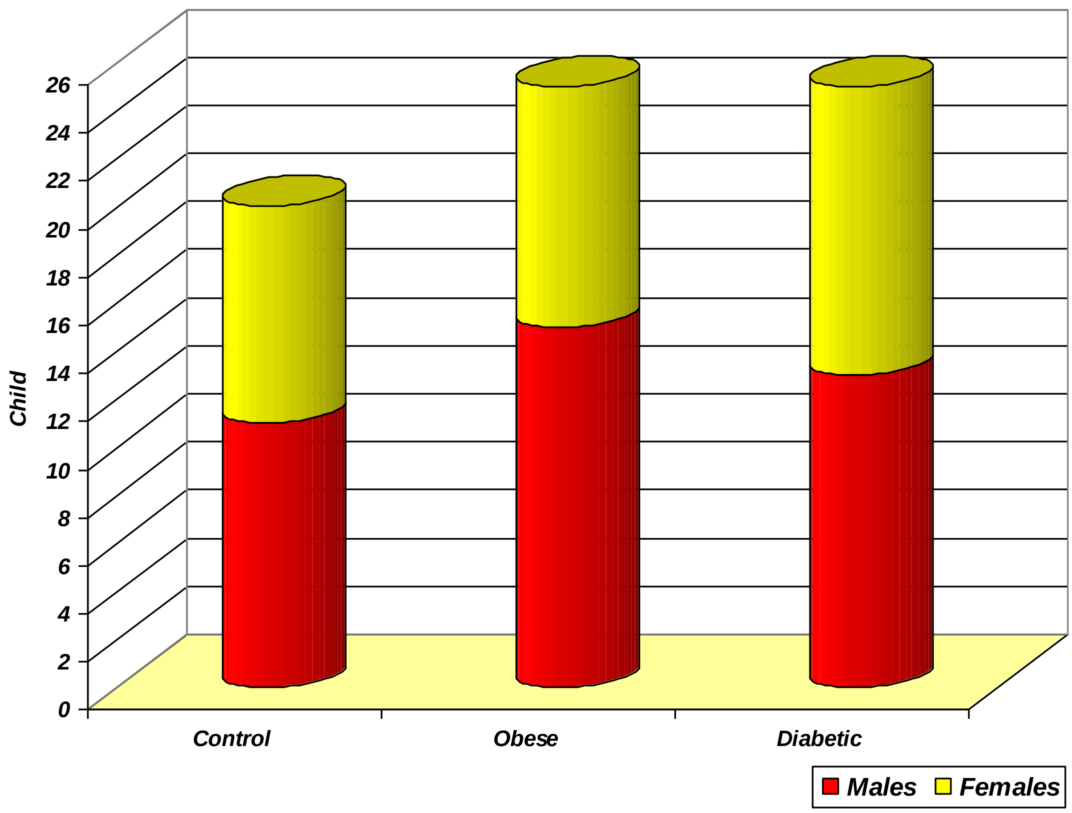
Parameter \ Group		Control	Patients		
			Obese	Diabetic	Total
Gender	Males	11 (55%)	15 (60%)	13 (52%)	28 (56%)
	Females	9 (45%)	10 (40%)	12 (48%)	22 (44%)
Age (years)		11.8±1.8	11.6±1.5	11.5±1.5	11.5±1.5

Data are presented as mean±SD & numbers; percentages are in parenthesis

There was a non-significant difference concerning gender distribution among studied groups and compared to control group, (Table 1, Fig. 2).

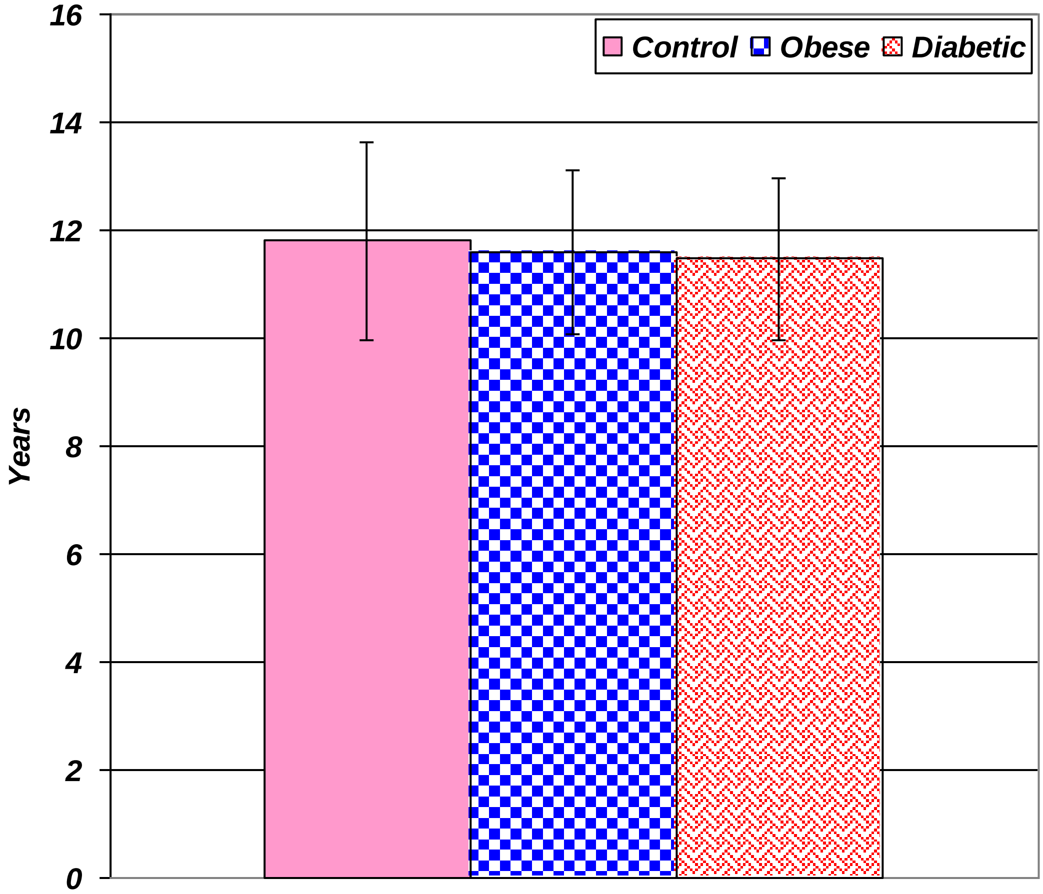
Mean age of studied patients was 11.5±1.5; range: 9-15 years with non-significant difference among studied groups, (Table 1, Fig. 3).

Fig. (2): Gender distribution of enrolled children within each group



There was a non-significant difference concerning gender distribution among studied groups and compared to control group, (Fig. 2).

Fig. (3):Mean (±SD) age of studied subjects



Mean age of studied patients was 11.5±1.5; range: 9-15 years with non-significant difference among studied groups, (Fig. 3).

Anthropometric Data

Mean body weight was significantly higher in both obese and diabetic groups compared to control group with significantly higher body weight of obese patients compared to diabetic group, (Table 2, Fig. 4).

On contrary, mean body height was non-significantly higher in both obese and diabetic groups compared to control group, with non-significantly higher body height of obese patients compared to diabetic group, (Table 2, Fig. 5).

In turn, mean body mass index was significantly higher in both obese and diabetic groups compared to control group with significantly higher BMI of obese patients compared to diabetic group, (Table 2, Fig. 6).

There were 20 (40%) overweight patients, 25 (50%) obese patients, while 2 patients (4%) were over obese and 3 patients (6%) were morbidly obese. The frequency of obese and over obese patients was non-significantly, (X^2=2.498, p>0.05) higher in obese group compared to diabetic group, (Table 3, Fig. 7).

Table (2): Body weight, height and BMI data of studied children enrolled in the studied groups

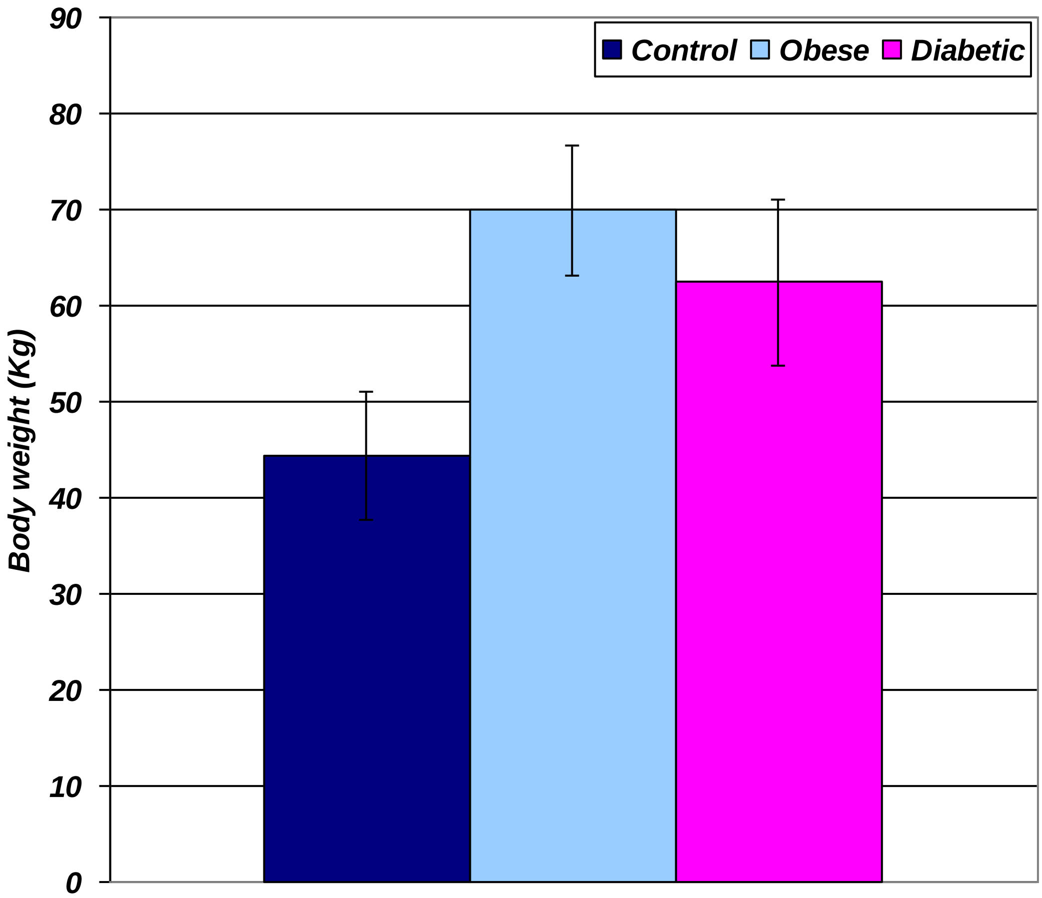
			Control	Obese	Diabetic
Weight (kg)	**Mean±SD**		**44.5±6.7**	**69.9±6.8**	**62.4±8.7**
	Range		**31-55**	**52-77**	**49-77**
	Statistical analysis	**t**		**16.140**	**7.661**
		p_1		**<0.001**	**<0.001**
		t			**3.841**
		p_2			**<0.001**
Height (cm)	**Mean±SD**		**142.1±11.3**	**148.2±11.1**	**143.2±9.8**
	Range		**119-160**	**121-162**	**119-161**
	Statistical analysis	**t**		**1.152**	**0.950**
		p_1		**>0.05**	**>0.05**
		t			**1.433**
		p_2			**>0.05**
BMI (kg/m^2)	**Mean±SD**		**21.9±1.2**	**32.1±4.2**	**30.5±3.5**
	Range		**19.6-23.8**	**28.4-44.8**	**26.4-40.3**
	Statistical analysis	**t**		**9.772**	**9.500**
		p_1		**<0.001**	**<0.001**
		t			**2.214**
		p_2			**=0.037**

Data are presented as mean±SD

p_1: significance versus control group

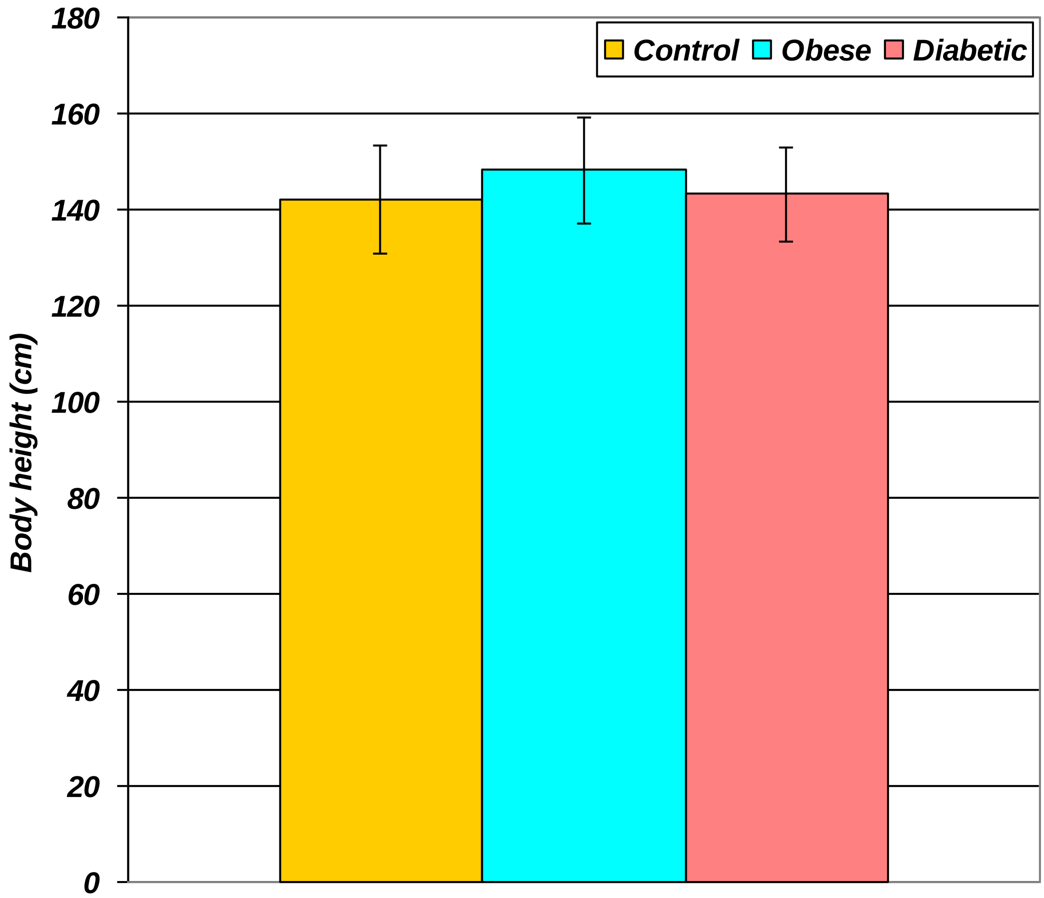
p_2: significance versus obese group

Fig. (4):Mean (±SD) body weight of studied subjects



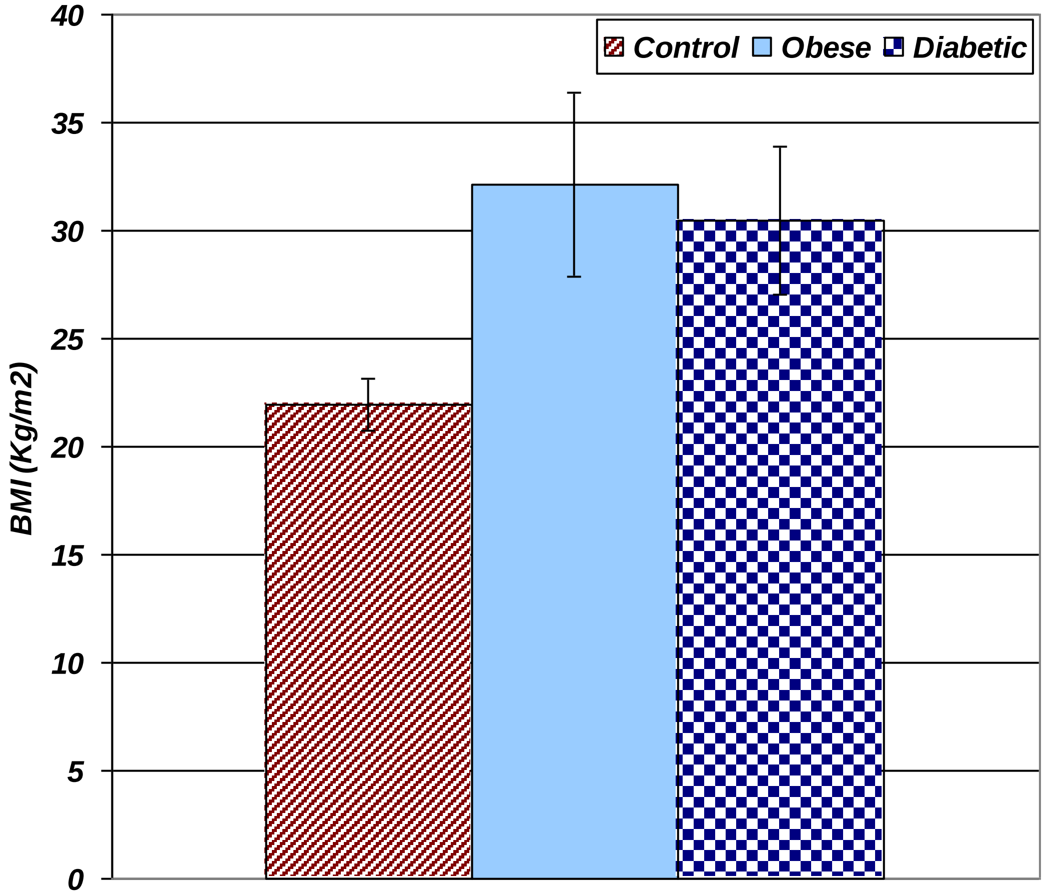
Mean body weight was significantly higher in both obese and diabetic groups compared to control group with significantly higher body weight of obese patients compared to diabetic group, (Fig. 4).

Fig. (5):Mean (±SD) body height of studied subjects



On contrary, mean body height was non-significantly higher in both obese and diabetic groups compared to control group, with non-significantly higher body height of obese patients compared to diabetic group, (Fig. 5).

Fig. (6):Mean (±SD) BMI of studied subjects

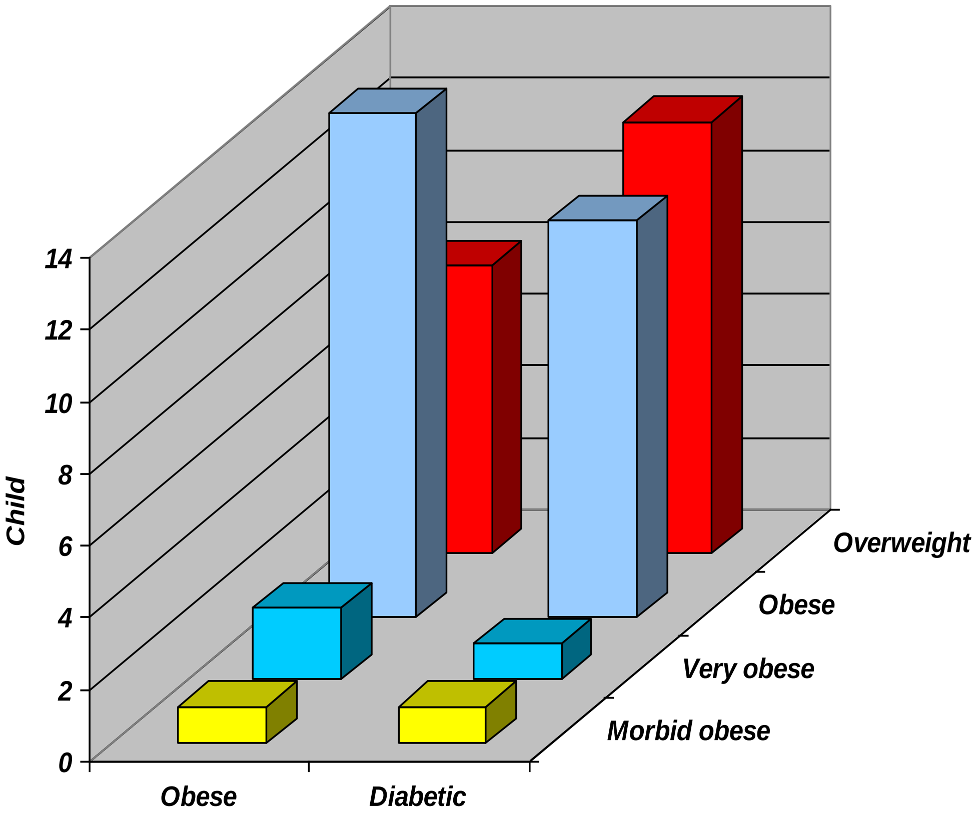


In turn, mean body mass index was significantly higher in both obese and diabetic groups compared to control group with significantly higher BMI of obese patients compared to diabetic group, (Fig. 6).

Table (3): Patients' distribution among studied groups according to obesity grades categorized according to BMI

		Patients		
	Control	**Obese**	**Diabetic**	**Total**
Normal (18.5-24.9 kg/m^2)	**20 (100%)**	**0**	**0**	**0**
Overweight (25-29.9 kg/m^2)	**0**	**8 (32%)**	**12 (48%)**	**20 (40%)**
Obese (30-34.9 kg/m^2)	**0**	**14 (56%)**	**11 (44%)**	**25 (50%)**
Very obese (35-39.9 kg/m^2)	**0**	**1 (4%)**	**1 (4%)**	**2 (4%)**
Morbid obese (>40 kg/m^2)	**0**	**2 (8%)**	**1 (4%)**	**3 (6%)**

Fig. (7): Patients' distribution according to BMI grade among obese and diabetic groups



Insulin Resistance Data

A) Blood Glucose data

Mean fasting blood glucose levels were significantly ($p<0.001$) higher in diabetic patients compared both to control and obese group with significantly higher FBG in obese patients compared to controls, (Table 4, Fig. 8).

Mean 2-h postprandial blood glucose levels were significantly ($p<0.001$) higher in diabetic patients compared both to control and obese group with significantly higher FBG in obese patients compared to controls, (Table 4, Fig. 9).

There were 16 obese patients showed impaired glucose tolerance (IGT), while the other 9 patients had normal glucose tolerance (NGT). Patients had impaired glucose tolerance (IGT) showed significantly higher blood glucose levels compared both to controls and to obese patients with normal glucose tolerance with non-significantly higher levels in obese compared to controls, (Table 5, Fig. 10).

Table (4): Mean (±SD) fasting and 2-h postprandial blood glucose levels estimated at time of enrollment in the study for patients of studied groups

			Control	Obese	Diabetic
FBG (mgdl)	**Mean±SD**		**78±8.2**	**125±7.5**	**146.4±12.4**
	Range		**65-91**	**112-135**	**132-175**
	Statistical analysis	**t**		**9.191**	**22.541**
		p_1		**<0.001**	**<0.001**
		t			**8.196**
		p_2			**<0.001**
2-h PP (mg/dl)	**Mean±SD**		**105.2±5.9**	**136.4±27.1**	**240.3±17.1**
	Range		**93-115**	**100-170**	**215-300**
	Statistical analysis	**t**		**5.539**	**11.592**
		p_1		**<0.001**	**<0.001**
		t			**9.180**
		p_2			**<0.001**

FBG: fasting blood glucose

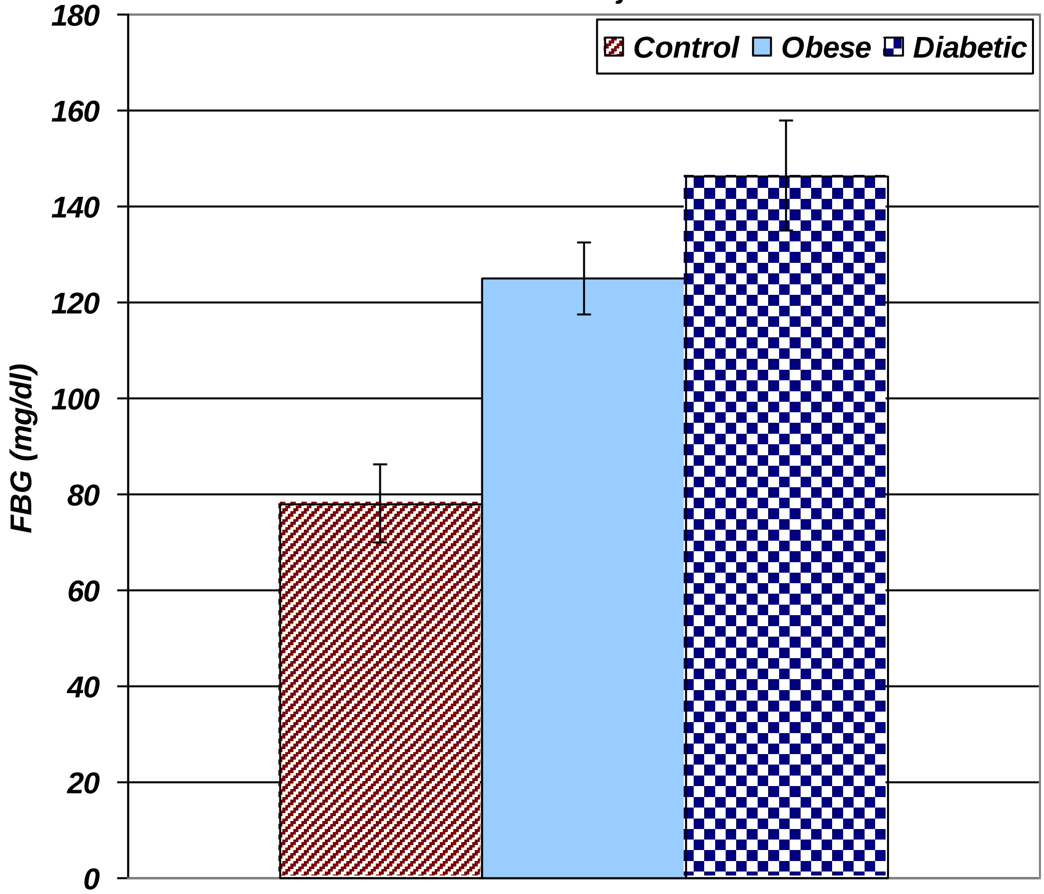
2-h PP: 2-h postprandial blood glucose

Data are presented as mean±SD

p_1: significance versus control group

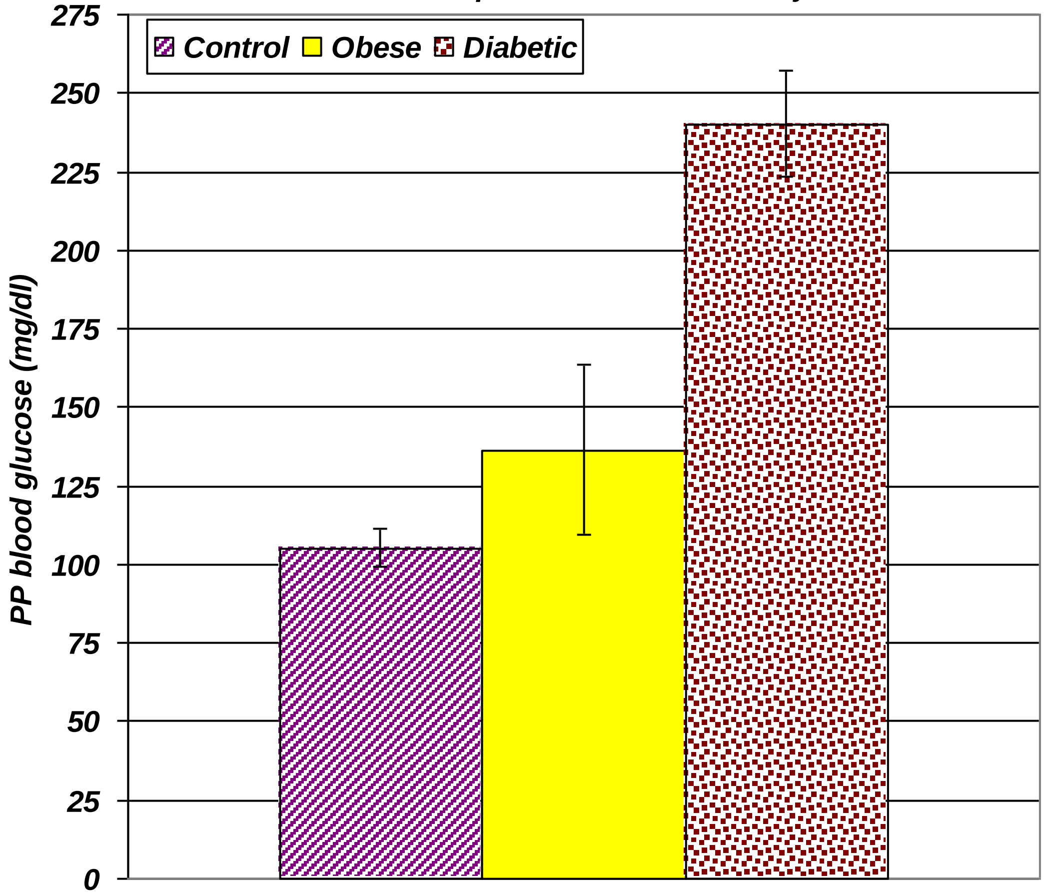
p_2: significance versus obese group

Fig. (8):Mean (±SD) FBG levels estimated for patients of studied subjects



Mean fasting blood glucose levels were significantly ($p<0.001$) higher in diabetic patients compared both to control and obese group with significantly higher FBG in obese patients compared to controls, (Table 4, Fig. 8).

Fig. (9):Mean (±SD) 2-h postprandial blood glucose levels estimated for patients of studied subjects



Mean 2-h postprandial blood glucose levels were significantly ($p<0.001$) higher in diabetic patients compared both to control and obese group with significantly higher FBG in obese patients compared to controls, (Fig. 9).

Table (5): Mean (±SD) fasting and 2-h postprandial blood glucose levels estimated at time of enrollment of obese patients categorized according to glucose tolerance

			Control	Obese group	
				NGT (n=9)	IGT (n=16)
FBG (mgdl)	**Mean±SD**		**78±8.2**	**105±3.2**	**127.8±7**
	Range		**65-91**	**100-108**	**122-135**
	Statistical analysis	**t**		**1.816**	**14.093**
		p_1		**>0.05**	**<0.001**
		t			**10.292**
		p_2			**<0.001**
2-h PP (mg/dl)	**Mean±SD**		**105.2±5.9**	**115.3±7**	**157.3±8.3**
	Range		**93-115**	**107-123**	**145-170**
	Statistical analysis	**t**		**0.141**	**20.375**
		p_1		**>0.05**	**<0.001**
		t			**17.508**
		p_2			**<0.001**

FBG: fasting blood glucose

2-h PP: 2-h postprandial blood glucose

NGT: normal glucose tolerance

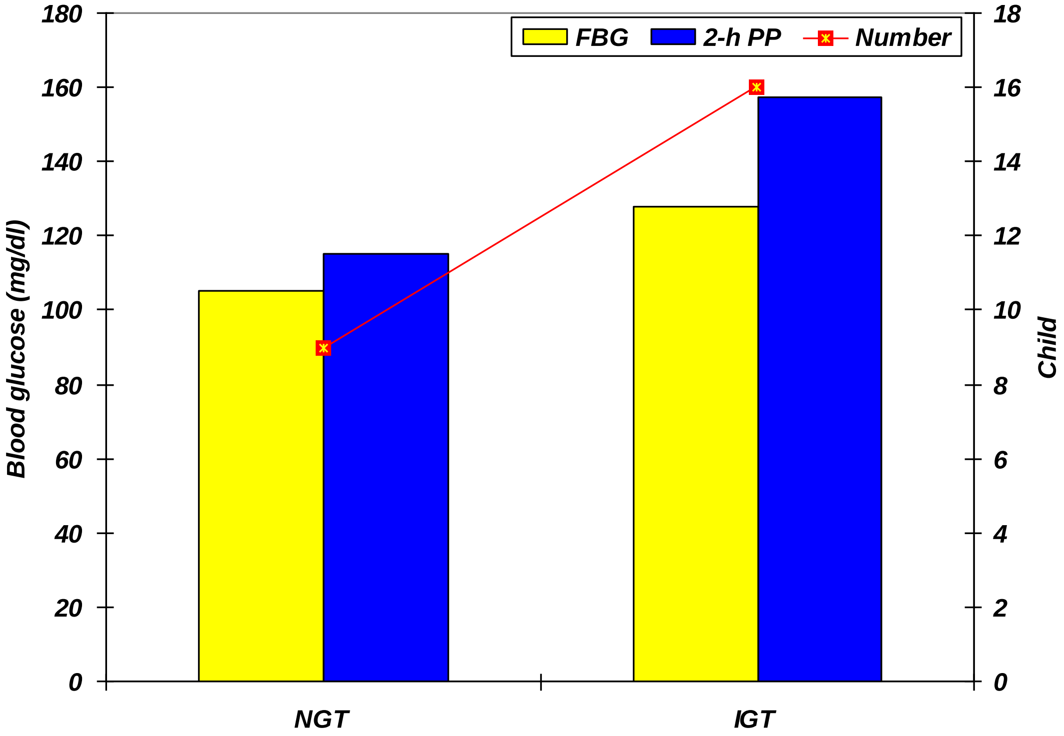
IGT: impaired glucose tolerance

Data are presented as mean±SD

p_1: significance versus control group

p_2: significance versus obese with NGT group

Fig. (10): Mean FBG and 2-h PP blood glucose estimated in obese children in relation to their frequency



There were 16 obese patients showed impaired glucose tolerance (IGT), while the other 9 patients had normal glucose tolerance (NGT). Patients had impaired glucose tolerance (IGT) showed significantly higher blood glucose levels compared both to controls and to obese patients with normal glucose tolerance with non-significantly higher levels in obese compared to controls, (Table 5, Fig. 10).

Table (6): Correlation coefficient between fasting blood glucose levels estimated at time of enrollment and body mass index of obese patients

	"r"	p
Obese children	0.421	=0.036
Diabetic children	0.495	=0.012
Total studied children	0.523	<0.001

There was a positive significant correlation (r=0.523, p<0.001) between estimated FBG levels in the total studied children and BMI, (Fig. 11). However, such correlation was more significant in diabetic children (Fig. 12) than in obese children, (Table 6, Fig. 13).

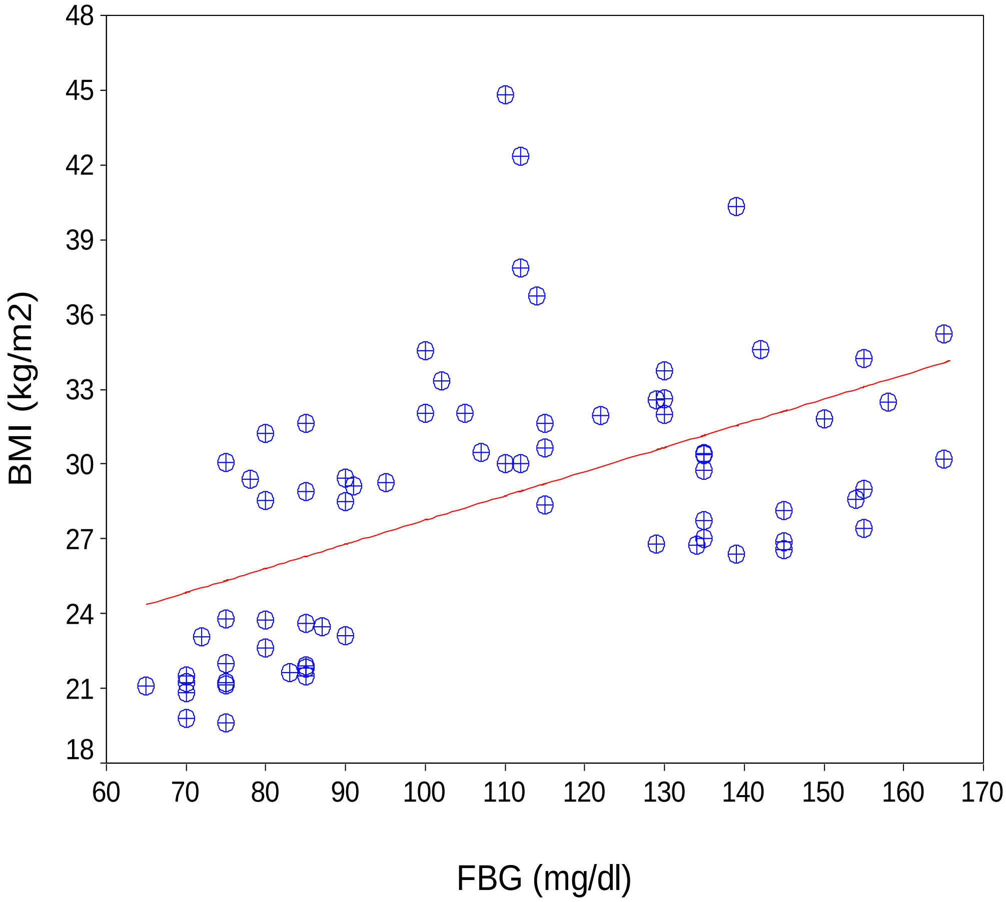


Fig. (11): Correlation between BMI and FBG levels estimated in the study population

There was a positive significant correlation (r=0.523, p<0.001) between estimated FBG levels in the total studied children and BMI, (Fig. 11).

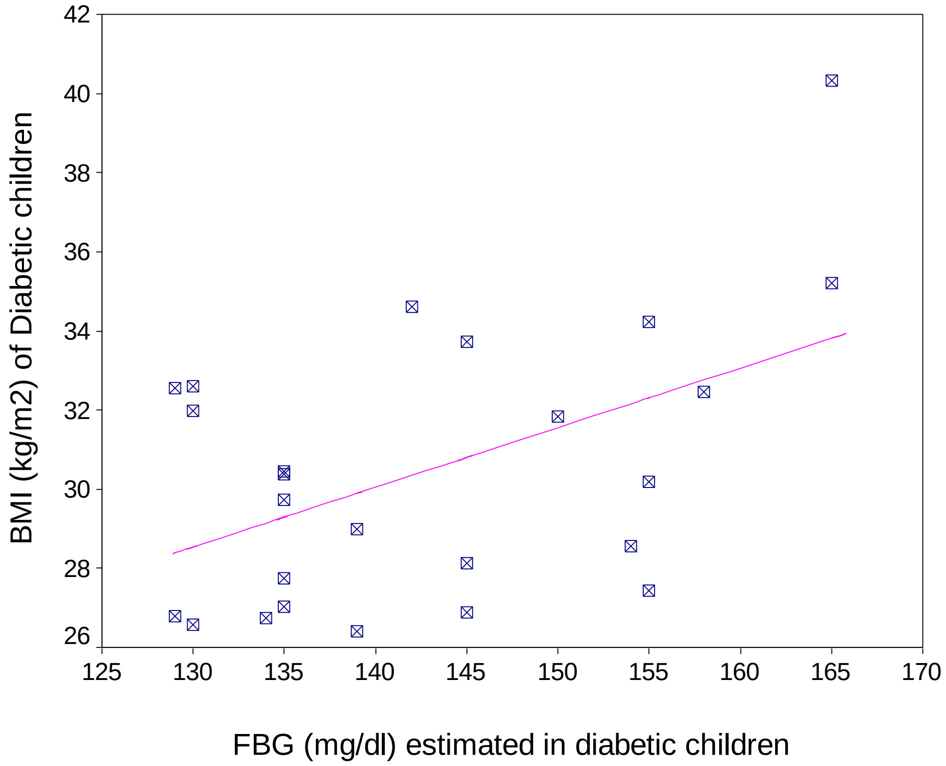


Fig. (12): Correlation between BMI and FBG levels estimated in diabetic children,

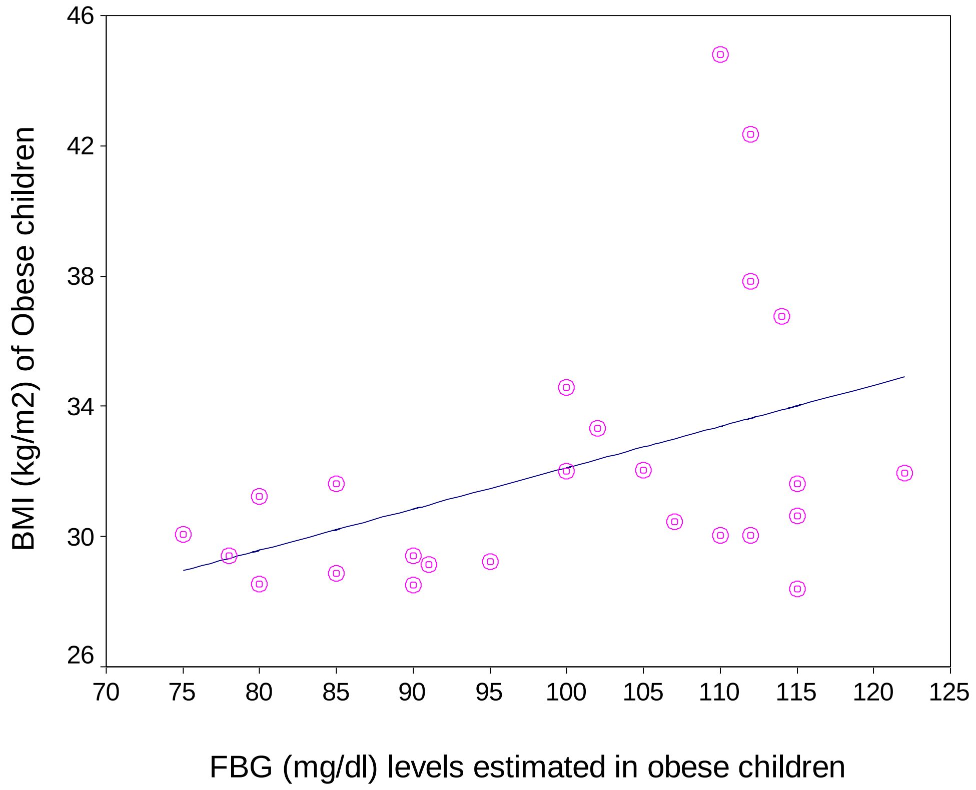


Fig. (13): Correlation between BMI and FBG levels estimated in obese children

However, such correlation was more significant in diabetic children (Fig. 12) than in obese children, (Fig. 13).

B) Fasting Plasma Insulin Data

Table (7): Mean (±SD) fasting plasma insulin levels estimated at time of enrollment in the study for patients of studied groups

		Control	Obese	Diabetic
Mean±SD		**2±0.35**	**6.05±1.48**	**6.72±0.61**
Range		**1.3-2.65**	**3.65-7.8**	**5.14-7.54**
Statistical analysis	**t**		**10.918**	**13.005**
	p_1		**<0.001**	**<0.001**
	t			**2.631**
	p_2			**=0.034**

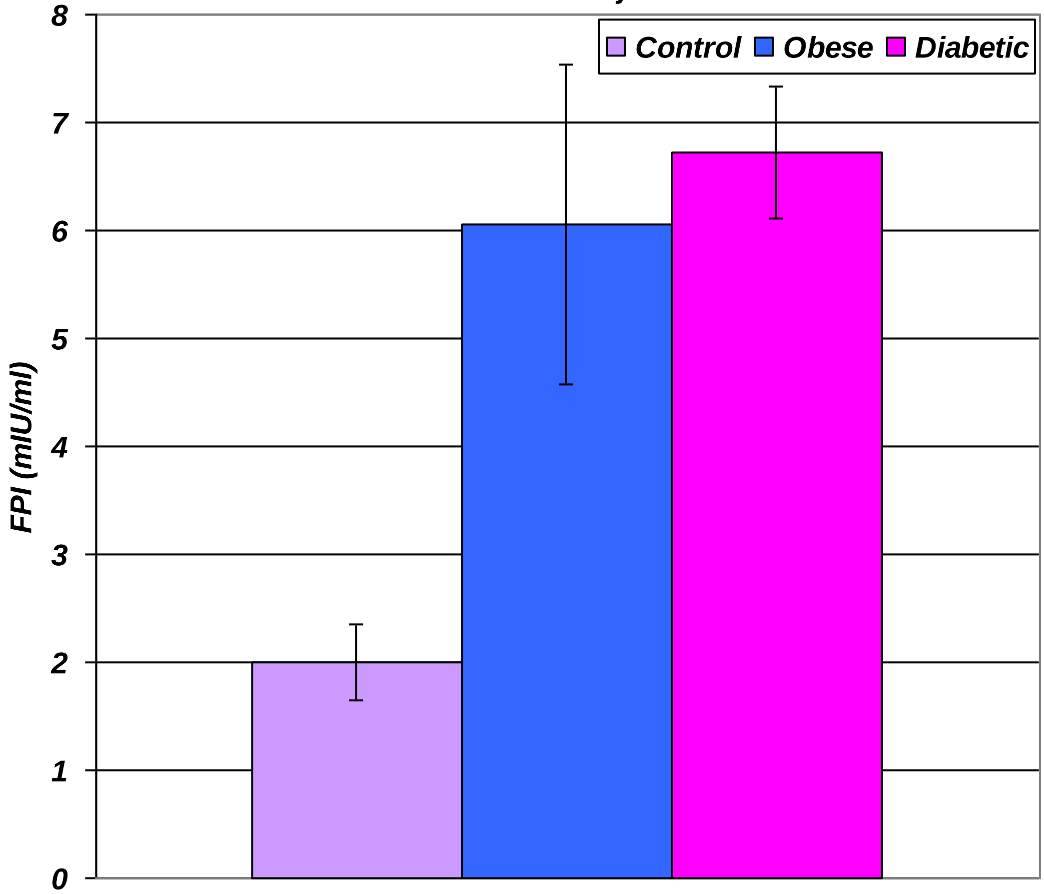
Data are presented as mean±SD

p_1: significance versus control group

p_2: significance versus obese group

Mean serum insulin was found significantly higher in diabetic patients compared both to control group (p<0.001) and to obese group (p=0.036) with significantly higher (p<0.001) serum insulin in obese patients compared to controls, (Table 7).

Fig. (14):Mean (±SD) FPI levels estimated for patients of studied subjects



Mean serum insulin was found significantly higher in diabetic patients compared both to control group (p<0.001) and to obese group (p=0.036) with significantly higher (p<0.001) serum insulin in obese patients compared to controls, (Fig. 14).

B) HOMA-IR Data

Table (8): Mean (±SD) HOMA-IR scores estimated at time of enrollment in the study for patients of studied groups

		Control	Obese	Diabetic
Mean±SD		**0.38±0.08**	**1.88±0.51**	**2.42±1.9**
Range		**0.25-0.54**	**1.12-2.49**	**1.9-2.89**
Statistical analysis	**t**		**14.780**	**37.955**
	p_1		**<0.001**	**<0.001**
	t			**4.606**
	p_2			**=0.001**

Data are presented as mean±SD

p_1: significance versus control group

p_2: significance versus obese group

Mean HOMA-IR score was found significantly higher in diabetic patients compared both to control group (p<0.001) and to obese group (p=0.001) with significantly higher (p<0.001) HOMA-IR score in obese patients compared to controls, (Table 8).

Fig. (15):Mean (±SD) HOMA-IR scores estimated for patients of studied subjects

Mean HOMA-IR score was found significantly higher in diabetic patients compared both to control group ($p<0.001$) and to obese group ($p=0.001$) with significantly higher ($p<0.001$) HOMA-IR score in obese patients compared to controls, (Fig. 15).

Table (9): Mean (±SD) HOMA-IR scores estimated at time of enrollment in the study for obese children categorized according to glucose tolerance

		Control	Obese	
			NGT	IGT
Mean±SD		**0.38±0.08**	**1.23±0. 1**	**2.24±0.15**
Range		**0.25-0.54**	**1.12-1.42**	**2.03-2.49**
Statistical analysis	**t**		**21.540**	**43.222**
	p_1		**<0.001**	**<0.001**
	t			**15.072**
	p_2			**=0.001**

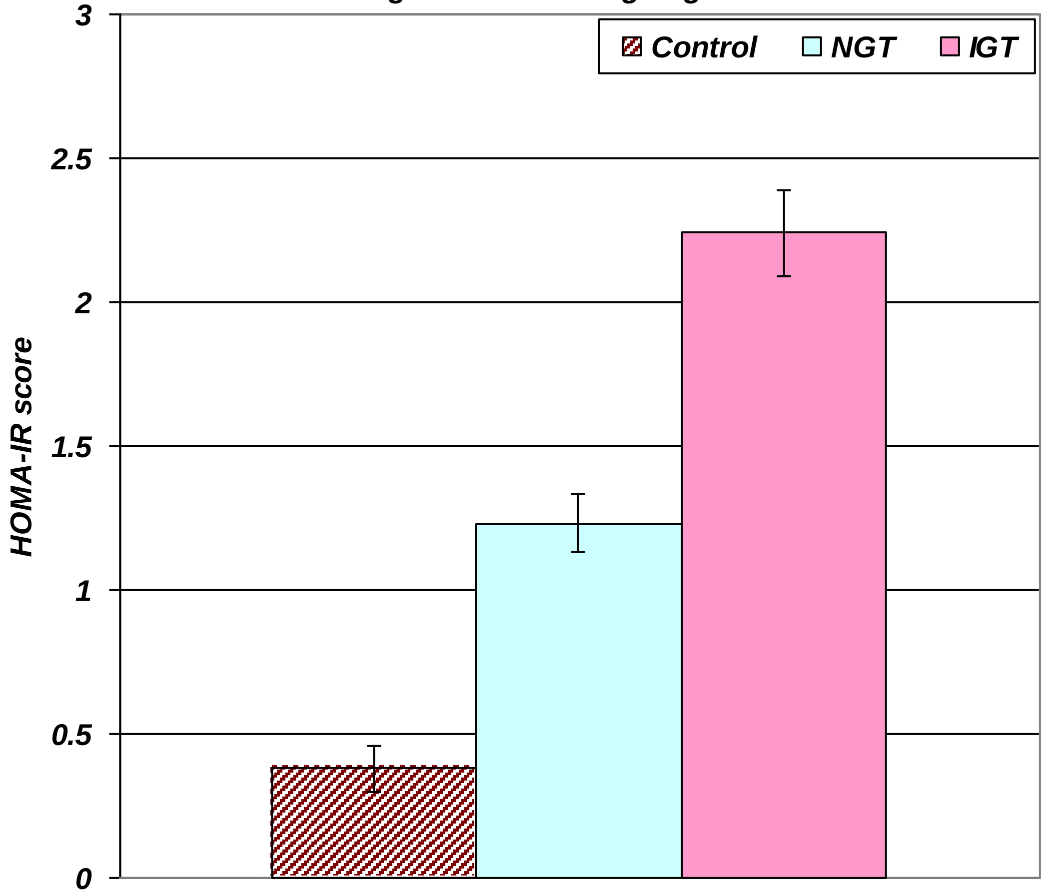
Data are presented as mean±SD

p_1: significance versus control group

p_2: significance versus NGT group

Mean HOMA-IR score was found significantly higher in IGT obese children compared both to control group (p<0.001) and to NGT obese children (p<0.001) with significantly higher (p<0.001) HOMA-IR score in NGT obese children compared to controls, (Table 9, Fig. 16).

Fig. (16):Mean (±SD) HOMA-IR scores estimated for obese children categorized according to glucose tolerance



Mean HOMA-IR score was found significantly higher in IGT obese children compared both to control group (p<0.001) and to NGT obese children (p<0.001) with significantly higher (p<0.001) HOMA-IR score in IGT obese children compared to controls, (Fig. 16).

Preliminary Laboratory Findings

Table (10): Mean (±SD) serum PGRN levels estimated at time of enrollment in the study for patients of studied groups

		Control	Obese			Diabetic
			NGT (n=9)	IGT (n=16)	Total	
Mean±SD		**186.1±22**	**198.9±18**	**223.4±33.5**	**214.6±30.8**	**288.1±29.8**
Range		**155-215**	**175-235**	**175-275**	**175-275**	**215-325**
Statistical analysis	**t**		**1.737**	**4.069**	**3.110**	**11.343**
	p_1		**>0.05**	**=0.001**	**=0.006**	**<0.001**
	t					**8.479**
	p_2					**<0.001**
	t			**1.254**		
	p_3			**>0.05**		

NGT: normal glucose tolerance

IGT: impaired glucose tolerance

Data are presented as mean±SD

p_1: significance versus control group

p_2: significance versus total obese group

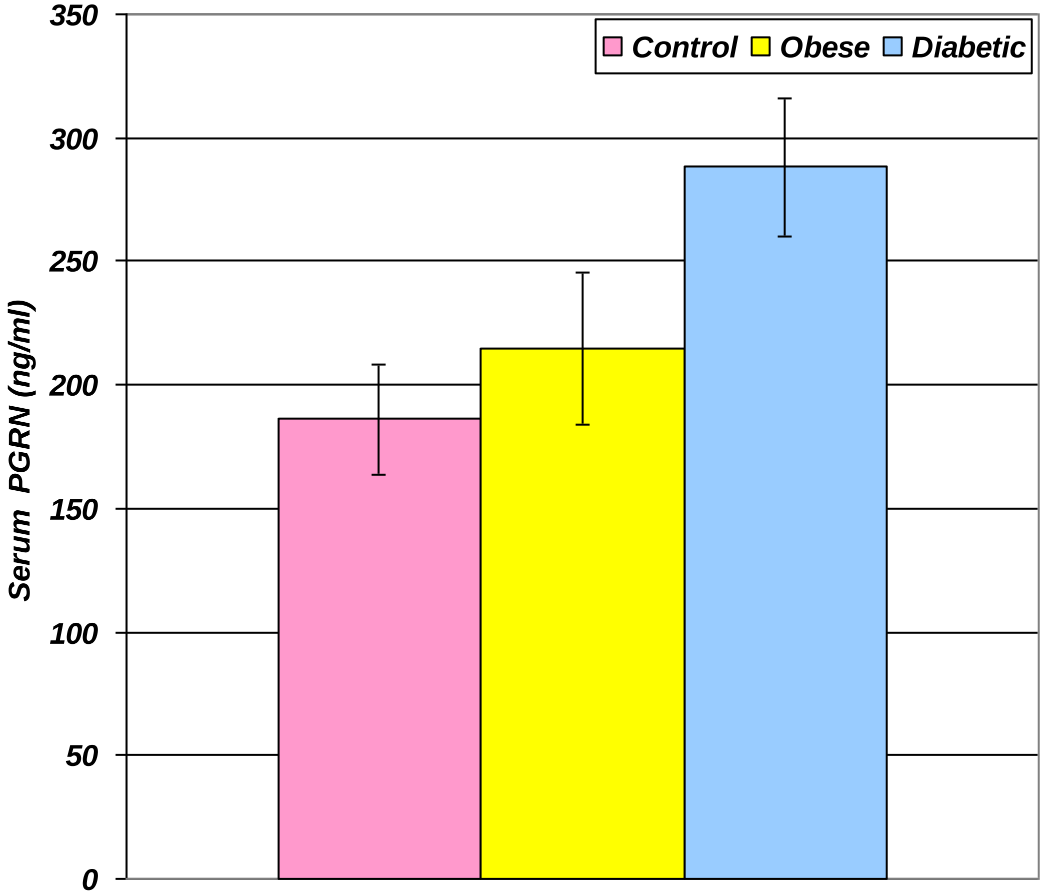
p_3: significance versus obese-NGT children

Mean serum PGRN was found significantly higher (p<0.001) in diabetic patients compared both to control and obese groups with significantly higher (p=0.006) serum PGRN in total obese patients compared to controls.

On contrary, obese patients who had IGT had significantly higher (p=0.001) serum PGRN compared to control group and non-significantly higher (p>0.05) levels compared to obese patients had NGT.

Moreover, patients had NGT showed non-significantly higher (p>0.05) serum PGRN levels compared to control group, (Table 10).

Fig. (17):Mean (±SD) serum Progranulin levels estimated at time of enrollment of studied children



Mean serum PGRN was found significantly higher ($p<0.001$) in diabetic patients compared both to control and obese groups with significantly higher ($p=0.006$) serum PGRN in total obese patients compared to controls.

On contrary, obese patients who had IGT had significantly higher ($p=0.001$) serum PGRN compared to control group and non-significantly higher ($p>0.05$) levels compared to obese patients had NGT.

Moreover, patients had NGT showed non-significantly higher ($p>0.05$) serum PGRN levels compared to control group.

Table (11): Mean (±SD) serum YKL-40 levels estimated at time of enrollment in the study for patients of studied groups

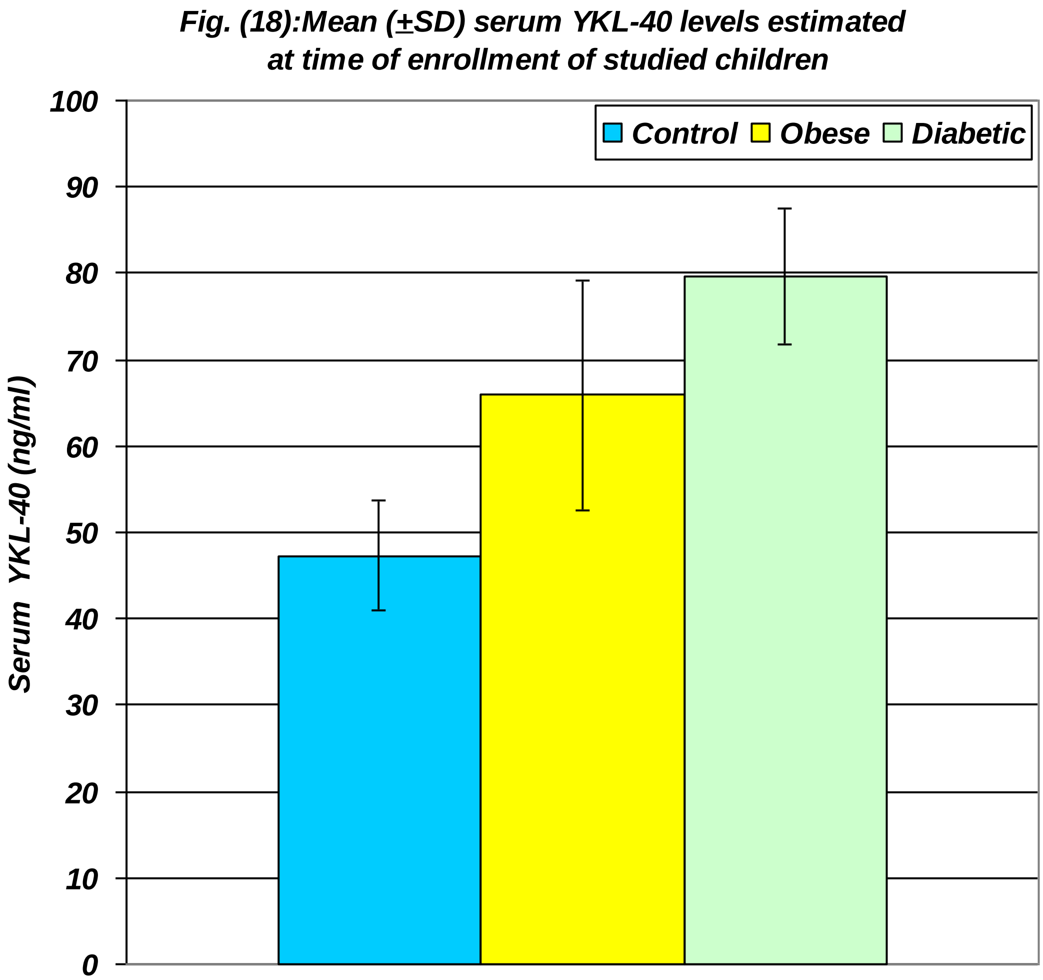
		Control	Obese	Diabetic
Mean±SD		**47.3±6.3**	**65.9±13.3**	**79.6±7.9**
Range		**40.7-60.7**	**41.6-85.9**	**61.8-95.5**
Statistical analysis	**t**		**6.138**	**15.548**
	p_1		**<0.001**	**<0.001**
	t			**4.824**
	p_2			**<0.001**

Data are presented as mean±SD

p_1: significance versus control group

p_2: significance versus obese group

Mean serum YKL-40 was found significantly higher (p<0.001) in diabetic patients compared both to control and obese groups with significantly higher (p<0.001) serum YKL-40 in obese patients compared to controls.



Mean serum YKL-40 was found significantly higher ($p<0.001$) in diabetic patients compared both to control and obese groups with significantly higher ($p<0.001$) serum YKL-40 in obese patients compared to controls.

Table (12): Mean (±SD) serum YKL-40 levels estimated at time of enrollment in the study for patients enrolled in obese group categorized according to glucose tolerance and BMI

		NGT			IGT			
		Average	Obese	Total	Average	Obese	M. Obese	Total
Mean±SD		45.6±3.1	58.4±6.2	50.4±7.7	67.4±6.8	72.9±8	78.1±5.4	73.2±8
Range		41.6-49.5	51.3-62.7	41.6-62.7	59.8-73.1	58-81.9	73.4-85.9	58-85.9
Statistical analysis	t				3.426			
	p_1				<0.05			
	t					8.703		
	p_2					<0.001		
	t						1.363	
	p_3						>0.05	
	t		2.267					
	p_4		>0.05					
	t							6.777
	p_5							<0.001

NGT: normal glucose tolerance

IGT: impaired glucose tolerance

Data are presented as mean±SD

p_1: significance versus NGT patients with average BMI

p_2: significance versus obese NGT patients

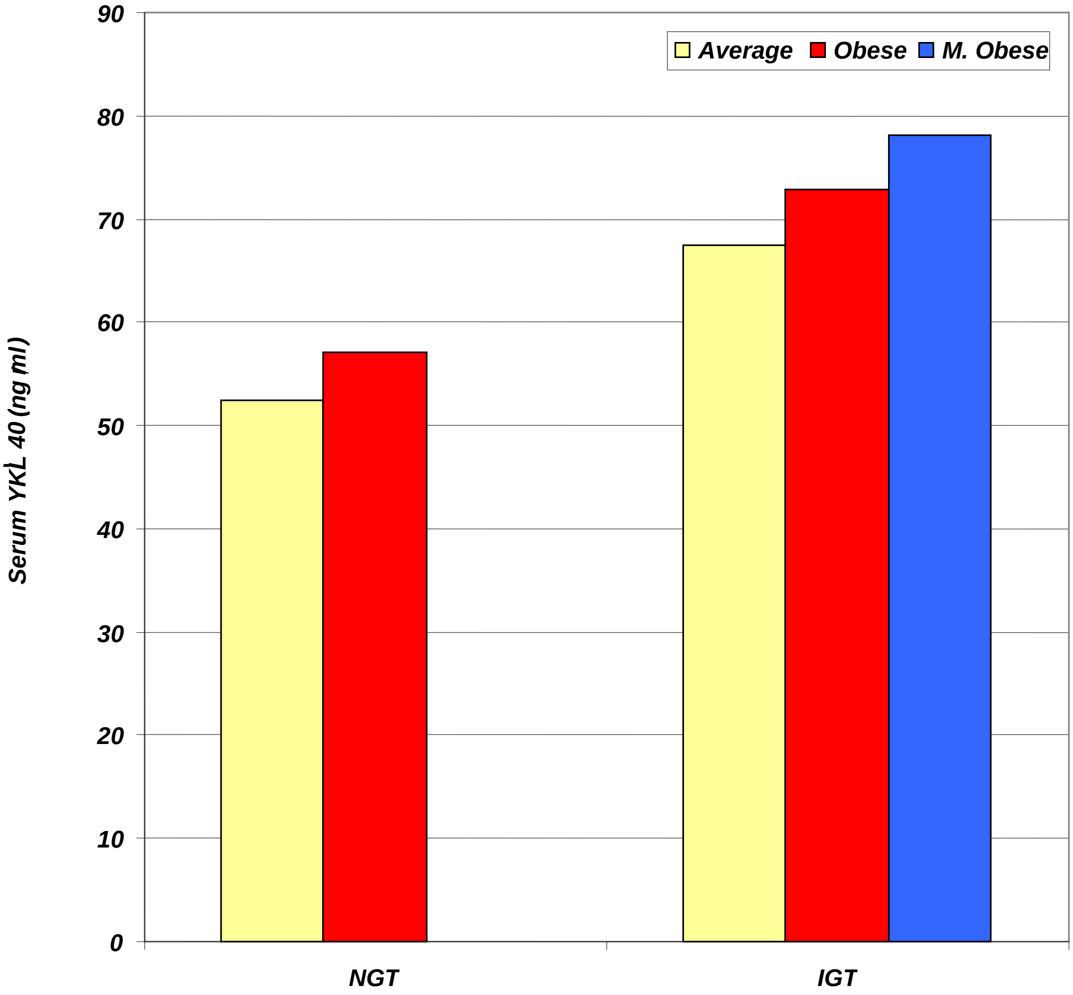
p_3: significance versus obese IGT patients

p_4: significance versus NGT patients with average BMI

p_5: significance versus total NGT patients

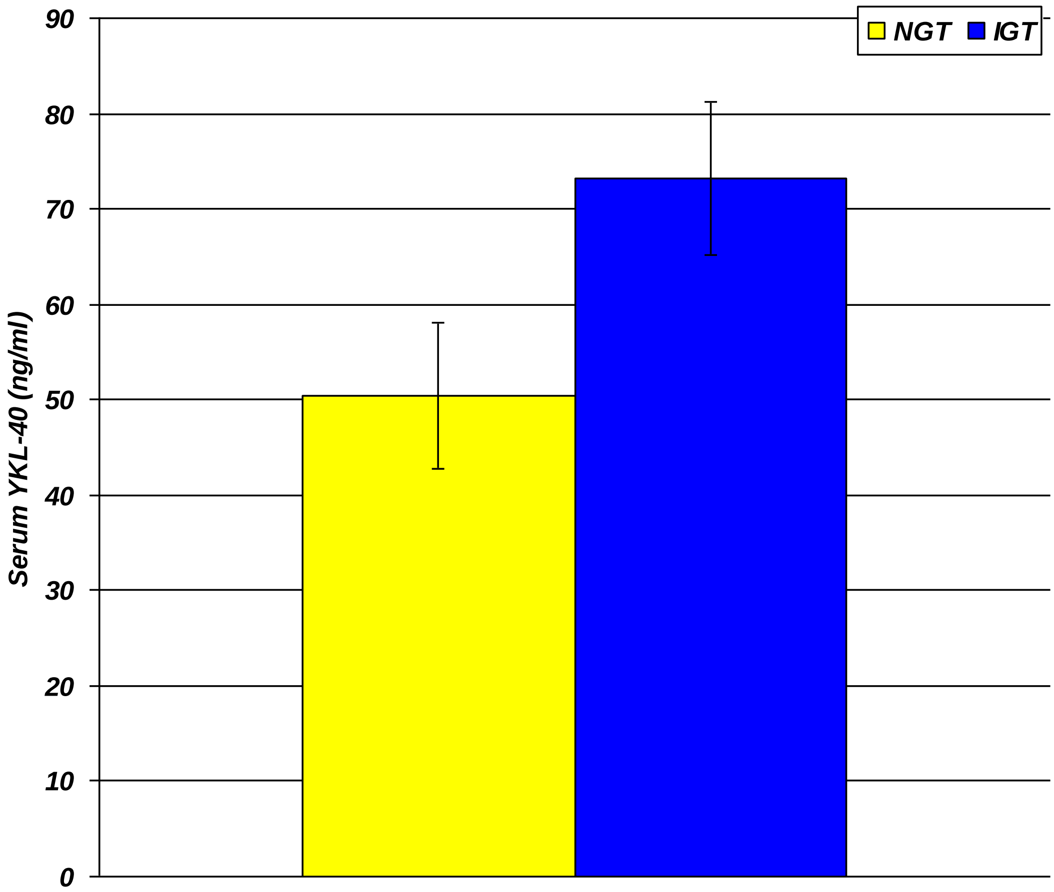
Mean serum YKL-40 was found significantly higher (p<0.05) in patients had average BMI and IGT versus those showed NGT and was significantly higher (p<0.001) in obese patients with IGT versus obese patient showed NGT. On contrary very-morbid obese patients with IGT showed non-significantly higher serum YKL-40 levels compared to obese patients with IGT. It is to be noted that obese patients with NGT showed non-significantly higher (p>0.05) serum YKL-40 compared to NGT patients with average BMI, (Table 12).

Fig. (19): Mean (+SD) serum YKL-40 levels estimated in obese patients categorized according to glucose tolerance and BMI



Mean serum YKL-40 was found significantly higher ($p<0.05$) in patients had average BMI and IGT versus those showed NGT and was significantly higher ($p<0.001$) in obese patients with IGT versus obese patient showed NGT. On contrary very-morbid obese patients with IGT showed non-significantly higher serum YKL-40 levels compared to obese patients with IGT. It is to be noted that obese patients with NGT showed non-significantly lower ($p>0.05$) serum YKL-40 compared to NGT patients with average BMI.

Fig. (20): Mean (+SD) serum YKL-40 estimated in obese patients categorized according to glucose tolerance



Total obese patients with IGT showed significantly higher ($p<0.001$) YKL-40 serum levels compared to total obese patients with NGT.

Table (13): Mean (±SD) serum YKL-40 levels estimated at time of enrollment in the study for patients enrolled in diabetic group categorized according to BMI

		Average	Obese	M. Obese
Mean±SD		**75.3±4.7**	**82.1±6.1**	**91.1±7.9**
Range		**61.8-84.7**	**74.2-95.5**	**61.8-95.5**
Statistical analysis	**t**		**2.931**	**2.783**
	p_1		**<0.05**	**<0.05**
	t			**1.53**
	p_2			**>0.05**

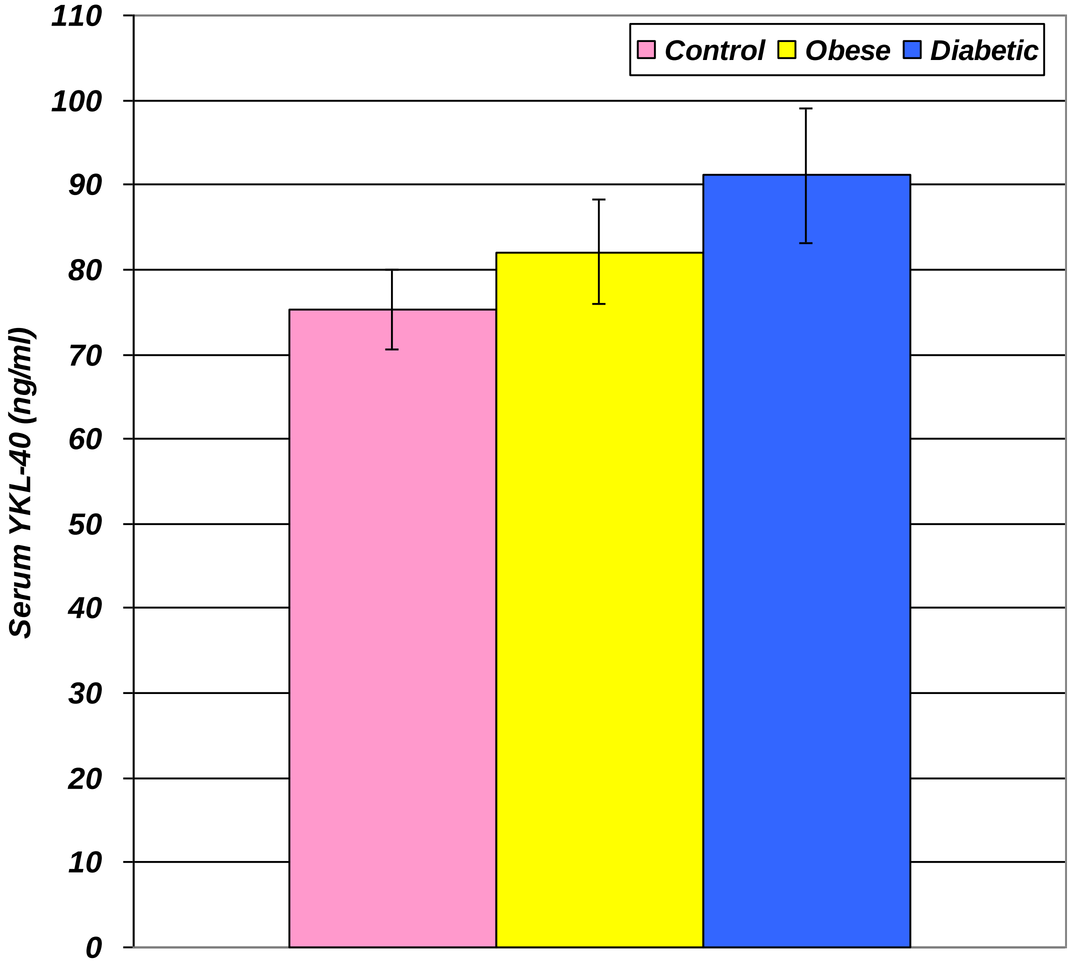
Data are presented as mean±SD

p_1: significance versus patients with average BMI

p_2: significance versus obese patients

Mean serum YKL-40 was found significantly higher ($p<0.05$) in obese and morbid obese patients compared to those had average BMI. On contrary very-morbid obese patients showed non-significantly higher serum YKL-40 levels compared to obese patients.

Fig. (21): Mean (±SD) serum YKL-40 estimated in diabetic patients categorized according to BMI



Mean serum YKL-40 was found significantly higher ($p<0.05$) in obese and morbid obese patients compared to those had average BMI. On contrary very-morbid obese patients with showed non-significantly higher serum YKL-40 levels compared to obese patients.

Weight reduction Program Outcome

A) Body weight change Data

Weight reduction interventions significantly reduced body weight of studied patients of both obese and diabetic groups compared to their baseline weight. However, obese children still had significantly higher body weight compared to diabetic children, (Table 14, Fig. 22).

The %EWL showed progressive increase throughout the duration of intervention with significant difference of %EWL at 3-months compared to that recorded at 1-month and 2-months with significantly higher %EWL at 2-months compared to 1-month loss. These data are observed for both diabetic and obese groups; however, the %EWL at 1-month and 3-months was significantly higher in obese children compared to diabetic children, while at 2-months the difference was non-significant in favor of obese group, (Table 15, Fig. 23).

Table (14): Body weight of studied children at the end of 3-months of weight reduction intervention compared versus baseline weight

			Baseline	1-month	2-months	3-months
Group II	**Mean±SD**		**70±6.8**	**66.5±6.4**	**63.4±6.8**	**60±7.2**
	Range		**52-77**	**49-74**	**46-70**	**43-69**
	Statistical analysis	**t**		**13.717**	**20.682**	**19.940**
		p_1		**<0.001**	**<0.001**	**<0.001**
		t			**15.823**	**15.712**
		p_2			**<0.001**	**<0.001**
		t				**11.739**
		p_3				**<0.001**
Group III	**Mean±SD**		**62.4±8.7**	**60±8.6**	**57.6±8.4**	**55.2±8.7**
	Range		**49-77**	**45-75**	**43-72**	**40-70**
	Statistical analysis	**t**		**18.767**	**29.042**	**26.227**
		p_1		**<0.001**	**<0.001**	**<0.001**
		t			**11.953**	**13.599**
		p_2			**<0.001**	**<0.001**
		t				**11.379**
		p_3				**<0.001**
Statistical analysis		**t**	**3.841**	**3.363**	**3.059**	**2.445**
		P_4	**=0.001**	**=0.003**	**=0.005**	**0.022**

Data are presented as mean±SD

p_1: significance versus baseline weight

p_2: significance versus 1-month weight

p_3: significance versus 2-month weight

p_4: significance versus group II

Weight reduction interventions significantly reduced body weight of studied patients of both obese and diabetic groups compared to their baseline weight. However, obese children still had significantly higher body weight compared to diabetic children, (Table 14).

Table (15): The percentage of excess weight loss recorded throughout the weight reduction intervention period in both study groups

			1-month	2-months	3-months
Group II	**Mean±SD**		**17.4±7.3**	**31.3±8**	**47.1±7.2**
	Range		**4.7-31.3**	**16.3-53.8**	**27.7-69.2**
	Statistical analysis	**t**		**8.189**	**9.049**
		p_1		**<0.001**	**<0.001**
		t			**8.787**
		p_2			**<0.001**
Group III	**Mean±SD**		**12.9±3.7**	**28.2±11**	**40.6±10.1**
	Range		**6.3-20**	**12.5-66.7**	**20-100**
	Statistical analysis	**t**		**16.863**	**19.326**
		p_1		**<0.001**	**<0.001**
		t			**12.862**
		p_2			**<0.001**
Statistical analysis		**t**	**2.777**	**1.121**	**2.745**
		P_3	**=0.010**	**>0.05**	**=0.043**

Data are presented as mean±SD

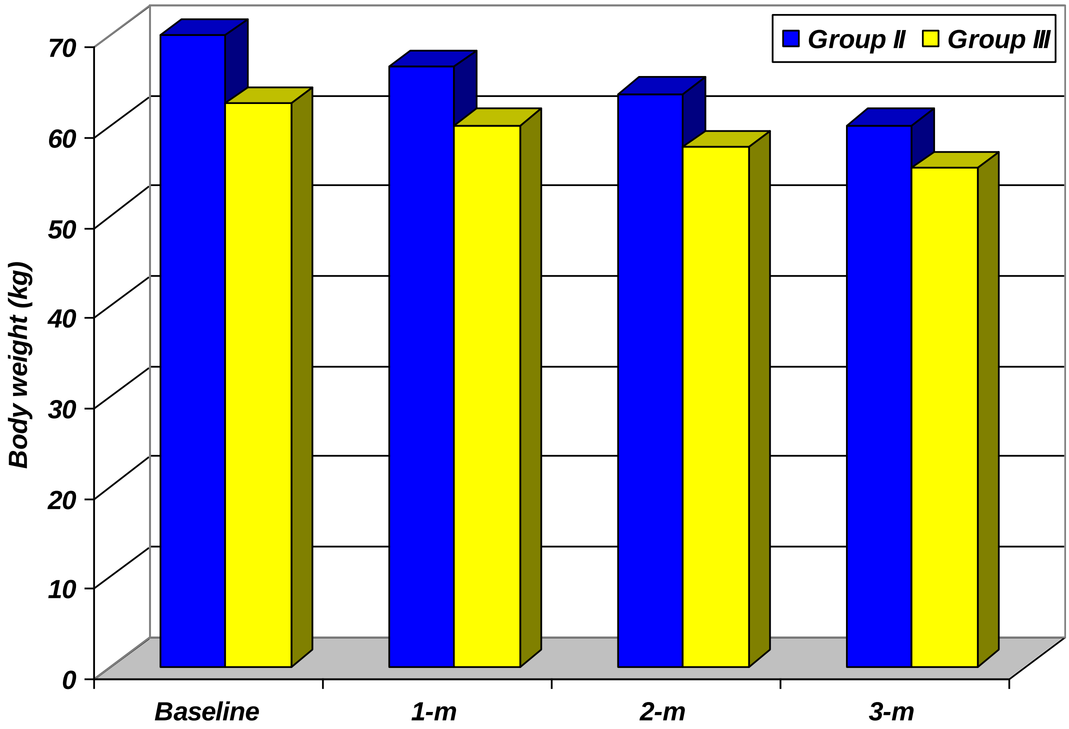
p_1: significance versus 1-month %EWL

p_2: significance versus 2-month %EWL

p_3: significance versus group II

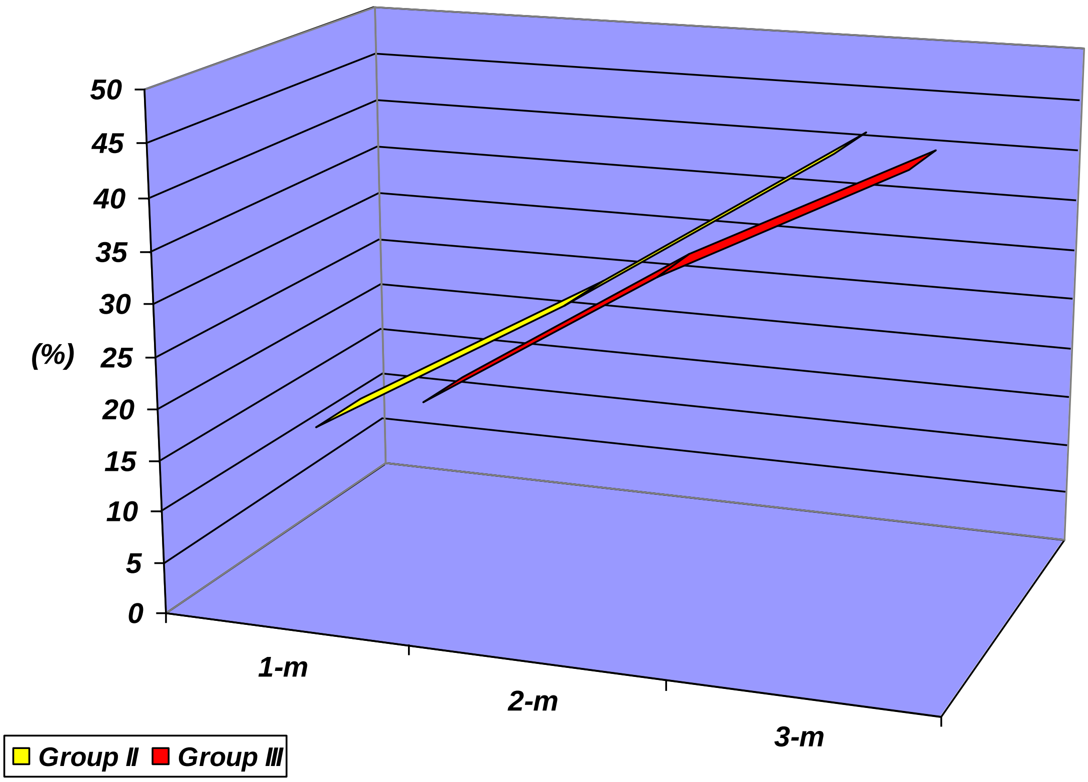
The %EWL showed progressive increase throughout the duration of intervention with significant difference of %EWL at 3-months compared to that recorded at 1-month and 2-months with significantly higher %EWL at 2-months compared to 1-month loss. These data are observed for both diabetic and obese groups; however, the %EWL at 1-month and 3-months was significantly higher in obese children compared to diabetic children, while at 2-months the difference was non-significant in favor of obese group, (Table 15)

Fig. (22): Mean body weight of studied children throughout intervention period compared to baseline weight in both groups



Weight reduction interventions significantly reduced body weight of studied patients of both obese and diabetic groups compared to their baseline weight. However, obese children still had significantly higher body weight compared to diabetic children, (Fig. 22).

Fig. (23): Mean %EWL recorded in both study groups throughout the intervention period



The %EWL showed progressive increase throughout the duration of intervention with significant difference of %EWL at 3-months compared to that recorded at 1-month and 2-months with significantly higher %EWL at 2-months compared to 1-month loss. These data are observed for both diabetic and obese groups; however, the %EWL at 1-month and 3-months was significantly higher in obese children compared to diabetic children, while at 2-months the difference was non-significant in favor of obese group, (Fig. 23).

B) Body mass index change Data

At the end of 3-months of weight reduction interventions BMI was significantly reduced in both obese and diabetic groups compared to their baseline BMI. However, the difference of BMI between obese and diabetic children was non-significant at end of 3-months, but in favor of diabetic children, (Table 16, Fig. 24).

The %EBMIL showed progressive increase throughout the duration of intervention with significant difference of %EWL at 3-months compared to that recorded at 1-month and 2-months with significantly higher %EWL at 2-months compared to 1-month loss. These data are observed for both diabetic and obese groups; with significantly higher %EBMIL at 1-, 2- and 3-months in diabetic children compared to obese children, (Table 17, Fig. 25).

Table (16): Body mass index of studied children at the end of 3-months of weight reduction intervention compared versus baseline BMI

			Baseline	1-month	2-months	3-months
Group II	**Mean±SD**		**30.5±3.5**	**29.3±3.2**	**28.1±3.1**	**26.9±3.1**
	Range		**26.4-40.3**	**25.4-38.4**	**24-37.1**	**22.5-35.2**
	Statistical analysis	**t**		**10.960**	**17.406**	**16.172**
		p_1		**<0.001**	**<0.001**	**<0.001**
		t			**14.741**	**17.246**
		p_2			**<0.001**	**<0.001**
		t				**10.231**
		p_3				**<0.001**
Group III	**Mean±SD**		**32.1±4.2**	**30.6±4**	**29.1±3.8**	**27.5±3.4**
	Range		**28.4-44.8**	**26.6-42.9**	**24.8-39.7**	**22.5-36.5**
	Statistical analysis	**t**		**23.641**	**19.142**	**15.712**
		p_1		**<0.001**	**<0.001**	**<0.001**
		t			**9.041**	**9.809**
		p_2			**<0.001**	**<0.001**
		t				**9.229**
		p_3				**<0.001**
Statistical analysis		**t**	**2.215**	**1.639**	**1.376**	**0.766**
		P_4	**=0.037**	**>0.05**	**>0.05**	**>0.05**

Data are presented as mean±SD

p_1: significance versus baseline BMI

p_2: significance versus 1-month BMI

p_3: significance versus 2-month BMI

p_4: significance versus group II

At the end of 3-months of weight reduction interventions BMI was significantly reduced in both obese and diabetic groups compared to their baseline BMI. However, the difference of BMI between obese and diabetic children was non-significant at end of 3-months, but in favor of diabetic children, (Table 16).

Table (17): The percentage of excess BMI loss recorded throughout the weight reduction intervention period in both study groups

			1-month	2-months	3-months
Group II	**Mean±SD**		**3.8±1.5**	**7.83±1.9**	**11.64±3.2**
	Range		**1.32-8.16**	**4.23-12.24**	**5.63-18.37**
	Statistical analysis	**t**		**10.827**	**12.215**
		p_1		**<0.001**	**<0.001**
		t			**11**
		p_2			**<0.001**
Group III	**Mean±SD**		**4.91±1.15**	**9.42±1.87**	**14.36±3.31**
	Range		**2.63-6.85**	**5.63-12.7**	**9.86-21**
	Statistical analysis	**t**		**16.722**	**14.681**
		p_1		**<0.001**	**<0.001**
		t			**10.363**
		p_2			**<0.001**
Statistical analysis		**t**	**2.429**	**3.403**	**3.642**
		P_3	**=0.023**	**0.002**	**=0.001**

Data are presented as mean±SD

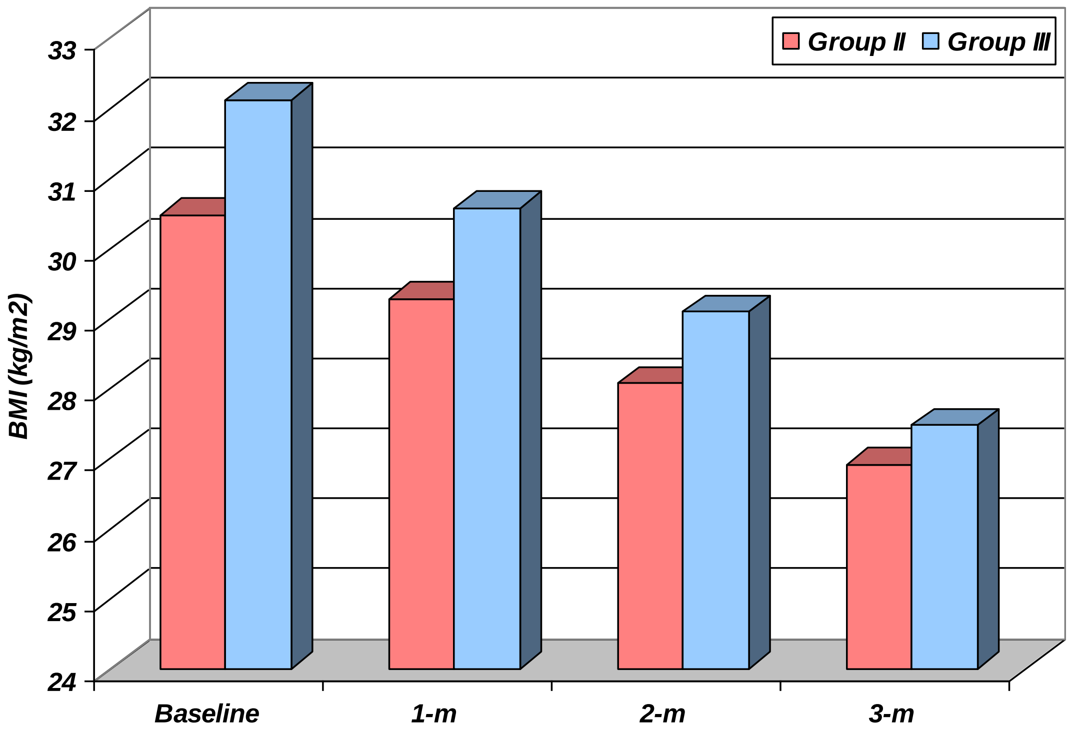
p_1: significance versus 1-month %EBMIL

p_2: significance versus 2-month %EBMIL

p_3: significance versus group II

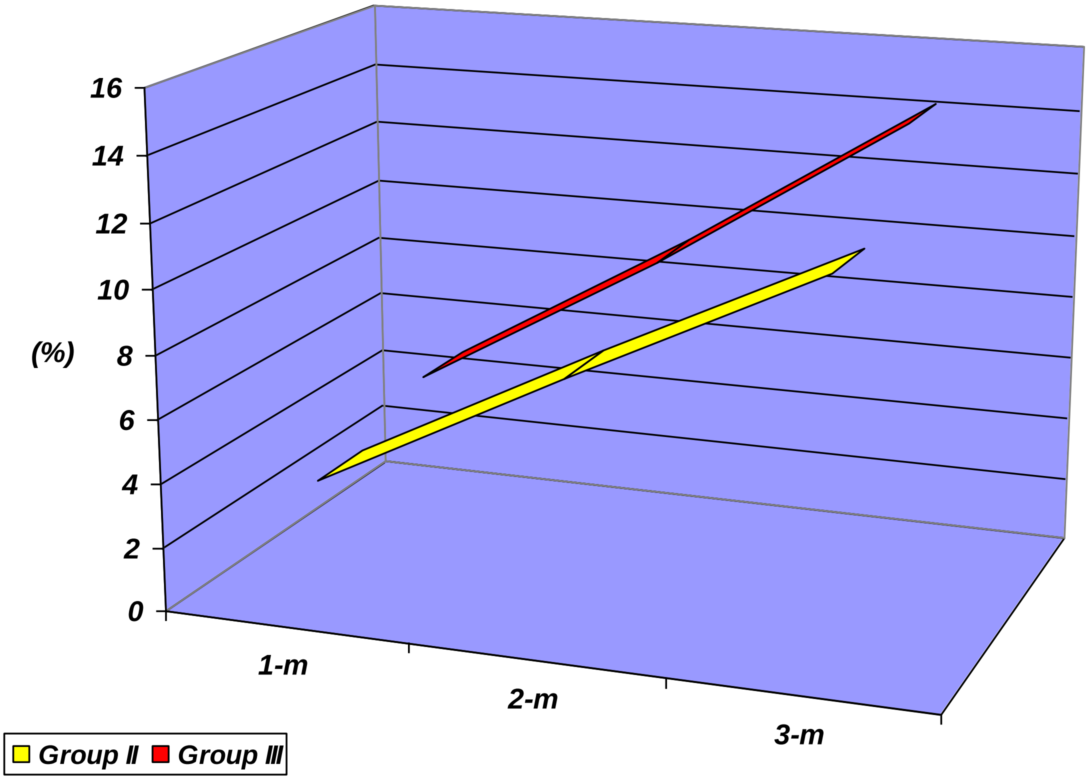
The %EBMIL showed progressive increase throughout the duration of intervention with significant difference of %EWL at 3-months compared to that recorded at 1-month and 2-months with significantly higher %EWL at 2-months compared to 1-month loss. These data are observed for both diabetic and obese groups; with significantly higher %EBMIL at 1-, 2- and 3-months in diabetic children compared to obese children, (Table 17).

Fig. (24): Mean BMI of studied children throughout intervention period compared to baseline BMI in both groups



At the end of 3-months of weight reduction interventions BMI was significantly reduced in both obese and diabetic groups compared to their baseline BMI. However, the difference of BMI between obese and diabetic children was non-significant at end of 3-months, but in favor of diabetic children, (Fig. 24).

Fig. (25): Mean %EBMIL recorded in both study groups throughout the intervention period



The %EBMIL showed progressive increase throughout the duration of intervention with significant difference of %EWL at 3-months compared to that recorded at 1-month and 2-months with significantly higher %EWL at 2-months compared to 1-month loss. These data are observed for both diabetic and obese groups; with significantly higher %EBMIL at 1-, 2- and 3-months in diabetic children compared to obese children, (Fig. 25).

C) Insulin resistance change Data

Table (18): FBG levels of studied children at the end of 3-months of weight reduction intervention compared versus baseline FBG levels

			Baseline	3-month	% of change
FBG (mg/dl)	Group II		125±7.5 (112-135)	115.6±7.1* (106-129)	7.44±3.9 (2.44-17.4)
	Group III		146.4±12.4 (132-175)	124.6±9.2* (109-142)	14.5±7.1 (7.2-29.4)
	Statistical analysis	t	6.845	3.932	4.257
		p	<0.001	=0.001	<0.001
FPI	Group II		6.1±1.48 (3.65-7.8)	4.41±1.05* (3-5.99)	26.6±5.6 (17.81-38.82)
	Group III		6.72±0.61 (5.14-7.54)	5.37±0.76* (4.12-6.72)	20.1±7.2 (10.2-32.6)
	Statistical analysis	t	2.205	3.859	3.394
		p	=0.039	=0.001	=0.002
HOMA-IR	Group II		1.88±0.51 (1.12-2.5)	1.27±0.35* (0.8-1.9)	32±7 (23.6-46.5)
	Group III		2.42-0.25 (1.9-2.89)	1.66-0.29* (1.32-2.1)	31.3±9.7 (16.7-48.4)
	Statistical analysis	t	12.585	3.912	3.415
		p	<0.001	=0.001	=0.002

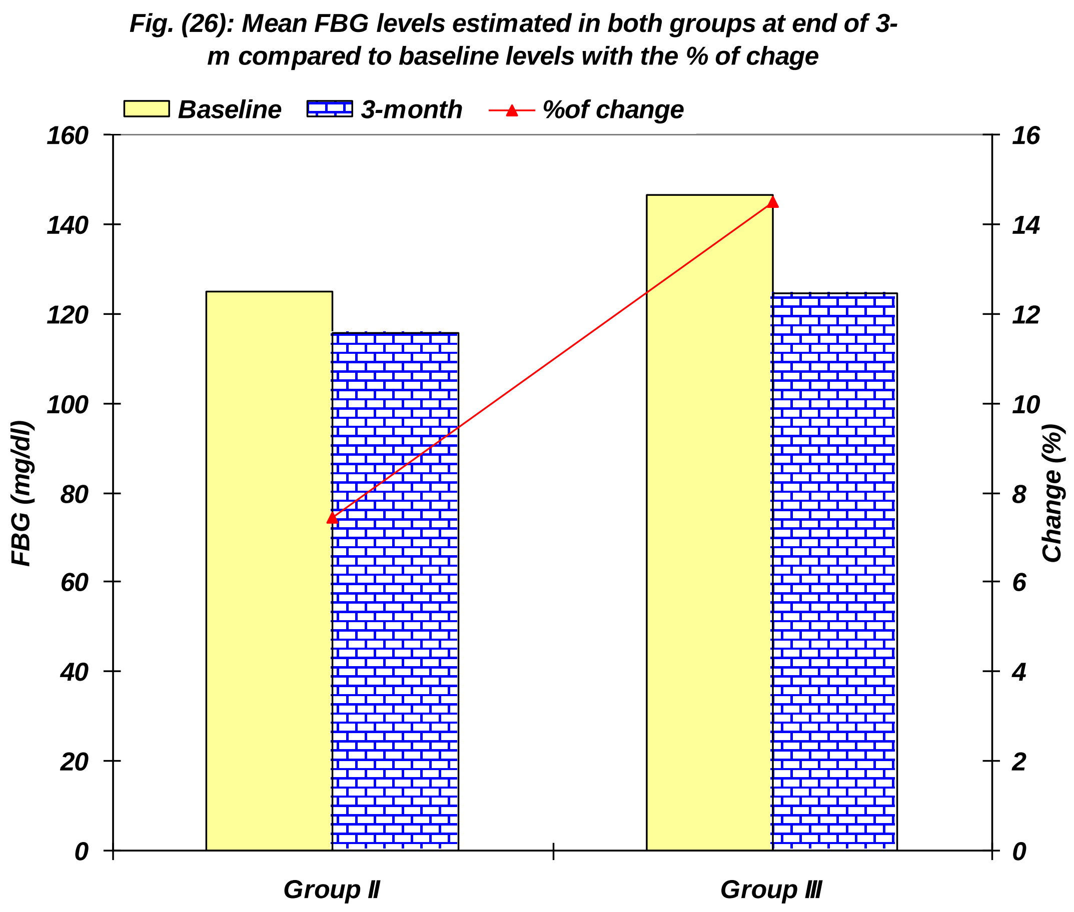
Data are presented as mean±SD, ranges are in parenthesis

*: significance versus baseline levels

p: significance versus group II

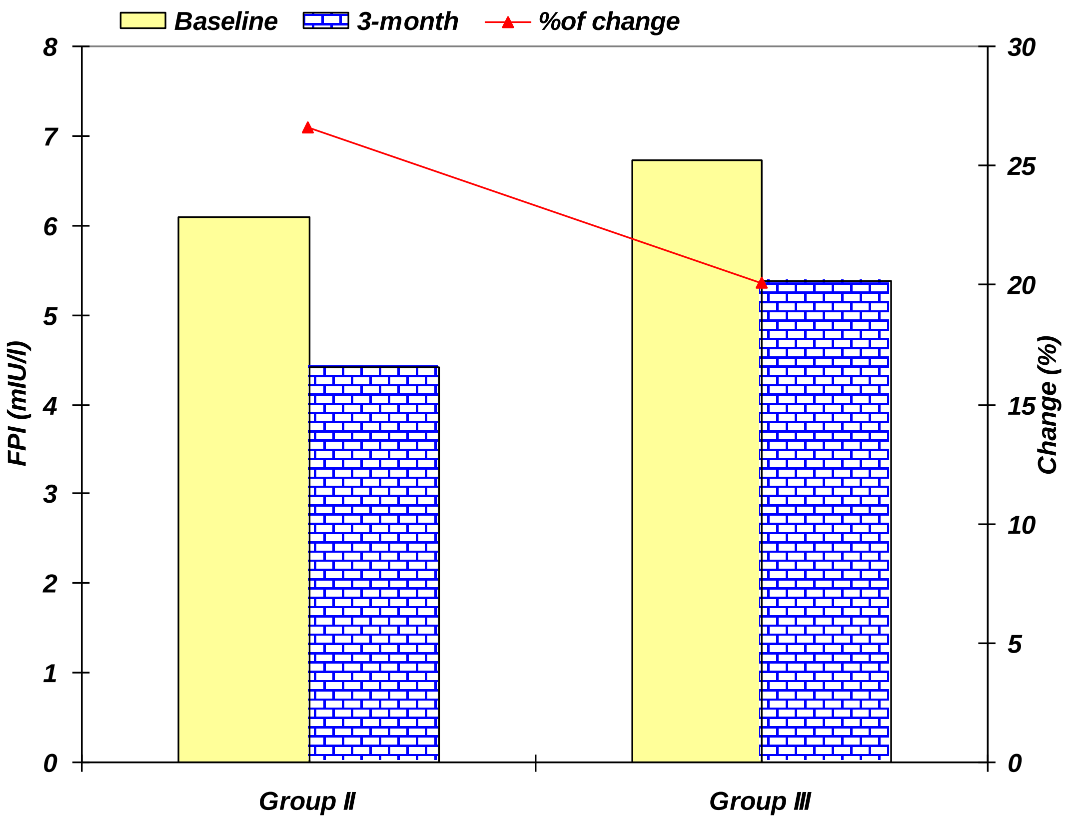
At the end of 3-months of weight reduction interventions FBG, FPI and HOMA-IR were significantly reduced in both obese and diabetic groups.

However, at the end of 3-months of intervention, diabetic children still have significantly FBG and FPI levels with significantly higher HOMA-IR score compared to obese children. (Table 18, Fig. 26, 27, 28).



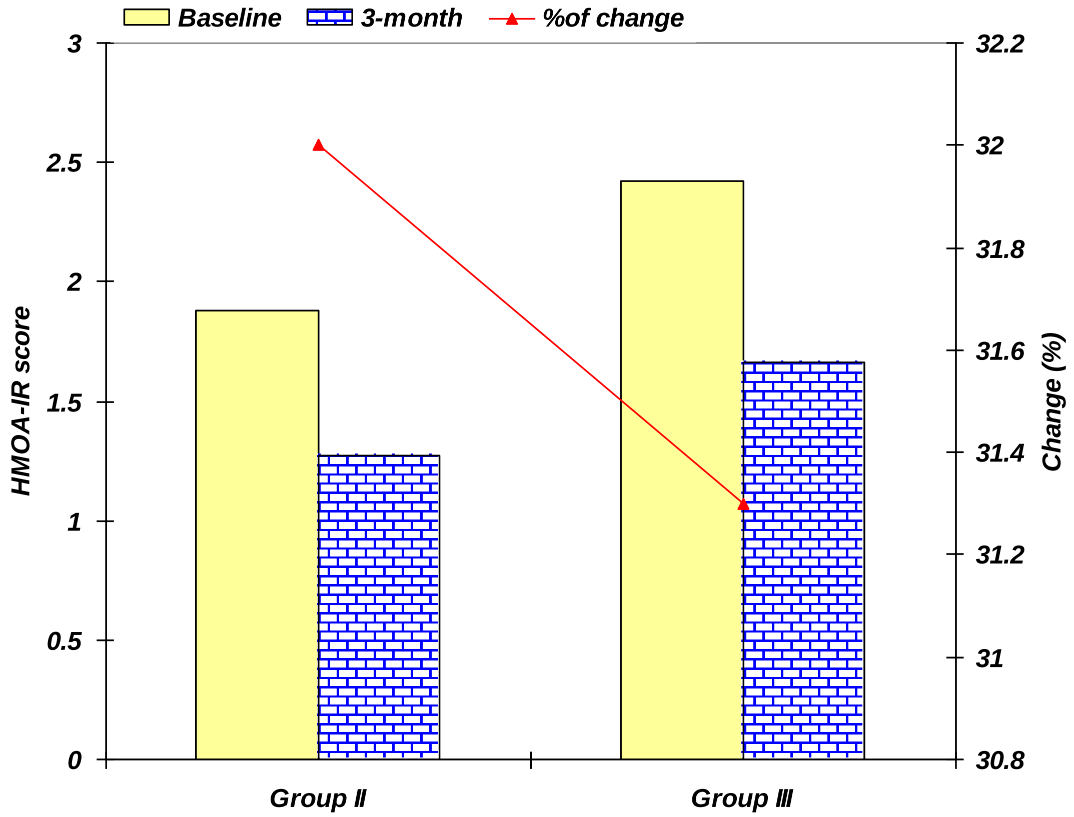
At the end of 3-months of weight reduction interventions FBG, FPI and HOMA-IR were significantly reduced in both obese and diabetic groups.

Fig. (27): Mean FPI levels estimated in both groups at end of 3-m compared to baseline levels with the % of chage



At the end of 3-months of weight reduction interventions FBG, FPI and HOMA-IR were significantly reduced in both obese and diabetic groups .

Fig. (28): Mean HOMA-IR scores estimated in both groups at end of 3-m compared to baseline levels with the % of chage



The % of change of FBG was significantly (p<0.001) higher in diabetic children compared to obese children. On the other hand, the % of change of FPI levels and HMOA-IR scores were significantly (p=0.002) higher in obese compared to diabetic children.

Diagnostic yield of Estimated Parameters

A) Serum Progranulin (PGRN)

Serum PGRN levels were found positively correlated with body weight, excess body weight above the normal range, BMI, FBG, FPI and HOMA-IR score.

Table (19): Correlation coefficient between serum PGRN levels and other evaluated parameters

	Weight	EW	BMI	FBG	FPI	HOMA-IR
"r"	0.254	0.602	0.569	0.475	0.509	0.565
P	>0.05	=0.001	=0.003	=0.016	0.009	=0.003

The correlation was significant with excess body weight, BMI, FBG, FPI and HOMA-IR score, but was non-significant with body weight (Table 19, Fig. 29 a-f).

Table (20): Stepwise regression analysis for predictors for serum PGRN ≥205 ng/ml

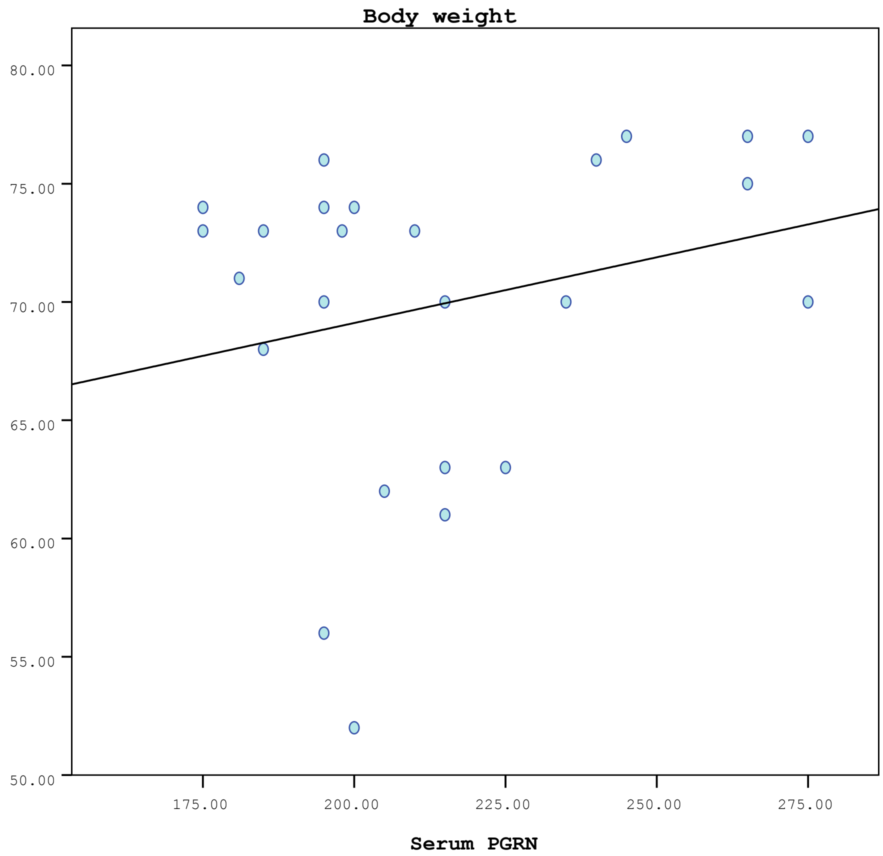
		B	T	Significance
Model 1	EW	0.585	4.165	<0.001
	BMI	0.454	3.232	=0.004
Model 2	EW	0.602	3.611	=0.001

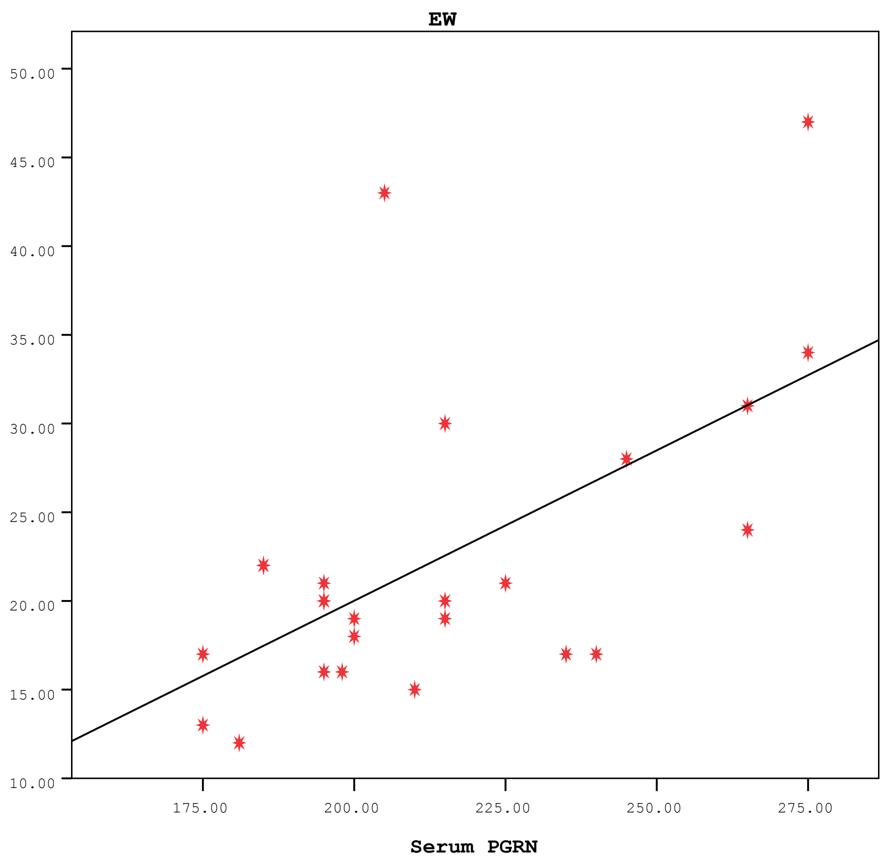
Stepwise regression analysis defined EW as dependent predictor for high serum PGRN in 2 models, followed by FBG in one model, while body weight, BMI, FPI and HOMA-IR were excluded as predictors for serum PGRN.

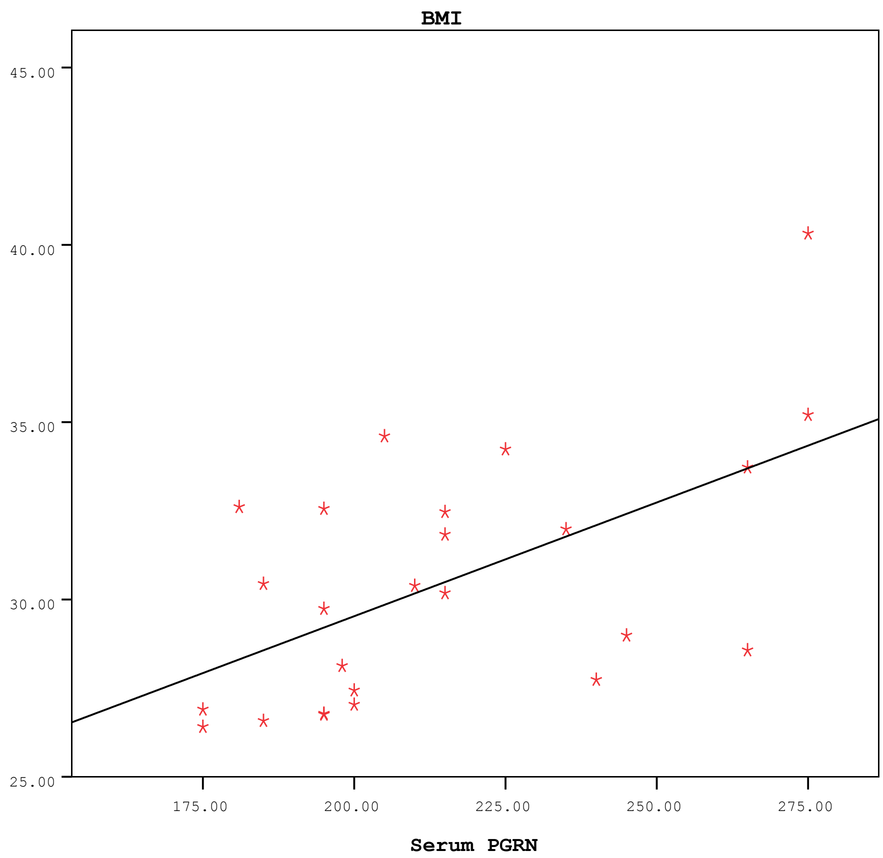
Table (21): ROC curve analysis for sensitivity and specificity of evaluated parameters as predictors for elevated serum PGRN level ≥205 ng/ml

	AUC	Diagnostic Significance
Body Weight	**0.125**	**Sensitive**
EW	**0.958**	**Specific**
BMI	**0.917**	**Specific**
FBG	**0.125**	**Sensitive**
FPI	**0.750**	**Specific**
HOMA-IR	**0.396**	**Non-sense**

ROC curve analysis defined body weight and FBG score as sensitive predictors for serum PGRN ≥205 ng/ml, while EW, BMI and FPI could be considered as specific predictors.




EW
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
175.00
200.00
225.00
250.00
275.00
Serum PGRN


BMI
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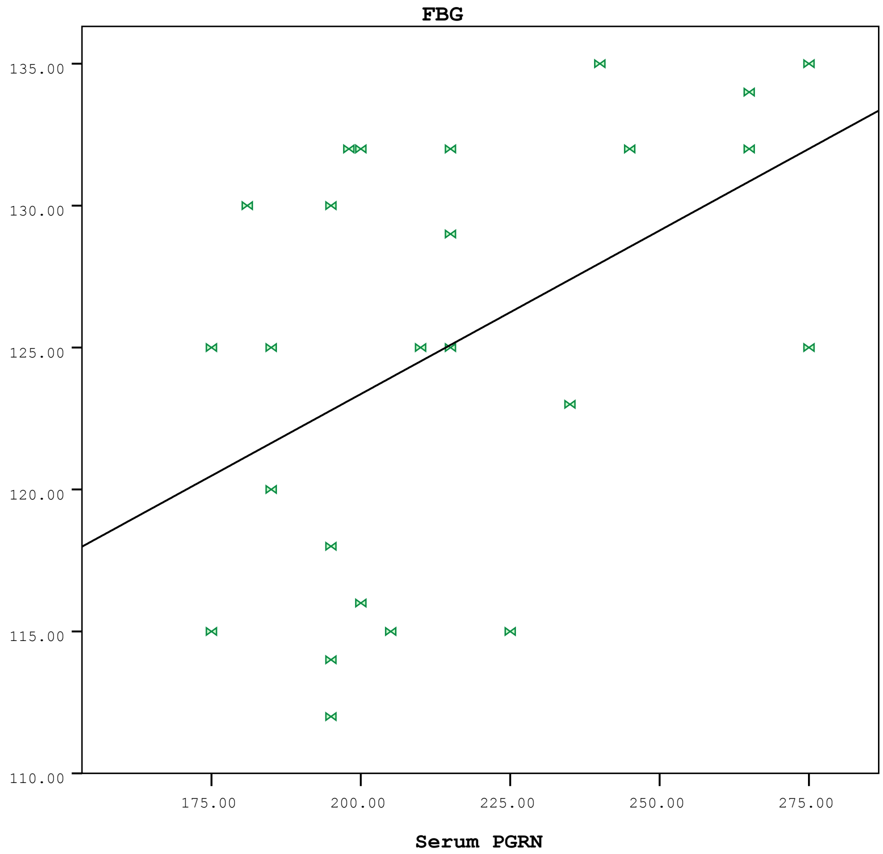
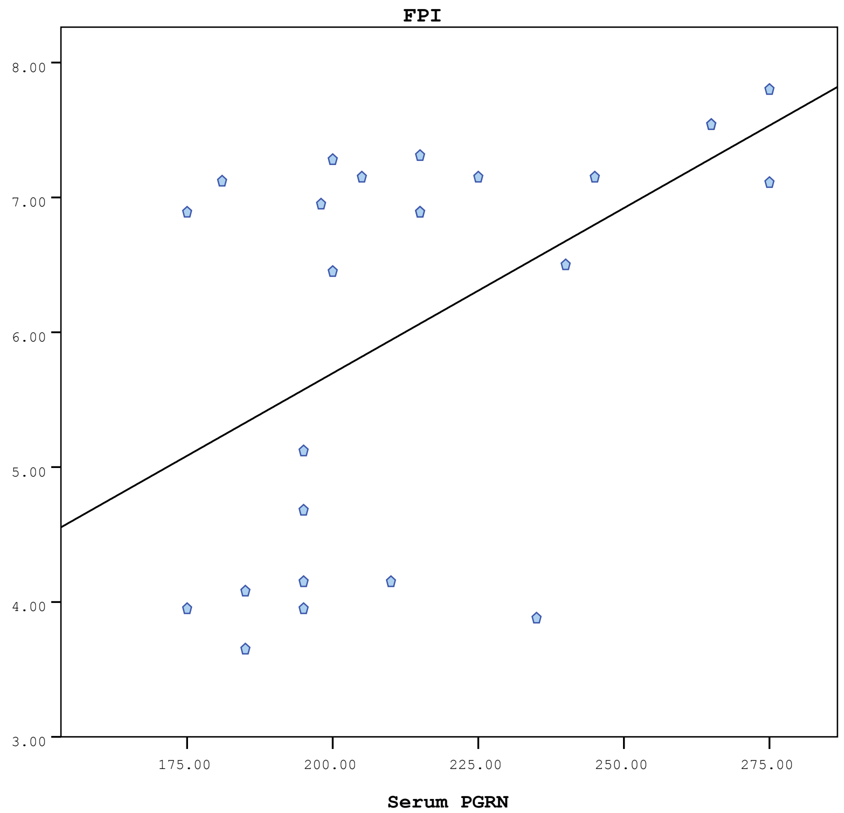
40.00
35.00
30.00
25.00
175.00
200.00
225.00
250.00
275.00
Serum PGRN


FBG
135.00
130.00
125.00
120.00
115.00
110.00
175.00
200.00
225.00
250.00
275.00
Serum PGRN


FPI
8.00
7.00
6.00
5.00
4.00
3.00
175.00
200.00
225.00
250.00
275.00
Serum PGRN

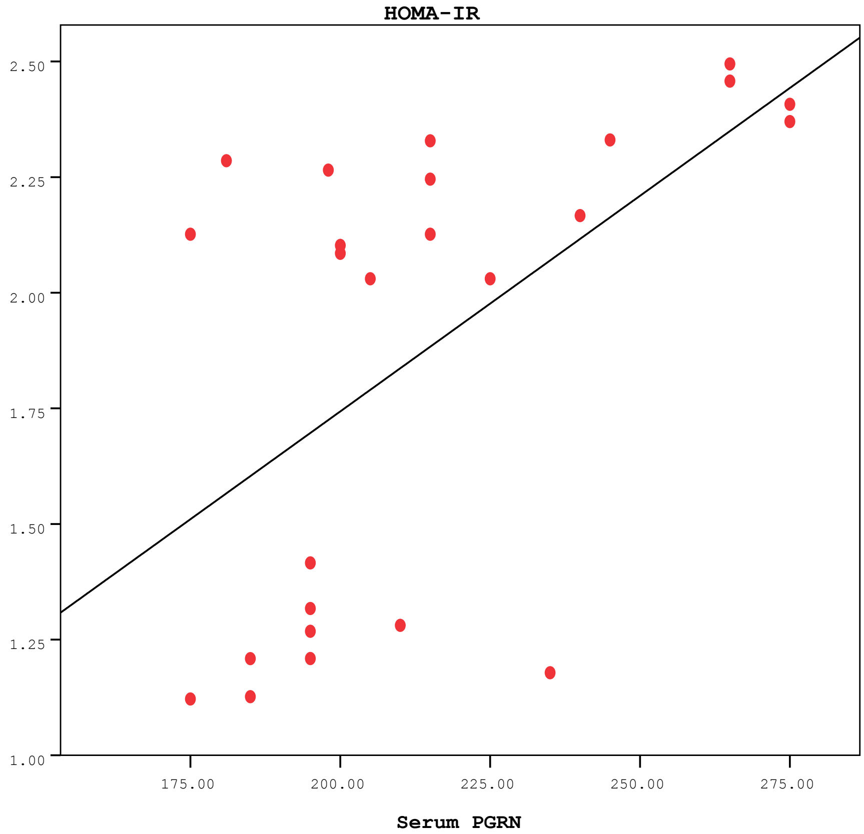


Fig. (29): Correlation between serum PGRN levels and evaluated parameters in studied children

The correlation was significant with excess body weight, BMI, FBG, FPI and HOMA-IR score, but was non-significant with body weight.

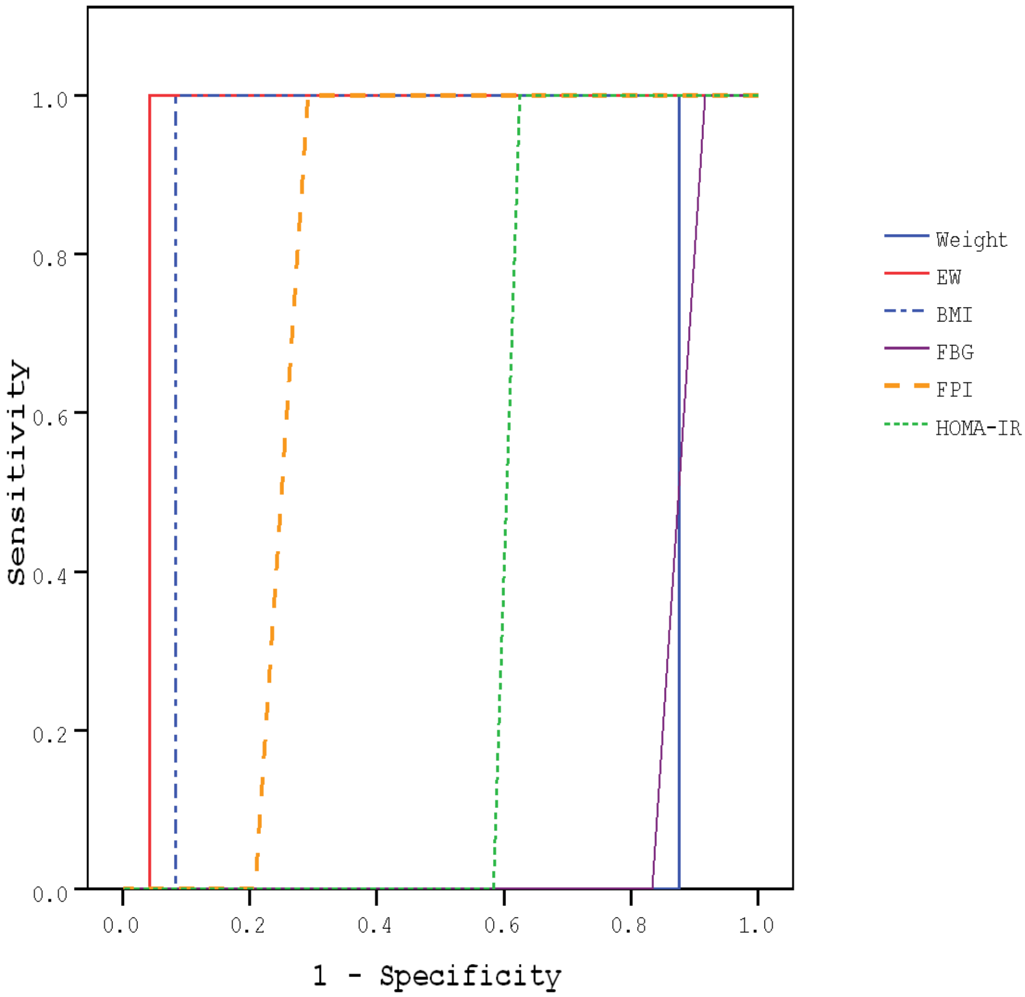


Fig. (30): ROC curve analysis of evaluated parameters as predictors of serum PGRN level ≥205 ng/ml

ROC curve analysis defined body weight and FBG score as sensitive predictors for serum PGRN ≥205 ng/ml, while EW, BMI and FPI could be considered as specific predictors.

Table (22): Mean (±SD) serum PGRN levels estimated at end of 3-month of intervention compared to baseline levels with reference to percentage of change

		Obese group			Diabetic group		
		Baseline	At 3-m	% of change	Baseline	At 3-m	% of change
Mean±SD		214.6±30.8	162.6±30.7	52±11.6	288±29.8	217.7±31	70.4±15.1
Range		120-275	120-215	27-66	215-325	162-281	28-82.2
Statistical analysis	t				4.824		
	p_1				<0.001		
	t		22.350			23.371	
	p_2		<0.001			<0.001	
	t					5.858	
	p_3					<0.001	
	t						4.574
	p_4						<0.001

Data are presented as mean±SD and ranges

p_1: significance between baseline levels of both groups

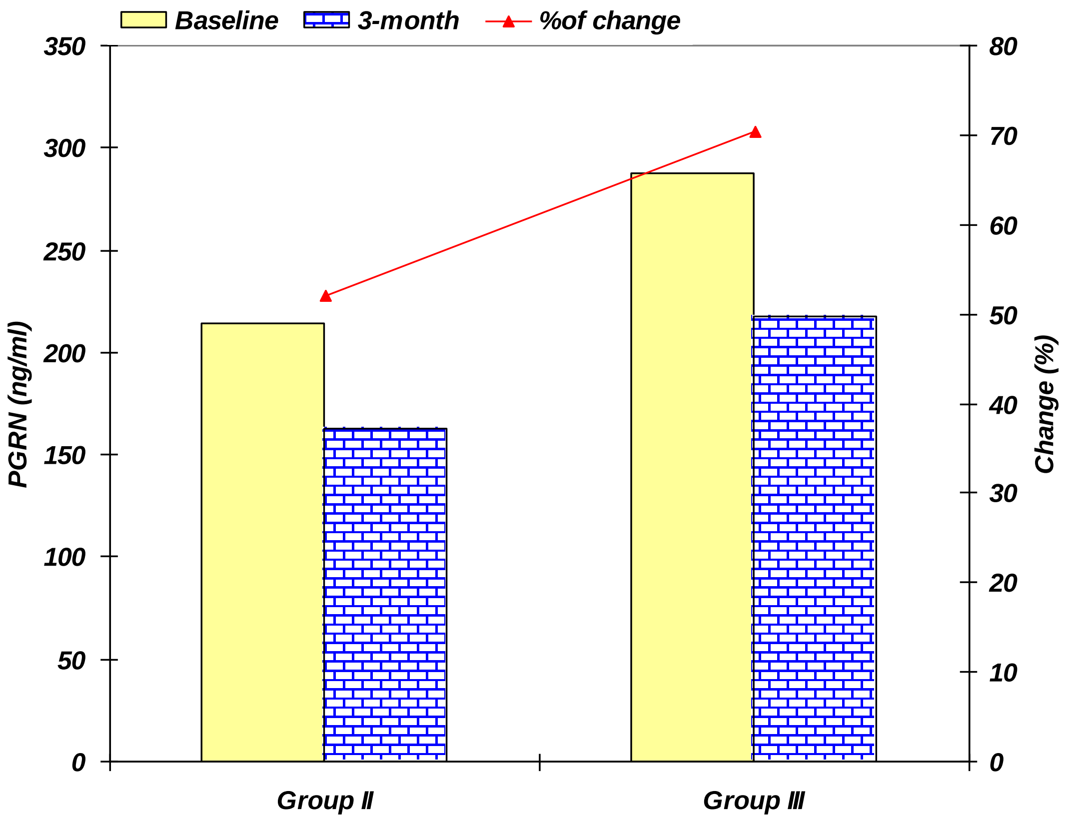
p_2: significance between 3-month versus baseline levels of both groups

p_3: significance between 3-month levels of both groups

p_4: significance between the % of change of 3-month levels in both groups

Mean serum PGRN showed significant decrease after weight reduction interventions compared to baseline levels in both obese and diabetic children with significantly higher percentage of decreased serum PGRN levels in diabetic children.

Fig. (31): Mean Serum PGRN levels estimated in both groups at end of 3-m compared to baseline levels with the % of chage



Mean serum PGRN showed significant decrease after weight reduction interventions compared to baseline levels in both obese and diabetic children with significantly higher percentage of decreased serum PGRN levels in diabetic children.

B) Serum YKL-40

Serum YKL-40 levels were found positively correlated with body weight, excess body weight above the normal range, BMI, FBG, FPI and HOMA-IR score.

Table (23): Correlation coefficient between serum YKL-40 levels and other evaluated parameters

	Weight	EW	BMI	FBG	FPI	HOMA-IR
"r"	0.339	0.436	0.204	0.431	0.399	0.460
P	>0.05	=0.029	>0.05	=0.031	0.048	=0.021

The correlation was significant with excess body weight, FBG, FPI and HOMA-IR score, but was non-significant with body weight and BMI.

Table (24): Stepwise regression analysis for predictors for serum YKL-40 ≥48.7 ng/ml

		B	t	Significance
Model 1	HOMA-IR	2.184	2.954	=0.008
	BMI	0.520	3.274	=0.004
	FPI	1.796	2.416	=0.025
Model 2	HOMA-IR	0.436	2.594	=0.017
	BMI	0.411	2.444	=0.023
Model 3	HOMA-IR	0.640	2.486	=0.021

Stepwise regression analysis defined HOMA-IR as dependent predictor for high serum YKL-40 in 3 models, followed by EW in 2 models and FPI in one model, while body weight, BMI and FBG were excluded as predictors for serum YKL-40.

Table (25): ROC curve analysis for sensitivity and specificity of evaluated parameters as predictors for elevated serum YKL-40 level ≥48.7 ng/ml

	AUC	Diagnostic Significance
Body Weight	**0.250**	**Non-sense**
EW	**0.688**	**Specific**
BMI	**0.042**	**Sensitive**
FBG	**0.458**	**Non-sense**
FPI	**0.786**	**Specific**
HOMA-IR	**0.0.54**	**Sensitive**

ROC curve analysis defined BMI and HOMA-IR score as sensitive predictors for serum YKL-40 ≥48.7 ng/ml, while EW and FPI could be considered as specific predictors.

Table (26): Mean (±SD) serum YKL-40 levels estimated at end of 3-month of intervention compared to baseline levels with reference to percentage of change

		Obese group			Diabetic group		
		Baseline	At 3-m	% of change	Baseline	At 3-m	% of change
Mean±SD		65.9±13.3	45.67±8.1	15.4±4.5	79.6±7.9	67.2±6.2	12±6.4
Range		41.6-85.9	36.7-62.7	9.5-29.1	61.8-95.5	53.2-80.9	7-27.1
Statistical analysis	t				4.824		
	p_1				<0.001		
	t		5.675			13.992	
	p_2		<0.001			<0.001	
	t					10.554	
	p_3					<0.001	
	t						2.891
	p_4						=0.008

Data are presented as mean±SD and ranges

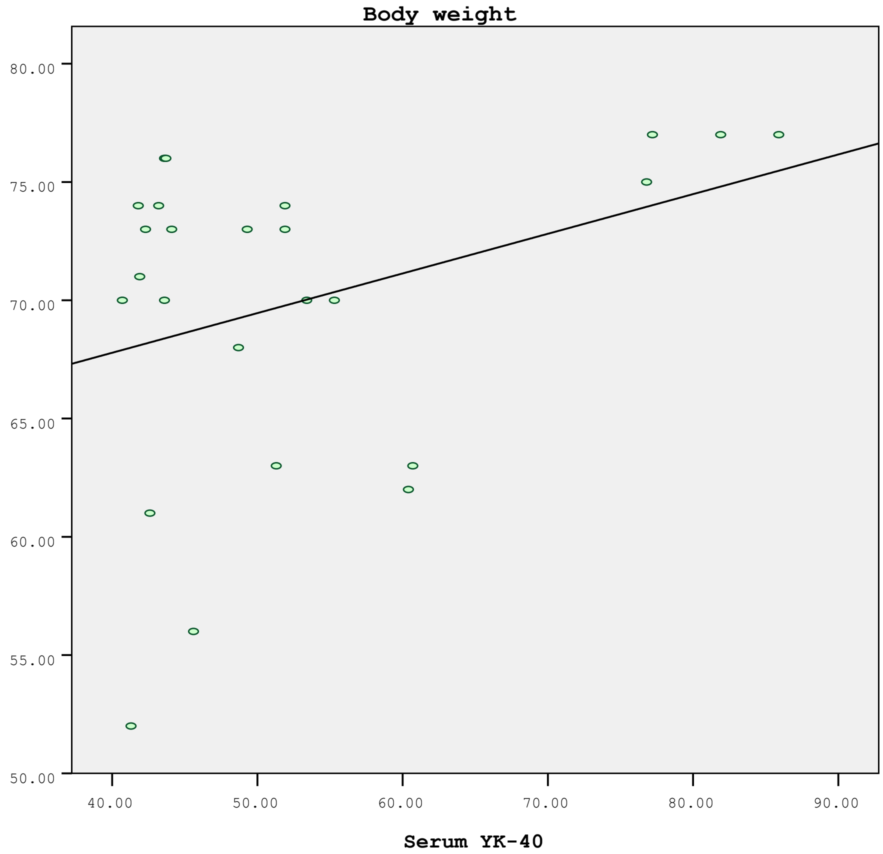
p_1: significance between baseline levels of both groups

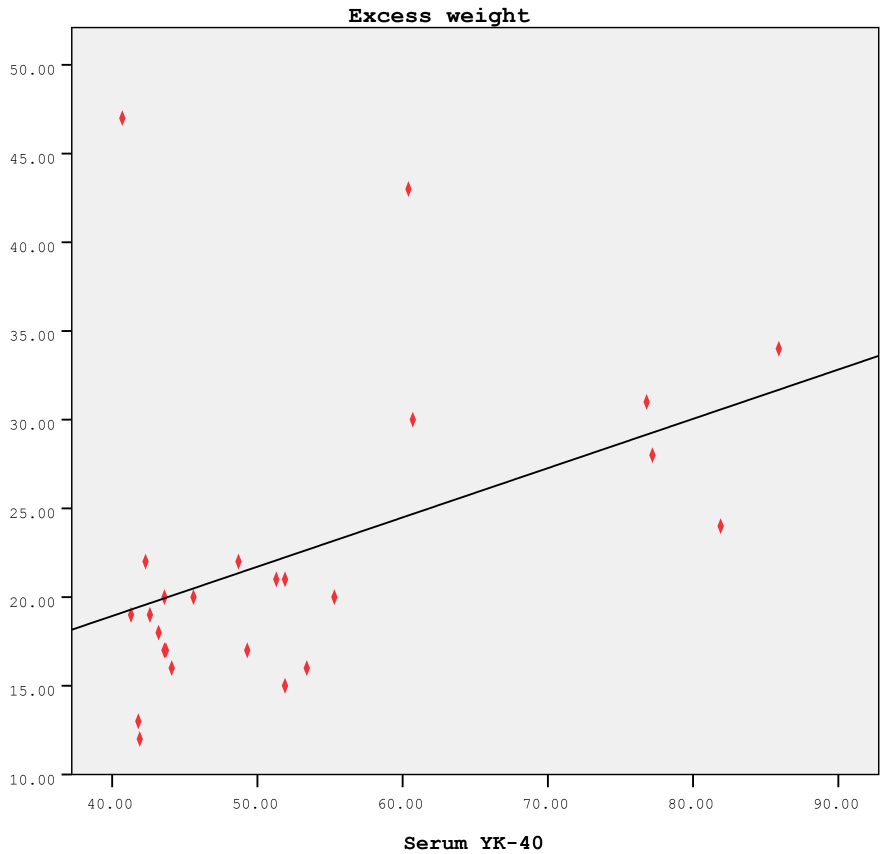
p_2: significance between 3-month versus baseline levels of both groups

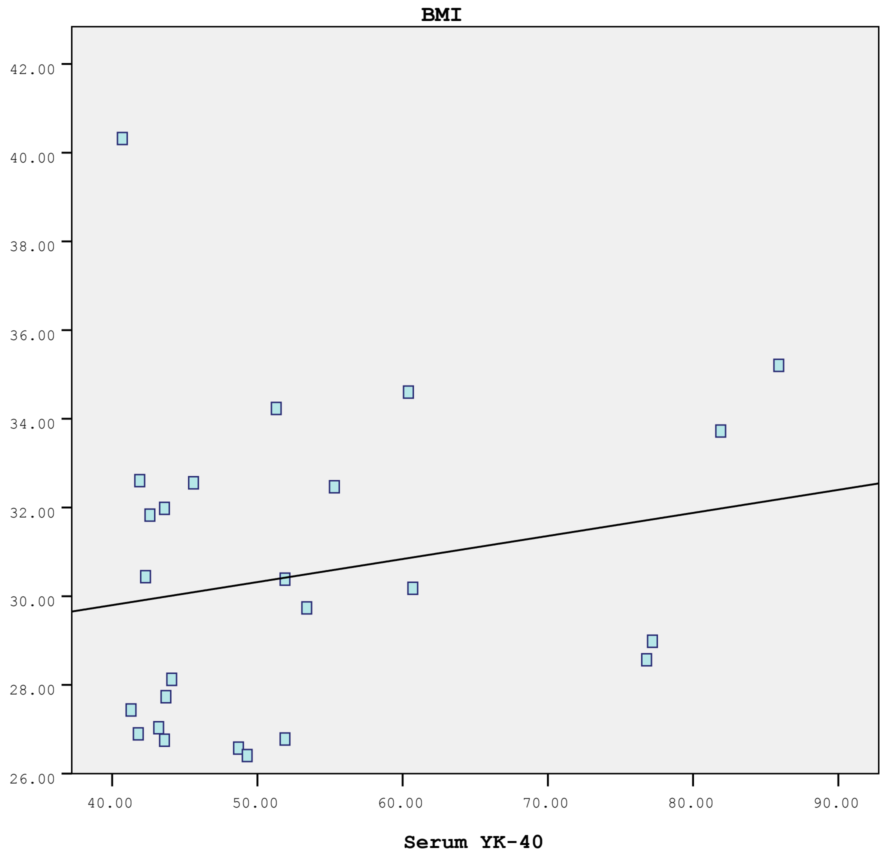
p_3: significance between 3-month levels of both groups

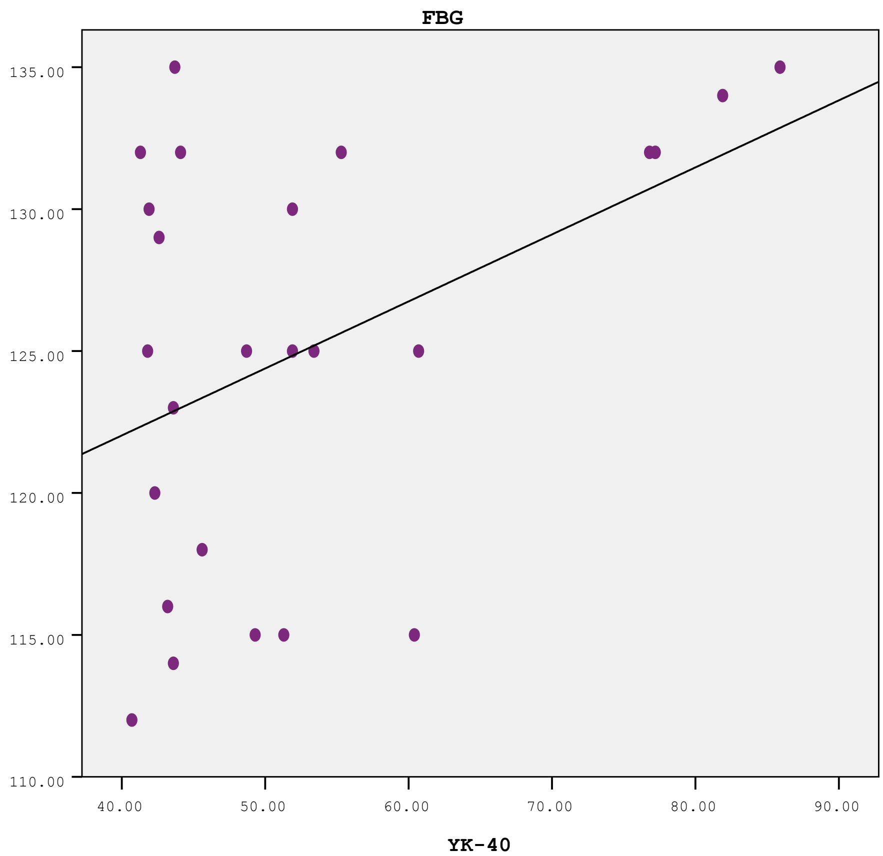
p_4: significance between the % of change of 3-month levels in both groups

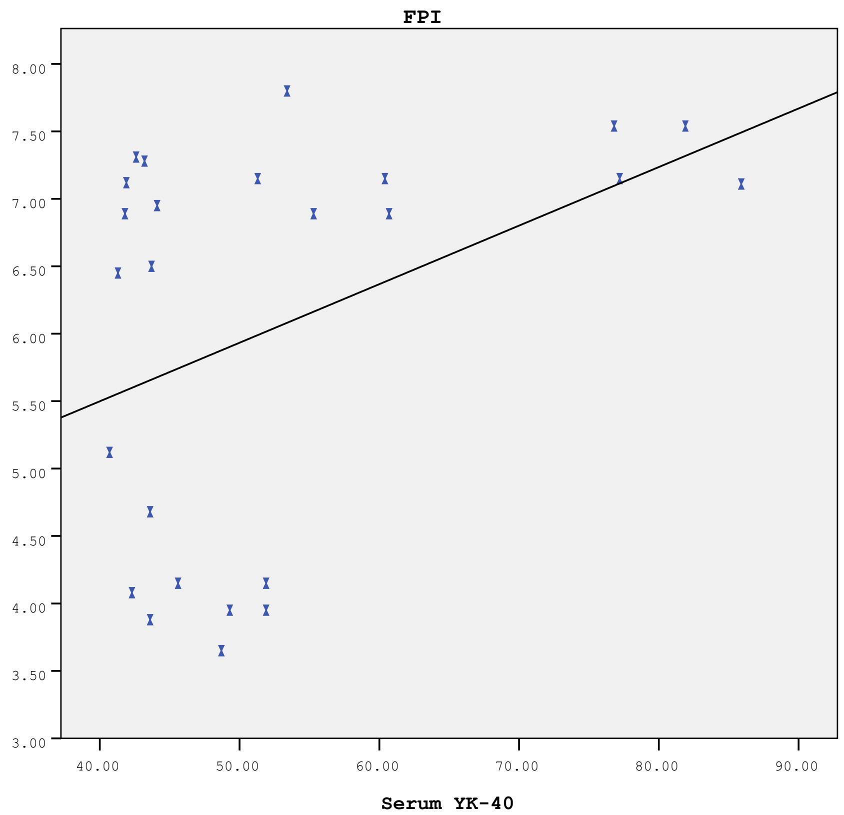
Mean serum YKL-40 showed significant decrease after weight reduction interventions compared to baseline levels in both obese and diabetic children with significantly higher percentage of decreased serum YKL-40 levels in obese children.


Body weight
80.00
75.00
70.00
65.00
60.00
55.00
50.00
40.00
50.00
60.00
70.00
80.00
90.00
Serum YK-40


Excess weight
50.00
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
40.00
50.00
60.00
70.00
80.00
90.00
Serum YK-40


BMI
42.00
40.00
38.00
36.00
34.00
32.00
30.00
28.00
26.00
40.00
50.00
60.00
70.00
80.00
90.00
Serum YK-40


FBG
135.00
130.00
125.00
120.00
115.00
110.00
40.00
50.00
60.00
70.00
80.00
90.00
YK-40



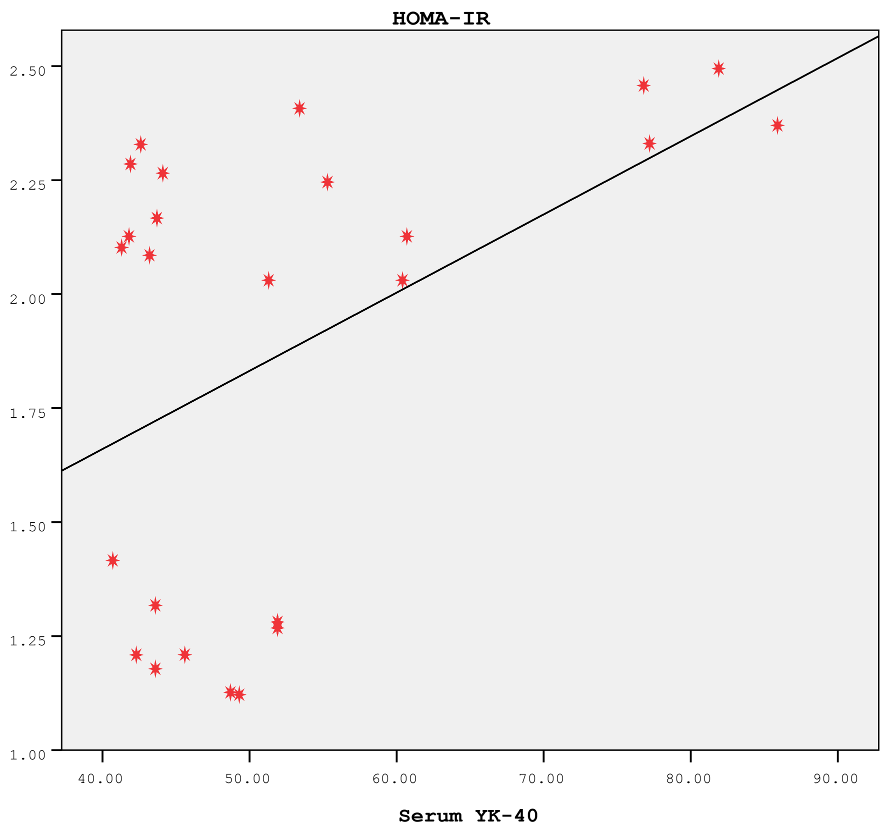


Fig. (32): Correlation between serum YKL-40 levels and evaluated parameters in studied children

The correlation was significant with excess body weight, FBG, FPI and HOMA-IR score, but was non-significant with body weight and BMI .

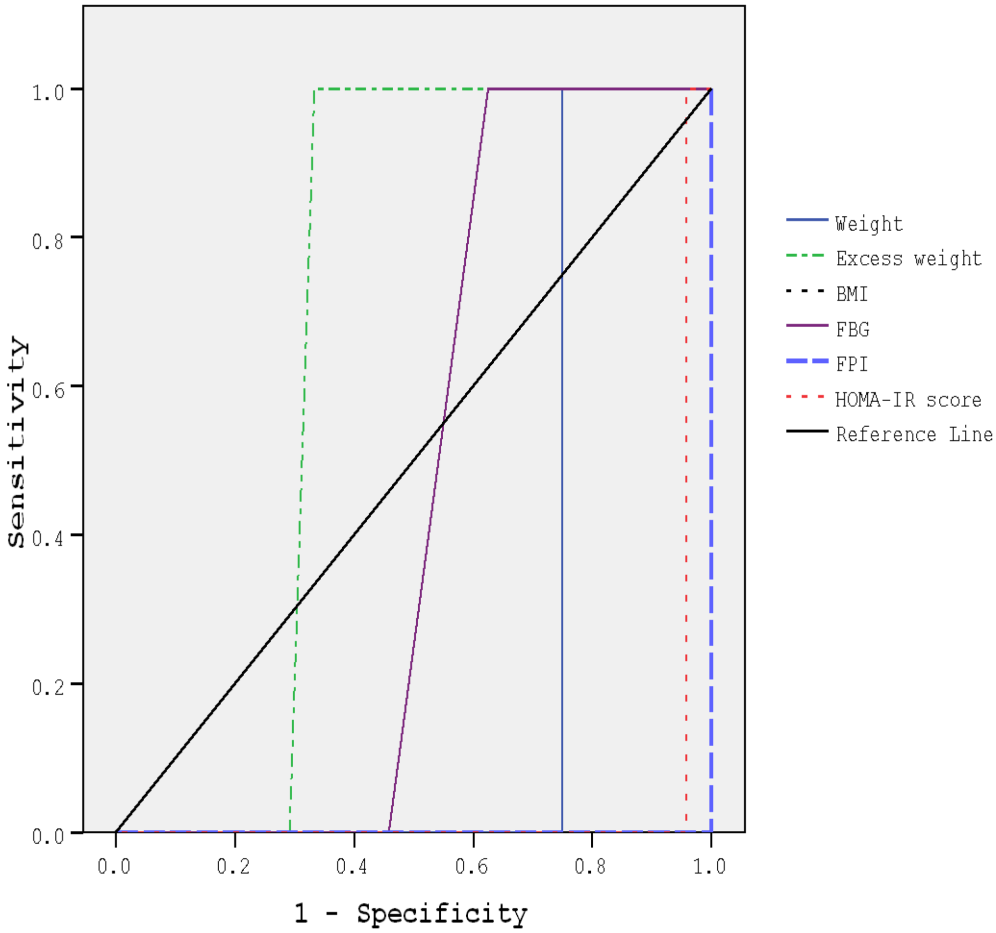
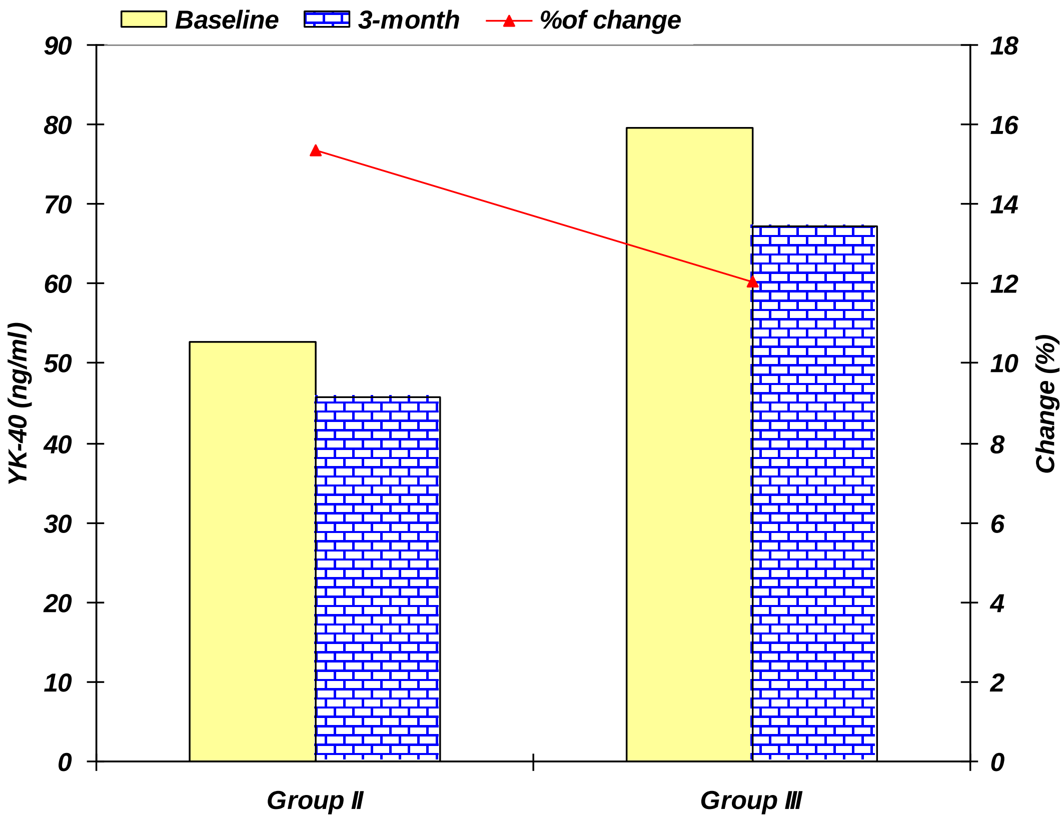


Fig. (33): ROC curve analysis of evaluated parameters as predictors of serum YKL-40 level ≥47.8 ng/ml

ROC curve analysis defined BMI and HOMA-IR score as sensitive predictors for serum YKL-40 ≥48.7 ng/ml, while EW and FPI could be considered as specific predictors.

Fig. (34): Mean Serum YKL-40 levels estimated in both groups at end of 3-m compared to baseline levels with the % of chage



Mean serum YKL-40 showed significant decrease after weight reduction interventions compared to baseline levels in both obese and diabetic children with significantly higher percentage of decreased serum YKL-40 levels in obese children.