Mediterranean Journal of Nutrition and Metabolism 8 (2015) 187–197
DOI:10.3233/MNM-150040
IOS Press

Effect of education on nutrition and diabetes status in type 2 diabetics in El Jadida province of Morocco

Youssef Dinar[a], Noureddin Elkhoudri[b] and Rekia Belahsen[a,*]

[a]*Laboratory of Biotechnology, Biochemistry, & Nutrition, Training and Research Unit on Nutrition & Food Sciences, Chouaib Doukkali University, School of Sciences, El Jadida, Morocco*
[b]*Laboratory of Human Ecology, Faculty of Sciences Semlalia Marrakech, Morocco*

Abstract.
STUDY OBJECTIVE: Diabetes is placed throughout the world at the forefront of health concerns because of the complications it causes and their adverse repercussions on health and economy. In Morocco, it is increasingly high and 90% of the diabetics have type II Diabetes. This disease may be preventable by the change of life style in diabetics and in populations at-risk. Education is reported to have positive impact on health. The aim of this study was to investigate the effect of an education program on the improvement of diabetes care in Moroccan diabetic adults.
MATERIAL AND METHODS: A sample of 240 type II diabetic patients; 20–65 years old, visiting the Azemmour hospital between January 2011 and March 2012 are divided in two groups: an educated group (EG) that received and a non-educated group (NEG) that did not receive any training on diabetes and improvement of diabetes care. Data on anthropometrical measurements, biochemical, socio-demographics and food consumption using 24 h dietary recall were collected in both groups.
RESULTS: The results show that HbAc1 was significantly higher in NEG than in the EG group (9.24% vs. 7.15% respectively). Globally 57.5% of diabetics cannot balance their diabetes; with high percentage among NEG (76.6%) than EG (23.4%) and in rural (78.4%) than in urban populations. Compared to the EG, the NEG patients have higher prevalence of physical inactivity, abdominal obesity, low HDL, high LDL, hypertriglyceridemia, hypertension, higher BMI mean (29.56 vs 26.48 kg/m^2) and longer duration of diabetes (9,13 vs 8,17 years respectively). Total food energy intake (TEI) was also higher (2411 $\pm$ 196) in the NEG than in EG (1966 $\pm$ 221 Kcal). The contributions of carbohydrates, proteins and lipids to the TEI were respectively (37.39 $\pm$ 4.48%), (22.88% $\pm$ 3.24) and (39.37 $\pm$ 4.43%); with a low intake of fiber (16.84 $\pm$ 3.55) in NEG.
CONCLUSION: The study results show an improvement of diabetes status in the educated patients. The data justify the fundamental role of patient education for an effective and efficient management of diabetes. The study recommends also an establishment of and access to care facilities especially for rural population of diabetic patients.

Keywords: Type 2 diabetes, complications, nutrition, education, Morocco

1. Introduction

Placed at the forefront of non-communicable diseases, diabetes is recognized by international organizations as a threat to global Heath and continues to preoccupy governments and health policy makers because of its complications and their adverse impact on health and on the economy.

*Corresponding author: Prof. Rekia Belahsen, Laboratory of Biotechnology, Biochemistry & Nutrition, Training and Research Unit on Nutrition & Food Sciences, Chouaib Doukkali University, School of Sciences, El Jadida, 24000, Morocco. Tel.: +212 523342325/664 97 16 16; Fax: +212 523 34 21 87/4449; E-mails: rbelahsen@yahoo.com; or b.rekia@gmail.com.

ISSN 1973-798X/15/$35.00 © 2015 – IOS Press and the authors. All rights reserved

Type II Diabetes (T2D) represents 90% of diabetes cases and it is progressing markedly achieving alarming proportions in the last decades [1]. Globally this pathology is considered by WHO an epidemic, predicted to be the seventh leading cause of death in the world by 2030 [3]. In the opposite of the type I, type II diabetes is largely preventable [2] by acting on lifestyle factors [4].

According to the 2013 estimates of the International Diabetes Federation (IDF), approximately 382 million people suffer from diabetes in the world and 80% of them live in low and middle incomes countries. If no measure is taken in the future and the increased trend continues, this number will approximately achieve 592 million by the year 2035. Diabetes has become one of the most common diseases and one of the main causes of premature death in most of the countries, particularly because of the increased cardiovascular risk [5].

Also, the prevalence of diabetes estimated by IDF in 2013, is 10,7% in the region of North America and the Caribbean. In Africa, about 20 million adults (4.9%) are affected, 522600 people died of diabetes associated disorder and 63% have undiagnosed diabetes and already have complications [6–8].

In Europe, 56.3 million of people are diabetic according to the 2013 IFD estimates and 21.2 million do not aware that they are affected. In the Middle East and Gulf region, very high prevalences are found achieving 23.7% in Saudi Arabia for example [9, 10].

In Morocco, the IFD estimated the prevalence of diabetes to 7.35% in 2012 corresponding to 1 million and 403 thousands diabetics. A recent study undertaken in the eastern region of Morocco on 1628 subjects, reported that 10.2% of the subjects were diabetic and 8.1% with pre-diabetes, showing that the disease is in continuous progress [11]. Acting on the main triggering modifiable factors such as obesity or overweight, physical inactivity, unhealthy diet and smoking can prevent this disease [3]. The awareness and education of people with diabetes can be the basis of any preventive and therapeutic action against its resurgence [12].

The present study aims to examine the effect of an awareness and education program on diabetes status, nutritional status and on metabolic control of diabetic patients; the purpose being to evaluate the role of education on self-management of diabetes.

2. Subject, materials and methods

The study was undertaken between January 2011 and March 2012 and focused on a sample of 240 patients with already known type II diabetes 20 to 65 years old, 150 female and 90 male. Pregnant women are excluded from the study. The sample was divided into two groups according to their adherence to the education and awareness program on diabetes established by the Ministry of Health: a group that followed the programme sessions for at least 2 months i.e. 8 sessions, called also educated group (EG, $n = 95$) and a second group of patients who have never attended any of the program sessions and called non-educated group (NEG, $n = 145$).

The program on diabetes consists of sessions, using Brochures and leaflets as teaching materials, to raise awareness on diabetes definition, treatment and care, life hygiene and dietary measures, physical activity, diabetic foot and, acute and chronic diabetes complications. The sessions are conducted once a week by a staff composed of a technician in nutrition, comprehensive nurses and two medical practitioners having already benefited from a training organized by the Ministry of Health on diabetes at the province level.

Venous blood samples were collected for the determination of biochemical parameters. Total cholesterol (CHO), triglycerides (TG) and high density lipoprotein Cholesterol (CHO-HDL) are determined by enzymatic methods and the Low Density Lipoprotein Cholesterol (CHO-LDL), was calculated by Friedwal method. The level of blood glucose was determined in fasting and in postprandial phase by enzymatic method and that of glycated hemoglobin (HbA1c) by immunological method. All biological analyses are determined using a biochemistry automated anlyzer (CS-T240). Anthropometrical parameters were also measured on the subjects wearing a minimum of clothing and without shoes: weight was measured using scales, and expressed in kg at the nearest of 0.5 kg, height (in cm) was measured using a strait jacket at the nearest of 0.5 cm; the waist circumference (WC) was measured at horizontal level of the umbilicus and hip circumference (H) at the widest circumference of the hip, using a tape measure and expressed in (cm). Body mass index (BMI) (weight in kg divided by height square in m^2) and the waist to hip ratio (WHR) (WC divided by hip circumference in cm) were calculated [13]. BMI and WC are respectively determining general and abdominal obesity and fat distribution (WHO, 2003). The risk of obesity is present when the BMI is ≥ 30

for both sexes and when the WC is greater than 102 cm in men and 88 cm in women. The subjects systolic (SBP) and diastolic (DBP) blood pressure are measured in the sitting position after 10 minutes rest using a Vaquez manometer.

Data on food intake are determined using the 24 hours recall method and the food composition is calculated using the software BILNUT 2.01. (S.C.D.A. NUTRISOFT-BILNUT. Information on the socio-economic and demographic characteristics was collected using questionnaires and data on smoking and physical inactivity are also collected. Subjects which do not exceed 150 min per week of physical activity of moderate intensity are considered sedentary as recommended by most of the international agencies (HAS, IFD and ADA).

Approval of the study protocol and oral consent were obtained from health authority and patient respectively.

2.1. Statistical analysis

Statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) program, version 18 (SPSS Inc., Chicago, Illinois, USA). The Mann-Whitney test was used for the comparison of quantitative variables means of anthropometric parameters according to age groups. Qualitative variables are compared using Chi2 or Fisher's test. Logistic regression was used to determine variables predicting uncontrolled diabetes among the study population with adjusting for different confounding variables. The results are presented as Odds Ratio and confidence interval at 95%. The threshold of significance was set at $p < 0.05$.

3. Results

The final study sample was of 240 type 2 diabetic patients divided into two groups, educated group (EG; $n = 95$) having followed and the non educated one (NEG; $n = 145$) who did not follow the education and awareness program on diabetes. The Table 1 shows data on the sample sociodemographic characteristics. Overall, the average age of the studied population was 49 years; 59.6% are women and 40.4% men, 49% of the subjects were from rural areas; about 77% were married and 58% were without professional activity (68% of them are within the NEG). The illiteracy rate was 39%, higher among the NEG compared to the EG (65.2% vs 34.8% respectively).

The Table 1 shows also that the percentage of females was high in EG due to a high participation of women in the education programme (about 70%). This result can be explained by the availability of women and their interest in health awareness programs.

The results show that the study subjects had diabetes for on average 9 years, this duration was <5 years in 34%, of 5–15 years among 44% and >15 years in 22% of subjects. In the NEG about 69% of the subjects had diabetes for 5–15 years.

3.1. Physical activity and tobacco use

Concerning the lifestyle data, as shown in Table 1, 22% of the subjects are smokers and the rate of smoking was higher in NEG (∼68%) than in the EG (32.1%). Similarly physical inactivity (low physical activity) was more prevalent in the NEG (77%) compared to the EG (46%).

3.2. Anthropometrical and biochemical parameters

Table 2 shows that more than 70% of the study subjects had overweight or obesity. The NEG had higher rate overweight and obesity (77.5% vs 22.5%), higher mean BMI (29.6 ± 3.5 vs $26.5 \pm 3.43\,kg/m^2$), higher mean WC (98.67 ± 15.4 vs. 89.25 ± 11.50 cm) than EG and 74% of NEG subjects have uncontrolled diabetes. Uncontrolled diabetes was also more prevalent among women than men (61% vs 39%). The HbA1cmean is higher in NEG than in the EG (9.16 ± 2.06 vs 7.13 ± 1.47) (Table 2) and the % of diabetics with highest HbA1c rate (>7%) increases with age (non shown). In addition the mean levels of fasting glucose, postprandial glucose, total cholesterol, triglycerides and lower mean HDL cholesterol and LDL cholesterol in NEG than in EG. On the other hand, 57% of study sample are hypertensive with 63% of them belong to NEG.

Table 1
Socio-demographic characteristics of the study subjects

Socio-demographic	EG *n* (%)	NEG *n* (%)	χ^2 test	*P*
Sex				
Male	29 (44,0%)	61 (56,0%)	3.26	0.71
Female	66 (32,2%)	84 (67,8%)		
Age	46,45 ± 8,20	51,67 ± 8,30	–	0.000
Area of residency				
Urban	80 (65%)	43 (35%)	68.37	0.000
Rural	15 (12,8%)	102 (87,2%)		
Marital status				
Maried	69 (37,5%)	115 (62,5%)	1.43	0.32
No-maried	26 (46,4%)	30 (53,6%)		
Education level				
None	32 (34,8%)	60 (65,2%)	2.67	0.44
Primary	26 (48,1%)	28 (51,9%)		
Secondary	22 (37,9%)	36 (62,1%)		
Superior	15 (41,7%)	21 (58,3%)		
Diabetes duration				
<5 years	42 (51,2%)	40 (48,8%)	7.83	0.020
5–15 years	33 (31,1%)	73 (68,9%)		
>15 years	20 (38,5%)	32 (61,5%)		
Sedentarity				
Yes	44 (28,2%)	112 (71,8%)		0.0000
No	51 (60,7%)	33 (39,3%)	4.21	
Diabetes Family history				
Yes	73 (47,1%)	82 (52,9%)	3.28	0.73
No	22 (25,9%)	63 (74,1%)		
Professional occupation				
Yes	50 (49,5%)	51 (50,5%)	48.3	0.90
No	45 (32,4%)	94 (67,6%)		
Smoking status				
Yes	17 (32,1%)	36 (67,9%)	3.02	0.08
Non	85 (45,5%)	102 (54,5%)		

Abbreviations: EG: Educated Group; NEG: Non Educated Group.

The Table 3 shows the overall recommended therapeutic goals within each group (a rate of HbA1c <7%, a SBP <135 mm Hg and DBP <85 mm Hg, a rate of LDL-cholesterol<100 mg/dl, a rate of HDL-C >40 mg/dl for men and >50 mg/dl for women, a fasting blood glucose <126 and a postprandial glucose <190 mg/dl). These goals were achieved in only 0.68% (1/145) among the NEG and 4,21% (4/95) in the EG. In general, 42.5% only of the study subjects have their HbA1c controlled ($\leq$7) and about 57% have hypertension that was more prevalent among women than men (64,7% vs 35.3%). The levels of SBP and DBP were higher in NEG compared to EG (180.44 ± 54.47 vs 102.92 ± 21.08); (145.58 ± 21.20 vs 90.44 ± 12.45) (Tables 2 and 3).

3.3. Complications of diabetes

Table 4 shows that the overall prevalence of complications in NEG exceeds that of EG (52.6% vs 47,4%) as well as that of each complication, namely nephropathy, retinopathy, neuropathy, the diabetic foot and infections that are respectively (41.9% vs 58.1%), (58.0 vs 42.0%), (42.9% vs 57.1%), (33.3 vs 66.7%) and (32.4 vs 67.6%) in the EG and NEG respectively.

Table 2
Biochemical and anthropometrical parameters

Parametres	EG ($n=95$)	NEG ($n=145$)	P
FG (mg/dl)	127 ± 45	181 ± 50	0.000
PPG (mg/dl)	164 ± 52	265 ± 58	0.000
HbA1c (%)	$7{,}13 \pm 1{,}47$	$9{,}16 \pm 2{,}06$	0.000
TC (mg/dl)	179 ± 48	214 ± 59	0.000
TG (mg/dl)	135 ± 45	153 ± 50	0.015
HDL (mg/dl)	40 ± 11	35 ± 11	0.002
LDL (mg/dl)	144 ± 49	131 ± 46	0.000
WC (cm)	$89{,}25 \pm 11{,}50$	$98{,}67 \pm 15{,}40$	0.000
H (cm)	$107{,}63 \pm 12{,}59$	$114{,}64 \pm 15{,}26$	0.001
WHR	$0{,}82 \pm 0{,}05$	$0{,}85 \pm 0{,}047$	0.000
BMI	$26{,}48 \pm 3{,}43$	$29{,}56 \pm 3{,}54$	0.000
SBP (mmHg)	$145{,}58 \pm 21{,}20$	$180{,}44 \pm 54{,}47$	0.000
DBP (mmHg)	$90{,}44 \pm 12{,}45$	$102{,}92 \pm 21{,}08$	0.000

Abbreviations: FG: fasting glucose; PPG: Post- Prandial Glycaemia; HbA1c: Hemoglobin A1c; TC: Total Cholesterol; TG: Triglycerids; HDL: High Density lipoprotein; LDL: Low Density Lipoprotein; WC: Waist Circumference; H: Hip Circumference; WHR: Waist to Hip Ratio; BMI: Body Mass Index; SBP: SystolicBlood Pressure; DBP: Diastolic Blood Pressure; EG: Educated Group; NEG: Non Educated Group.

Table 3
Prevalence of therapeutic goals achievement in the study subjects

Therapeutic goals		EG (95)		NEG (145)		Total (240)	
		N	%	N	%	N	%
HbA1C	$\leq$7%	63	66,3	39	26,9	102	42,5
SBP	$\leq$135 mm Hg	47	49,4737	39	26,9	86	35,83
DBP	$\leq$85 mm Hg	27	28,4211	23	15,86	50	20,83
HDL/F	>50 mg/dl	24	25,2632	17	11,72	41	17,08
HDL/M	>40 mg/dl	15	15,7895	23	15,86	38	15,83
LDL	<100 mg/dl	46	48,4211	28	19,31	74	30,83
FG	$\leq$126 mg/dl	52	54,7368	25	17,24	77	32,08
PPG	$\leq$190 mg/dl	68	71,5789	24	16,55	92	38,33
Total Achievement		4	4,21	1	0,69	5	2,08

Abbreviations: SBP: SystolicBlood Pressure; DBP: Diastolic Blood Pressure; HDL/M: HDL in Male; HDL/F: HDL in Female; LDL: Low Density Lipoprotein; FG: Fasting Glycaemia; PPG: Post Prandial Glyceamia; EG: Educated Group; NEG: Non Educated Group.

3.4. Daily food intake

As shown in the Table 5 the total energy intake (TEI) was significantly higher in NEG than in the EG (2411 ± 196 vs 1996 ± 221 Kcal). NEG has low contribution of carbohydrates to their TEI ($37.39 \pm 4.48\%$). This contribution is different of the international recommendation that is 50 to 55% of the TEI. The protein and lipids contributed respectively to $22.8 \pm 3.24\%$ and $39.73 \pm 4.43\%$ of TEI. On the other hand the NEG subjects have high intake of SFA and cholesterol and low intake of fiber. The ratio PA/PV (animal to vegetal protein ratio) was also higher in the NEG than the EG (0.8216 ± 0.1684 vs 0.7253 ± 0.1891).

Table 4
Declared diabetes complications

Diabetes complications	EG	NEG	χ^2 test	*P*
	n (%)	*n* (%)		
Nephropathy				
Yes	13 (41,9%)	18 (58,1%)	0,082	0,77
No	82 (39,2%)	127 (60,8%)		
Retinopathy				
Yes	29 (58,0%)	21 (42,0%)	8,95	**0,003**
No	66 (34,7%)	124 (65,3%)		
Neuropathy				
Yes	3 (42,9%)	4 (57,1%)	0,032	0,9
No	92 (39,5%)	141 (60,5%)		
Diabetic foot				
Yes	3 (33,3%)	6 (66,7%)	0,15	0,9
No	92 (39,8%)	132 (60,2%)		
Infections				
Yes	12 (32,4%)	25 (67,6%)	0,93	0,33
No	83 (40,9%)	120 (59,1%)		

Abbreviations: EG: Educated Group; NEG: Non Educated Group.

Table 5
Dietary intake in the study subjects

Daily dietary intake	EG	NEG	P
Total Enery Intake (TEI)			
Kcal	1996,13 ± 221,16	2411 ± 196,2	0.000
Carbohydrates			
g/d	209,31 ± 20,92	223,99 ± 21,35	0.000
%TEI	42,33 ± 5,32	37,39 ± 4,48	0.000
Proteins			
g/d	94,85 ± 21,21	138,74 ± 25,90	0.000
%TEI	18,86 ± 3,00	22,88 ± 3,24	0.000
PA/PV	0,7253 ± 0,1891	0,8216 ± 0,1684	0.000
Lipids			
g/d	82,72 ± 14,79	106,78 ± 16,97	0.000
%AET	37,1185 ± 3,792	39,73 ± 4,43	0.000
SFA(%TEI)	12,44 ± 2,89	14,09 ± 2,89	0.000
MUFA (%TEI)	12,84 ± 2,53	13,02 ± 2,45	0.58
PUFA (%TEI)	11,82 ± 3,71	12,62 ± 4,62	0.15
C mg/d	352,47 ± 79,04	436,93 ± 85,79	0.000
Fiber			
g/d	21,78 ± 3,67	16,84 ± 3,55	0.000

Abbreviations: PA/PV: Animal to Vegetal ratio; SFA:Saturated Fatty Acids; MUFA: Monounsaturated Fatty acids; PUFA: polyunsaturated Fatty acids; C: Cholesterol; TEI: Total Energy Intake? EG: Educated Group; NEG: Non Educated Group.

Table 6
Metabolic imbalance in diabetic patients and risk factors

Variables	Controlled Diabetes (HbA1C ≤7)	Uncontrolled Diabetes (HbA1C >7)	χ^2 test	*P*
Age	46,47 ± 8,06	51,92 ± 8,32	–	0.000
Sex				
Male	43 (47,8%)	47 (52,2%)	1.64	0.2
Female	59 (39,3%)	91 (60,7%)		
Marital status				
Maried	74 (40,2%)	110 (59,8%)	1.68	0.19
Non-maried	28 (50,0%)	28 (50,0%)		
Area of residence				
Urban	81 (65,9%)	42 (34,1%)	56.3	0.000
Rural	21 (17,9%)	96 (82,1%)		
Education level				
None	18 (19,6%)	74 (80,4%)	38.9	0.000
Primary	29 (53,7%)	25 (46,3%)		
Secondary	28 (48,3%)	30 (51,7%)		
Superior	27 (75,0%)	9 (25,0%)		
Diabetes duration (years)				
<5	54 (65,9%)	28 (34,1%)	32.3	0.000
5–15	26 (24,5%)	80 (75,5%)		
>15	22 (42,3%)	30 (57,7%)		
BMI (kg/m^2)				
<25	62 (87,3%)	9 (12,7%)	84.051	0.000
25–30	22 (20,6%)	85 (79,4%)		
>=30	18 (29,0%)	44 (71,0%)		
Fasting Glyceamia				
<126 mg/dl	18 (29,0%)	44 (71,0%)	1.53	0.000
≥126 mg/dl	25 (15,3%)	138 (57,5%)		
PPG				
<190 mg/dl	86 (95,6%)	4 (4,4%)	1.65	0.000
≥190 mg/dl	16 (10,7%)	134 (89,3%)		
Physical Activity				
Yes	71 (84,5%)	13 (15,5%)	93.39	0.000
No	31 (19,9%)	125 (80,1%)		
Total Energy Intake (Kcal)	2062,18 ± 283,14	2384,30 ± 206,54	–	0.000
Fiber g/d	21,15 ± 4,25	17,05 ± 3,50	–	0.000

Abbreviations: BMI: Body Mass Index; PPG: Post Prandial Glyceamia.

3.5. Metabolic imbalance and associated risk factors in diabetic patients

The HbA1c is a blood test that serves as indicator of glucose control or metabolic imbalance in diabetics. Variables predicting for HbAc1 control among the study population are studied by adjusting to different confounding factors in the 2 subjects groups, the group of diabetics having HbA1c control (≤7) and the group of diabetics with metabolic imbalance (HbA1c >7).

The Table 6 shows a statistically positive association of metabolic equilibrium with physical activity, the area of residence, the duration of diabetes, PPG, FG, age, the TEI, fiber intake and the education level of the study subjects.

The multiple linear regression analysis showed that the PPG, physical activity, BMI and education level, were the variables predicting metabolic imbalance in the study diabetic subjects (Table 7). A negative association is also noted

Table 7
Odds ratios of metabolic disequilibrium associated factors

	p	O.R	CI
Education level	0.001	2.96	1.54–5.68
BMI	0.002	9.628	2.317–40.008
PPG	0.000	268.434	36.4–1979.5
Physical Activity	0.001	59.309	5.583–630.09

BMI: Body Mass Index, PPG: Post Prandial Glyceamia. OR: Odds Ratio, CI: Confidence Intervalle.

between the education level and glycemia imbalance, being educated reduced three times the risk of uncontrolled diabetes (O.R = 2.96; 95% IC1, 54–5.68).

4. Discussion

In this study we found a higher overall achievement of the therapeutic goals recommended by the education programme in educated than in non educated diabetic subjects. However these recommended goals were globally – low as they were achieved in only 0.68% among the NEG and 4,21% in the EG.

This study conducted in the Moroccan province of El-Jadida on a final sample of 240 subjects with type II diabetes, showed a high participation of women (62,5%). The same observation was reported before by other studies carried out in Morocco on obesity by Lahmame et al. (2008) and on diabetes and obesity by Ramdani et al. (2008) [14, 15]. This can be explained by the availability of women and their interest in health awareness programs. The high prevalence of overweight and obesity reported in this population (70%) is also consistent with the literature as type II diabetes is associated with these two abnormalities [16].

On the other hand, more than 60% of people with type II diabetes do not benefit from a therapeutic education. As the majority of the study subjects (more than 70%) are of rural origin, this can be related to the problem of access to care for the populations in rural areas which is still a constraint for the country health system. Bailie et al. (2004) have also shown the difficulty of providing complete diabetes care in small and remote communities because of the problems of keeping staff as well as the lack of support offered to clinicians and, in some cases, the refusal of services [17].

The low percentage of diabetic patients achieving the overall objectives recommended by international bodies has been already reported in Morocco [18] in a cross-sectional study undertaken on 215 with type I diabetes (TID) and 509 with type II diabetes (TIID) recruited by general practitioners and specialists in the framework of an international multicentre study (International Diabetes Management Practice Study, IDMPS (Wave 2)). The study reported that only 0,6% of TID and 0.4% of TIID had reached the recommended goals [18] which is in agreement with the data reported here and testified the poor quality of care available for diabetic patients population.

In this study, education level is a determining factor for the control of diabetes that may explain the results reported here concerning the response rate to the educational intervention. In fact 80.4% among the subjects who had uncontrolled diabetes are illiterate.

While an educational approach is based on the establishment of education, cultural and social diagnosis, to identify in each patient, the resources, the potential, the needs and the difficulties influencing the learning process [19], in this study we have not taken into consideration the degree of training of the subjects or the quality of the educational program. Indeed it is reported in the literature that more patients are being educated, more they follow the dietary guidelines and they adopt healthy lifestyle [20]. A study conducted by Garay-Sevilla ME et al. (2003) on 156 type 2 diabetic patients has demonstrated that adhering to the dietetic measures was significantly associated with the socio-economic level ($p = 0.001$) and that adhering to the treatment appeared to be also associated with the education level ($p = 0.001$) [21].

Our results show that globally diabetes complications are more prevalent in the NEG than in EG with HbA1c rates of 9.16 ± 2.06 vs 7.13 ± 1.47% respectively. This result is consistent with a previous pilot study UKPDS (United

Kingdom Prospective Diabetes Study) over 20 years (1977–1998) that included 5000 subjects with type II diabetes. This study demonstrated that improving metabolic control decreases the risk of micro and macro vascular complications. Also, a reduction of glycosylated haemoglobin by 1% was accompanied by a decrease of the microvascular complications risk by 30%, myocardial infarction risk by 18% and mortality risk related to diabetes by 25% [22]. On the other hand, Nicolucci et al. [23] in a case-control study conducted on 886 people with diabetes, and multi complications compared to 1890 control subjects without complication; report that patients without any education background had increased risk to develop complications.

In the present study there might be an under estimation of the complications prevalence within the NEG as the data are a self-declaration of complications and the NEG subjects do not benefit from a systematic screening of diabetes complications and the data are a self-declaration of complications. Therefore there might be an under estimation of the complications prevalence within this group. Also the sample was not balanced in both EG and NEG groups. This information has been mentioned during the international study IDMPS stating that 34 to 63% of people with diabetes have never been screened for complication during the last year [18].

The TEI of about 2411 kcal in the NEG associated with the high prevalence of physical inactivity ($\simeq$72%) reflect an imbalance between food energy intake and energy expenditure consistent with their metabolic disequilibrium with high means of PPG ($2.65 \pm 0{,}58$), HbA1c (9.16 ± 2.06) and BMI (29.6 ± 3.5) in addition to their inadequate intake of fibers, fruit and vegetables. The imbalance is more marked in NEG subjects who have their dietary intake high in lipids and protein and low in carbohydrates. In our opinion, there is no data in the literature arguing or suggesting that diabetics have needs different from those of the general population, the daily intakes in protein, carbohydrates and lipids being respectively 15%, 55% and 30% of the overall energy intake are recommended. However, generally the energy distribution must take in account the clinical and metabolic profile as well as each patient dietary habit [24–27]. Adhering to educational program seems to be imperative to improve these parameters.

There is evidence that an intensive intervention associating healthy diet with physical activity to lifestyle may lower at least 50% the risk of contracting diabetes, promote weight loss and can prevent the emergence of other chronic diseases, such as hypertension and cardiovascular disease [28].

The HbA1c that represents 2 to 3 months retrospective and cumulative indicator of glycemia level was considered as a mean to evaluate the study subjects metabolic equilibrium, the multivariate analysis shows a significant association between uncontrolled HbA1c (HbA1c >7%) and post-prandial glycemia, physical activity, BMI and education levels. A good therapeutic education program for diabetic patients focused on self-management, adoption of a non sedentary lifestyle and weight loss in overweight or obese people would be beneficial. Our results are consistent with those of Warsi et al. (2004) and Weaver et al. (2014) studies, reporting that diabetic patients involved in self-management educational programs have their HbA1c decreased [29, 30]. Accordingly we found a strong association between PPG (the reference is the blood glucose 2 hr after the beginning of lunch) and metabolic equilibrium (O.R = 268.434; 95% CI, 36.4–1979,5). Monnier et al. have also reported that increases of PPG contribute significantly to the 24 hours hyperglycaemia and to uncontrolled diabetes, proportionally to the increase of HbA1c [31]. In the same way, Avignon et al. (1997) in a transversal study have found a better correlation between PPG and HbA1c rates [32]. It was also reported [33] that the metabolic equilibrium is more significantly influenced by the control of the postprandial hyperglycaemia than the control of fasting blood glucose.

Finally, the therapy characteristics as a potential factor on the final results in the EG are not reported in this study. However the medical follow-up and adaptation of patients' therapy to their biochemical results (glycemia and HbAc1) and body weight were among the components included in the educational program. Therefore, patients who did not attend the education program (NEG) and medical follow-up, have difficulty to adapt themselves their therapy (i.e. monitoring of their insulinemia), which certainly affect their metabolic equilibrium. This is in accordance with the studies of Warsi et al. (2004) and Weaver et al. (2014) reporting a reduction of HbA1c in diabetic patients after self-management education programs.

5. Conclusion

The reported data show that diabetes care is a health problem in the diabetic patients in the study region. The therapeutic education program has a positive impact on the management of diabetes. The data show also that a

significant proportion of the population of people with diabetes do not benefit from a therapeutic education to manage this illness and ovoid its associated complications particularly in rural area. In these areas, by facilitating access to care with ressources and facilities of quality including qualified staff and acquire fungible to ensure the monitoring and control of diabetes, can lead to the improvement of the diabetic patients status. Establishing a national therapeutic education program for patients with diabetes mellitus might also be a major factor of primary prevention by avoiding the occurrence of the disease in the population at risk or secondary prevention to minimize complications in the long and short term. The culmination to an improvement of diabetes care can also minimize the economic burden posed by diabetes disease.

Acknowledgments

The authors wish to thank the medical delegation in the province of El Jadida, Ministry of Health of Morocco and the medical and biomedical team for their cooperation.

References

[1] WHO. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: Diagnosis and classification of diabetes mellitus. Geneva, World Health Organization, (WHO/NCD/NCS/99.2). 1999.

[2] Amed S, Nuernberger K, McCrea P, et al. Status report on the British Columbia Paediatric Diabètes Program. 2010.

[3] WHO. Global status report on non-communicable diseases (2010) Geneva, World Health Organisation. 2011.

[4] Coutinho M, Gerstein HC, Wang Y, et al. The relation-ship between glucose and incident cardiovascular events. Diabetes Care. 1999;22: 233-40.

[5] Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Research and Clinical Practice. 2010;87(1):4-14.

[6] Plantinga LC, Crews DC, Coresh J, et al. Prevalence of chronic kidney disease in US adults with undiagnosed diabetes or prediabetes. Clin J Am Soc Nephrol. 2010;5(4):673-82.

[7] Flores-Le Roux JA, Comin J, Pedro-Botet J, et al. Seven-year mortality in heart failure patients with undiagnosed diabetes: An observational study. Cardiovasc Diabetol. 2011;10:39.

[8] Spijkerman AMW, Dekker JM, Nijpels G, et al. Microvascular complications at time of diagnosis of type 2 diabetes are similar among diabetic patients detected by targeted screening and patients newly diagnosed in general practice: The hoorn creening study. Diabetes Care. 2003;26(9):2604-8.

[9] Nozha MM, Al-Maatouq MA, Al-Mazrou YY, Al-Harthi SS, et al. Diabetes mellitus in Saudi Arabia Saudi. Medical Journal. 2004;25(11):1603-10.

[10] Boutayeb A, Lamlili MEN, Boutayeb W, Maamri A, Ziyyat A, Ramdani N. The rise of diabetes prevalence in the Arab region. OJEpi. 2012;2(2):55-60.

[11] Avignon A, Radauceanu A, Monnier L. Non fasting plasma glucose is a better marker of diabetic control than fasting plasma glucose in type 2 diabetes. Diabetes Care. 1997;20:1822-6.

[12] Duncan I, Birkmeyer C, Coughlin S, Qijuan EL, Sherr D, Boren, S. Assessing the value of diabetes education. The Diabetes Educator. 2009;35:752-60.

[13] Basdevant A, Laville M, Ziegler O. Recommandations pour le diagnostic, la prévention et le traitement des obésités. Diab Metab. 1998;24 (Suppl 2):1-48.

[14] Lahmam A, Baali A, Hilali MK, Cherkaoui M, Chapuis-Lucciani N, Boetsch G. Obesity, overweight and body-weightperception in a High Atlas Moroccan population. Obes Rev. 2008;9:93-9.

[15] Ramdani N, Vanderpas J, et al. Diabetes and obesity in the eastern Morocco Mediterr J Nutr Metab. 2012;5:149-55

[16] Hramiak I, Leiter LA, Paul UR, et al. Assessment of obesity and its complications in adults. JAMC. 2007;176(8):36-39.

[17] RS Bailie, D Si, Robinson GW, et al. A multifaceted health-service intervention in remote Aboriginal communities: 3-year follow-up of the impact on diabetes care. Med J Aust. 2004;181:195-200.

[18] Farouqi A, Harti M-A, Nejjari· C. Prise en charge du diabète au Maroc: Résultats de l'International Diabetes Management Practices Study (IDMPS) – Vague 2. Médecine Des Maladies Métaboliques. 2010;4(6):704-11.

[19] Lacroix A, Assal J-P. L'éducation thérapeutique des patients: Nouvelles Approches de la maladie chronique. Éditions Maloine, 2003. pp. 23-35.

[20] Hulshof KF. Diet and other life–style factors in high and low socio-economic groups (Dutch Nutrition Surveillance System). Eur J ClinNutr. 1991;45:441-50.

[21] Garay-Sevilla ME, Malacara JMH, Gonzalez-Parada F, Jordan-Gines L. The belief in conventional medicine and adherence to treatment in non-insulindependent diabetes mellitus patients. J Diabetes Complications. 1998;12:239-45.

[22] U.K.P.D.S. Étude internationale: Le contrôle du diabète de type 2. 1998. http://www.diabete.qc.ca/html/recherche/ukpds.html

[23] Nicolucci A, Cavaliere D, Scorpiglione N, Carinci F, Capani F, Tognoni G, et al. A comprehensive assessment of the avoidability of long-termcomplications of diabetes. A case-control study.Diabetes Care. 1996;19:927-33.

[24] Tuomilehto J, ET Lindstrom J. The major diabetes prevention trials. Curr Diab Rep. 2003;3(2):115-22.

[25] Henry RR. Protein content of the diabetic diet. Diabetes Care. 1994;17:1502-13.

[26] American Diabetes Association. Nutrition recommendations and principles for people with diabetes mellitus. Diabetes Care. 1999;S42-5.

[27] Van Horn L, McCoin M, Kris-Etherton PM, Burke F, Carson JA, Champagne CM Karmally W, Sikand G. The evidence for dietary prevention and treatment of cardiovascular disease. J Am Diet Assoc. 2008;108:287-331.

[28] Franz MJ, Bantle JP, Beebe CA, Brunzell JD, Chiasson JL, Garg A, Holzmeister LA, Hoogwerf B, Mayer-Davis E, Mooradian AD, Purnell JQ, Wheeler M. Evidence- based nutrition principles and recommendations for the treatment and prevention of diabetes and related complications. Diabetes Care. 2002;25:148-98.

[29] Warsi A, Wang PS, Lavalley MP, Avorn J, Solomon DH. Self-management education programs in chronic disease. Arch Intern Med. 2004;164:1641.

[30] Weaver RG, Hemmelgarn BR, Rabi DM, Sargious PM, Edwards AL, Manns BJ, Tonelli M, James MT. Association between participation in a brief diabetes education programme and glycaemic control in adults with newly diagnosed diabetes. Diabet Med. 2014;31:1610-4.

[31] Monnier L, Lapinsky H, Colette C. Contribution of fasting and postprandial glucose increments to the overall diurnal hyperglycemia of type 2 diabetic patients. Diabetes Care. 2003;24:881-5.

[32] Paquot N. Le régime alimentaire chez le patient diabétique de type 2. Rev Med Liège. 2005;60:392-4.

[33] Bastyr EJ, Stuart CA, Brodows RG, et al. For the IOEZ Group. Therapy focused on lowering postprandial glucose, not fasting glucose, may be superior for lowering HbA1c. Diabetes Care. 2000;23:1236-41.