Scientific Research Publishing

Journal of Diabetes Mellitus, 2024, 14, 108-121
https://www.scirp.org/journal/jdm
ISSN Online: 2160-5858
ISSN Print: 2160-5831

Epidemiological and Hemato-Biochemical Profiles of Diabetic Patients at the Diabetology, Endocrinology, and Metabolic Diseases Department of the Alpha Oumar Diallo Regional Hospital, Kindia (Republic of Guinea)

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How to cite this paper: Bah, F., Camara, C., Sangare, O., Balde, E.S., Toure, K., Dos Camara, T., Kourouma, M. and Hagassou, C. (2024) Epidemiological and Hemato-Biochemical Profiles of Diabetic Patients at the Diabetology, Endocrinology, and Metabolic Diseases Department of the Alpha Oumar Diallo Regional Hospital, Kindia (Republic of Guinea). *Journal of Diabetes Mellitus*, **14**, 108-121.
https://doi.org/10.4236/jdm.2024.142010

Received: April 11, 2024
Accepted: May 26, 2024
Published: May 29, 2024

Abstract

This study aims to enhance the healthcare services for diabetic patients in the administrative region of Kindia by suggesting dietary interventions to assist diabetics in better managing their condition. Conducted over a period of six months, from February 18 to July 18, 2021, this prospective and descriptive cross-sectional study involved 220 diabetic patients. Among these, 48 patients (22%) maintained balanced glucose levels (<0.80 - 1.30 g/l), while 122 patients (68.18%) exhibited unbalanced glucose levels, and 22 (10%) presented with highly unbalanced glucose levels (>2 g/l). Positive glycosuria was observed in 54% of the patients, whereas 46% demonstrated normal glycosuria. An analysis of urinary parameters revealed that 15% of the patients had abnormal Ketone Bodies. Normal HbA1c levels (<7%) were observed in 37.93% of patients, with 13.79% showing unbalanced (7% - 9%) and highly unbalanced (>9%) HbA1c levels. Hematological assessments indicated significant variation: 56% of the patients had low hemoglobin levels, 4% suffered from hyper-eosinophilia, and 1% each from hyper-basophilia and hyper-hemoglobinemia. The anemic profile was characterized as mild anemia in 75%, moderate anemia in 20%, and severe anemia in 5%. Furthermore, 25% of patients were affected by Microcytic anemia and 75% by Normocytic anemia. Demographically, women constituted 65% of the study group compared to 35% of men. The most represented age bracket was 41 to 60 years, accounting for 52% of the patients, while those between 61 and 80 years comprised 36%. Every district in Kindia was impacted by diabetes.

Keywords

Epidemiology, Diabetes, Glucose Levels, Glycosuria, Metabolic Disorders, Kindia

1. Introduction

Diabetes was the fifth leading cause of death worldwide in 2019, with a prevalence of 463 million that is projected to reach 548 million by 2045 [1] [2]. Type 2 diabetes mellitus is the most common type of diabetes, accounting for over 90% of all cases, and is the fifth leading cause of death among people aged 50 to 74 [1]. This type of diabetes is part of a group of metabolic diseases characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both [3]. This leads to a number of severe complications, thereby reducing the quality of life and functional abilities of patients [4]. The health consequences of diabetes can be significant, as it is a major risk factor for cardiovascular diseases (heart attacks, heart failure, arteritis, stroke), neuropathy, and microangiopathic disorders that can lead to blindness (retinopathy) and chronic kidney failure (nephropathy). It has also been clearly defined as a major predisposing risk factor for periodontal disease (serious infections that damage the gums and can destroy the jawbone) [3]. According to estimates, the burden of diabetes and the resulting economic costs will continue to rise until 2030, even if the targets of the sustainable development goals and the global action plan of the World Health Organization are met [5]. It is therefore imperative to take steps to reduce its modifiable risk factors, such as unhealthy lifestyles and obesity, which are associated with an increased risk of type 2 diabetes [6]. Increasing evidence also suggests that air pollution is a risk factor for type 2 diabetes mellitus and could affect its clinical outcomes, including an increased risk of death [7] [8]. Diabetes is strongly linked to cardiovascular diseases. The prevalence of cardiovascular diseases is higher in diabetic adults than in non-diabetics. This risk increases progressively with the rise in fasting blood glucose levels, even before reaching levels sufficient for a diabetes diagnosis [9] [10]. Cardiovascular diseases are one of the main causes of death among people with diabetes. Approximately half of the deaths in individuals with diabetes are attributable to cardiovascular diseases, and individuals with type 2 diabetes have twice the risk of cardiovascular mortality compared to healthy individuals [11] [12]. One of the main objectives in managing diabetes is the early detection and management of cardiovascular risks in diabetic patients. Understanding the mechanisms of this risk-disease or disease-disease relationship is necessary to prevent devastating complications. One of the challenges in appropriately managing cardiometabolic risk factors in type 2 diabetes is the complex pathophysiological mechanism of the link between type 2 diabetes and cardiovascular diseases. Traditional cardiometabolic risk factors, such as hypertension, dyslipidemia, and obesity, which are common phenotypes in type 2 diabetes, synergistically increase the risk of cardiovascular disease. Furthermore, numerous studies have reported several factors often present in patients with type 2 diabetes, including a genetic predisposition, hypoglycemia during treatment, and increased insulin resistance. These factors have been considered a major obstacle in preventing cardiovascular diseases. However, there are effective strategies to prevent cardiovascular diseases in patients with type 2 diabetes. For example, evidence shows that lifestyle changes can effectively improve cardiovascular risk and prevent cardiovascular events [3]-[16]. Additionally, recent trials have demonstrated that the use of new antidiabetic drugs can significantly reduce the risk of cardiovascular disease in individuals with type 2 diabetes at high risk of cardiovascular disease [17] [18] [19]. This situation makes diabetes a significant public health probem. In this study, we focus on the epidemiology and hematobiochemical profile of diabetic patients at the Diabetes, Endocrinology, and Metabolic Diseases Service of the Alpha Oumar Diallo Regional Hospital in Kindia, Republic of Guinea.

2. Methods

2.1. Study Framework

The medical biology laboratories of the Alpha Oumar DIALLO Regional Hospital located in the Urban Commune of Kindia, specifically in the Fodé Fissa District (Abattoir 3), and the Department of Biology at Gamal Abdel Nasser University (UGANC) served as the sites for our study. This investigation was a six-month prospective and descriptive cross-sectional study, spanning from February 18 to July 18, 2021. It focused on diabetic patients who attended the diabetology, endocrinology, and metabolic diseases department at the Alpha Oumar Diallo Regional Hospital in Kindia during the specified period. The sampling method employed was simple and random. The sample size (N = 220) was derived based on the national diabetes prevalence in the Republic of Guinea, which stood at 4.7% in 2016, calculated using the SCHWARTZ formula. Our study included all patients who came to the laboratory and were documented in an examination report or a notebook, which requested measurements of blood glucose, glycosuria, and complete blood count (CBC). For sample analysis, urinary strips for glycosuria, the OneTouch glucometer for blood glucose with the reactive strip, HemoCue HbA1c 501 for glycated hemoglobin, and HemoCue® WBC DIFF Analyzer for complete blood count (CBC) were utilized.

2.2. Variables Submitted to the Study

- **Biological variables:** Blood sugar, glycosuria, glycated hemoglobin, hemoglobin level (THB), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (CCMH) and complete blood count (NFS).
- **Epidemiological variables:** Age, sex, marital status, profession and resi-

dence.

- **Biomaterial:** Blood and urine of patients.

2.3. Data Collection, Processing and Analysis

Data collection was conducted utilizing a survey sheet designed in line with the study's objectives and variables, which facilitated the gathering of information and samples from patients. This was followed by the analysis of blood and urine samples from each participant. Subsequently, the collected data were inputted into Word 2016, and then processed and analyzed using Excel from the Office 2016 suite on Microsoft Windows 8.1 and SPSS.

2.4. Ethical Considerations

Prior to the commencement of this study, informed consent was obtained from all participating patients. Confidentiality was maintained throughout the data collection process, and the results were utilized solely for scientific purposes.

2.5. Limitations and Difficulties

The principal challenges encountered during this study included the non-cooperation of some patients and the considerable distance between the university and the laboratory.

3. Results

Figure 1 illustrates the glycemic profiles of the 220 patients evaluated in the laboratory. It shows that 48 patients, or 22%, had balanced blood glucose levels ranging from 0.80 g/l to 1.26 g/l. In contrast, 150 patients, or 68%, exhibited unbalanced blood glucose levels between 1.30 g/l and 2 g/l; additionally, 22 patients, or 10%, had highly unbalanced levels exceeding 2 g/l. The high incidence of significantly unbalanced blood glucose—68% of the sample—can likely be attributed to factors such as inadequate physical activity, dietary non-adherence,

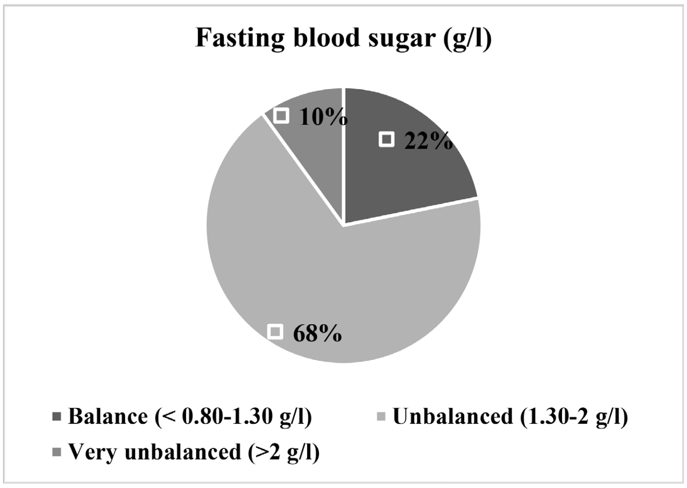


Figure 1. Determination of blood glucose in patients.

and a sedentary lifestyle.

For glycosuria to test positive during fasting in diabetic individuals, their blood glucose levels must exceed 1.86 g/L. Reflecting on this criterion, Figure 2 demonstrates that out of the 220 diabetic patients surveyed, 119, or 54%, exhibited positive glycosuria, while 101 patients, or 46%, maintained normal glycosuria levels.

Figure 3 illustrates minor variations in biochemical parameters across all 220 diabetic patients. Specifically, 33 patients, or 15%, showed abnormal Ketone Bodies; Leukocytes were elevated in 19 patients, accounting for 9%; Proteins were detected in 27 patients, making up 12%; Nitrites were present in 29 patients, representing 13%; and Specific Gravity was noted in 14% of cases. Additionally, pH levels were abnormal in 3% of patients, Urobilinogen in 1%, Bilirubin in 2%, and Blood was found in 22 patients, equating to 10%. These abnormalities in biochemical parameters are indicative of renal impairment caused by diabetes, which impacts multiple organs.

Table 1 reveals that among the 220 diabetic patients studied, 48 (21.81%) maintained normal HbA1c levels (<7%). Conversely, 148 patients (67.27%) exhibited unbalanced HbA1c levels ranging from 7% to 9%, and 24 patients (10.90%)

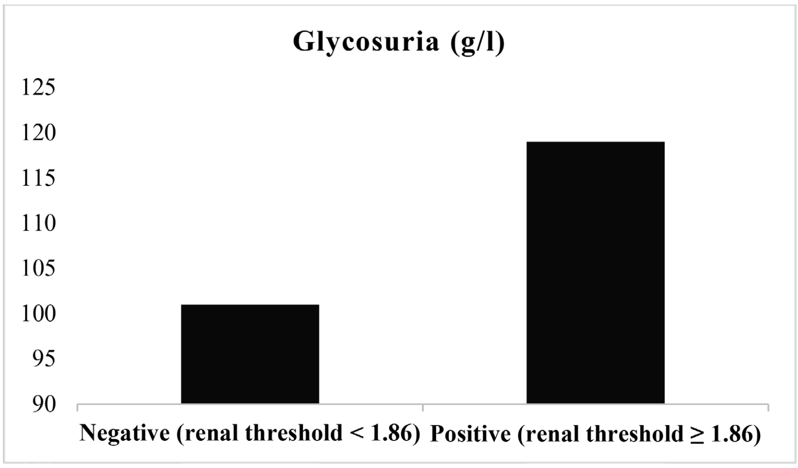


Figure 2. Distribution of diabetic patients according to glycosuria.

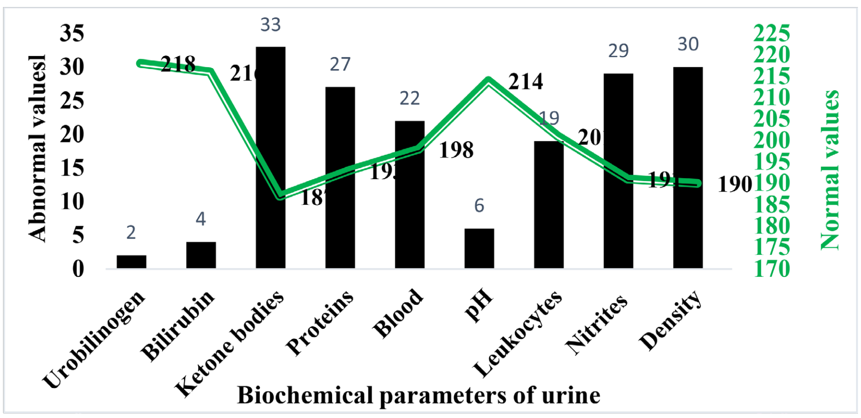


Figure 3. Distribution of diabetic patients according to urine biochemical parameters.

presented with very unbalanced HbA1c levels (>9%). Elevated HbA1c results suggest that these patients may struggle to effectively manage their diabetes, potentially due to external factors such as illness (e.g., influenza), stress, or suboptimal treatment strategies.

Table 2 illustrates considerable fluctuations in hematological parameters among all 220 diabetic patients studied. Specifically, 123 patients (56%) displayed low hemoglobin levels, and 141 patients (64%) had low neutrophil counts. Additionally, lymphopenia was observed in 50 patients (23%), and monocytosis was noted in 127 cases (58%). Hypo-eosinophilia was present in 9 patients (4%). Conversely, 25 diabetic patients (43%) exhibited lymphocytosis, 37 patients (17%) showed hyper-neutrophilia, 20 patients (9%) had leukocytosis, 2 patients (1%) suffered from hemoglobinosis, 9 patients (4%) had hyper-eosinophilia, and 21 patients (9%) were affected by monopenia. These substantial variations in hematological parameters underscore the importance of their assessment in all diabetic patients to enhance the management of this chronic disease.

Table 3 demonstrates that among 123 diabetic patients with low hemoglobin levels, the breakdown of anemia types is as follows: 93% have mild anemia, 4% moderate anemia, and 3% severe anemia. This distribution underscores the necessity for careful monitoring of hemoglobin levels in diabetic patients. It also highlights the importance of administering anti-anemic treatments and ensuring a nutritious and well-balanced diet, particularly for those with mild to moderate

Table 1. Distribution of diabetic patients according to glycated hemoglobin.

N°	Values	Patients	Percentage
1	Normal (<7%)	48	21.81
2	Unbalanced (7% - 9%)	148	67.27
3	Very Unbalanced (>9%)	24	10.90
	Total	**220**	**100**

Table 2. Determination of hematological parameters in diabetic patients.

Parameters	Values					
	Low		Normals		High	
	Patients	%	Patients	%	Patients	%
Hemoglobin	123	56	95	43	2	1
WBC (Leukocytes)	19	9	181	82	20	9
Neutrophils	141	64	42	19	37	17
Eosinophil	50	23	161	73	9	4
Basophils	-	-	217	99	3	1
Lymphocytes	50	23	40	18	130	59
Monocytes	21	9	72	33	127	58

anemia. For patients experiencing severe anemia, management strategies should include blood transfusions.

Table 4 reveals that out of 123 diabetic patients, 93 (76%) exhibited Microcytic anemia, while 30 (24%) had Normocytic anemia. Notably, there were no instances of severe anemia reported among these patients.

Table 5's analysis indicates that of the 123 diabetic patients, 91 (74%) were diagnosed with Hypochromic anemia, and 32 (26%) with Normochromic anemia. There were no recorded cases of Hyperchromic anemia among these patients.

Figure 4 highlights that among the 220 diabetic patients, females predominantly represent the sample with 144 cases, accounting for 65%, versus 76 cases or 35% of males (**Figure 4(a)**). The probability of diabetes is equal among both genders. Among age groups, those aged 41 to 60 years are most affected, comprising 114 cases or 52%, followed by those aged 61 to 80 years with 80 cases, representing 36%. The groups aged 21 to 40 years and over 81 years are the least represented, with 9% and 3%, respectively (**Figure 4(b)**). In terms of socio-professional categories, Housewives are the most represented with 102 cases or 46%, followed by Administrative Workers and Commerce Agents with 53 cases (24%) and 41 cases (19%) respectively. The least represented are Workers, Farmers, Health Agents, and Security Agents with 5%, 3%, 2%, and 1% respectively (**Figure 1**); Determination of blood glucose in patients (**Figure 4(c)**). This notable prevalence among Housewives may be attributed to factors such as sedentary lifestyle, unbalanced diets, and obesity. Concerning marital status, Married individuals comprised the largest group related to this disease, with 213

Table 3. Typology of anemia in diabetic patients.

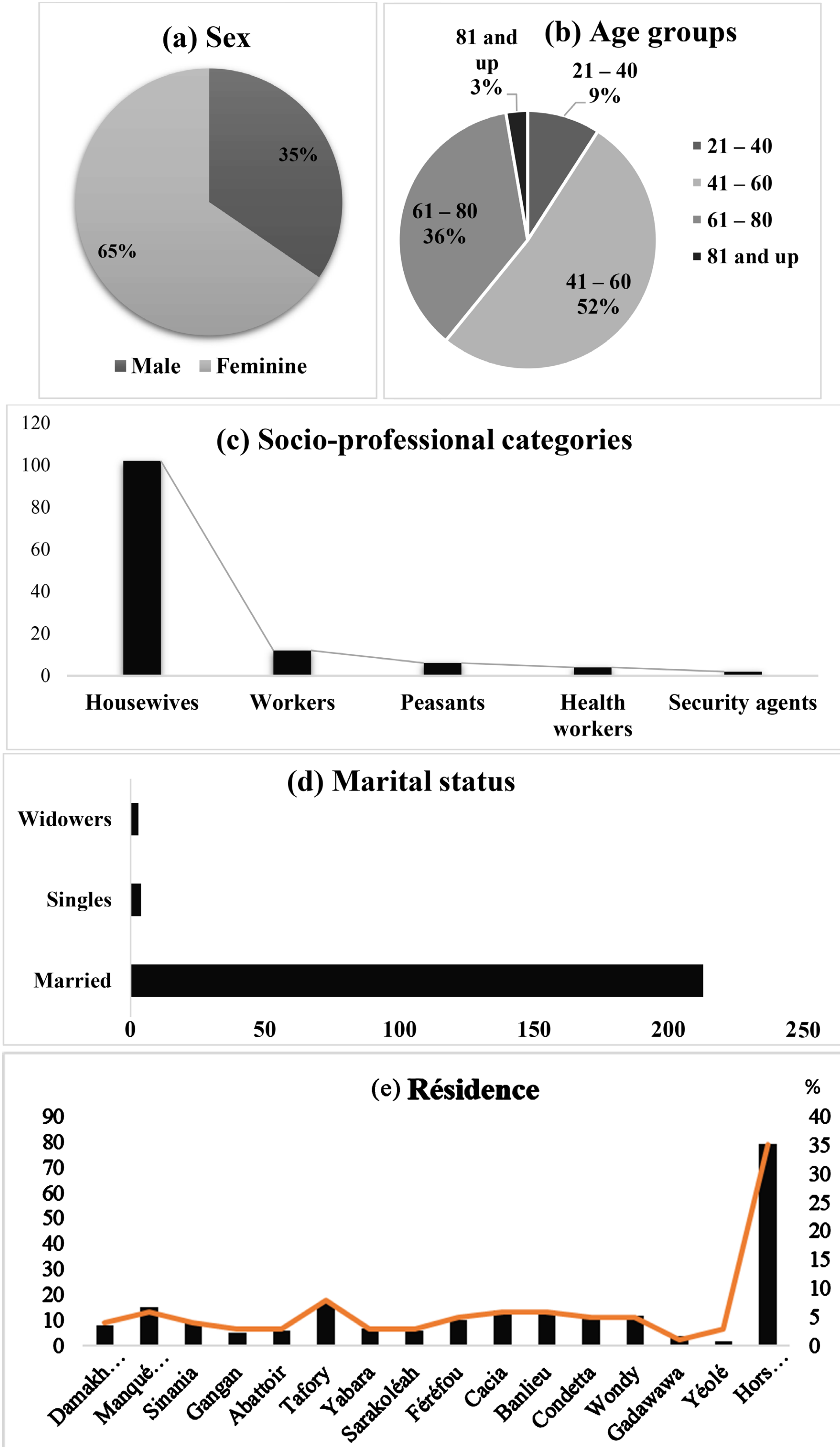
Total		Anemias					
		Frustrated		Moderate		Severe	
Patients	**%**	**Patients**	**%**	**Patients**	**%**	**Patients**	**%**
123	100	114	93	5	4	4	3

Table 4. Pathophysiological variation of MCV in diabetic and anemic patients.

Total		Mean corpuscular volume (MCV)					
		Microcytic		Normocytic		Macrocytic	
Patients	**%**	**Patients**	**%**	**Patients**	**%**	**Patients**	**%**
123	100	93	76	30	24	-	-

Table 5. Pathophysiological variation of MCHC in diabetic and anemic patients.

Total		Mean Corpuscular Hemoglobin Concentration (MCHC)					
		Hypochromic		Normochromic		Hyperchromic	
Patients	**%**	**Patients**	**%**	**Patients**	**%**	**Patients**	**%**
123	100	91	74	32	26	-	-



Outside Kindia: Patients from Pita, Forécariah, Coyah and Mamou.

Figure 4. Distribution of diabetic patients according to epidemiological parameters.

cases or 97%, compared to 2% Unmarried and 1% Widowed (**Figure 4(d)**). Despite this, marital status does not influence the incidence of diabetes, making the high rate among Married individuals random, as all are exposed to similar risks such as sedentariness, obesity, and excessive soda consumption. Regarding residential data, every district in Kindia is impacted, with prevalence rates ranging from 1% to 8%, with Tafory being the most affected area at 8%. Notably, 79 diabetic patients, representing 35%, originated from outside Kindia (**Figure 4(e)**), with a majority presenting in diabetic ketoacidosis upon hospitalization.

4. Discussion

Our research at the Diabetology, Endocrinology, and Metabolic Diseases Department of Alpha Oumar Diallo Regional Hospital in Kindia (Republic of Guinea) showed that out of 220 patients, 150 (68%) exhibited unbalanced glucose levels ranging from 1.30 to 2 g/l, with an additional 22 patients (10%) showing very unbalanced levels (>2 g/l), while 48 patients (22%) maintained balanced levels (0.80 - 1.26 g/l) (**Figure 1**). These figures compare to a 2021 study by Camara C., *et al.* (2022) [3] at the ANASTASIS Health Center in Nongo, Conakry, which found very unbalanced glucose levels in 11.33% of patients, unbalanced levels in 9.33%, and only 0.33% with balanced glucose levels among 300 examined. Although our findings align with their results for unbalanced and very unbalanced glucose levels, there is a marked disparity in the proportion of patients with balanced levels—22% in our study versus only 0.33% in theirs. This variance could stem from differences in the nutritional environment, potentially influenced by inadequate or excessive caloric intake. Other factors such as diabetes management, medication, insulin use, physical activity, or meal skipping could also account for these glycemic variations among the diagnosed patients. Additionally, it has been established that glycosuria tests positive in fasting diabetic patients when their glucose levels are 1.86 g/L or higher. Reflecting on this, our research indicated that among 220 diabetic patients, 119 or 54% (**Figure 2**) exhibited positive glycosuria. This proportion is higher compared to the 21% reported by Bah A. at CHU Conakry in 2015 but lower than the 75% observed by Diaby M. at CHU Mamou in 2018 [20] [21]. Variations could be attributed to the differing patient numbers involved in these studies and the variations in the quality of diabetic care across these facilities. Moreover, these disparities might also be due to the diabetic patients' understanding of their condition and their adherence to sound dietary practices, prompting them to choose diets and lifestyles that align with their health needs. Moreover, our research identified minor variations in biochemical parameters across all diabetic participants. Specifically, 15% of the patients exhibited abnormal Ketone Bodies, 9% abnormal Leukocytes, 12% abnormal Proteins, 13% abnormal Nitrites, 3% abnormal pH levels, 1% abnormal Urobilinogen, 2% abnormal Bilirubin, and 10% had abnormal Blood levels. These abnormalities in biochemical markers indicate renal impairment resulting from diabetes, which impacts several organs. Our study demonstrated various changes in the levels of hemogram elements among type 2 diabetes patients, undoubtedly revealing the hematological impact of this form of diabetes and the role of red blood cells [22]. Hosseini *et al.* (2014) showed that hyperglycemia increases the level of sorbitol in red blood cells, which impairs the Na+/K+-ATPase pump, leading to osmotic imbalance and resulting in cell death [23]. Indeed, both decreases and increases in hemoglobin levels were evident in our patients; we believe these variations are due to diabetes-induced changes in the small blood vessels that supply the kidneys. Indeed, impaired kidney function is associated with lower hemoglobin levels, thus leading to an increased prevalence and severity of anemia [20]. Low hemoglobin levels, along with the observed hematocrit rates, could also be explained by the fact that anemia is a common complication in patients with diabetes mellitus, especially those with evident nephropathy [22]. Furthermore, research by Pretorius *et al.* (2015) in a comparative study between type 2 diabetics and controls, showed that red blood cells in type 2 diabetics had significantly greater membrane rigidity than those in controls, which could be mitigated by the addition of iron chelators [24]. However, although anemia may be a sign of diabetic kidney disease, reduced or borderline hemoglobin levels can identify increased risks of microvascular complications in diabetic patients [23]. Variations in white blood cell counts, and thus in the total leukocyte formula, were evident in our patients. We indeed believe that the low white blood cell count could indicate a decrease in immune system defenses, which could also be due to the presence of foreign organisms [25] [26]. In the leukocyte formula, the most abundant elements are neutrophils. Khan *et al.* (2014) reported that neutrophils play a central role in host defense against invading pathogens; they are an essential component of the innate immune system with several effector and regulatory immune functions. We thus estimate that patients with low white blood cell counts were likely in a state of oxidative stress. Other studies have shown that neutrophils from patients with iron deficiency have a reduced capacity to produce oxygen radicals [25] [26]; and functional abnormalities of neutrophils occur in patients with kidney failure, at least partly responsible for increased susceptibility to infections [27] [28]. Additionally, changes in lymphocyte levels corroborate the findings of Neamtu *et al.* (2015); who later showed that T lymphocytes are among the first cells to infiltrate the arterial intima during the early stages of atherosclerosis. Thus, changes in blood distribution, lymphocytes could be associated with stimulation of atherosclerotic plaque development [20]. However, cases of lower monocyte levels that were evident in our patients are of course indicative of certain complications. Investigations by Persson *et al.* (1998) had shown that monocyte levels often decrease in type 2 diabetics with atherosclerosis [29]. Some diabetic cases had shown a mean corpuscular volume lower than 80 femtoliters and others had normal levels; these results corroborate those of Hosseini *et al.* (2014) who found in their study that about a third of patients with type 2 diabetes suffered from normocytic anemia and others from microcytic anemia.

Our analysis revealed among the diabetic patients we studied, a significant number presented with unbalanced and very unbalanced HbA1c levels (**Table 1**). The HbA1c is a crucial biomarker for diagnosing and monitoring both type 1 and type 2 diabetes, reflecting the glycemic control over a period of 2 to 3 months. Our findings indicate that 78.17% of our diabetic cohort exhibited poorly controlled glycated hemoglobin levels. This association suggests that elevated HbA1c levels are indicative of suboptimal diabetes management, a finding supported by researcher M. Zendjabil (2015), who noted that elevated glycated hemoglobin formation in such patients correlates with the emergence of long-term degenerative complications of diabetes [30]. Factors such as incidental illnesses like flu, stress, or inappropriate treatment could contribute to these imbalances.

Limitations of the study

This study had limitations. Although the sample size of 220 diabetics allows for drawing acceptable conclusions, not all diabetic patients could achieve glycated hemoglobin measurements. Nevertheless, this work has conceptual value and could serve as a reference for future studies. It demonstrated the impact of diabetes on variations in biochemical and hematological parameters.

5. Conclusion

This study, conducted at the Diabetology Department of the Alpha Oumar Diallo Regional Hospital in Kindia, revealed that a lack of education among diabetic patients, identified through the examination of urine and blood samples, could lead to serious consequences. Despite the absence of appropriate equipment at Kindia Regional Hospital, effective monitoring, good care, and proper food and nutritional education regarding diet choices can still significantly help diabetic patients manage their condition more effectively and prolong their lives. This research highlights the dangers of diabetes if treatment is not properly adhered to.

Compliance with Ethical Standards

Acknowledgments

The authors would like to thank the managers and technicians of the laboratories of the Diabetology Department of the Alpha Oumar Diallo Regional Hospital in Kindia, those of the Biology Laboratory of the Gamal Abdel Nasser University of Conakry and the Ecole Supérieur du Tourisme and the Hôtellerie de Guinée for their support in carrying out this work.

Author Contributions

All authors contributed to this research and read and approved the final version of the manuscript.

Ethical Approval Statement

Confidentiality was respected throughout the data collection process and all results were used for strictly scientific purposes.

Statement of Informed Consent

Before our study was carried out, patients gave their consent to participate in the study.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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