MINISTRY OF HEALTH OF UKRAINE

NATIONAL UNIVERSITY OF PHARMACY

Pharmaceutical Faculty

Department of Pharmacology and Clinical Pharmacy

QUALIFICATION WORK

on the topic: **«STUDYING THE ROLE OF MODERN PHARMACOTHERAPY AND PHARMACEUTICAL CARE IN ACHIEVING CONTROL OF TYPE 2 DIABETES»**

Prepared by: applicant for higher education of group Фм20(4.10)а-04

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ANNOTATION

The qualification work examined the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes. Problem areas of pharmaceutical care that need to be addressed were identified. The master's thesis is presented on 41 pages, includes 4 tables, 15 figures, 35 sources of literature and 2 applications.

Key words: Type 2 diabetes, modern pharmacotherapy, pharmaceutical care, pharmacist, hypoglycemic drugs.

АННОТАЦІЯ

В кваліфікаційній роботі було вивчено роль сучасної фармакотерапії та фармацевтичної опіки в досягненні контролю цукрового діабету 2 типу. Визначені проблемні напрями фармацевтичної опіки, які потребують вирішення. Кваліфікаційна робота викладена на 41 сторінці, включає 4 таблиці, 15 малюнків, 35 джерел літератури та 5 додатків.

Ключові слова: діабет 2 типу, сучасна фармакотерапія, фармацевтична опіка, фармацевт, гіпоглікемічні препарати.

CONTENT

ABBREVIATIONS LIST

ADA — American Diabetes Association's;

AGIs — Alpha-Glucosidase Inhibitors;

CDC — Centre for Disease Control and Prevention;

CKD — chronic kidney disease;

DPP-4 — Dipeptidyl Peptidase IV;

FBS — fasting blood sugar;

GLP-1 antagonists — Glucagon-like peptide type 1 receptor antagonists;

GTT — glucose tolerance test;

HbA1c — glycated hemoglobin;

IDF — International Diabetes Federation;

M — arithmetic means;

NICE — National Institute for Health and Care Excellence;

SD — standard deviations;

SGLT-2 inhibitors — Sodium-glucose Cotransporter type 2 Inhibitors;

TZD — Thiazolidinediones;

WHO — World Health Organisation.

INTRODUCTION

Relevance of the topic. Diabetes is one of the most serious public health problems in countries around the world. According to WHO, the number of people living with diabetes has increased from 200 million in 1990 to 830 million in 2022. IDF forecasts that by 2050, the incidence of diabetes will increase by 46% to an estimated 853 million. At the same time, 8.7 million adults aged 18 and over have undiagnosed diabetes. More than 90% of people with diabetes have type 2 diabetes.

The goal of diabetes pharmacotherapy isn't only to normalize blood glucose levels, but also to prevent the development of chronic complications that lead to the death of patients. Despite the fact that according to modern recommendations for pharmacotherapy of type 2 diabetes, 7 pharmacological classes of first-line hypoglycemic drugs with different mechanisms of action are recommended, only in 50% of cases is high effectiveness in the treatment of type 2 diabetes achieved. Such a low treatment effectiveness rate may be due to insufficient adherence to recommendations for pharmacotherapy of type 2 diabetes.

Pharmaceutical care is the process in which a pharmacist has a direct (or indirect) relationship with a patient to optimize pharmacotherapy and improve its outcomes. Pharmacies play a major role in providing patients with both type 1 and type 2 diabetes with insulin and hypoglycemic drugs. Accordingly, the implementation of all principles of pharmaceutical care by a pharmacist can contribute to achieving glycemic control in patients with diabetes.

In a literature review conducted by the authors in 2022, 86 types of pharmaceutical services were identified. In world science, the process of studying the quality of pharmaceutical care is constantly underway, and a number of studies have shown insufficient practical implementation of certain areas.

Thus, in-depth research of individual areas of pharmaceutical care for patients with diabetes can contribute to improving the effectiveness of pharmacotherapy and achieving control of type 2 diabetes.

Purpose of the research. The purpose of the master's thesis was to research the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes.

Research objectives:

1.   Write a literature review to summarize data on modern pharmacotherapy and pharmaceutical care for type 2 diabetes.

2.   Develop a questionnaire for surveying research participants.

3.   Give a general description of research participants.

4.   Study the knowledge of research participants about modern approaches pharmacotherapy and criteria of pharmacotherapy effectiveness of type 2 diabetes.

5.   Study the knowledge and participation of full-time pharmacists in the implementation of certain areas of pharmaceutical care.

6.   Based on the data obtained, draw conclusions about the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes.

Object of research. The object of research is type 2 diabetes.

Subject of research. The subject of research is the students and full-time pharmacist and their participation in achieving control of type 2 diabetes.

Research methods. When writing the master's thesis, the method of searching and analyzing literary data was used. To obtain research materials, the method of surveying pharmacy students and working pharmacists was used. To evaluate the obtained data, statistical research methods were used, in particular, Fisher's exact test.

Practical significance of the obtained results. The practical significance of the results of the master's thesis lies in determining the level of knowledge of the research participants about modern pharmacotherapy of type 2 diabetes mellitus, studying the participation of full-time pharmacists in the implementation of certain aspects of pharmaceutical care. Based on the data obtained, areas of

pharmaceutical care were identified, the practical implementation of which requires significant improvement.

Approbation of research results and publication. The results of the research were published in abstract:

1.   Review of the modern guidelines for pharmacotherapy of type 2 diabetes mellitus to achieve diabetes control / Abdessalam Chkeirni, scientific supervisor: Associated Professor Zhabotynska N.V. // Актуальні питання створення нових лікарських засобів: матеріали XXX міжнародної науково-практичної конференції молодих вчених та студентів (23-25 квітня 2025 р., м. Харків). – Харків: НФаУ, 2025. – С. 289-290. (Application A).

Structure and volume of master's thesis. The master's thesis consists of an introduction, 3 chapters: literature review, description of research methods, research results and their analysis; conclusions. The master's thesis is presented on 41 pages, includes 4 tables, 15 figures, 35 sources of literature and 2 applications.

CHAPTER 1
LITERATURE REVIEW

1.1. Prevalence and incidence rate of diabetes

Diabetes is one of the most serious public health problems in countries around the world. According to World Health Organisation (WHO), the number of people living with diabetes has increased from 200 million in 1990 to 830 million in 2022. In 2021, diabetes and diabetic kidney disease caused more than 2 million deaths [1].

The International Diabetes Federation (IDF) Diabetes Atlas 2025 reports that 11.1% − or 1 in 9 − of adults (20-79 years) has diabetes, but more than 4 in 10 people are unaware of their condition [2]. IDF forecasts that by 2050, the incidence of diabetes will increase by 46% to an estimated 853 million [3].

According to National Diabetes Statistics Report of Centre for Disease Control and Prevention (CDC) in 2021, 38,4 million people of all ages in the United States of America, or 11,6% of the population, had diabetes. 8,7 million adults aged 18 years and older who met the laboratory criteria for diabetes did not know or report having diabetes, that is, had undiagnosed diabetes. In addition, it was reported that among people aged 65 years and older, the percentage of people with diabetes increased and reached 29,2% [4].

In Morocco, diabetes is also a serious problem for the health of the population, because the prevalence of diabetes is 12.4% among adults. At the same time, the death rate from diabetes in Morocco reached more than 2 million human period from 2011 to 2015 [6].

And according to the WHO, in 2022, more than half of people with diabetes were not taking their diabetes medication and had serious complications such as blindness, kidney failure, heart attacks, strokes and lower limb amputations [1]. The American Diabetes Association's (ADA) statistics draw particular attention to the presence of prediabetes in 97.6 million Americans aged 18 and over in 2021

[5]. In Morocco, more than 50% of patients with diabetes did not reach the recommended treatment goals [6].

More than 90% of people with diabetes have type 2 diabetes. This figure is driven by socio-economic, demographic, environmental and genetic factors. The main reasons for the increase in type 2 diabetes are [3]:

- Urbanization
- Aging population
- Decreasing levels of physical activity
- Increasing prevalence of overweight and obesity

Data from studies in Morocco showed that older age and a higher body mass index were the most closely related risk factors for the development of diabetes [6].

Summarizing all the data, we can say that diabetes, especially type, 2 is a global problem worldwide, which has a significant impact on the health status and mortality of the population and treatment in almost 50% of cases is not sufficiently effective.

1.2. Pharmacological characteristics of hypoglycemic drugs

Diabetes is a group of metabolic diseases characterized by an increase in blood glucose — hyperglycemia, which is a consequence of defects in insulin secretion, impaired insulin action, or both [7 , 8, 9].

In modern classification of diabetes, we distinguish

- Type 1 diabetes, which develops with an absolute deficiency of insulin, which develops due to autoimmune destruction of cells [9].

- Type 2 diabetes develops as a result of a relative deficiency of insulin due to the influence of various genetic and external factors leading to a violation of all types of metabolism, primarily carbohydrate metabolism, accompanied by an increase in blood sugar levels (hyperglycemia).

- Gestational diabetes is diabetes first diagnosed in women during pregnancy [9].

In this master's theses, we are studying type 2 diabetes, so we will consider the pharmacological characteristics of hypoglycemic drugs for the treatment of type 2 diabetes.

According to current guidelines for the treatment of type 2 diabetes [10, 11], the use of the following pharmacological classes of hypoglycemic drugs is permitted (Table 1.1).

Table 1.1

Pharmacological classes of hypoglycemic drugs for pharmacotherapy of type 2 diabetes

	Pharmacological class	Drugs
1.	Biguanides	Metformin
2.	Sodium-glucose Cotransporter type 2 Inhibitors (SGLT-2 inhibitors) or Gliflozins	Dapagliflozin Empagliflozin Canagliflozin
3.	Glucagon-like peptide type 1 receptor (GLP-1) antagonists	Exenatide Liraglutide Semaglutide
4.	Dipeptidyl Peptidase IV (DPP-4) inhibitors or Gliptins	Sitagliptin Saxagliptin Linagliptin Alogliptin
5.	Thiazolidinediones (TZD)	Rosiglitazone Pioglitazone
6.	Meglitinides	Repaglinide Nateglinide
7.	Sulfonylureas (second and third generation)	Gliburide * Glipizide * Gliclazide * Gliquidone * Glimepiride ^

* Second generation of Sulfonylureas

^ Third generation of Sulfonylureas

Biguanides are first-line drugs for the treatment of type 2 diabetes, and Metformin is considered the "gold standard" for the treatment of type 2 diabetes [11].

Biguanides have three main mechanisms of action [12]:

- reducing glucose synthesis in the liver by inhibiting gluconeogenesis and glycogenolysis;

- increasing muscle sensitivity to insulin by improving the uptake and utilization of peripheral glucose;

- reducing glucose absorption in the intestine.

Metformin does not cause hypoglycemia and weight gain, so it is definitely recommended for patients with obesity. The drug also has additional positive effects, namely cardioprotective, hypolipidemic.

The most common side effects of metformin (10% of patients in the first days of treatment) are gastrointestinal, including a metallic taste in the mouth, mild anorexia, nausea, abdominal discomfort and soft stools or diarrhoea [13].

SGLT-2 inhibitors is a group of oral hypoglycemic agents, the main mechanism of action of which is to block reabsorption of up to 50% of glucose in the proximal tubules of the kidneys, which leads to glucosuria and a decrease in blood glucose concentration [14, 15]. SGLT-2 inhibitors have shown a significant reduction in the number of hospitalizations due to heart failure and mortality due to fatal cardiovascular events, as well as a positive effect on the progression of albuminuria [16]. Therefore, SGLT-2 inhibitors are recommended for patients with type 2 diabetes mellitus who have atherosclerotic lesions or high-risk factors for the development of cardiovascular complications complicated by kidney disease or chronic heart failure. This group of drugs is recommended as part of an approach aimed at lowering glucose levels regardless of the concentration of glycated hemoglobin (HbA1c), taking into account the individual characteristics of the patient [10]. In the updated 2022 National Institute for Health and Care Excellence (NICE) guideline [10], SGLT-2 inhibitors is recommended as a monotherapy option for patients with type 2 diabetes who cannot take Metformin or for whom

diet and exercise alone are insufficient to control type 2 diabetes. Side effects of SGLT-2 inhibitors are rare and usually mild. Decreased urine output occurs in elderly patients and those taking diuretics. Genital mycotic infections are four times more common in patients taking SGLT-2 inhibitors [16].

The hypoglycemic effect of GLP-1 antagonists is primarily due to a glucose-dependent increase in insulin secretion and inhibition of glucagon release. The key mechanism that ensures the normalization of postprandial glycemia under the influence of GLP-1 antagonists is a marked slowing of gastric emptying, which leads to an increase in glucose absorption [9]. In addition, GLP-1 antagonists have the potential to reduce the risk of cardiovascular events in patients with or without diabetes [17]. The use of GLP-1 antagonists as monotherapy is also recommended for the pharmacotherapy of poorly controlled type 2 diabetes in adults as an adjunct to diet and physical activity when Metformin is contraindicated or inappropriate due to intolerance or contraindications. The most common side effects of GLP-1 antagonists' drugs are gastrointestinal symptoms such as nausea, vomiting, diarrhoea or constipation [18]. The peculiarity is that of GLP-1 antagonists has a parenteral route of administration in the form of subcutaneous injections.

The main mechanism of action of DPP-4 inhibitors is the inactivation of the enzyme DPP-4, which breaks down glucagon-like peptide-1 and glucose-dependent insulin-like polypeptide. This mechanism provides a prolonged action of endogenous incretins that stimulate insulin synthesis by β-cells and inhibit glucose release [19]. A feature of DPP-4 inhibitors is that they increase insulin secretion by pancreatic beta cells, thereby reducing postprandial and fasting hyperglycemia [20]. DPP-4 inhibitors allow effective control of carbohydrate metabolism with a low risk of hypoglycemia, are well tolerated, have a neutral effect on the gastrointestinal tract, body weight, and have a number of positive pleiotropic properties: cardioprotective and immunomodulatory effects [21]. DPP-4 inhibitors have a low incidence of adverse events, including upper respiratory tract infections, nasopharyngitis, headache, urinary tract infections, arthralgia, and

hypersensitivity reactions. There is a possible risk of hypoglycemia, which is increased when used in combination with a Sulfonylurea [20].

The mechanism of action of TZDs is based on increasing the sensitivity of peripheral tissues to insulin. TZDs stimulate PPAR-γ receptors, which regulate the transcription of genes responsible for the metabolism of carbohydrates and fats [22]. This increases the transport of glucose into adipocytes and myocytes, where the processes of glycogenesis and glycolysis are activated [23]. The use of TZDs is considered most rational in combination with Metformin, if monotherapy with the latter has not been successful, or Metformin is contraindicated in a particular patient (for example, with chronic kidney disease (CKD) with renal failure) [23].

Meglitinides exert their hypoglycemic effect by increasing the production of endogenous insulin by the pancreas, thereby reducing blood glucose levels in the body [24, 25]. As a member of the meglitinide group of insulin-secreting agents, repaglinide monotherapy has been associated with adverse effects that include hypoglycemia, upper respiratory tract infections, gastrointestinal upset, joint pain, and weight gain [24, 25]. Meglitinides can be used as a combination therapy for diabetes with first-line drugs. Meglitinides should not be given in combination with Sulfonylureas such as Glipizide due to similar mechanisms of action that involve the closure of ATP-sensitive potassium channels [25].

Sulfonylureas drugs remain among the most widely used antidiabetic drugs. Sulfonylureas increase the sensitivity of β-cells to blood glucose, so their use is justified only in patients with functioning β-cells [26]. Sulfonylureas bind to ATP-sensitive potassium channels (K) on pancreatic beta cells and inhibit them. Sulfonylureas cause insulin release regardless of blood glucose levels. Sulfonylureas have a number of side effects, the most important of which is an increased risk of developing complications from the cardiovascular system and mortality in patients with type 2 diabetes from cardiovascular complications. Considering that such side effects of Sulfonylureas are more pronounced in the first generation of PS (Glibenclamide), preference should be given to the use of

Sulfonylureas of the second and third generations (Glimepiride and Gliclazide) [26].

Thus, current guidelines for pharmacotherapy of type 2 diabetes consider 7 pharmacological groups of hypoglycemic drugs, most of which are administered orally.

1.3. Pharmaceutical care in achieving control of type 2 diabetes

According to the definition, pharmaceutical care is "the provision of drug therapy services aimed at achieving specific outcomes that enhance the quality of life." Pharmaceutical care is a process in which the pharmacist has a direct (or indirect) relationship with the patient to optimize pharmacotherapy and improve its outcomes. In the process of pharmaceutical care, the pharmacist may also collaborate with other health professionals [27].

Pharmacies play a major role in providing patients with diabetes with both insulin and other hypoglycemic drugs. Accordingly, the implementation of all pharmaceutical care principles by the pharmacist can contribute to achieving glycemic control in patients with diabetes.

In 2022, Shawahna R et al [28] conducted a systematic review of 56 articles on pharmaceutical care for patients with diabetes. The results showed the possibility of providing 86 types of pharmaceutical care services. Among these services, the following were distinguished:

- diabetes screening/prevention (2,3%);
- patient support (7,0%);
- history taking (3,5%);
- patient education (17,4%);
- assessment/development of care plans (10,5%);
- effectiveness of pharmacotherapy (3,5%);
- collaboration with patients and other healthcare professionals (2,3%);
- identification/resolution of medication-related problems (26,7%);
- dispensing hypoglycemic drugs (7,0%);

- determination of patient adherence (4,7%);

- monitoring/improving outcomes (5,8%);

- follow-up (2,3%).

In 2023, a study was conducted in Brazil to investigate the effects of pharmaceutical care of patients with type 2 diabetes in primary care settings on metabolic control, cardiovascular risk, adherence to treatment, and quality of life. The study found a significant ($p=0.048$) reduction in cardiovascular risk, a significant ($p=0.024$) improvement in lipid control, and an improvement in HbA1c. Also, after pharmaceutical care, patients' quality of life and adherence to treatment significantly ($p \leq 0.01$) improved [29].

An important element of pharmaceutical care is the education of patients with diabetes. Education includes educational measures that explain to the patient the features of the development and course of diabetes and its treatment, measures to improve patient compliance, such as providing information about medications, adverse reactions, method of administration and storage (in particular, insulin), education aimed at recognizing and correcting hypoglycemia, lifestyle changes (quitting smoking, alcoholism, proper diet and foot examination), and promotion of self-care (monitoring glucose levels) [30]. The authors also demonstrated a positive effect of pharmaceutical care on reducing systolic blood pressure, HbA1c, fasting glucose and triglyceride levels, and on increasing high-density lipoprotein levels in patients with diabetes [30].

In 2016, a study was conducted in India to examine the impact of pharmacist-led care on not only quality of life and satisfaction with treatment, but also on stress responses in patients with diabetes. The study assessed the following types of pharmaceutical care: diabetes education, medication counselling, lifestyle changes, and dietary guidelines for their medications. The study concluded that pharmacist-led patient counselling, diabetes medication, and lifestyle modifications will improve quality of life and glycemic control. More attention should be paid to addressing the psychological problems of patients with diabetes, rather than focusing solely on diabetes pharmacotherapy [31].

Another research focused on the role of pharmaceutical care in achieving control in patients with type 1 diabetes, namely in pharmacists' adherence to insulin storage and dispensing rules [32.]. Improper storage can lead to a decrease in insulin activity, which will affect its ability to effectively and predictably control the patient's blood sugar level. Insulin can be used to treat not only type 1 diabetes, but also type 2 diabetes if control can't be achieved with oral hypoglycemic drugs. Therefore, monitoring compliance with insulin storage rules is relevant. Based on the results of the study, the authors developed recommendations for pharmacists and diabetics on the storage of insulin preparations [32.].

Thus, based on the literature data, it can be stated that pharmaceutical care for patients with both type 1 and type 2 diabetes contributes to improving the effectiveness of diabetes pharmacotherapy and improving the quality of life of patients. Pharmaceutical care can positively affect the reduction of cardiovascular risk, increase patient adherence to treatment and, therefore, can help delay the onset of major chronic complications of diabetes. However, the results of almost all studies contain recommendations for further in-depth study of the possibilities of pharmaceutical care in achieving diabetes control.

Conclusion to Chapter 1

Diabetes is a chronic disease that can lead to serious complications and death of patients. The incidence of diabetes mellitus according to data from different countries is about 11% of the population, among which more than 90% are patients with type 2 diabetes. According to modern guidelines for pharmacotherapy, 7 pharmacological classes of drugs with different mechanisms of action are recommended. A special role in achieving diabetes control is given to pharmaceutical care. About 86 directions of pharmaceutical care are described in the literature. However, a number of studies emphasize the need for a more in-depth study of pharmaceutical care for patients with diabetes.

CHAPTER 2
RESEARCH METHODS

The first stage of the master's thesis was writing a literature review. For this purpose, information from 35 literature sources was analyzed and summarized. To adhere to the principles of evidence, the literature review included only articles from scientific journals and guidelines for providing medical care for diabetes approved by various associations: IDF, CDC, ADA.

Typically, the goals of conducting literature reviews are usually to:

▪ summarize information that has already been written on a particular topic;

▪ determine the degree of interpretability of certain trends or patterns in the topic under study;

▪ familiarize yourself with empirical conclusions that are based on evidence;

▪ develop new theories; identify a range of issues that require further research [33].

In master's thesis, while writing a literature review, the prevalence and incidence rate of diabetes worldwide were determined, data on the pharmacological characteristics of hypoglycemic drugs were summarized, directions of pharmaceutical care of patients with diabetes and its role in achieving glycemic control were described. Based on the literature review data, insufficiently studied aspects of pharmaceutical care of patients with type 2 diabetes were identified.

In the practical part of the master's thesis, a survey method was used to assess the role of pharmaceutical care in achieving control of type 2 diabetes. Surveys in research are the collection of information from a sample of individuals through their responses to questions [34]. Surveys allow for the involvement of diverse groups of participants in the study. Survey research can use quantitative research strategies (e.g., using questionnaires with numerically scored items),

qualitative research strategies (e.g., using open-ended questions), or both strategies (i.e., mixed methods) [34]. The use of the survey method in our study was most appropriate, since pharmacists implement pharmaceutical care and can provide all the necessary information.

The survey was conducted over a period of 2 months (January-February 2025) among foreign graduate students of the 5th year of the National University of Pharmacy and among working pharmacists in Morocco.

To attract a larger number of respondents, the survey was conducted using Google Forms. The questionnaire in the form of a Google Forms included 23 questions.

The questionnaire began with 4 general questions that related to age, gender, education, and work in a pharmacy or continuing education. The survey was anonymous.

Then there were 4 questions of the questionnaire related to the knowledge of the research participants about modern approaches to pharmacotherapy of type 2 diabetes. In particular, the questions concerned the groups of hypoglycemic drugs recommended by modern guidelines, the choice of the pharmacological classes for the initial therapy and for complications of type 2 diabetes (chronic heart failure (CHF), diabetic chronic kidney disease (CKD)).

The next 3 questions concerned such an aspect of pharmaceutical care as the effectiveness of pharmacotherapy. Research participants were asked about their knowledge of the criteria for diagnosing type 2 diabetes and the criteria used to assess the effectiveness of pharmacotherapy, as well as the frequency of monitoring the effectiveness of pharmacotherapy.

The next 8 questions concerned an important section of pharmaceutical care, patient support. Respondents were asked about their knowledge of the side effects of pharmacological drugs, and the participation of pharmacists in the prevention of side effects, and in explanation to patients the medication regimen.

According to the literature data of Shawahna R et al [28] more than 17% of pharmaceutical care is patient education. The following 4 questions were devoted

to the participation of pharmacists in teaching patients what diabetes is, its first signs and symptoms of acute complications (hypo- and hyperglycemic states), teaching patient's lifestyle changes.

One of the advantages of using Google Forms for conducting a survey is obtaining data that has already undergone automatic statistical processing and is presented in the form of diagrams. To present some data (age, gender), arithmetic means (M) with standard deviations (SD), as well as percentage values, were used. To calculate such data, Microsoft Excel from the Microsoft Office suite of office programs was used.

For statistical analysis of the obtained data, in particular, to establish the significantly of the obtained data, Fisher's exact test was used. Fisher's exact test is a non-parametric test for investigating associations between two categorical, binary variables [35]. To calculate Fisher's exact test, an online calculator is used. (https://www.omnicalculator.com/statistics/fishers-exact-test). The results of all statistical procedures were considered significant at $p < 0.05$.

Conclusion to Chapter 2

A number of scientific methods were used in the qualification work. The method of searching and analyzing data was used when writing a literature review. The method of surveying student pharmacists and working pharmacists was used to obtain research materials. A questionnaire in the form of a Google Forms was developed for the survey, which contained 23 questions. Statistical research methods, in particular Fisher's exact test, were used to evaluate the data obtained.

CHAPTER 3

THE RESULTS OF THE RESEARCH.

THE DISCUSSION OF THE RESULTS

3.1. General description of research participants

A survey to examine the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes was conducted among 5th-year international graduate students at the National University of Pharmacy and among working pharmacists in Morocco. 24 students and 8 full-time working pharmacists voluntarily agreed to participate in the survey, for a total of 32 participants.

The age of the study participants ranged from 22 to 46 years, with an average age of $22,53 \pm 4,76$ years.

The survey was conducted among women male 21 (65,63%) and female 11 (34,37%) (Fig. 3.1.). Among men there were 15 students and 6 full-time working pharmacists, among women there were 9 students and 2 full-time working pharmacists.
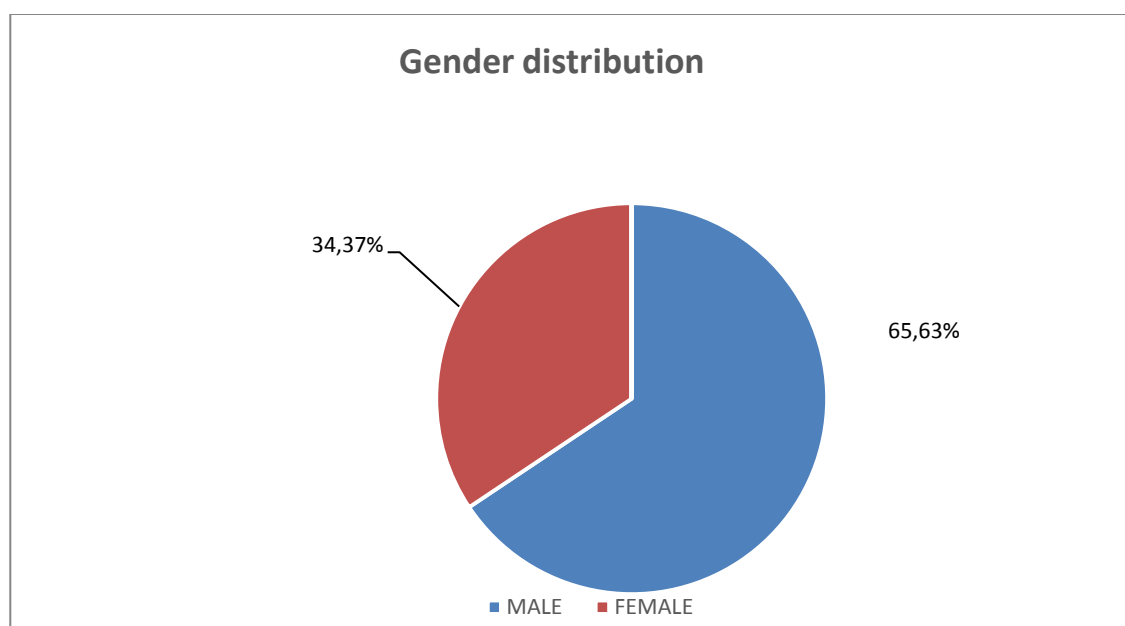

Fig. 3.1. Distribution of research participants by gender

Among the survey participants who are full-time working pharmacists, 3 (37.5%) completed their studies 10 years ago, 3 (37.5%) completed their studies 5 to 10 years ago, and 2 (25%) completed their studies less than 5 years ago.

Among the student participants in the study, 14 people were identified who had experience working in a pharmacy, 7 who continue to work in a pharmacy while studying at the National University of Pharmacy (Fig. 3.2.).
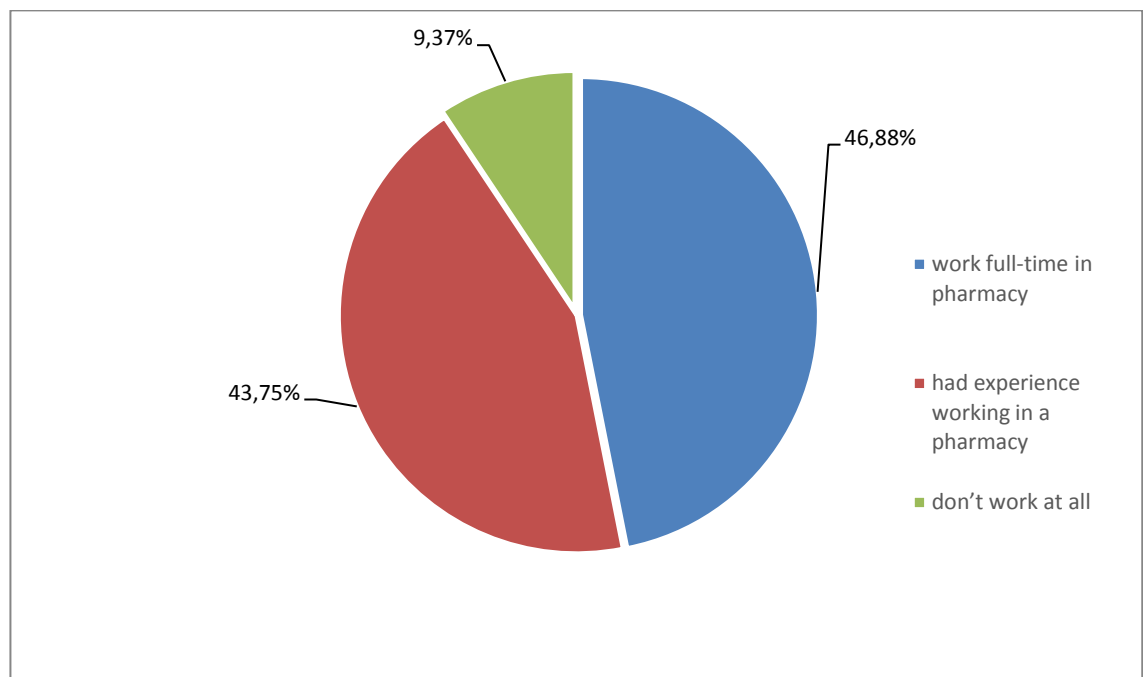

Fig. 3.2. Distribution of research participants by employment

For further analysis of the responses of the research participants, they were divided into 2 Groups:

Group 1 consisted of 15 (46.87%) pharmacists who are working full-time. This group was divided into subgroup 1S, which included 7 working students, and subgroup 1PH, which included 8 permanently employed pharmacists who had completed their studies.

Group 2 consisted 17 (53.13%) unemployed students who had not yet completed their studies.

Summarizing the general data on the research participants, it was found that their average age was 22,53 years; there were 1,9 times more male, and no

significant difference was observed between the number of full-time employed and unemployed research participants.

3.2. Analysis of the knowledge of research participants about modern approaches to type 2 diabetes pharmacotherapy

According to modern pharmacotherapy guidelines, 7 pharmacological classes of drugs have been proven effective in the treatment of type 2 diabetes. Over the past 5 years, recommendations for pharmacotherapy of type 2 diabetes have changed significantly: 1st generation Sulfonylureas, Alpha-Glucosidase Inhibitors (AGIs) have been excluded from the guidelines, and modern pharmacological classes of drugs such as GLP-1, iSGLT-2, and others have been added. To achieve glycemic control, it is important that pharmacists use only the recommended drug.

The answers to the question 1 "Choose the pharmacological classes of drugs recommended by guidelines for the treatment of type 2 diabetes" are presented in Fig.3.3. Multiple answers were possible.
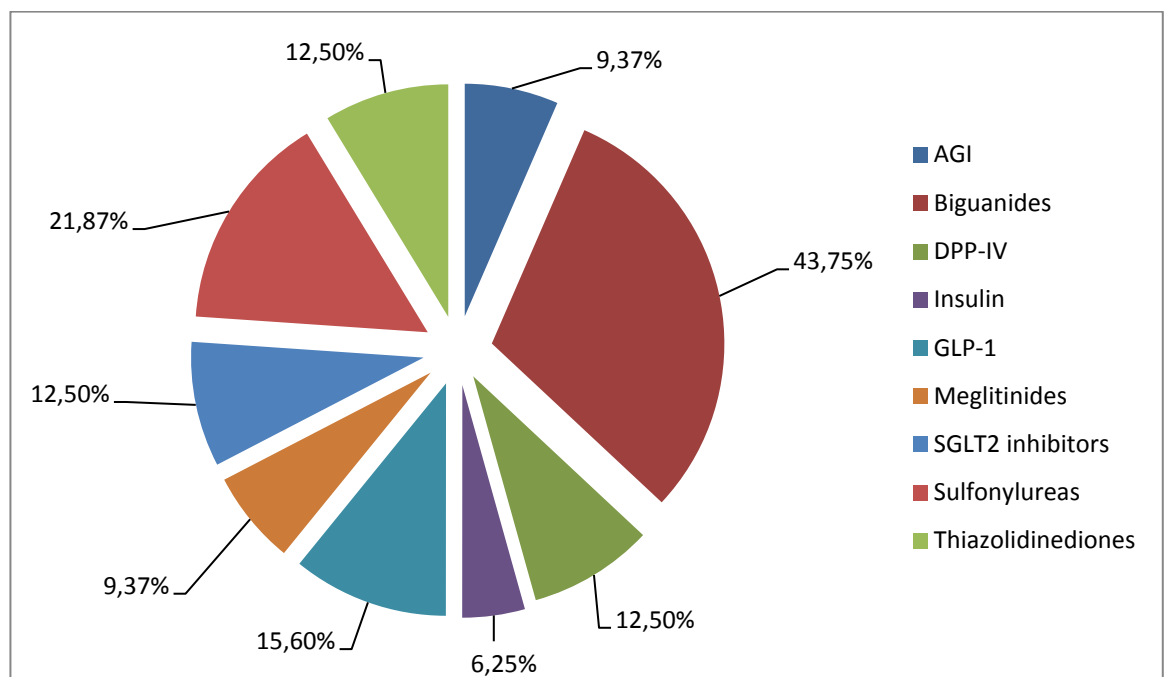

Fig. 3.3. The pharmacological classes of drugs recommended by guidelines for the treatment of type 2 diabetes

The answers to this question showed that the majority (43.75%) of the research participants preferred Biguanides and Sulfonylureas (21.87%). Indeed, the drug of the Biguanide class — Metformin is the "gold standard" for the treatment of type 2 diabetes. When using the pharmacological class of Sulfonylureas, only 2nd and 3rd generations should be chosen (with Glibenclamide excluded from the guidelines). At the same time, 6.25% of the research participants chose insulin as a medicine for pharmacotherapy of type 2 diabetes, but they do not indicate under what conditions it should be used in such patients. It is also worth noting that 9.37% research participants chose AGIs respectively, as drugs recommended for pharmacotherapy of type 2 diabetes, although they have not been discussed in recent guidelines.

In the 2022 ADA recommendations [8], the greatest attention was paid to the optimal choice of drug for the initial therapy of type 2 diabetes. Therefore, the next 2 question of the questionnaire was formulated as follows: "Choose the best drug for the initial pharmacotherapy of type 2 diabetes for all patients" (Fig.3.4.). Multiple answers were possible.
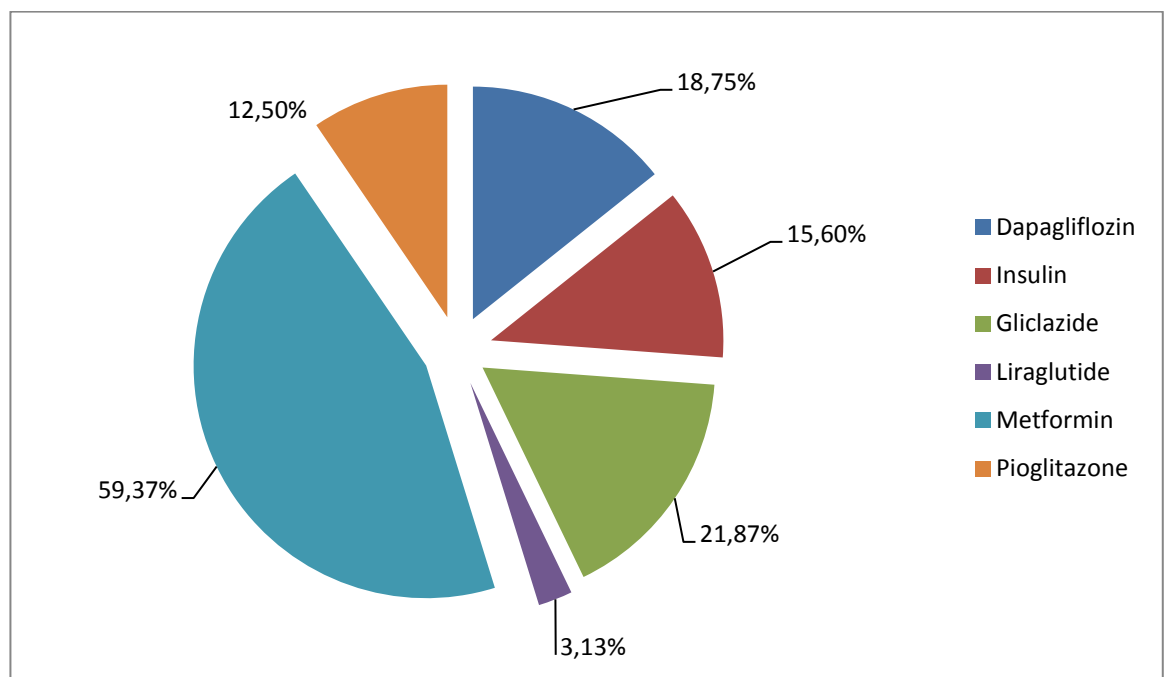

Fig. 3.4. The best drug for the initial pharmacotherapy of type 2 diabetes for all patients

Among the responses received, the highest percentage of 59.37% selected Metformin, which belongs to the pharmacological class of Biguanides, which is the best choice for the initial treatment of type 2 diabetes. But the percentage of research participants, who chose Metformin, in our opinion, is quite low. The second most frequently (21.87%) chosen was Gliclazide, which belongs to the pharmacological class of Sulfonylureas and, according to the latest guidelines, is not the optimal drug for the initial therapy of diabetes. And almost 18.75% of research participants chose Dapagliflozin from the pharmacological class of SGLT-2 inhibitors. Despite the fact that SGLT-2 inhibitors is the most modern and effective in the treatment of type 2 diabetes with renal complications and in combination with CHF, research participants paid insufficient attention to them.

One of the main problems of type 2 diabetes is the development of chronic complications with damage to target organs (heart, kidneys, eyes, etc.). And the main goal of pharmacotherapy of type 2 diabetes isn't only to control the glycemia's level of, but also to prevent the development of chronic complications, in particular CHF and diabetic CKD. Different pharmacological classes of hypoglycemic drugs have different evidence bases regarding their effects on the prevention and treatment of chronic complications of type 2 diabetes.

The recommendations provide evidence of the advantages of using various hypoglycemic drugs for the prevention of chronic complications. The research participants were asked the following question 3: "Choose the best hypoglycemic drug to prevent the development of CHF" (Fig.3.5.). It was allowed to choose only one answer.

The answers to this question showed that the vast majority of research participants (43.75%) chose Metformin (Biguanide class) as the drug of choice for pharmacotherapy of type 2 diabetes complicated by CHF. The second most frequently chosen (25%) was Gliclazide (Sulfonylureas), which does not have a proven positive effect on the course of CHF. And the recommended classes of drugs for CHF, i.e. iSGLT-2 and GLP-1 antagonists, were chosen by an absolute minority of research participants (6.25%) and (3.12%).
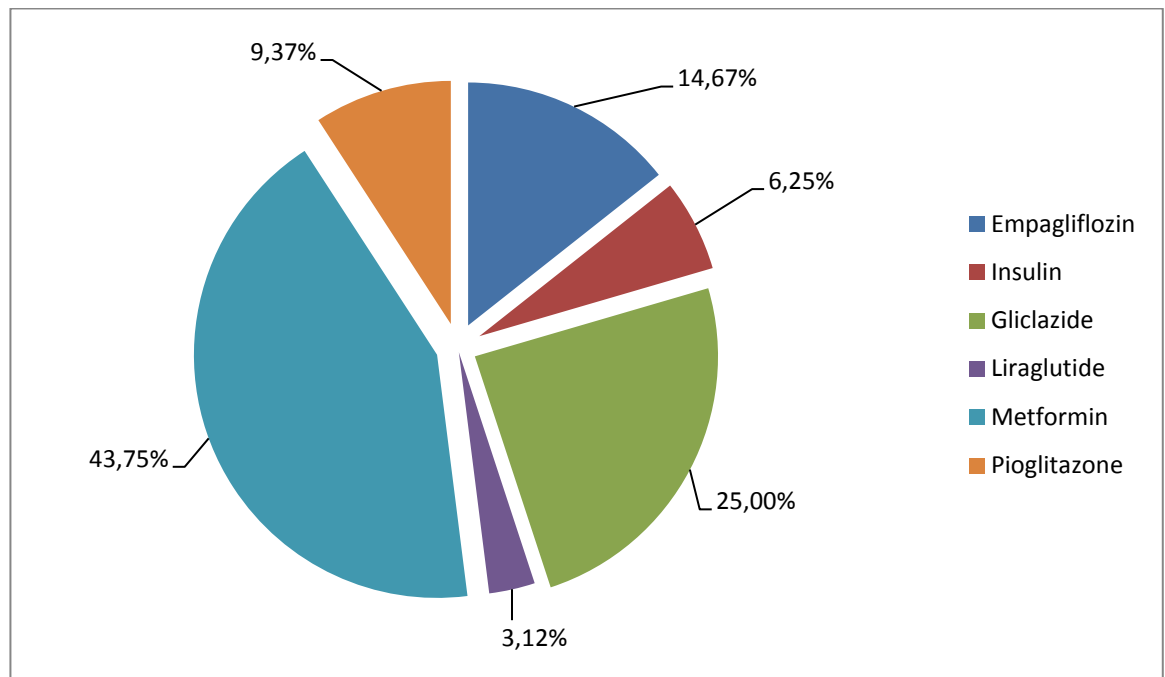
Fig. 3.5. The best hypoglycemic drug to prevent the development or treat of CHF

The second most common complication of type 2 diabetes is the development of diabetic CKD, which is the second cause of death in patients with type 2 diabetes after acute cardiovascular events (heart attacks and strokes). The following 4 question was formulated for the study participants: "Choose the best drug for pharmacotherapy of type 2 diabetes complicated by diabetic CKD" (Fig.3.6.). It was allowed to choose only one answer.

The research participants' responses were similar to the responses to the previous question. The largest number of research participants (34.37%) chose Metformin (Biguanides), the second most frequently chosen (25%) was Canagliflosin (SGLT-2 ingibitors), the third (21.87%) was Glimepiride (Sulfonylureas). Liraglutide (GLP-1 antagonists) was chosen by only 8.8% of research participants. Although in current recommendations on pharmacotherapy of type 2 diabetes emphasize that if a patient has diabetic CKD, it is advisable to start pharmacotherapy with SGLT-2 ingibitors with initial evidence of slowing the progression of diabetic CKD or GLP-1 antagonists with proven cardiovascular benefits in case of intolerance or contraindications to SGLT-2 ingibitors [8].
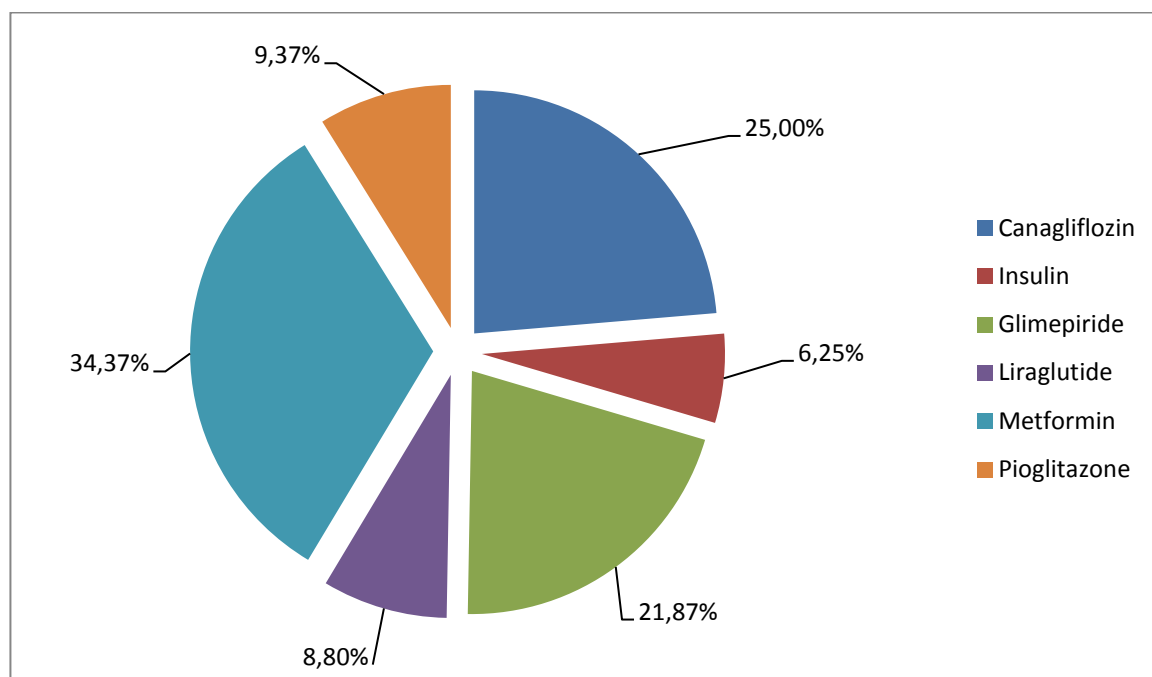
Fig. 3.6. The best drug for pharmacotherapy of type 2 diabetes complicated by diabetic CKD

The answers to the last two questions indicate insufficient knowledge of the study participants regarding current recommendations for pharmacotherapy of type 2 diabetes complicated by CHF and diabetic CKD.

A comparative analysis of the answers in two groups of research participants (Group 1 consisted of pharmacists who are working full-time in the pharmacy; Group 2 consisted of unemployed students) showed that in group 1, correct answers were significantly ($p \leq 0,05$) chosen more often to questions 1, 3, and 4 about modern pharmacotherapy of type 2 diabetes (Table 3.1). The obtained result shows that practical activities in the pharmacy contribute to improving knowledge of pharmacotherapy of type 2 diabetes. It is important that pharmacists working full-time are likely to be better versed in pharmacotherapy of complicated type 2 diabetes.

Unfortunately, 6,25 % of research participants (all of them are students who had not yet completed their studies) consider insulin to be a necessary drug for the treatment and prevention of complications of type 2 diabetes. But according to current recommendations, insulin for type 2 diabetes is recommended for patients

only if glycemic control cannot be achieved and the level of HbA1c remains more than 9%.

Table 3.1

Comparative analysis answers of the research participants to questions about modern pharmacotherapy of type 2 diabetes

№	Question	Group 1 / Group 2
1	"Choose the pharmacological classes of drugs recommended by guidelines for the treatment of type 2 diabetes"	$\varphi_{емп.} = 1.983$; $p = 0.0237*$
2	"Choose the best drug for the initial pharmacotherapy of type 2 diabetes for all patients"	$\varphi_{емп.} = 0.735$; $p = 0.2313$
3	"Choose the best hypoglycemic drug to prevent the development of CHF"	$\varphi_{емп.} = 1.871$; $p = 0.0306*$
4	"Choose the best drug for pharmacotherapy of type 2 diabetes complicated by diabetic CKD"	$\varphi_{емп.} = 1.802$; $p = 0.0358*$

* Significance ($p \leq 0,05$) of the results of the comparative analysis of responses in Group 1 and Group 3

The responses of the research participants to questions about modern approaches to pharmacotherapy of type 2 diabetes showed an insufficient level of knowledge, but the level of knowledge of full-time working pharmacists, especially regarding the treatment of complicated type 2 diabetes, was significantly ($p \leq 0,05$) higher.

3.3. Analysis of the knowledge of research participants about effectiveness of type 2 diabetes pharmacotherapy

An important aspect of pharmaceutical care is monitoring the effectiveness of pharmacotherapy received by a patient with diabetes. Therefore, it is important

to examine the knowledge of research participants about the criteria and terms for determining the effectiveness of treatment.

The next 5 questions were formulated as follows: "Choose the indicators that need to be examined in the patient to establish the diagnosis" (Fig. 3.7.). Multiple answers were possible.
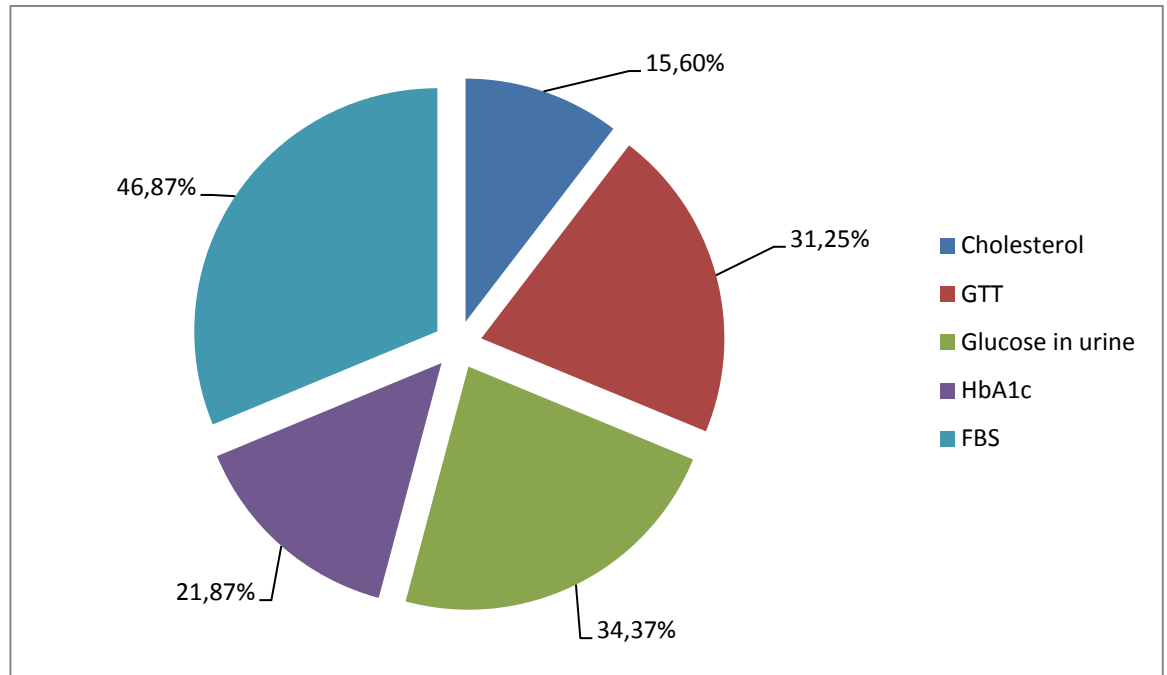

Fig. 3.7. The indicators that need to be examined in the patient to establish the diagnosis

According to modern protocols, the following tests are recommended to diagnose type 2 diabetes: fasting blood sugar (FBS), glucose tolerance test (GTT) and HbA1c test [8]. The significantly ($p \leq 0,05$) majority of the research participants chose three indicators necessary for establishing the diagnosis. More than a third of the research participants consider it necessary to determine the level of glucose in the urine for the diagnosis of type 2 diabetes. But glucose in the urine appears only when the glycemia is more than 11 mmol/l. In addition, it is recommended to take into account the level of ketones in the urine for diagnosis. The level of cholesterol isn't an indicator for diabetes, but is an indicator of the development of atherosclerosis, a complication of diabetes.

Modern recommendations clearly outline laboratory indicators that allow monitoring the effectiveness of type 2 diabetes, the leading of which is the level of HbA1c [8]. HbA1c test shows your average blood glucose level for the past 3 months. It measures the percentage of blood glucose attached to hemoglobin, the oxygen-carrying protein in red blood cells.

The next 6 questions were formulated as follows: "Choose the laboratory indicator that is most informative for assessing the effectiveness of pharmacotherapy for type 2 diabetes" (Fig. 3.8.). It was allowed to choose only one answer.
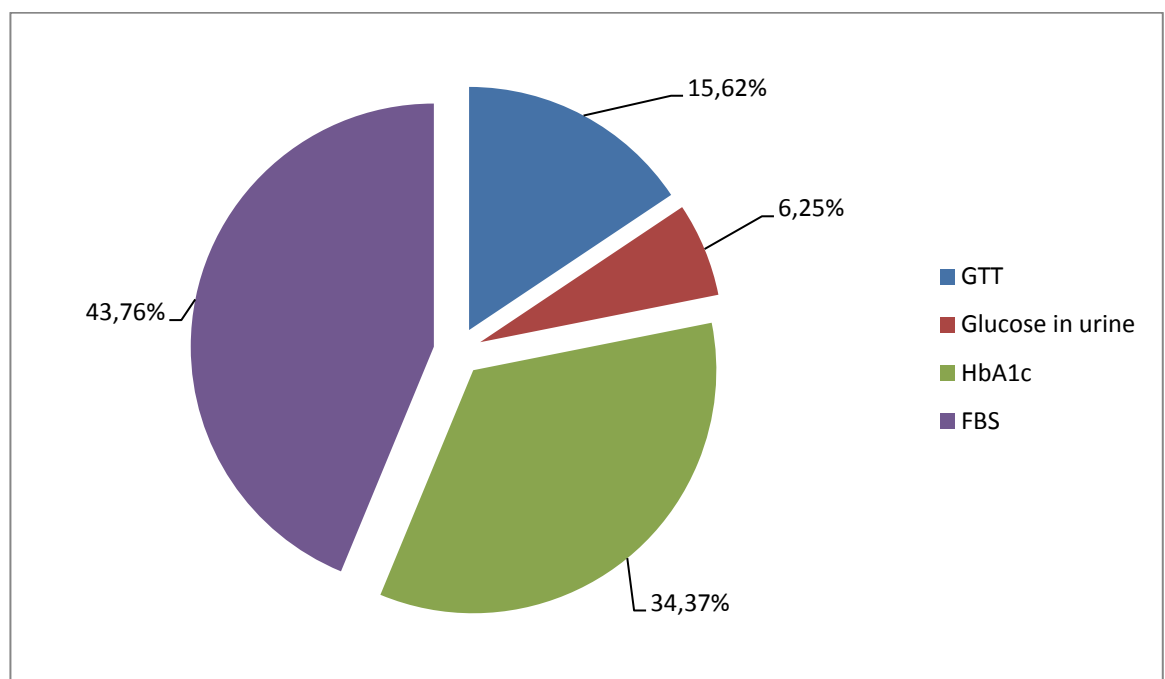
Fig. 3.8. The laboratory indicator that is most informative for assessing the effectiveness of pharmacotherapy for type 2 diabetes

Analysis of the responses showed that research participants were 1.27 times more likely to choose FBS as an indicator of the effectiveness of pharmacotherapy. This is not the correct answer, since the guidelines describe the HbA1c test. However, there was no significant ($\varphi_{емп.} = 0.77$; $p = 0.2207$) difference between the choice FBS and the HbA1c test.

This result may indicate some confusion in the knowledge of research participants regarding diagnostic criteria and indicator for the effectiveness of pharmacotherapy for type 2 diabetes.

An important aspect of pharmaceutical care is to explain not only the need to monitor the effectiveness of the hypoglycemic drugs being taken, but also the frequency of such monitoring. Therefore, the next 7 questions were formulated as follows: "Choose the frequency of HbA1c test monitoring" (Fig. 3.9.).
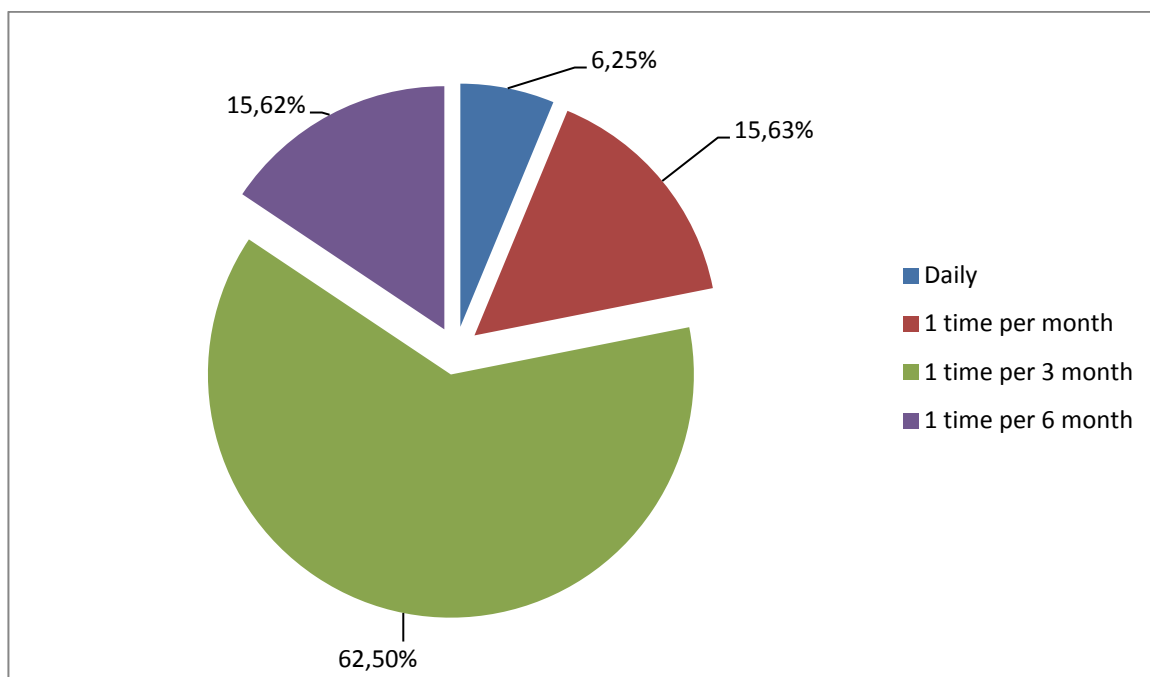
Fig. 3.9. The frequency of HbA1c test monitoring

Most of the research participants significantly ($p \leq 0,05$) chose the correct answer — once every 3 months. This is due to the fact that red blood cells are completely renewed within 120 days, and, accordingly, the dynamics of the HbA1c level should be assessed every three months. Doing the HbA1c test more often will not be informative enough, and less often — it is possible provided that the course of type 2 diabetes is not severe and not labile.

Next, a comparative analysis of the answers to the question about pharmaceutical care as the effectiveness of pharmacotherapy was conducted in the two groups of research participants (Table 3.2). The results showed that the

research participants in Group 1 (full-time pharmacists) had significantly (p ≤ 0,05) better knowledge of the indicators that allow for the diagnosis of type 2 diabetes and the required frequency of monitoring the effectiveness of pharmacotherapy. No significant difference in knowledge between Group 1 and 2 about the main indicators that allows monitoring the effectiveness of treatment was found.

Table 3.2

Comparative analysis answers of the research participants to questions about pharmaceutical care as the effectiveness of pharmacotherapy

№	Question	Group 1 / Group 2
5.	"Choose the indicators that need to be examined in the patient to establish the diagnosis"	$\varphi_{емп.} = 2.157$; p = 0.0155*
6.	"Choose the laboratory indicator that is most informative for assessing the effectiveness of pharmacotherapy for type 2 diabetes"	$\varphi_{емп.} = 1.387$; p = 0.0828
7.	"Choose the frequency of HbA1c test monitoring"	$\varphi_{емп.} = 1.983$; p = 0.0237*

* Significance (p ≤ 0,05) of the results of the comparative analysis of responses in Group 1 and Group 3

3.4. Analysis of the knowledge of research participants about patient with diabetes type 2 support

One of the important problems of pharmacotherapy of any disease, including type 2 diabetes, is the development of side effects while taking medications, which will limit the ability to achieve disease control. When providing pharmaceutical care, it is important that the pharmacist not only knows about the possible side effects of hypoglycemic drugs, but also warns patients about them and explains possible ways to avoid them.

For research participants, questions 8-13 were related to establishing the correspondence of the most common side effects and the pharmacological classes of hypoglycemic drugs to which they are inherent. The responses were summarized in Table 3.3.

Table 3.3

Correspondence between possible side effects and the pharmacological classes of hypoglycemic drugs to which they are inherent

Side effect	Biguani-des	DPP-IV	GLP-1 antagonists	SGLT-2 inhibitors	Sulfony-lureas	TZDs
Constipation	6,28%	3,12%	59,37%	3,12%	12,5%	15,6%
Diarrhoea	68,75%*	25%	6,26%	0%	0%	0%
Nausea	28%	31,25%	28%	6,28%	3,12%	3,12%
Hypoglycemia	0%	3,12%	9,37%	3,12%	84,37%*	3,12%
Stomach pain	9,37%	34,37%*	15,6%	9,37%	15,6%	15,6%
Urinary tract infection	6,28%	15,6%	15,6%	46,87%*	9,37%	6,28%
Water retention	6,26%	15,6%	18,75%	25%	6,26%	28,13%

* Significance ($p \leq 0,05$) of the answers of the research participants

Analyzing the knowledge of the research participants, it was determined that the significantly vast majority gave the correct answer about the side effects of Biguanides ($\varphi_{\text{емп.}} = 3.075$; $p = 0.0011$); DPP-IV ($\varphi_{\text{емп.}} = 1.761$; $p = 0.0391$); SGLT-2 inhibitors ($\varphi_{\text{емп.}} = 2.782$; $p = 0.002$); Sulfonylureas ($\varphi_{\text{емп.}} = 6.064$; $p \leq 0.01$). The side effects were correctly selected for GLP-1 antagonists 59,37% research participants ($\varphi_{\text{емп.}} = 1.509$; $p = 0.0657$), for DPP-IV — 31,25% ($\varphi_{\text{емп.}} = 0.274$; $p = 0.3922$), and for TZDs — 28,13% ($\varphi_{\text{емп.}} = 1.221$; $p = 0.1111$). But these data weren't significant.

Knowledge of the most frequent side effects of different pharmacological groups of hypoglycemic drugs indicates that pharmacists are best aware of Biguanides and Sulfonylureas. These results coincide with the answers to previous questions about the choice of hypoglycemic drugs for initial therapy and in the presence of complications, where was also more often chosen Biguanides and Sulfonylureas.

Interestingly, 15 (46,87%) research participants correctly indicated that a most common side effect of the use of SGLT-2 inhibitors is Urinary tract infection. Increased Urinary tract infection rates associated with increased glucose excretion in the urine (glucosuria), which creates conditions for the development of bacteria. A more detailed analysis showed that only participants in Group 1 gave the correct answers. This once again confirms previous findings that practical activities improve pharmacists' knowledge and ensure better implementation of pharmaceutical care.

Not only is pharmacist knowledge important, but also providing patients with information about the possibility of developing and preventing side effects. This will prevent the development of side effects and improve patient adherence to medication.

The following 14 question are formulated as follows: "Do you provide patients with information about possible side effects of medications when dispensing drugs?" (Fig. 3.10.). Only the participants of Group 1 — full-time pharmacists — gave an answer to this question.

The majority of the Group 1 research participants significantly ($\varphi_{\text{емп.}} = 1.861$; $p = 0.0313$) provide patients with the necessary information about side effects (either always or when asked), thus implementing pharmaceutical care. 20% don't do this due to heavy workload.

Another aspect of patient support is explaining the medication regimen. The following 15 question are formulated as follows: "Do you explain the medication regimen to patients when they are discharged?" (Fig. 3.11.). This question was also answered only by research participants of Group 1.
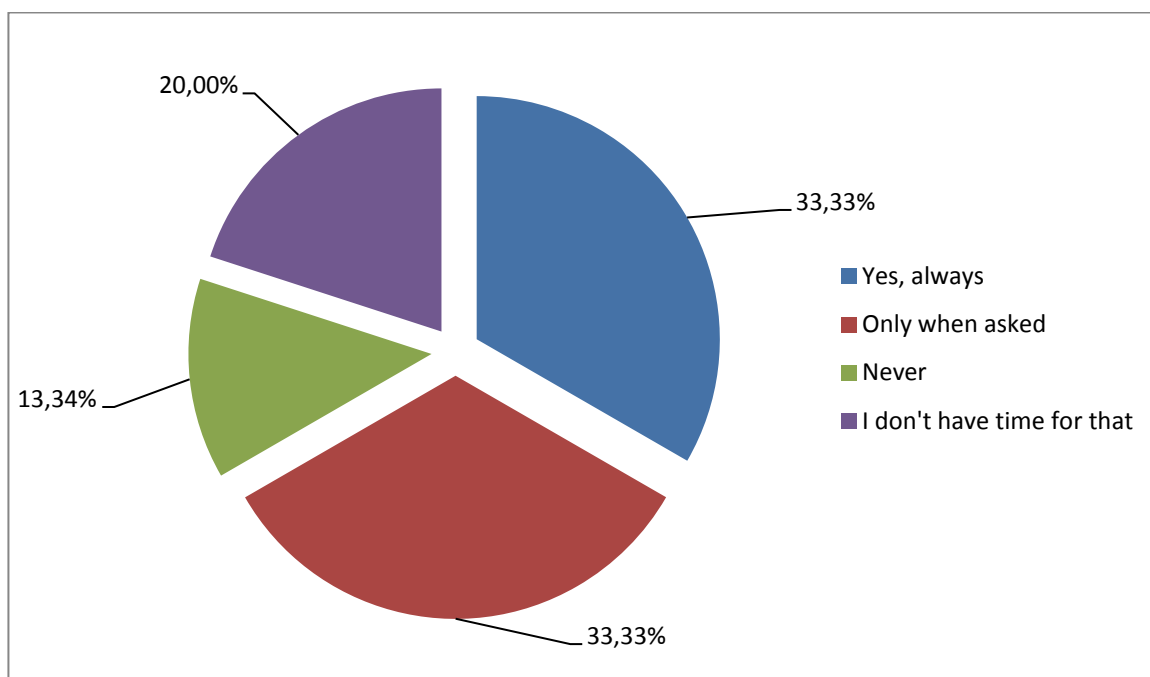
Fig. 3.10. The participation of research participants (Group 1) in providing information to patients about possible side effects of medications
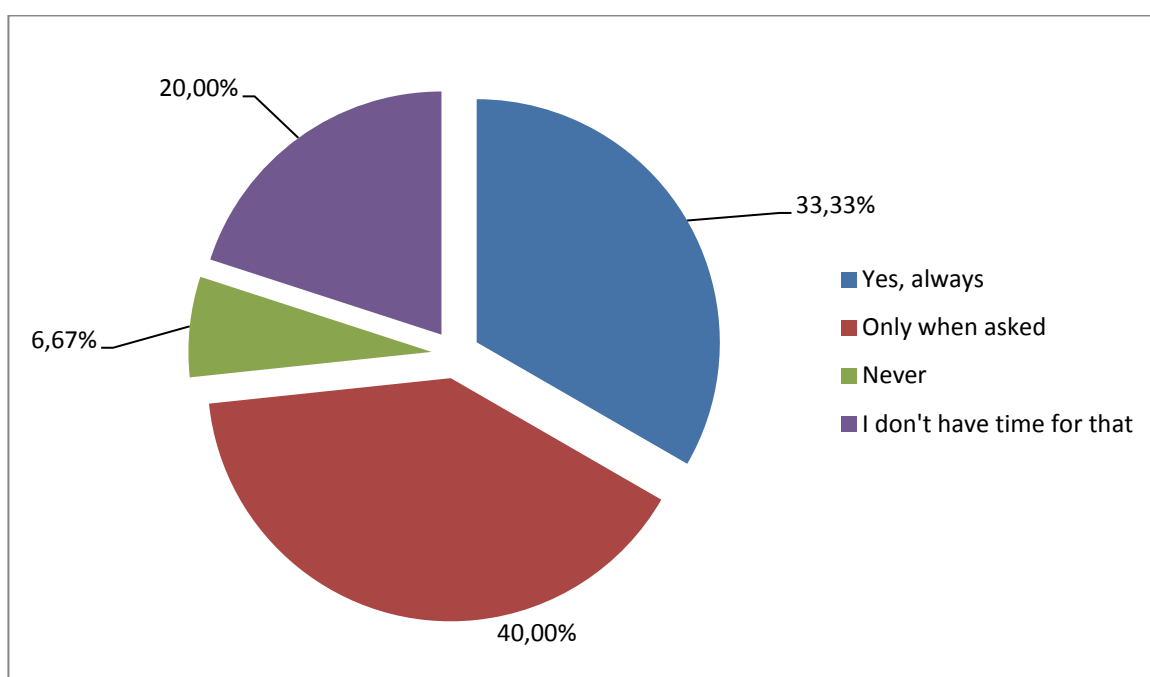

Fig. 3.11. The participation of research participants (Group 1) in explanation to patients the medication regimen

The distribution of answers to this question was similar to the answers to the previous question. It is significantly ($\varphi_{\text{emp.}} = 2.659$; $p = 0.0039$) more — 73% —

that the research participants explain patients on the medication regimen (either always or when asked). Only 1 (6,67%) study participant never does this. But there are 20% of overworked pharmacists who do not do this. In our opinion, it is necessary to increase the activity of pharmacists in implementing such an aspect of pharmaceutical care as patient support (providing information about both side effects and the medication regimen use), considering that only about 33% do it always.

3.5.   Analysis of the role of research participants in patient education

Another important aspect of pharmaceutical care is patient education. This education includes, first of all, the ability to identify the first signs and symptoms of acute complications (hypo- and hyperglycemic states), as well as teaching patients lifestyle modifications.

The following 16 question are formulated as follows: "Choose the symptoms of hypoglycemia" (Fig. 3.12.). Multiple answers were possible.
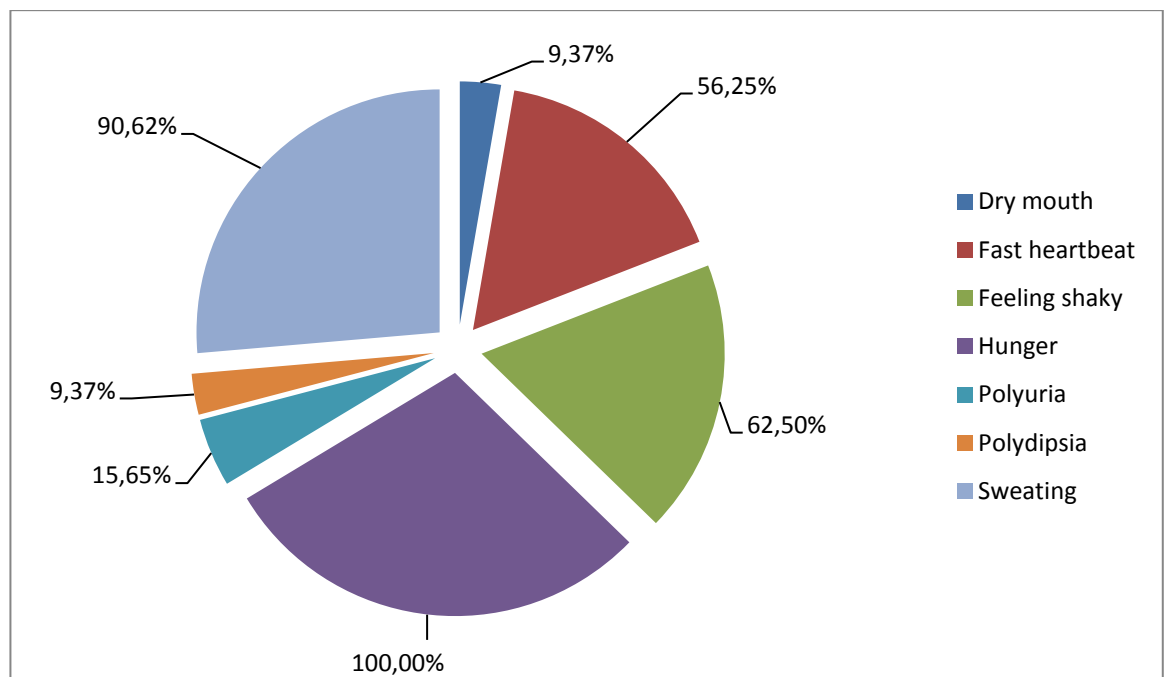

Fig. 3.12. The knowledge of research participants about the symptoms of hypoglycemia

The significantly (p ≤ 0.01) of research participants correctly selected the symptoms of hypoglycemia, namely hunger (100%), sweating (90,62%), feeling shaky (62,5%), and fast heartbeat (56,25%).

The following 17 question are formulated as follows: "Choose the symptoms of hyperglycemia" (Fig. 3.13.). Multiple answers were possible.
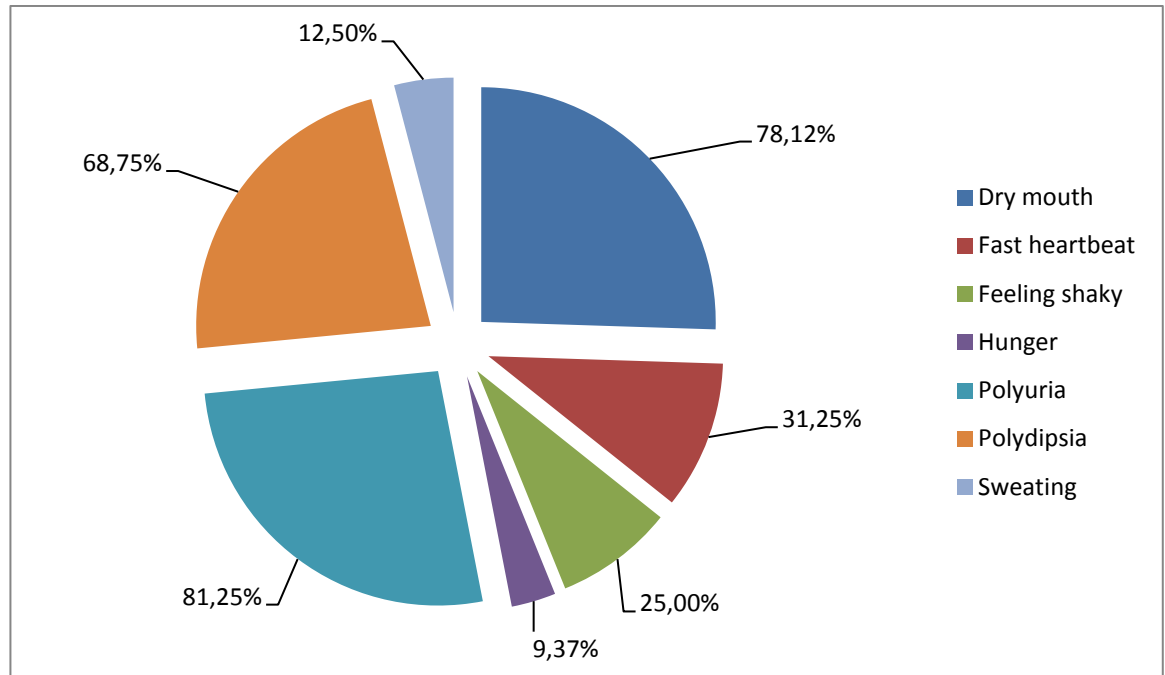
Fig. 3.13. The knowledge of research participants about the symptoms of hyperglycemia

The distribution of correct answers to this question was similar to the distribution of answers to the previous question. The significantly (p ≤ 0.01) of research participants correctly selected the symptoms of hyperglycemia, namely polyuria (81,25%), dry mouth (78,12%), polydipsia (68,75%).

A comparative analysis of the answers to questions 14 and 15 didn't show any significant differences between the frequency of correct answers between Groups 1 and 2 of the research participants.

The distribution of correct answers to both 14 and 15 questions indicates a high level of knowledge of research participants about such acute complications of type 2 diabetes as hypo- and hyperglycemic states.

Lifestyle modification is an important element of non-pharmacological treatment of type 2 diabetes. Educating patients on lifestyle changes is an important aspect of pharmaceutical care.

The following 18 question are formulated as follows: "Choose interventions that relate to lifestyle changes for patients with type 2 diabetes" (Fig. 3.14.). Multiple answers were possible.
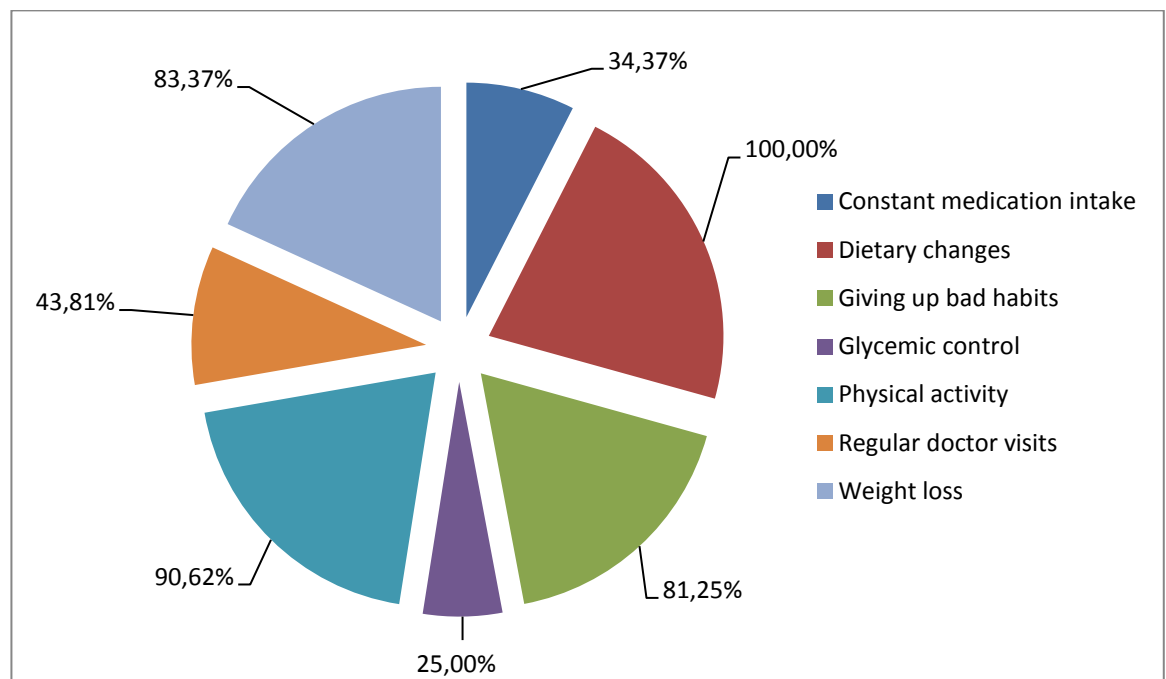
Fig. 3.14. The knowledge of research participants about lifestyle changes for patients with type 2 diabetes

The significantly (p ≤ 0.01) majority of research participants chose the correct lifestyle changes elements, namely dietary changes (100%), physical activity (90,62%), weight loss (83,37%), and giving up bad habits (81,25%). Some of the research participants (not significant) chose as elements of lifestyle changes. These are important aspects of pharmacotherapy for type 2 diabetes, but they are not an integral part of lifestyle changes.

A comparative analysis of the answers to this question didn't show any significant differences between the frequency of correct answers between Groups 1 and 2 of the research participants. This indicates a high level of knowledge about

lifestyle changes among both students who are still continuing their studies and full-time pharmacists.

In the last 19 questions in Group 1 of the full-time pharmacists, we found out whether they participate in patient education: "Do you educate patients about acute symptoms of hypo- and hyperglycemic states or lifestyle changes?" (Fig. 3.15.). Analysis of the responses showed that the majority of participants in Group 1 of 7 (47.92%) never participate in patient education. If we add another 20% of pharmacists who are overworked, it becomes clear that the significantly ($\varphi_{\text{емп.}} = 1.861$; $p = 0.0313$) majority of working pharmacists, unfortunately, don't participate in patient education.

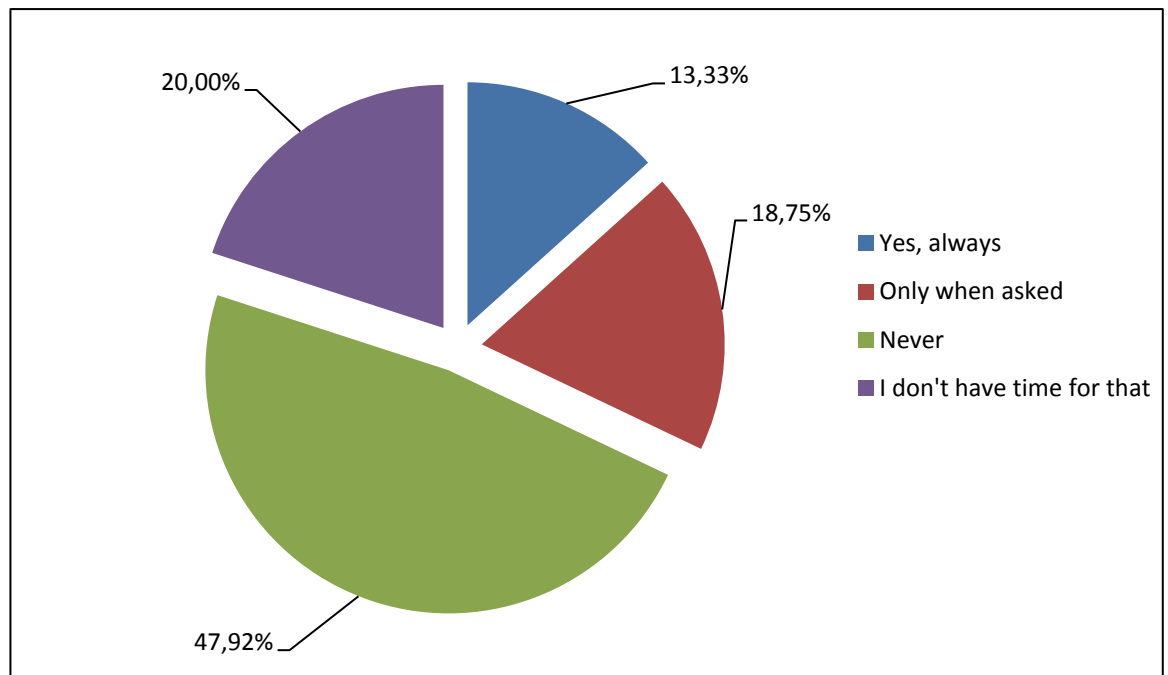Fig. 3.15. The participation of research participants (Group 1) in patient education

Analyzing the responses of the research participants about participation in patient education, it was determined that all participants are well-versed in the symptoms of acute complications of type 2 diabetes and lifestyle changes, but the significantly ($p \leq 0.05$) majority of full-time pharmacists don't participate in

patient education, either about the signs of acute conditions or about elements of lifestyle changes.

Conclusion to Chapter 3

This chapter of the master's thesis presents the results of the research. A survey of 32 research participants showed insufficient level of knowledge regarding modern approaches to pharmacotherapy of type 2 diabetes. However, the level of knowledge of pharmacists working full-time, especially regarding the treatment of complicated type 2 diabetes, was significantly ($p \leq 0.05$) higher. The research participants were most knowledgeable about the side effects of Biguanides and Sulfonylureas, but only participants in group 1 gave significantly ($p \leq 0.05$) more correct answers. The research results also showed the need to increase the implementation of patient support (providing information about both side effects and the medication regimen), given that only about 33% full-time pharmacists always do this. In addition, the results of the study indicate some confusion in the knowledge of the study participants regarding the diagnostic criteria and indicators of the effectiveness of pharmacotherapy for type 2 diabetes. At the same time, staff pharmacists had significantly ($p \leq 0.05$) better knowledge about the indicators that allow diagnosing type 2 diabetes and the required frequency of monitoring the effectiveness of pharmacotherapy. The results also showed that all research participants were well aware of the symptoms of acute complications of type 2 diabetes and lifestyle changes, but a significant ($p \leq 0.05$) majority of full-time pharmacists unfortunately don't participate in patient education regarding either the signs of acute conditions or the elements of lifestyle changes. Thus, the implementation of such an area of pharmaceutical care as patient education needs to be significantly strengthened.

CONCLUSIONS

1.   To summarize data on modern pharmacotherapy and pharmaceutical care for type 2 diabetes, a review of 35 literature sources was conducted.

2.   A questionnaire in the form of a Google Form with 23 questions was developed to survey the research participants. They were designed to determine the level of knowledge of the research participants about modern approaches of pharmacotherapy and such aspects of pharmaceutical care as the selection of the best drugs for pharmacotherapy of a particular patient, assessment of the effectiveness of pharmacotherapy, support and education of patients, as well as the level of participation of full-time pharmacists in the implementation of pharmaceutical care.

3.   24 students of National University of Pharmacy and 8 full-time pharmacists in Morocco, aged 22 to 46 years, voluntarily agreed to participate in the research. For further analysis of the responses of the research participants, they were divided into two Groups.

4.   The results of the research showed an insufficient level of knowledge regarding modern approaches to pharmacotherapy of type 2 diabetes, namely the choice of hypoglycemic drugs for pharmacotherapy of complicated type 2 diabetes. The research results also indicate some confusion in the knowledge of study participants regarding diagnostic criteria and indicators of the effectiveness of pharmacotherapy for type 2 diabetes. At the same time, full-time pharmacists had significantly ($p \leq 0.05$) better knowledge of both modern approaches to pharmacotherapy of complicated type 2 diabetes and the indicators for diagnosis and assessment of the effectiveness of pharmacotherapy.

5.   The results showed that the study participants were best informed about the side effects of Biguanides and Sulfonylureas, but full-time pharmacists significantly ($p \leq 0.05$) know better the side effects of modern pharmacological classes of hypoglycemic drugs, in particular SGLT-2 inhibitors. The results also showed that all research participants were well aware of the symptoms of acute

complications of type 2 diabetes and lifestyle changes, but a significant ($p \leq 0.05$) majority of full-time pharmacists, unfortunately, do not participate in patient education regarding either the signs of acute conditions or the elements of lifestyle changes.

6. The research results showed the need to strengthen the implementation of patient support (providing information on both side effects and the medication regimen), given that only about 33% full-time pharmacists always do this.

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APPLICATIONS

REVIEW OF THE MODERN GUIDELINES FOR PHARMACOTHERAPY OF TYPE 2 DIABETES MELLITUS TO ACHIEVE DIABETES CONTROL

Abdessalam Chkeirni
Scientific supervisor: Zhabotynska N.V.
National University of Pharmacy, Kharkiv, Ukraine
abdessalam2k@gmail.com

Introduction. Type 2 diabetes mellitus (DM) is the most common form of diabetes, accounting for 90-95% of all diabetes cases worldwide, placing a huge burden on healthcare systems in various countries. According to preliminary forecasts, the number of people with type 2 DM will increase to 642 million people by 2040. In this regard, the development of the most effective pharmacotherapy for type 2 DM, which allows controlling the course of the disease and preventing its complications, is one of the most important tasks of modern medical science.

Aim. The aim is to study the latest international guidelines for pharmacotherapy of type 2 DM aimed at achieving diabetes control.

Materials and methods. An analysis of the guidelines for pharmacotherapy of type 2 DM from the World Health Organization, the American Diabetes Association, and the European Association for the Study of Diabetes 2019-2024 was conducted.

Results and discussion. Initial pharmacotherapy for type 2 DM is recommended to begin with the prescription of a drug from the pharmacological class of biguanides — Metformin — the "gold standard" for the treatment of patients with type 2 DM. The guidelines emphasize that Metformin doesn't cause weight gain, doesn't provoke hypoglycemia and is recommended for the treatment of people who do not achieve the desired level of glycemia with diet and lifestyle modification. It is important to increase the dosage of Metformin gradually according to the guidelines for the management of type 2 DM: from the lowest dosage to the target one to ensure high-quality glycemic compensation. In most cases, Metformin drugs are well tolerated by patients if prescribed gradually and their dosage is increased according to the recommendations.

For patients with type 2 DM in combination with atherosclerotic cardiovascular diseases (CVD), sodium-dependent glucose cotransporter type 2 inhibitors (iSGLT-2) and glucagon-like peptide-1 receptor agonists (GLP-1 agonists) are recommended to reduce the risk of fatal cardiovascular events. From the iSGLT-2 class, Empagliflozin, Canagliflozin or Dapagliflozin are recommended, especially for individuals with very high CVD risk. From the GLP-1 agonist group, Liraglutide, Semaglutide or Dulaglutide are also recommended for patients with type 2 DM and CVD at very high risk of cardiovascular death.

In patients with chronic kidney disease (CKD) due to type 2 DM, it is recommended to use iSGLT-2 or GLP-1 agonists to slow disease progression. GLP-1 inhibitors should be the first choice for patients requiring insulin injections.

If the target level of glycated hemoglobin (HbA1c) in the blood is not achieved when using drugs of the iSGLT-2 or GLP-1 agonists, in case of intolerance or contraindications to taking GLP-1 agonists, it is necessary to choose a pharmacotherapy regimen with the lowest risk of weight gain. Dipeptidyl peptidase-4 inhibitors (iDPP-4) should be preferred. The drugs of this group, Saxagliptin, Alogliptin, Sitagliptin, are safe for the kidneys and moderately reduce albumimuria and have a neutral effect on body weight. In cases where HbA1c remains higher than the target value, thiazolidinediones (TZDs) (Pioglitazone) are recommended. Low-dose TZD therapy reduces the likelihood of weight gain and the development of oedema.

In cases where the HbA1c level remains above 9%, basal insulin (Degludec, Glargine U-100) is recommended to improve control of the type 2 DM.

Conclusions. Summarizing the modern guidelines, it becomes clear that pharmacotherapy of type 2 DM should be comprehensive: diet, lifestyle modification, first-line drug — Metformin. Patients with CKD, CVD at high risk are recommended to use inhibitors of iSGLT-2 (Empagliflozin, Canagliflozin, Dapagliflozin) or GLP-1 agonists (Liraglutide, Semaglutide, Dulaglutide). In patients unable to achieve the target HbA1c level with first-line drugs, treatment intensification can be used by prescribing iDPP-4 or TZDs. If the target HbA1c level is not achieved, basal insulin is recommended.

ANALYSIS OF THE COMPLIANCE OF PHARMACY SALES OF ANTIHYPERTENSIVE DRUGS WITH MODERN GUIDELINES FOR ARTERIAL HYPERTENSION PHARMACOTHERAPY

Abdessamad Kinan
Scientific supervisor: Zhabotynska N.V.
National University of Pharmacy, Kharkiv, Ukraine
kinanabdessamad@gmail.com

Introduction. Current data less than 50% of adults with arterial hypertension (AH) receive effective antihypertensive therapy. Initial antihypertensive monotherapy is often ineffective or slow to achieve target effective blood pressure (BP) levels. According to modern guidelines for arterial hypertension (AH) treatment, combined pharmacotherapy using fixed-dose combination drug (FDCD) in "single pill" comes first, which allows influencing several pathogenetic mechanisms of AH development at once and achieving more effective BP control.

Aim. The aim is assessing the compliance of pharmacy sales of drugs for the AH treatment with modern guidelines.

Materials and methods. During the research, an analysis of pharmacy sales reports of antihypertensive drugs containing a single active ingredient and fixed combinations of two or three active ingredients in a "single pill" was conducted. The data were processed using statistical methods, in particular, using the Fisher's exact test.

Results and discussion. According to pharmacy sales reports for 3 months, the sales volume of combined antihypertensive drugs amounted to 566 drugs. Sales of combined antihypertensive drugs significantly ($\varphi_{emp.} = 4.531; p \leq 0.01$) exceeded sales volumes of drugs containing one active substance. At the same time, sales of double combinations in a "single pill" significantly ($\varphi_{emp.} = 9.623; p \leq 0.01$) exceeded sales of triple combinations. But the frequency of total sales of two drugs of different pharmacological classes, as separate drugs, is higher than sales of drugs of two or three pharmacological classes, as combinations in a "single pill". At the same time, by individual active substances among angiotensin-converting enzyme inhibitors and angiotensin II receptor blockers, sales of combinations in a "single pill" prevailed.

Conclusions. Data on the pharmacy sale of FDCD of two or three active substances in a "single pill" demonstrated the compliance of antihypertensive drug sales with modern guidelines for AH pharmacotherapy, which provide for the appointment of combination therapy to the vast majority of patients with AH. Probably, lower sales of triple FDCD are associated with a statistically lower number of patients with severe stage III AH who do not achieve blood pressure control with dual combination pharmacotherapy.

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

СЕРТИФІКАТ УЧАСНИКА

Цим засвідчується, що

Abdessalam Chkeirni
Scientific supervisor: Zhabotynska N.V.

брав(ла) участь у роботі

XXXI Міжнародної науково-практичної конференції молодих вчених та студентів

«АКТУАЛЬНІ ПИТАННЯ СТВОРЕННЯ НОВИХ ЛІКАРСЬКИХ ЗАСОБІВ»

В.о. ректора
Національного фармацевтичного
університету

Алла КОТВІЦЬКА

National University of Pharmacy

Faculty <u>Pharmaceutical</u>
Department <u>of Pharmacology and Clinical Pharmacy</u>

Level of higher education <u>master</u>

Specialty <u>226 Pharmacy, industrial pharmacy</u>
Educational and professional program <u>Pharmacy</u>

<div align="right">

APPROVED
The Head of Department
Pharmacology and
Clinical Pharmacy

_____

Sergii SHTRYGOL
«02» September 2024

</div>

ASSIGNMENT

FOR QUALIFICATION WORK
OF AN APPLICANT FOR HIGHER EDUCATION

Abdessalam CHKEIRNI

1. Topic of qualification work: «Studying the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes», supervisor of qualification work: Nataliia ZHABOTYNSKA, PhD, assoc. prof.
approved by order of NUPh from <u>"27" of September 2024 № 237</u>
2. Deadline for submission of qualification work by the applicant for higher education: <u>May 2025.</u>
3. Outgoing data for qualification work: <u>publications on problems in the pharmacotherapy of and pharmaceutical care of type 2 diabetes.</u>
4. Contents of the settlement and explanatory note (list of questions that need to be developed):
<u>Develop a questionnaire for surveying pharmacists; study the level of knowledge of pharmacists about modern approaches to pharmacotherapy and criteria for the effectiveness of pharmacotherapy for type 2 diabetes, as well as about pharmaceutical care of the type 2 diabetes.</u>
5. List of graphic material (with exact indication of the required drawings):
<u>- pharmacological classes of hypoglycemic drugs for pharmacotherapy of type 2 diabetes (1 table);</u>
<u>- distribution of research participants by gender and employment (2 figures);</u>
<u>- features of the choice of drugs for the initial pharmacotherapy of type 2 diabetes and for the pharmacotherapy of complications of type 2 diabetes (4 figures);</u>
<u>- knowledge of research participants about modern pharmacotherapy of type 2 diabetes(1 table);</u>

- knowledge of research participants about effectiveness of type 2 diabetes pharmacotherapy (3 figures; 1 table);
- knowledge of research participants about possible side effects and the pharmacological classes of hypoglycemic drugs (1 table);
- evaluation of pharmacists' participation in the practical implementation of pharmaceutical care in type 2 diabetes (6 figures).

6. Consultants of chapters of qualification work

| Signature | Name, SURNAME, position of consultant | Signature, date | |
		assignment was issued	assignment was received
1	Nataliia ZHABOTYNSKA, associate professor of higher education institution of Clinical Pharmacology and Clinical Pharmacy department	12.09.2024	12.09.2024
2	Nataliia ZHABOTYNSKA, associate professor of higher education institution of Clinical Pharmacology and Clinical Pharmacy department	06.03.2025	06.03.2025
3	Nataliia ZHABOTYNSKA, associate professor of higher education institution Clinical Pharmacology and Clinical Pharmacy department	03.04.2025	03.04.2025

7. Date of issue of the assignment: "02" September 2024

CALENDAR PLAN

№	Name of stages of qualification work	Deadline for the stages of qualification work	Notes
1.	Writing Chapter 1 "Literature Review"	December 2024	**done**
2.	Development of a questionnaire for conducting a survey of patients	December 2024	**done**
3.	Conducting a patient survey, writing Chapter 2 "Research Methods"	March 2025	**done**
4.	Statistical processing of survey results	March 2025	**done**
5.	Writing Chapter 3 "Research Results"	March 2025	**done**
6.	Finalization of qualification work and preparation of documents	May 2025	**done**

An applicant of higher education _____ Abdessalam CHKEIRNI

Supervisor of qualification work _____Nataliia ZHABOTYNSKA

ВИТЯГ З НАКАЗУ № 237
По Національному фармацевтичному університету
від 27 вересня 2024 року

Затвердити теми кваліфікаційних робіт здобувачам вищої освіти 5-го курсу Фм20(4,10д) 2024-2025 навчального року, освітньо-професійної програми – Фармація, другого (магістерського) рівня вищої освіти, спеціальності 226 – Фармація, промислова фармація, галузь знань 22 Охорона здоров'я, денна форма здобуття освіти (термін навчання 4 роки 10 місяців), які навчаються за контрактом (мова навчання англійська та українська) згідно з додатком № 1.

Прізвище, ім'я здобувача вищої освіти	Тема кваліфікаційної роботи		Посада, прізвище та ініціали керівника	Рецензент кваліфікаційної роботи
по кафедрі фармакології та клінічної фармації				
Чкеірні Абдессалам	Вивчення ролі сучасної фармакотерапії та фармацевтичної опіки в досягненні контролю цукрового діабету 2 типу.	Studying the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes.	доцент Жаботинська Н.В.	професор Литвинова О.М.

Ректор

Вірно Секретар

ВИСНОВОК

експертної комісії про проведену експертизу
щодо академічного плагіату у кваліфікаційній роботі

здобувача вищої освіти

«02» травня 2025 р. № 331104348

Проаналізувавши кваліфікаційну роботу здобувача вищої освіти Чкеірні Абдессалам, групи Фм20(4.10)а-04, спеціальності 226 Фармація, промислова фармація, освітньої програми «Фармація» навчання на тему: «Вивчення ролі сучасної фармакотерапії та фармацевтичної опіки в досягненні контролю цукрового діабету 2 типу / Studying the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes», експертна комісія дійшла висновку, що робота, представлена до Екзаменаційної комісії для захисту, виконана самостійно і не містить елементів академічного плагіату (компіляції).

**Голова комісії,
проректор ЗВО з НПР,
професор**

Інна ВЛАДИМИРОВА

REVIEW

of scientific supervisor for the qualification work of the master's level of higher education of the specialty 226 Pharmacy, industrial pharmacy

Abdessalam CHKEIRNI

on the topic: «Studying the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes»

Relevance of the topic. According to the statistics of the World Health Organization, more than 422 million people in the world suffer from type 2 diabetes. The main goal of pharmacotherapy of type 2 diabetes is to achieve control of diabetes and effectively prevent the development of complications. Pharmacists play one of the key roles in achieving control of type 2 diabetes, performing pharmaceutical care. Therefore, it is necessary to study of practical realization of type 2 diabetes mellitus of pharmaceutical care by the pharmacists.

Practical value of conclusions, recommendations, and their validity. The practical significance of the results of the master's thesis lies in the fact that, based on the data obtained, areas of pharmaceutical care were identified, the practical implementation of which requires significant improvement.

Assessment of work. The qualification work is a completed research, designed in accordance with all requirements. It is recommended to conduct an additional check of spelling errors.

General conclusion and recommendations on admission to defend. The work is performed in full, designed in accordance with the current requirements for the qualification works at the National University of Pharmacy, and can be recommended for submission to the Examination commission for further defense.

Scientific supervisor   _____   Nataliia ZHABOTYNSKA

«12» May 2025

REVIEW

for qualification work of the master's level of higher education, specialty 226 Pharmacy, industrial pharmacy

Abdessalam CHKEIRNI

on the topic: «Studying the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes»

Relevance of the topic. Diabetes mellitus is one of the most common non-communicable diseases and its prevalence tends to increase constantly. Among the total number of patients, almost 90% are patients with type 2 diabetes. Crucial importance for achieving diabetes control is the knowledge of pharmacists about modern directions of pharmacotherapy of diabetes mellitus type 2, as well as the implementation of pharmaceutical care. Therefore, the study of the degree of implementation and compliance with modern recommendations for pharmacotherapy of type 2 diabetes and the high-quality implementation of pharmaceutical care in the practical activities of pharmacists is very relevant.

Theoretical level of work. The qualification work has a high theoretical level, based on the international guidelines for the pharmacotherapy pharmaceutical care of type 2 diabetes.

Author's suggestions on the research topic. The author developed a questionnaire for a survey of pharmacists, based on the survey data, an analysis of pharmacists' knowledge of modern approaches to the selection of drugs for pharmacotherapy of type 2 diabetes and its complications was conducted, the practical implementation of pharmaceutical care by a pharmacist was analyzed, and the importance of pharmaceutical care in achieving control over of type 2 diabetes was assessed.

Practical value of conclusions, recommendations, and their validity. The results of the work obtained by the author and the conclusions drawn on their basis

are of high practical significance for improving pharmaceutical care and increasing its role in achieving control of type 2 diabetes.

Disadvantages of work. There are grammatical and punctuation errors, unsuccessful stylistic turns in the work.

General conclusion and assessment of the work. The work meets the requirements for qualification work in National University of Pharmacy and can be recommended for defense.

Reviewer   _____   Olga LYTVYNOVA

«14» May 2025

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ'Я УКРАЇНИ
НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ
ВИТЯГ З ПРОТОКОЛУ № 19
засідання кафедри фармакології та клінічної фармації

15   травня 2025 р.   м. Харків

Голова: завідувач кафедри, доктор мед. наук, професор Штриголь С. Ю.
Секретар: кандидат фарм. наук, доцент Вєтрова К. В.

ПРИСУТНІ: зав. каф., проф. Штриголь С.Ю., проф. Деримедвідь Л.В., доц. Бєлік Г.В., доц. Вєтрова К.В., доц. Жаботинська Н.В., доц. Кононенко А. В., доц. Матвійчук А.В., доц. Отрішко І.А., доц. Очкур О.В., доц. Рябова О.О., доц. Савохіна М.В., доц. Степанова С. І., доц. Таран А.В., ас. Верховодова Ю.В., ас. Підгайна В.В. та здобувачі вищої освіти.

ПОРЯДОК ДЕННИЙ:
1.Розгляд кваліфікаційних робіт здобувачів вищої освіти для подання робіт до Екзаменаційної комісії.

СЛУХАЛИ:
1.   Здобувача вищої освіти Чкеірні Абдессалама зі звітом про проведену наукову діяльність за темою кваліфікаційної роботи: «Вивчення ролі сучасної фармакотерапії та фармацевтичної опіки в досягненні контролю цукрового діабету 2 типу» («Studying the role of modern pharmacotherapy and pharmaceutical care in achieving control of type 2 diabetes»).

УХВАЛИЛИ:
1. Кваліфікаційну роботу розглянуто. Здобувач вищої освіти Чкеірні Абдессалам допускається до захисту даної кваліфікаційної роботи в Екзаменаційній комісії.

Голова
Завідувач кафедри, проф.   Штриголь С. Ю.

Секретар, доц.   Вєтрова К. В.

НАЦІОНАЛЬНИЙ ФАРМАЦЕВТИЧНИЙ УНІВЕРСИТЕТ

ПОДАННЯ
ГОЛОВІ ЕКЗАМЕНАЦІЙНОЇ КОМІСІЇ
ЩОДО ЗАХИСТУ КВАЛІФІКАЦІЙНОЇ РОБОТИ

Направляється здобувач вищої освіти Абдессалам Чкеірні до захисту кваліфікаційної роботи за галуззю знань 22 Охорона здоров'я
спеціальністю 226 Фармація, промислова фармація
освітньо-професійною програмою Фармація
на тему: «Вивчення ролі сучасної фармакотерапії та фармацевтичної опіки в досягненні контролю цукрового діабету 2 типу».

Кваліфікаційна робота і рецензія додаються.

Декан факультету   _____ / Микола ГОЛІК /

Висновок керівника кваліфікаційної роботи

Кваліфікаційна робота здобувача вищої освіти Абдессалама ЧКЕІРНІ є самостійним оригінальним дослідженням, виконана на високому науковому рівні, відповідає всім вимогам, може бути представлена в Екзаменаційну комісію Національного фармацевтичного університету та рекомендована до захисту на здобуття освітньо-кваліфікаційного рівня магістра та заслуговує позитивної оцінки.

Керівник кваліфікаційної роботи

_____   Наталія ЖАБОТИНСЬКА

"12" травня 2025 року

Висновок кафедри про кваліфікаційну роботу

Кваліфікаційну роботу розглянуто. Здобувач вищої освіти Абдессалам ЧКЕІРНІ допускається до захисту даної кваліфікаційної роботи в Екзаменаційній комісії.

Завідувач кафедри
фармакології та клінічної фармації

_____   Сергій ШТРИГОЛЬ

"15" травня 2025 року

Qualification work was defended

of Examination commission on

«   » June 2025

with the grade _____

Head of the State Examination commission,

DPharmSc, Professor

_____ / Volodymyr YAKOVENKO/