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Study of Anthropometric and Biological parameters in a Diabetic population of Casablanca, Morocco

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ABSTRACT

Diabetes mellitus is a public health problem. Our objective is to study the epidemiological profile of diabetes in a population of Casablanca in the Sidi-Othmane district. A retrospective study which took place from January 2007 to May 2018. It is a collection of anthropometric parameters and certain biological parameters. Statistical analysis was studied using the Pearson test and the Student test. The p value <0.05 is statistically significant. A total of 1479 subjects were collected, mainly women (78.7%), with an average age of 56 ± 11 years. The average BMI is 28.34 ± 5.11 kg / m². 40.45% of patients are overweight and 31% obese. The average fasting blood glucose = 1.82 ± 0.73 g / l while the average postprandial glycemia = 2.55 ± 1.16 g / l. Mean HbA1c = 7.6 ± 1.4% confirming the poor glycemic control observed. A significant correlation was observed between glycated hemoglobin (HbA1c) and fasting blood glucose (r^2 = 0.58, p = 0.001). Hypertension was found in 43.7% of the diabetics. The lipid balance of our patients is characterized by an average cholesterolemia of 2 ± 0.41g / l, HDLc = 0.5 ± 0.21g / l, LDLc: 1.73 ± 0.43g / l and a triglyceride level = 1.37 ± 0.73 g / l. Of the 21.4% of diabetics who died, 58% were women. The most serious causes of death are linked to hypertension. The study shows the existence of factors predisposing to fatal complications that must be worked on to at least reduce the costly complications to manage. The use of HbA1c as a means of controlling the glycemic balance of individuals is a practical and motivating tool for the primary prevention of degenerative complications of diabetes.

***Key Words**: Body Mass Index, Diabetes, Hba1c, Lipid Profile, Mortality, Obesity.*

1. INTRODUCTION

Diabetes is an insidious and evolutionary chronic metabolic disease that results in a disorder of the assimilation, use and storage of glucose. It is a multifactorial disease that manifests itself in different forms. The most common types are insulin-dependent type 1 diabetes (DT1) and non-insulin dependent type 2 diabetes (T2D). This latter type is the most common form of diabetes (represents 90% to 95% of diabetic patients worldwide) [1].

Its appearance and development depend on several factors. Modifiable factors such as physical inactivity, obesity, smoking and non-modifiable factors such as age, gender and genetic predisposition [2-3].

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Diabetes is a major public health problem because of its highly increasing prevalence and incidence rates over the years. It ranks first in the world due to the high costs of complications [4]. In 2019, diabetes-related health spending in the Middle East and North Africa region totaled 24.9 billion USD [3].

According to the World Organization for Health (WHO), diabetes is a major cause of blindness, kidney failure, cardiovascular disease, stroke and lower limb amputation [5]. According to the International Diabetes Federation (IDF), the number of cases has quadrupled from 108 million in 1980 to 425 million, which represents 8.5% of the world's population in 2017[6]. In 2019, diabetes affected 463 million people. This could reach 700 million diabetics in 2045 [3]. This is due to an aging population, changing eating habits and lack of physical activity. It should also be noted that the increase in the number of identified diabetes cases is generally due to campaigns of early screenings.

Diabetes is considered one of the world's deadliest diseases, with one person dying from diabetes every six seconds, or 1.5 million deaths worldwide, more than AIDS, tuberculosis or malaria [6]. Nationally, the mortality rate due to diabetes is 6.3% of all recorded deaths [7]. It is a major cause of morbidity and mortality and is therefore an expensive disease for the patient, the family and society.

Diabetes management is based on a tripod: medication, diet and physical activity. The role of these three axes is to ensure a good glycemic balance, greatly reducing the risk of complications, as well as a good quality of life [8], [9].

Unfortunately, we have very few studies on diabetes in Morocco; however, there are concerns about the figures. According to the Ministry of Santé, more than 2 million people with diabetes are aged of 25 years and over and 50% of whom are women. Worse still, 50% of all diabetics do not know about their disease [10]. Faced with these alarming statistics and awaiting large-scale studies, we found it useful to conduct a study on the epidemiological profile of diabetes in the Sidi-Othmane district (SOD).

This local study could shed light on the primary and secondary ways of preventing diabetes, by acting on the most important contributing factors and on reducing fatal complications in the population of the city of Casablanca.

2. SUBJECTS AND METHODES

This is a retrospective study conducted within the health service of the SOD, based on records of diabetic patients identified from January 2007 to March 2018 (135 months). This service maintains a register of aid for anti-diabetic medicinal products for the benefit of needy patients residing in this territory of Casablanca, as well as a register of deaths.

This locality represents a single arrondissement among sixteen in the commune of Casablanca and has a population of 220 047 inhabitants according to the General Census of 2014 of the Kingdom of Morocco [11].

Our work aims to study the epidemiological profile of diabetes within the SOD, across the population of patients registered in the register.

2.1 Inclusion criteria

During the study period, a weekly follow-up of some diabetic patients is carried out at the level of the health service of the DSO. All patients systematically benefited from a consultation for the control of capillary blood glucose, monitoring of hemodynamic parameters (BP and pulse), as well as anthropometric measurements (weight, size, BMI, waist circumference, hip circumference) and a clinical examination for possible complications of their diabetes

Subjects included in the study are all diabetic patients enrolled in the service register and have a balance sheet comprising at least one measure of weight, size, fasting capillary blood glucose (FBG), +/- one postprandial glucose (PPG) and one glycated hemoglobin (HbA1c).

Subjects excluded from the study are diabetics registered in the register to benefit from the medicines, but which are not followed within the Hygiene Service and non-resident diabetics in the territory of the SOD.

2.2 Type of data

Patient follow-up was carried out in all diabetics who regularly consulted the service. It is useful to note that the examinations carried out are carried out throughout the study period by the same people from the hygiene service for 11 years, using the same equipment and respecting the same measurement methods.

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The tracking register includes several parameters

Socio-demographic data: age, gender, level of study, occupation and physical activity.
Clinical data:

- Anthropometric measurements: weight, waist, waist circumference and hip circumference. The calculation of BMI (weight (kg)/size (m^2)) is used for the estimation of overall build according to WHO standards [12] and, the waist circumference ratio on hip circumference (WC/HC) allowing the distinction between Android obesity and gynoid obesity.
- Measuring blood pressure and peripheral pulse.
- The research of degenerative complications of diabetes.

The collection of some data was done, a posteriori, from medical records made in other medical institutions on the treatment of some complications.

Biological data: Fasting blood glucose (FBG), post prandial blood glucose (PPG), hemoglobineglyced (HbA1c), lipid profil (Total cholesterol, HDLc, LDLc, Triglycerides), creatininemia and uricemia.

2.3 Statistical analysis of the results

Data entry is managed using the MS Access 2007 application, while the results analysis was performed using the SPSS statistics software version 23. Quantitative variables were expressed on mean ± standard deviation and qualitative variables in numbers and percentages. The statistical analysis was studied using the Pearson test and the Student test. The value $p < 0.05$ is considered statistically significant.

Factor maps were drawn using a main component analysis (ACP). The ANOVA test was conducted to determine the effect of both variables and regressions in order to estimate the marginal effect of the variables between them.

3. RESULTS

3.1 Socio-demographic data

3.1.1 Age of patients

The study concerns 1479 diabetic patients aged 12 to 88 years, with a mean age of 56 ± 11. Our results showed that most diabetics (63.42%) belong to the adult age group (between 20 and 50 years old), followed by
seniors (51-88 years) with 36.04%. The lowest numbers were observed among adolescents (13-19 years) (0.2%) and children (0-12 years) 0.34%. A significant difference between the different age classes ($p < 0,0005$) was observed (Figure 1).

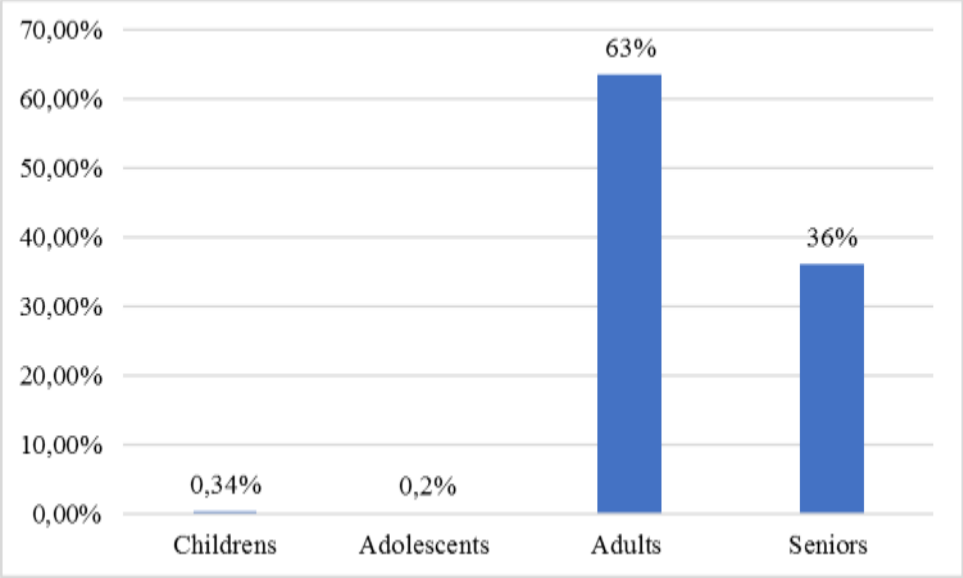

Figure 1. Diabetic patients distribution by age classes

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3.1.2 Gender

The population studied is predominantly female, with 1164 (78.7%) women versus 315 (21.3%) of men, (sex ratio = 0.27). A statistically significant difference between gender p < 0,0005 was observed (Figure 2).

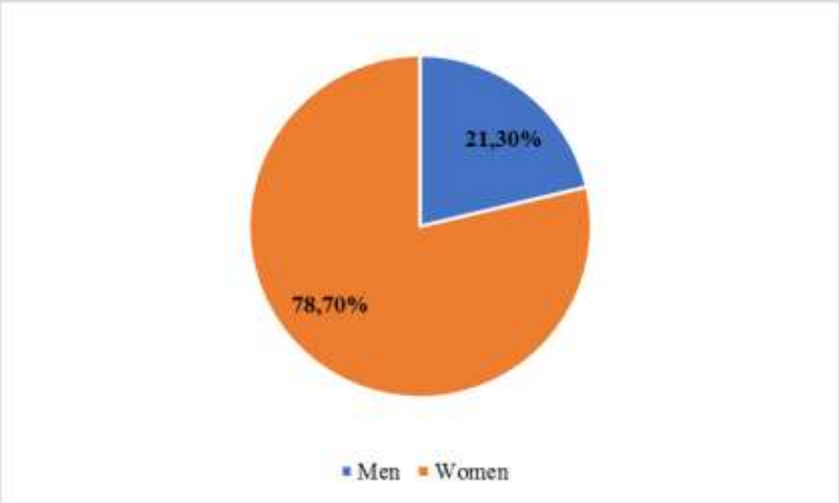

Figure 2. Diabetics distribution by gender

3.1.3 Professional activity

About professional activity, 1394 (94.2%) of patients are unemployed, of whom 8.3% are pensioners and 54.4% of housewives. 85 patients only (5.8%) had a professional activity of which 2% were employees, 1.8% of traders, 1% of civil servants and 1% were employed in other professions (workers, electricians, hairdressers, tailor, taxi drivers, maids, .. .) (Figure 3).

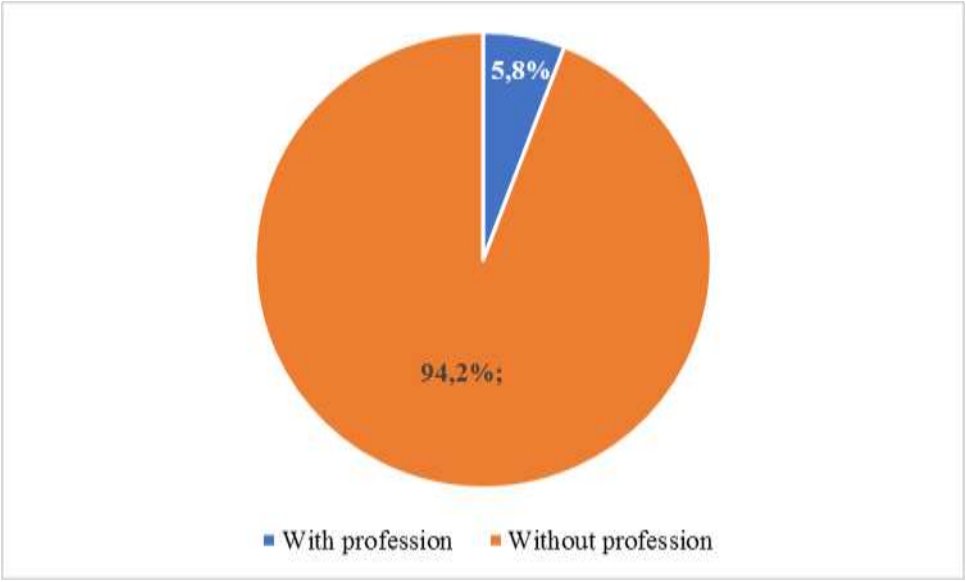

Figure 3. Distribution of population by professional activity

3.2 Clinical data

3.2.1 Weight, size and BMI

The BMI of the study population was between a minimum of 13.71 Kg/m², reflecting the existence of cases of thinness and a maximum of 51.69 kg/m². The mean value of BMI is 28.34 kg/m² ± 5.11, indicating a state of overweight in most diabetics (40.45%). It should also be noted that only 24.76% had a normal BMI (between 19 and 25 kg/m²). In addition, obesity (BMI > 30) was found only in 31% of cases, 24.42% were moderate obesity (BMI < 35); 6.94% have severe obesity (BMI < 40) and 1.97% of morbid obesity (BMI > 40) (Figure 4).

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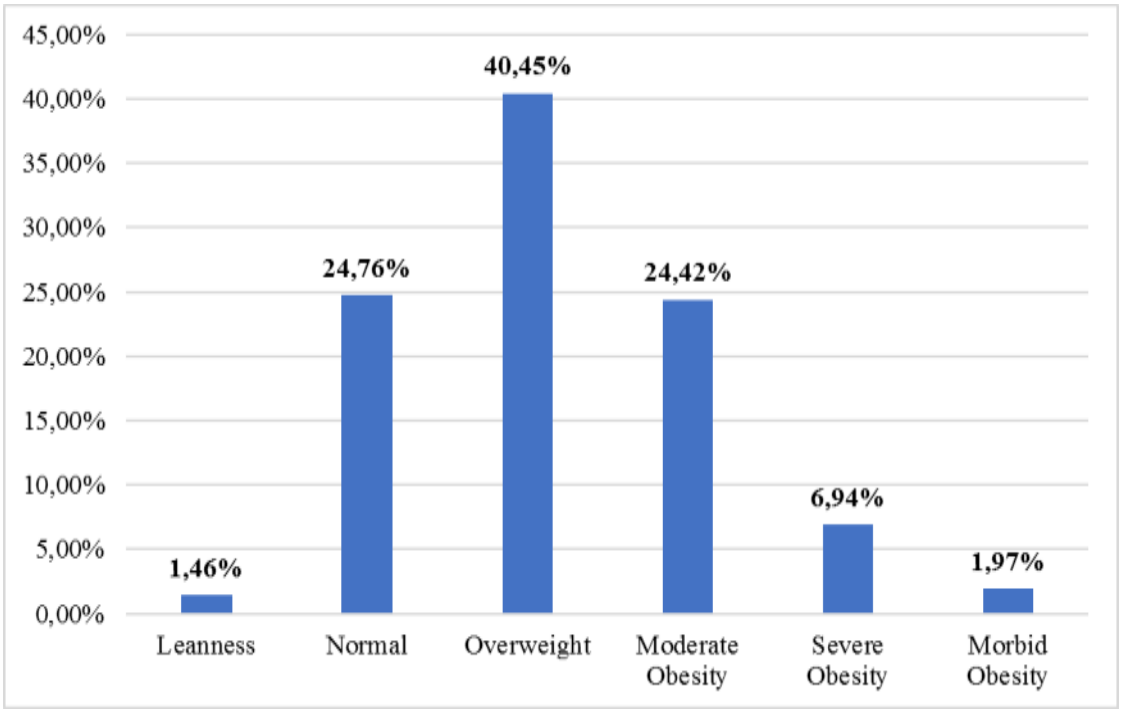

Figure 4. Distribution of population according to the body mass index

3.2.2 Type of diabetes

The distribution of patients according to the type of diabetes shows a high prevalence of type 2 diabetes T2D (67.6%; or 1000 patients) and 32.4% have type 1 Diabetes T1D (479 patients), 1/3 versus 2/3 (Figure 5).

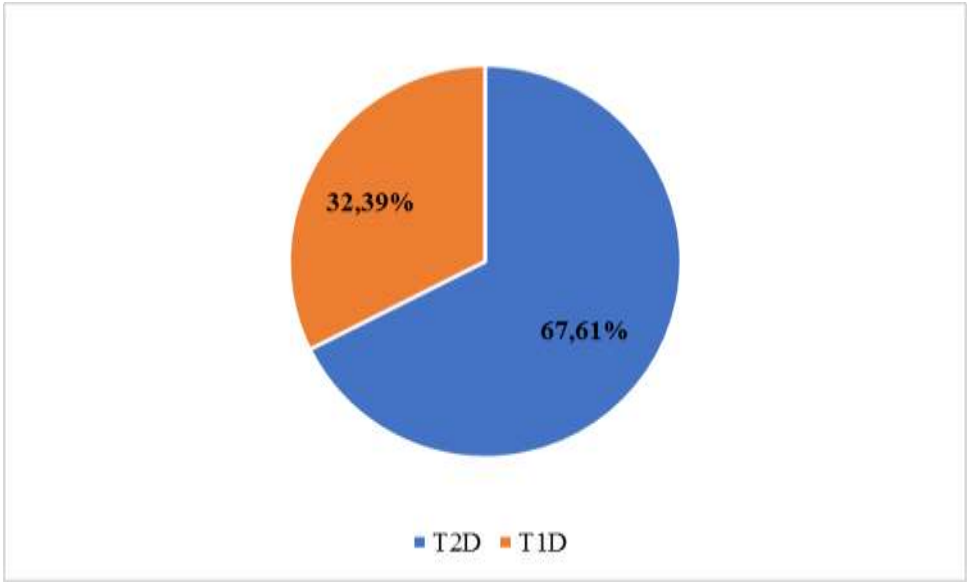

Figure 5. Distribution of population by type of diabetes

3.3 Hemodynamic parameters

3.3.1 Blood pressure

In our series, the HBP (Who classification for blood pressure [13]), which is a serious complication and evolving for its own account, adding its severity to that of diabetes, is strongly involved: 43.7 % of our patients are hypertensive (grade 1 = 30.56%; Grade 2 = 10.47%; Grade 3 = 2.21%). Subjects with normal or optimal pressure represent 56.33% of the series (optimal = 8.69%; Normal = 25.85%; Normal high = 21,79%). Isolated systolic HBP is rare (0.43%) (6 patients) (Figure 6). The mean BP Max is 149.56 mmHg (± 23.75) and the mean BP min is 84, 71mmHg (± 13.38).

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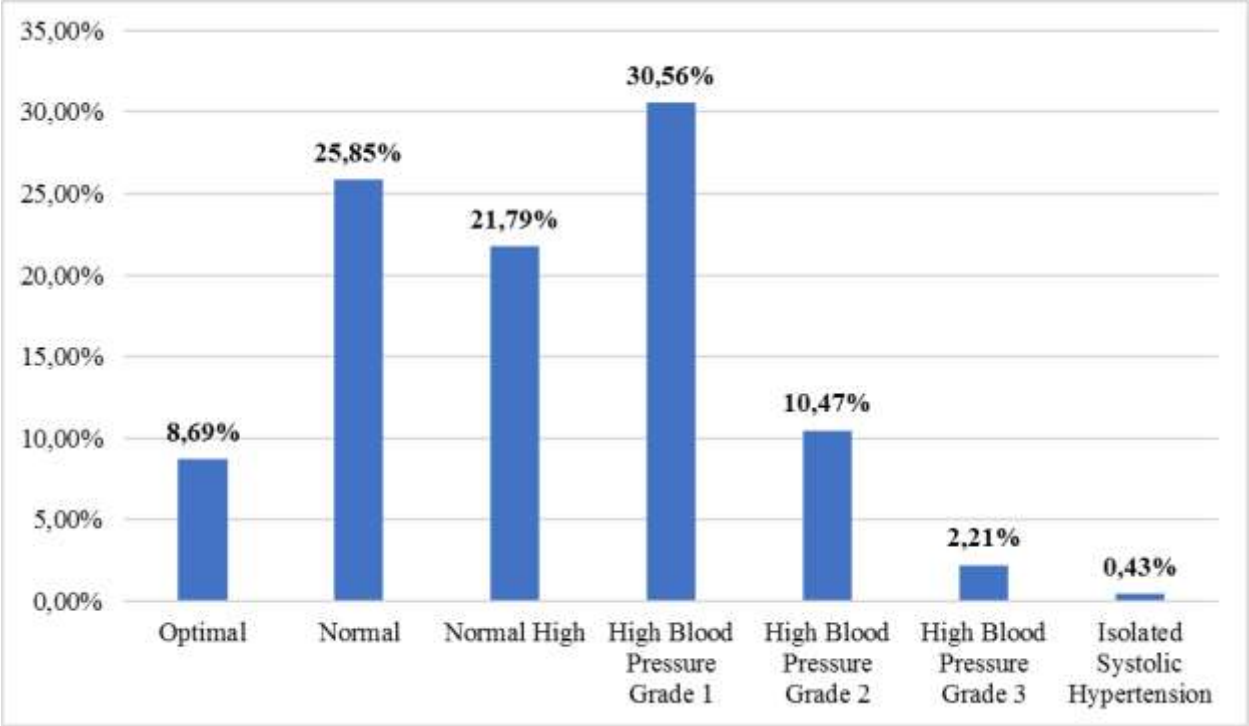

Figure 6. Classification of the blood pressure

3.3.2 Pulsed pressure (PP)

Pulsed pressure (PP), which is the difference between systolic pressure and diastolic pressure (normal value between 50 and 60 mmHg),It could be a prediction parameter for cardiovascular complications in diabetic patients [14].

The mean of the PP found in our patients is 60 ± 18 mmHg. This pressure gradient fluctuates between 42 and 78 mmHg. The abrupt increase in PP would expose the patient to complications.

3.4 Biological data

3.4.1 Control of blood glucose

The carbohydrate profile balance (dosage of FPG, PPG and HbA1c) reflects the glycemic control and helps to monitor diabetics. Thus, in our population, the mean FPG was 1.82 ± 0.73 g/l. PPG, analyzed at the laboratory, was 2.55 ± 1.16 g/l and the HbA1c was 7.6 ± 1.4%. This result testifies to the bad control of blood glucose in our patients (Table 1).

Table 1. Mean values of diabetics glycemic profile

Blood parameters	Mean (± Standard deviation)	Reference values according to WHO	% patients (value> Ref)
Fasting blood glucose (FBG) (g / l)	1,82±73	<1,26	76.30%
Postprandial blood glucose (PBG) (g / l)	2,55±16	<2	56%
HbA1c glycated hemoglobin (%)	7.6±1.4	<6	90.90%

More than three-quarters of our patients (76.3%) had an FPG level greater than 1.26 g/l, while about half of them had a high PPG. This explains the high percentage (90.9%) patients with HbA1c greater than 6%

3.4.2 Lipid Profile

In our series, the lipid balance is considered normal. The mean cholesterol is 2G/l, the HDLc is 0.5 g/l, the LDLc 1.37 g/l and triglyceridemia is 1.37 g/l (Table 2).

DOI: 10.31695/IJASRE.2020.33760

Table 2. Mean values of diabetics lipid profile

Blood parameters	Mean (± Standard deviation)	Reference values according to WHO	% patients (value> Ref)
Cholesterolemia (g / l)	2 ±0.41	< 2	49.30%
HDLc (g / l)	0,5±0.21	>0,4	35.30%
LDLc (g / l)	1,73±0.43	<1,6	33.30%
Triglyceridemia (g / l)	1,37±0.73	<1,5	29%

3.5 Degenerative and Metabolic complications of diabetes

The complications encountered in our patients are varied and affect several organs of the body. The most frequently observed are ophthalmologic complications (26.80%) cataract and cardiovascular complications, including HBP (18.31%). 15.03% of patients have uro-genital symptomatology (vaginal pruritus) that can or cannot be related to infection; 9.15% of complications dental and 5.88% complain of neurological complications which are most often manifested by the diabetic foot (Figure 7).

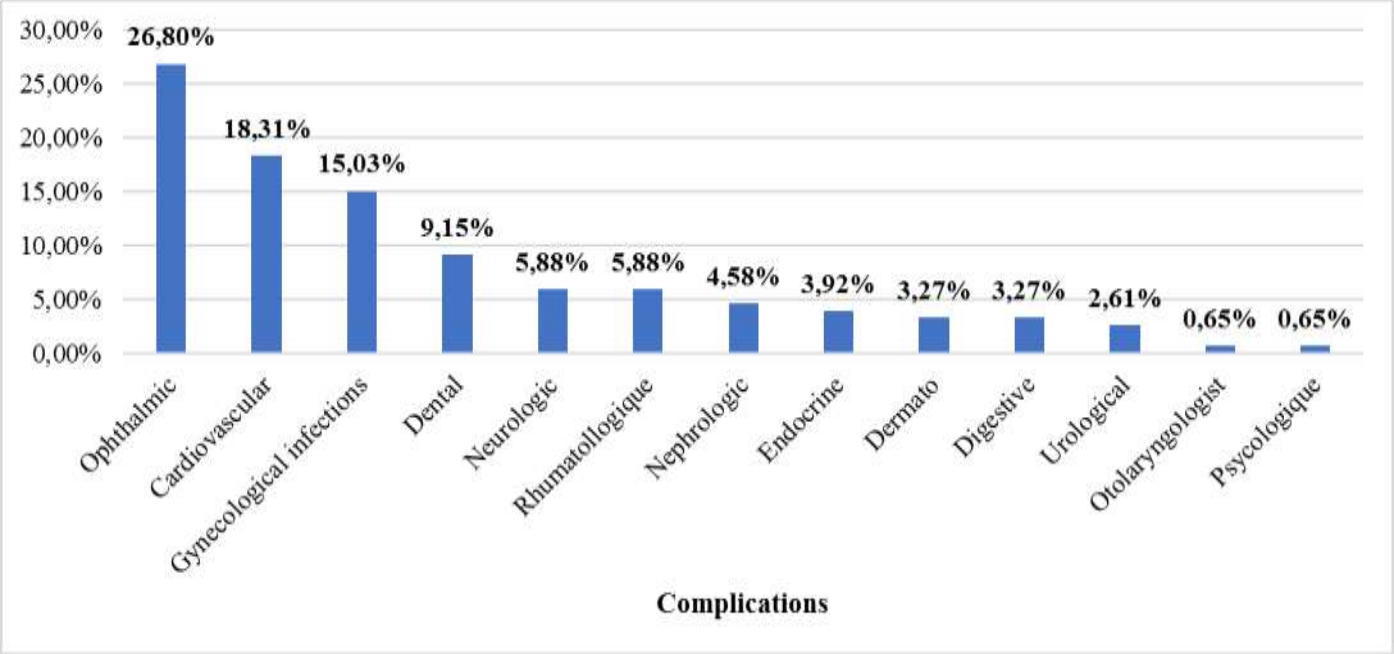

Figure 7. Degenerative and Metabolic complications of diabetics

3.6 Mortality

Of the 1479 diabetics followed in this study, 317 subjects (21.4%) died, which represents about 1/5 of this series.

3.6.1 Mortality by age

The mean age at death was 72 ± 12 years (60 to 84 years). It can be said that the SOD diabetic has a good life expectancy despite the biological disorder and the complications risks which must be happen.

3.6.2 Mortality by gender

58% of the deceased were female and 42% male, with a statistically significant difference between the gender ($p < 0,0005$). This significatively shows that the mortality of our diabetics also depends on gender.

3.6.3 Mortality by type of diabetes presented by patients

DOI: 10.31695/IJASRE.2020.33760

58.99% of patients who died had type1 diabetes, the remainder (41.01%) was of type 2, with a statistically significant difference between the two types of diabetes ($p < 0,0005$). This significatively shows that mortality also depends on the type of diabetes.

3.6.4 Mortality and associated pathologies

The most formidable causes of death in our series are related to cardiovascular problems, with a proportion of 40.96%; HBP is present in 30.32% of cases, most often isolated, but it may be associated with other complications. Stroke often ischemic, are also severe and come in second position with a percentage of 13.83%. Chronic renal failure (CRF) is present only in 12.77% of cases (Figure 8).

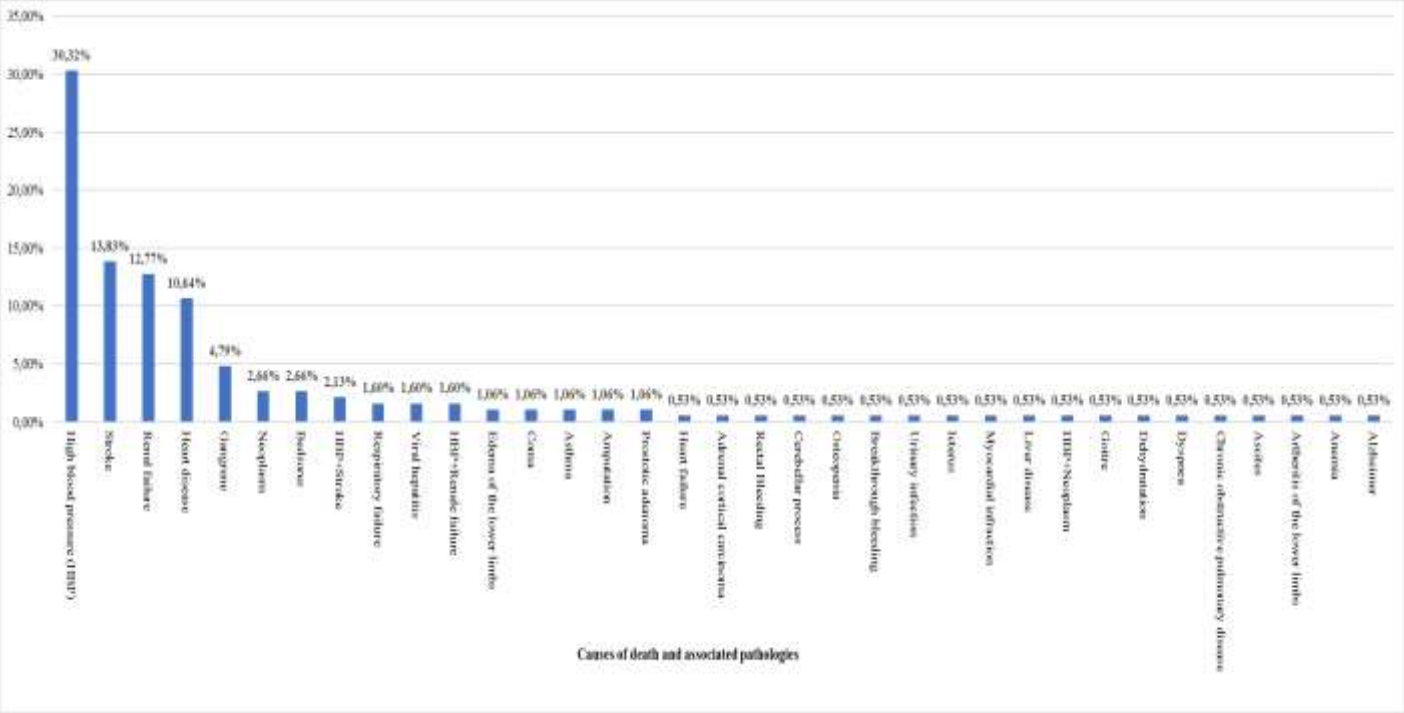

Figure 8. Causes of mortality observed in diabetics

3.7 Correlation study between glycemic parameters and other parameters studied

We have noticed two significant correlations:

- HbA1C and FBG: a highly significant positive correlation is observed for these two parameters, with a correlation coefficient $r^2 = 0.580$ and $p = 0.0001$. We have noticed that the two parameters evolve in the same way. By studying the marginal effect, it appears that an evolution of 1% HbA1c implies an increase of 1.1% of FBG.

- HbA1c and plasma creatinine: a weakly significant correlation was observed between HbA1c and plasma creatinine with $r^2 = 0.354$ and $p = 0,047$, which is very high, almost equal to 5%. Therefore, to decide, we proceeded through the analysis of variance (ANOVA) to a factor that made it possible to understand that the rate of HbA1c has no influence on serum creatinine.

Therefore, HbA1c and FPG evolve in the same direction, while creatinine-inemia evolves independently. This is shown on the factorial map of Figure 9.

- PPG and HbA1c: no association were observed between PPG and HbA1c ($p = 0.4$).

- BP and PPG : a negative correlation is observed, with a correlation coefficient $r^2 = -0.526$ and $p = 0,036$. The study of the marginal effect shows that the increase of the PPG by 1% lowers the mean tension by 2.1%.

DOI: 10.31695/IJASRE.2020.33760

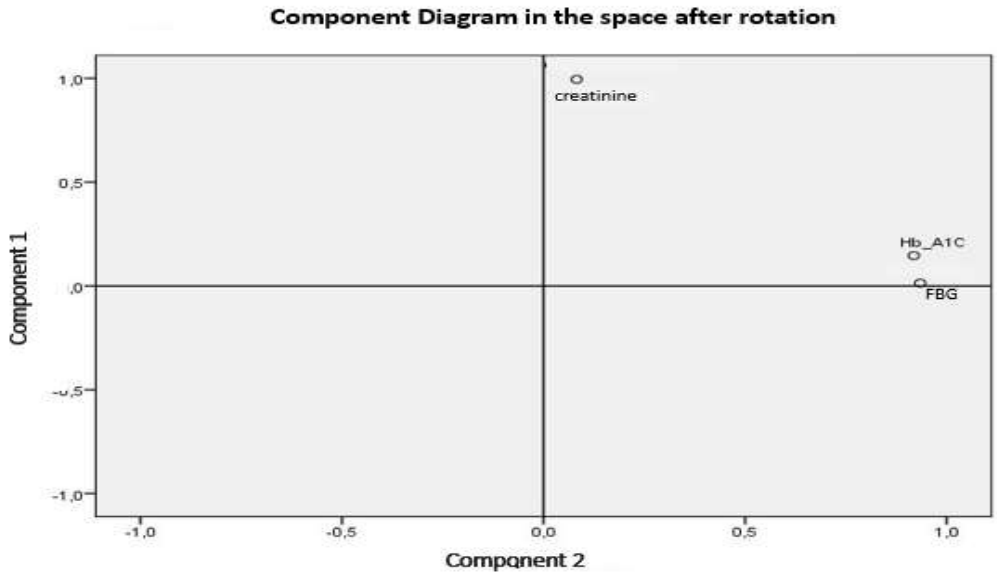

Figure 9. Factoriel map highlighting the Relationship between HbA1c, FPG and plasma creatinine

4. DISCUSSION

Diabetes is currently considered the most serious non-infectious epidemic. Several studies have shown an increase in its prevalence in almost every country in the world [15],[16]. At the ASO level, diabetics followed by the Hygiene Service represent 3% of the population of this district. This roughly reflects the actual prevalence of diabetes diagnosed in this territory of the municipality of Casablanca (4.9%) [17]. Although this figure is still lower than that observed nationally (7.1%), it reflects the extent of this scourge of public health [6].

In this study, we showed a significant association between age and diabetes ($p < 0,0005$). The mean age of patients was 56 ± 11 years, with a predominance of the adult age class (20 to 50 years), which accounted for more than half of the patients (63.4%). These results are consistent with those of other national studies that showed a mean age of 59 ± 11.8 years and 58 ± 12 years [18], [19].

The increase in the risk of diabetes with age has been observed by some authors [20]. This increase can be explained by long-term diabetic medications or by physiological aging of organs, which contributes to metabolic imbalance especially in the elderly [21]. It is for these reasons that fasting blood glucose screening is recommended from the age of 40. Screening should be done earlier and more frequently in people at risk of type 2 diabetes.

The increase in the risk of diabetes with age has been observed by some authors [20]. This increase can be explained by the taking of long-term diabetogenic medicinal products or, by the physiological ageing of the organs which contributes to a metabolic imbalance especially in the elderly [21]. It is for these reasons that testing by measuring fasting blood glucose is recommended from 40 years. Screening should be done sooner and more frequently in people with a risk of type 2 diabetes.

We observed a statically significant association between diabetes and sex ($p < 0.0005$), with female predominance (78.7%). Female predominance was noted at the national level (between 63.7% and 73.2%) [18], [19] which is explained on the one hand by the presence of health programmes dedicated to women who promote their contact with health centers and on the other hand by the availability of medical benefits only the morning, which coincides with the time of the work of most men. By contrast, in 2015 IDF counted 221.0 million of male diabetics against 203.9 of female [6]. Several studies have also shown the differences between the gender in the case of type 2 diabetes mellitus in the risk of complications and pathophysiology. The differences between the gender could also be related to the biological differences between men and women, which are caused mainly by differences in sex chromosomes, the sex expression of autosomal genes, sex hormones and their effects on the body. Women show more dramatic changes in hormones and body due to reproductive factors during life [22].

DOI: 10.31695/IJASRE.2020.33760

Our results also showed that 40.25% of patients are overweight, 33.33% are obese compared to 24.76% of those with a normal weight. A statistically significant association was also observed between diabetes and BMI ($p < 0.0005$).). Indeed, obesity is a major risk factor in developing diabetes causes a decrease in glucose tolerance, which can cause increased sensitivity to the manifestation of diabetes. Obesity also develops and strengthens insulin resistance [23].

The most important factors that are likely to lead to obesity are high calorie intake and which are greater than the daily energy requirements with physical inactivity. These results were confirmed by the sedentary lifestyle led by 94.2% of our population who are unemployed and without any specific physical activity. The distribution of fat in the body can increase the risk of diabetes. The risk is increased in the case of android obesity and it is less serious in the case of a gynoid distribution [24],[25]. In Cameroon, it has been shown that controlling obesity and overweight could reduce diabetes by 15% in men and 13% in women [26]. Thus, screening is recommended in adults who are overweight in order to prevent diabetes in our population.

The distribution of patients according to the type of diabetes showed that more than 2/3 (67%) are type 2 diabetics. This result is like that observed by Mansour in 2013 at the level of the Prefecture of Ben M'sik (district adjacent to the DSO) (66.36%) [19]. But it remains inferior to that observed in 2017 by Attar in another Moroccan city Kenitra [27]. This distribution has the same tendency as globally where type 2 diabetes is markedly predominant (90%) [28]. This is in relation to the lifestyle changes that the world has experienced (sedentary lifestyle and eating habits...).

HbA1c is a biological value used in the monitoring of diabetes and reflects the glycemic balance of the last three months, provided that it is measured by standardized techniques. The HbA1c mean in our series is 7.6%, which testifies to a poor glycemic balance as well as the risks of long-term complications. These values are like those observed by El Kahlaoui in 2011 in Fez (variation between $6,71 \pm 1.23$ to $8,45 \pm 2,18$) [29] and those observed in some European countries [30].

We didn’t observe a clear association between PPG and HbA1c ($p = 0.4$), contrary to the Shrestha study and collaborators in 2012, which showed a statistically significant correlation between PPG, HbA1c and FPG [31]. In contrast, our study showed a statistically significant correlation between HbA1c and FPG ($p = 0.0001$ and $r = 0.580$); a 1% increase in HbA1c resulted in a 1.1% increase in FPG. This result is like that observed by Habi in Algeria in 2015, which confirmed the existence of a moderately positive correlation between HbA1c and FPG [32]. In addition, Monnier and Colette in 2006 showed in France in type 2 diabetics that PPG was a better predictor of good or satisfactory control of diabetes than was FBG [33].

(Postprandial hyperglycemia has been shown to be associated with inflammation, oxidative stress, endothelial dysfunction, decreased fibrinolysis, plaque instability, and cardiac events [34]. There is a direct and proportional association between postprandial hyperglycemia, coronary artery disease and cardiac events. The hypothesis of postprandial hyperglycemia has been supported by interventional studies demonstrating that the reduction of blood glucose and postprandial lipids decreases inflammation, improves the endothelial function [35] and are associated with a lesser progression of atherosclerosis [36],[37],[38].

Our results showed an inverse correlation between GPP and BP, the 1% increase in GPP lowers the BP by 2.1%. This correlation could be explained by postprandial hypotension. This hypotension is characterized by a significant drop in blood pressure within 2 hours after the start of the meal, causing dizziness, nausea, fainting or falls. After each meal, the digestion process causes an influx of blood to the stomach and intestines, which can cause a slight decrease in blood pressure. In older people or weakened by the disease, this slight drop in pressure is enough to trigger symptoms of hypotension. Symptoms appear from 15 minutes to 2 hours after the meal [39]. Postprandial hypotension is more common in cases of diabetes, heart or kidney failure, or Parkinson's disease. It mainly affects older people with high blood pressure [40].

Our data show that diabetic complications were present in almost one-third (31%) of the population studied. Ophthalmologic complications are the most common complication (26.8%), most often cataracts, followed by cardiovascular complications (18, 3%), Gynecologic complications (15.03%) Dental complications (9.15%). These results reflect difficulties in accessing the care of our diabetics at the borough level. Indeed, the metabolic imbalance caused by diabetes is responsible for degenerative complications, the most alarming of which is the alteration of the vascular walls, which is the biggest cause of death for diabetics. Thus, diabetic retinopathy is the leading cause of blindness before the 55 years [41]. In addition, the risk of CRF, myocardial infarction, stroke, and amputation of a lower limb segment in diabetic patients is higher compared to the general population [42].

Hypertension and dyslipidemia are aggravating factors in the degenerative complications of diabetes [43]. The high levels of systolic and diastolic arterial pressures have a direct effect on the incidence of micro-angiopathic and macro-angiopathic complications. The high percentage of HBP (43.7%) reported in this study highlighted the difficulty of controlling the tension balance. This factor could be an additional marker to explain the high percentage of cardiovascular complications. On the other

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hand, the levels of pulsed pressure show that there are patients who are not immune from cardiovascular complications. A consultation of the cardiologist is strongly advocated. Several studies have shown that moderation of salt consumption, weight reduction and physical exercise reduce HBP. This is to say the interest of good awareness and health education in the field of hygiene of life.

We noticed that the mean lipid parameters of our patients is normal, suggesting that dyslipidemia is well controlled thanks probably to health education and drug treatment) in this cohort. This is an advantage for the people of DSO. Indeed, an unbalanced diet rich in fat can develop diabetes. It was shown by Belfort in 2005 in 21 lean, healthy and normal subjects tolerant to glucose, a progressive increase in plasma free fatty acid causes a dose-dependent inhibition of the elimination of glucose stimulated by insulin and signaling insulin [44].

Higher than normal plasma glucose is an important source of mortality and morbidity. In the world 1.5 million deaths were directly attributed to diabetes. This is the eighth leading cause of death in both gender and the fifth leading cause of death among women in 2012 [5].

The mortality in our series is 21.4%, with a mean age of 72 ± 12 years. It is high in both men and women, respectively 42% and 58%. The majority of deaths have type 1 diabetes. Our study shows that the main cause of death was cardiovascular, whose care is difficult for the residents of this borough. The association between diabetes, cardiovascular disease and mortality is well established [45].

Diabetes is an indirect cause of death through one of its complications. Mortality is said to be related to diabetes when the certifying physician has postponed that diabetes is either the initial cause of death or one of the causes associated with death. Today, diabetes is the leading cause of renal failure mortality; the leading cause of cardiovascular disease and mortality; the first cause of blindness and the first cause of amputation of the lower limbs [5].

5. CONCLUSION

Our study shows the following key points:

- This study shows the existence of factors predisposing diabetics to fatal complications (sedentary lifestyle, obesity, HBP...).
- Healthy nutrition, adequate and regular physical activity, and proper clinico-biological monitoring would reduce the incidence and prevalence as well as the acute complications of costly care (Myocardial infarction, Stroke, CRF).
- The use of HbA1c as a means of controlling the glycemic control of the last 3 months of the individual is a practical and motivating tool for the primary prevention of degenerative complications of diabetes.
- The elevation of PP can predict the imminence of vascular complications.

ABBREVIATIONS

BMI: Body mass index
BP: blood pressure
CRF: Chronic renal failure
FBG: Fasting blood glucose
HbA1c: Glycated hemoglobin
HBP: High blood pressure
IDF: International Diabetes Federation
PP: Pulsed pressure
PPG: postprandial glucose
SOD: Sidi-Othmane district
WHO: World Health Organization

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