

UDC 615.252.349.7:614.27:658.711

DOI: 10.15587/2519-4852.2022.263675

MONITORING OF INDICATORS OF PHYSICAL AVAILABILITY AND SOCIO-ECONOMIC AFFORDABILITY OF METFORMIN HYDROCHLORIDE MEDICINES

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The aim of the study was to monitor the physical availability and socio-economic affordability of metformin hydrochloride medicines, which are used for the treatment of type II diabetes mellitus.

Materials and methods. Medical and technological documentation on the standardization of medical care for patients with type II diabetes, data from the State Register of Medicinal Products of Ukraine, software complex "Apteka" of the company "Morion" and data from the pharmaceutical market research analytical company "Pharmstandard" of the company "Morion" were used as research materials to determine indicators of physical availability and socio-economic affordability of metformin HCL medicines for the treatment of type II diabetes. Documentary, analytical methods, the method of marketing research and the method of logical summarization of data were used during the research.

Results. According to the results of the analysis of the medical and technological documentation on the standardization of medical care for diabetes mellitus (DM) type II and the State Register of Medicines of Ukraine, a number of characteristics were formed for Metformin HCL pharmaceuticals, namely: tablets or film-coated tablets in a dose of 500 mg, which are manufactured: Ukrainian manufacturers (full cycle of production); Ukrainian manufacturers of tablets in bulk (primary and secondary packaging) and foreign manufacturers. The specified characteristics became the basis for the further selection of several metformin HCL medicines in terms of determining their indicators of physical availability and socio-economic affordability. When determining the physical availability of metformin HCL medications, it was established that Ukrainian-made pharmaceuticals (full production cycle) are presented in the wholesale chain of the pharmaceutical market in full. According to the socio-economic indicator of the solvency adequacy of payment capacity, among the metformin HCL pharmaceuticals, the most economically justified are the Ukrainian-made pharmaceuticals, which are made from tablets in bulk according to the full production cycle. Only 1 medicine was singled out among foreign-made ones, which has the lowest indicator of solvency adequacy for various categories of the population.

Conclusions. Monitoring of indicators of physical availability and socio-economic affordability of metformin HCL medicines showed that the most economically justified for able-bodied people and people of retirement age is the use of the Ukrainian-made pharmaceuticals (full cycle and production from tablets in bulk) for the treatment of type II DM)

Keywords: medicines, metformin, diabetes, physical availability, socio-economic affordability

How to cite:

Ryshchenko, O., Lytkin, D., Podolsky, I., Volkova, A., Vladymyrova, I. (2022). Monitoring of indicators of physical availability and socio-economic affordability of metformin hydrochloride medicines. ScienceRise: Pharmaceutical Science, 4 (38), 36–43. doi: <http://doi.org/10.15587/2519-4852.2022.263675>

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1. Introduction

An important indicator of the development of the health care system is the availability of medicines for the patient and ensuring the possibility of receiving qualified pharmaceutical care. One of the components of medicines availability, as an indicator of the development of the country's health care system, is the physical availability and socio-economic affordability of pharmaceuticals, which is determined by the ability of the population to obtain the necessary medicines in the required quantity and assortment. To implement this component, it is necessary to produce pharmaceuticals in-house, especially those used for the treatment of socially significant diseases, such as type II diabetes [1, 2].

According to the medical-technological documentation on the standardization of medical care in the treatment of type II diabetes mellitus, it is determined that during the medical correction of the blood glucose level in type II

diabetes mellitus, medicines are most often chosen, which must meet certain requirements, considering the individual characteristics of the patient (weight, age, duration diseases, presence of complications, etc.) [3]. One of the most important criteria for the selection of pharmaceuticals for type II diabetes is the predicted hypoglycemic effectiveness of the medicine and the lowest risk of developing complications. In addition, the choice of pharmaceuticals could be influenced by ease of use, the expected degree of patient adherence to treatment, as well as the cost of the medicines. According to the Adapted Clinical Guideline for type II diabetes, metformin HCL is currently the most studied medicines in terms of effectiveness and safety [4]. The main advantages of using these pharmaceuticals are the predictability of their therapeutic effect, the low level of occurrence of hypoglycemia, and the absence of an effect on weight gain. In addition, metformin HCL, unlike other medicines, has a number of additional positive ef-

fects – cardioprotective and hypolipidemic, which makes it possible to reduce the risk of developing such complications as damage to blood vessels and diseases of the cardiovascular system [5, 6].

Analysis of data from Ukrainian and foreign scientific literature showed that the issue of studying the provision of pharmaceuticals for patients with chronic diseases, in particular diabetes, was studied by scientists from Ukraine and other countries [7, 8]. However, the study of physical and socio-economic accessibility using the relevant criteria was carried out only by domestic scientists [9], while foreign experts paid more attention only to the influence of socio-economic factors on the level of providing the population with the appropriate pharmaceuticals [10, 11]. However, the determination of the availability of sugar-lowering medicines within one group with the same active pharmaceutical ingredient has not yet been carried out.

The aim of the study. To monitor indicators of physical availability and socio-economic affordability of metformin HCL medicines, which are used for the treatment of type II diabetes.

2. Planning (methodology) of research

The conducted research consisted of four stages.

The first stage of the study is devoted to the analysis of medical and technological documentation regarding the standardization of medical care for patients with type II diabetes and the State Register of Medicines of Ukraine with the aim of determining the characteristics of the selection of metformin HCL pharmaceuticals for further research and forming their list [3, 12]. Among the characteristics of the selection of pharmaceuticals, the following are highlighted: Ukrainian-made pharmaceuticals (full production cycle), Ukrainian-made pharmaceuticals made from tablets in bulk (primary and secondary packaging) and foreign-made pharmaceuticals. According to the data of the medical and technological documentation, the initial dosage of metformin HCL during pharmacological correction of the blood glucose level in patients with type II diabetes is 500 mg per dose. Therefore, during the analysis, metformin HCL in the form of tablets or film-coated tablets in a dose of 500 mg was whitely selected. On the basis of the obtained results, a list of metformin HCL medicines was formed for further research.

At the second stage of the study, monitoring of the physical availability of selected metformin HCL medicines was carried out. For this purpose, a comparative analysis of the list of metformin HCL pharmaceuticals according to the criteria defined above with the list of medicines offered by wholesale chain operators on the pharmaceutical market of Ukraine using data from the software complex “Apteka” of the “Morion” company was carried out [13]. After all, it is the presence of pharmaceuticals in the range of wholesale companies that creates the possibility of their ordering by pharmacies and their subsequent purchase by patients, which accordingly forms the physical availability of medicines.

At the third stage of the study, an analysis of socio-economic indicators of the affordability of metformin

HCL medicines was carried out. At the beginning of this stage of the research, the arithmetic average weighted retail price of metformin HCL as of December 2021 was determined according to the following formula [14]:

$$P_i = \frac{\sum p_i \times f_i}{\sum f_i},$$

where P_i – average arithmetic weighted retail price of metformin HCL medicine;

p_i – the price of the i trade name of metformin HCL medicine;

f_i – the frequency with which metformin HCL medicine are found at this price at the time of the study

Calculations of the average arithmetic weighted retail price were carried out according to the trade names of metformin HCL tablets. The specified indicator is the basic unit in determining such an indicator of socio-economic affordability of medicines as the solvency adequacy ratio [14, 15].

The next step in the study of the socio-economic indicator of the affordability of metformin HCL medicines was the determination of the solvency adequacy ratio, which characterizes the affordability of the medicine and the possibility of sale in conditions of low solvency of the population. The solvency adequacy ratio for able-bodied persons and persons of retirement age was calculated according to the following formula [14, 16]:

$$C_{a.s.i.} = \frac{P_i}{W_{a.w.}} \times 100 \%,$$

where $C_{a.s.i.}$ – solvency adequacy ratio;

P_i – arithmetic weighted average retail price of metformin HCL medicine for the study period;

$W_{a.w.}$ – average salary/pension for the study period.

Since the coefficient of adequacy of the ability to pay was calculated for each medicine of metformin HCL, it is advisable to add an index and, for example $C_{a.s.i.}$.

It is reasonably believed that the greater the value of the solvency adequacy ratio, the less affordable the medicine is for the consumer [17].

To determine the solvency adequacy ratio, we used official data from the State Statistics Service of Ukraine on the nominal average salary and average pension as of December 2021.

Retail prices for metformin HCL medicines were determined according to the data of the pharmaceutical market research analytical company “Pharmstandard” of the company “Morion” [18].

The drawing up of work results and conclusions, determination of the most affordable metformin HCL medicines for the patient based on indicators of physical availability and socio-economic affordability for the treatment of type II diabetes were carried out at the fourth stage of the study.

3. Materials and methods

As research materials, the data of the medical and technological documentation on the standardization of

medical care for patients with type II diabetes and the State Register of Medicines of Ukraine were used in order to determine the characteristics of the selection of metformin HCL pharmaceuticals and the subsequent formation of the list of specified medicines; data of the software complex "Apteka" of the company "Morion" and the analytical company of the research of the pharmaceutical market "Pharmstandard" of the company "Morion" for monitoring the indicators of physical and socio-economic availability of metformin HCL medicines.

The following methods were used during the research:

- documentary and analytical methods – for the study of medical and technological documentation on the treatment of type II diabetes and the State Register of Medicines of Ukraine to form a list of metformin HCL pharmaceuticals;
- marketing research – to conduct an analysis of the pharmaceutical market of Ukraine and determine

indicators of physical availability and socio-economic affordability of metformin HCL medicines;

- logical summarization of data – for formulating explanations and conclusions.

4. Research results

Based on the results of the analysis of the medical and technological documentation regarding the standardization of medical care for patients with type II diabetes and the State Register of Medicines of Ukraine, metformin HCL pharmaceuticals were selected, which were further divided into 3 groups (Table 1):

- medicines of Ukrainian production (full cycle of production);
- Ukrainian-made pharmaceuticals made from bulk tablets of foreign production (primary and secondary packaging);
- medicines of foreign production (full cycle of production).

Table 1

A list of metformin HCL medicines that meet the given characteristics

No.	No. and the validity period of the Registration Certificate	Trade name	Manufacturer name
Medicines of Ukrainian production (full cycle of production)			
1.	UA/18164/01/01 26.06.2020 26.06.2025	METAFORA®, tab. cov. with a film shell	JSC "KYIV VITAMIN FACTORY", Ukraine
2.	UA/2508/01/01 unlimited from 12.08.2019	DIAFORMIN®, tab.	JSC "Farmak", Ukraine
3.	UA/11506/02/01 unlimited from 24.11.2016	METAMIN®, tab. cov. with a shell	LLC "KUSUM FARM", Ukraine
Ukrainian-made pharmaceuticals made from bulk tablets of foreign production			
4.	UA/12062/01/01, unlimited from 12.04.2017	GLYBOPHOR®, tab. cov. with a film shell	JSC "Farmak" (packaging from the bulk form of the manufacturing company "USV Private Limited", India), Ukraine
5.	UA/14013/01/01, unlimited from 02.10.2019	METFORMIN, tab. cov. with a film shell	PJSC «Kyivmedpreparat» (bulk packaging of the manufacturing company "Indoco Remedies Limited", India), Ukraine
Medicines of Foreign production			
6.	UA/12645/01/01, unlimited from 11.01.2018	MAGLIFORT 500, tab. cov. with a film shell	"Indoco Remedies Limited", India
7.	UA/14631/01/03, unlimited from 28.08.2020	INSUFOR, tab. cov. with a film shell	WORLD MEDICINE ILAC SAN. VE TIC. A.S., Turkey
8.	UA/18723/01/01, 09.06.2021 09.06.2026	METFORMIN-TEVA, tab. cov. with a film shell	"Teva Czech Industries s.r.o." (full cycle production), Czech Republic "MICRO LABS LIMITED" (full cycle production), India JSC "Pharmaceutical Plant TEVA" (primary and secondary packaging, quality control, serial release permit), Hungary
9.	UA/9477/01/01, unlimited from 13.04.2020	METFORMIN SANDOZ®, tab. cov. with a film shell	"S.A. Lek", Poland
10.	UA/7769/01/01, unlimited from 31.10.2019	METFORMIN-TEVA, tabs.	"Teva Operations Poland" LLC, Poland
11.	UA/3994/01/01, unlimited from 21.09.2020	GLUCOPHAGE®, tab. cov. with a film shell	"Merck Sante" (full cycle production), France
12.	UA/15295/01/01, unlimited from 02.07.2021	METFORMIN-SANOFI, tab. cov. with a film shell	"Sanofi India Limited" (tablet manufacturing, primary and secondary packaging), India S.S. "Zentiva S.A." (control and series release), Romania
13.	UA/5247/01/02, unlimited from 05.03.2021	METFOGAMMA® 500, tab. cov. with a film shell	"Dragenofarm Aptekar Püschl" GmbH, Germany
14.	UA/3734/01/02, unlimited from 07.10.2020	SIOFOR® 500, tab. cov. with a film shell	"BERLIN-CHEMIE AG", Germany

Based on the results of the analysis, 14 trade names of metformin HCL medicines were selected, among which 3 trade names manufactured by such Ukrainian manufacturers as JSC “Kyiv Vitamin Factory”, JSC “Farmak” and LLC “Kusum Pharm” were included in the first group. The second group of pharmaceuticals includes 2 medicines of metformin HCL, produced by JSC “Farmak” and PJSC Kyivmedpreparat”, which are made from tablets in bulk of Indian production. The third group of medicines has the largest number of trade names and is represented by the following producing countries: India, Turkey, Hungary, Poland, France and Germany.

The results of determining the physical availability of metformin HCL medicines were carried out by comparing the defined list of metformin HCL pharmaceuticals with medicines offered by the operators of the wholesale chain of the pharmaceutical market of Ukraine based on the data of the “Apteka” software complex of the “Morion” company. The obtained results showed that all medicines metformin HCL pharmaceuticals manufactured by Ukrainian manufacturers (full production cycle) are presented in full, and accordingly, the indicator of their physical availability is 100 %.

Among the pharmaceuticals manufactured by Ukrainian manufacturers from bulk tablets of foreign production in the wholesale chain of the pharmaceutical market of Ukraine, only one medicine, Metformin, is represented, which is 50 % of the total number of this group. Among foreign-made metformin HCL medicines on the wholesale chain of the pharmaceutical market of Ukraine, only 3 out of 9 (9 in Table 1) selected medicines are represented, respectively 33.3 % (if 9 medicines, then 33.3 %) of the total number of foreign-made pharmaceuticals: Glucophage® (“Merck Sante”, France), Metformin-Sandoz® (“Lek S.A.”, Poland), Siofor®500 (“Berlin-Hemi AG”, Germany). Thus, according to the results of determining the physical availability of medicines, the wholesale sector of the pharmaceutical market of Ukraine is represented by metformin HCL pharmaceuticals, which are listed in Table 2.

Thus, based on the results of the study of the physical availability of metformin HCL medicines, it was established that out of 14 trade names of the selected *pharmaceuticals*, only 7 are represented on the wholesale pharmaceutical market of Ukraine, which indicates a

rather low indicator of the physical availability of the indicated medicines for the patient. When considering the level of the indicator of physical availability of metformin HCL medicines by group, it was determined that all registered medicines of Ukrainian production (full production cycle) are represented in the wholesale chain of the pharmaceutical market of Ukraine, the least – *pharmaceuticals* of foreign production (33.3 % of the total number of registered medicines of this groups).

Table 2

The list of metformin HCL medicines presented in the wholesale chain of the pharmaceutical market of Ukraine

No.	No. and the validity period of the Registration Certificate	Trade name	Manufacturer name
Medicines of Ukrainian production (full cycle of production)			
1.	UA/18164/01/01 26.06.2020 26.06.2025	METAFORA®, tab. cov. with a film shell	JSC “KYIV VITAMIN FACTORY”, Ukraine
2.	UA/2508/01/01 unlimited from 12.08.2019	DIAFORMIN®, tab.	JSC “Farmak”, Ukraine
3.	UA/11506/02/01 unlimited from 24.11.2016	METAMIN®, tab. cov. with a shell	LLC “KUSUM FARM”, Ukraine
Ukrainian-made medicines made from bulk tablets of foreign production			
4.	UA/14013/01/01, unlimited from 02.10.2019	METFORMIN, tab. cov. with a film shell	PJSC “Kyivmedpreparat” (bulk packaging of the manufacturing company “Indoco Remedies Limited”, India), Ukraine
Medicines of Foreign production			
5.	UA/9477/01/01, unlimited from 13.04.2020	METFORMIN SANDOZ®, tab. cov. with a film shell	“S.A. Lek”, Poland
6.	UA/3994/01/01, unlimited from 21.09.2020	GLUCOPHAGE®, tab. cov. with a film shell	“Merck Sante” (full cycle production), France
7.	UA/3734/01/02, unlimited from 07.10.2020	SIOFOR® 500, tab. cov. with a film shell	“BERLIN-CHEMIE AG”, Germany

The next stage of the study was the determination of the socio-economic indicator of the affordability of medicines metformin HCL medicines. At the beginning of the study, an analysis of retail prices for medicines metformin HCL preparations was carried out for a selected list of metformin HCL medicines, which is presented in the Table 2 and their arithmetic average weighted retail price is determined (Table 3).

According to the received data, it was determined that the Ukrainian-made medicine Metformin (PJSC “Kyivmedpreparat”), which is made from bulk tablets of foreign production, has the lowest average arithmetic weighted retail price per package among all metformin HCL medicines.

According to the received data, it was determined that the Ukrainian-made medicine Metformin (PJSC “Kyivmedpreparat”), which is made from bulk tablets of foreign production, has the lowest average arithmetic weighted retail price per package among all metformin HCL medicines.

For a more detailed study of indicators of socio-economic affordability of metformin HCL medicines, the coefficient of solvency adequacy was determined for able-bodied persons and persons of retirement age (Table 4).

Table 3

Arithmetic weighted average retail price of medicines metformin HCL in tablets (UAH per package)

No.	Trade name	Manufacturer name	Arithmetic weighted average retail price, UAH
Medicines of Ukrainian production (full cycle of production)			
1.	METAFORA®, tab. cov. with a film shell	JSC "KYIV VITAMIN FACTORY", Ukraine	34.33
2.	METAMIN®, tab. cov. with a shell	LLC "KUSUM FARM", Ukraine	49.35
3.	DIAFORMIN®, tab.	JSC "Farmak", Ukraine	38.48
Ukrainian-made pharmaceuticals made from bulk tablets of foreign production			
4.	METFORMIN, tab. cov. with a film shell	PJSC "Kyivmedpreparat" (bulk packaging of the manufacturing company "Indoco Remedies Limited", India), Ukraine	27.25
Medicines of Foreign production			
5.	GLUCOPHAGE®, tab. cov. with a film shell	"Merck Sante" (full cycle production), France	179.94
6.	METFORMIN SANDOZ®, tab. cov. with a film shell	"S.A. Lek", Poland	128.63
7.	SIOFOR® 500, tab. cov. with a film shell	"BERLIN-CHEMIE AG", Germany	288.85

Table 4

Results of calculation of the solvency adequacy ratio for able-bodied persons and persons of retirement age

No.	Trade name	Manufacturer name	Arithmetic average weighted retail price, UAH	$C_{a.s.i}$ relative to the average salary	$C_{a.s.i}$ relative to the average pension
Medicines of Ukrainian production (full cycle of production)					
1.	METAFORA®, tab. cov. with a film shell	JSC "KYIV VITAMIN FACTORY", Ukraine	34.33	0.26	0.89
2.	METAMIN®, tab. cov. with a shell	LLC "KUSUM FARM", Ukraine	49.35	0.38	1.27
3.	DIAFORMIN®, tab.	JSC "Farmak", Ukraine	38.48	0.29	0.99
Ukrainian-made pharmaceuticals made from bulk tablets of foreign production					
4.	METFORMIN, tab. cov. with a film shell	PJSC "Kyivmedpreparat" (bulk packaging of the manufacturing company "Indoco Remedies Limited", India), Ukraine	27.25	0.21	0.70
Medicines of Foreign production					
5.	GLUCOPHAGE®, tab. cov. with a film shell	Merck Sante (full cycle production), France	179.94	1.37	4.65
6.	METFORMIN SANDOZ®, tab. cov. with a film shell	S.A. Lek, Poland	128.63	0.98	3.33
7.	SIOFOR® 500, tab. cov. with a film shell	BERLIN-CHEMIE AG, Germany	288.85	2.20	7.47

According to the results of determining the coefficient of solvency adequacy for the working population, it was established that among the metformin HCL medicines of the first group, the most affordable is Metafora® (JSC "Kyiv Vitamin Factory"), the $C_{a.s.i}$ indicator of which is 0.26, among the third group – Metformin-Sandoz® ("Lek S.A.", Poland) with an indicator $C_{a.s.i}$ = 0.98. Metformin (PJSC "Kyivmedpreparat") has the lowest rate of $C_{a.s.i}$ and solvency adequacy for able-bodied persons, whose $C_{a.s.i}$ is 0.21. Thus, for the working-age population, the most affordable metformin HCL medicines according to socio-economic indicators are Ukrainian-made pharmaceuticals (full production cycle) and medicines made from tablets in bulk (the first and second groups, respectively).

The highest indicators of the solvency adequacy for the working population are noted among medicines of foreign production, namely for medicines Siofor® 500 tab. covered with film ("BERLIN-CHEMI AG", Germa-

ny) – 2.20 and Glucofage® tab. covered with film ("Merc Sante", France) – 1.37. The indicated values of the indicator of the solvency adequacy for metformin HCL foreign-made medicines in relation to Ukrainian-made pharmaceuticals (full cycle and from tablets in bulk) indicate a lower availability of imported medicines for the able-bodied category of the population and their use is less economically justified.

When conducting an analysis of the solvency adequacy ratio for persons of retirement age, it was found that $C_{a.s.i}$ for the specified population category have higher indicators than $C_{a.s.i}$ for able-bodied persons. Among medicines of Ukrainian production (full production cycle), Metafora® (JSC "Kyiv Vitamin Plant") and Diaformin® (JSC "Farmak") have the lowest indicators of solvency adequacy (0.89 and 0.99, respectively). Among foreign-made metformin HCL *pharmaceuticals*, the lowest indicator of adequacy of solvency was noted for Metformin Sandoz ("Lek S.A.", Poland) ($C_{a.s.i}$ = 3.33), which is

the most economically justified among this subgroup of medicines. The least available among medicines of foreign production is the Siofor® 500, tab. covered with film, “BERLIN-CHEMIE AG”, Germany, ($C_{a.s.i.}=7.47$), which indicates the economic impracticality of its use in the treatment of type II diabetes in people of retirement age. It should be noted that the lowest index of solvency adequacy among all metformin HCL medicines in Metformin, PJSC “Kyivmedpreparat” ($C_{a.s.i.}=0.70$), which is the most affordable and economically justified for use by persons of retirement age according to socio-economic indicator.

5. Discussion of research results

According to the results of earlier studies of the assortment of antidiabetic medicines by domestic and foreign scientists, it was established that metformin HCL medicines are the most prioritized and available for the pharmacotherapy of type II diabetes among pharmaceuticals of the antidiabetic pharmacological group [19–30]. However, considering the constant market changes that affect the availability of these *pharmaceuticals* on the Ukrainian market, as well as their price, it is relevant to conduct an analysis of the socio-economic indicators of metformin HCL medicines to meet the current needs of patients of various social groups.

In general, the results of monitoring the indicators of physical availability and socio-economic affordability of metformin HCL medicines showed that, despite the fact that metformin HCL medicines are the safest and are widely used as pharmaceutical of first choice in the pharmacological component therapy of type II diabetes, and the use of which, according to the medical-technological documentation of the standardization of medical care in the treatment of type II diabetes, are the most economically justified, most of the indicated medicines have acceptable indicators of accessibility to patients of various ages. It was noted that according to the indicator of physical availability, Ukrainian-made medicines are the most available (full cycle of production and production from tablets in bulk). When researching the affordability of medicines by socio-economic indicator, it was found that metformin HCL pharmaceutical have a lower index of solvency adequacy for people of retirement age among all groups of medicines. However, the obtained data indicate an acceptable indicator of the availability of metformin HCL among medicines of Ukrainian production and foreign production in bulk tablets for all categories of the population.

Study limitations. The limitation of the study was the research of the indicator of physical availability and socio-economic affordability of metformin HCL medicines of Ukrainian and foreign production, which meet certain characteristics, namely: dosage of 500 mg, dosage form – tablets with immediate release of the active substance, and the validity of the registration certificate – no later than 2025 year.

The prospect for further research. A promising direction of further scientific research is to conduct a more thorough analysis of the availability and effectiveness of metformin HCL medicines, study the volumes

and structure of their consumption, determine a set of additional indicators, such as the analysis of the dynamics of the availability of trade names of metformin HCL medicines over the last 5 years, the purchase price index, DDD – analysis, pharmaco-toxicological analysis, etc.

6. Conclusions

According to the results of the monitoring of indicators of physical availability and socio-economic affordability of metformin HCL pharmaceuticals, a list of medicines that meet the specified criteria was formed based on the analysis of medical and technological documentation on the standardization of medical care for type II diabetes and the State Register of Medicines of Ukraine.

When determining the physical availability of metformin HCL medicines of Ukrainian production (full production cycle and production from tablets in bulk), it was established that these medications are represented in the wholesale chain of the pharmaceutical market of Ukraine in full and are the most accessible to all segments of the population. At that time (of the 14 registered trade names of metformin HCL medicines in the wholesale market of Ukraine, only 7 are available, which indicates their lower physical availability compared to Ukrainian-made pharmaceuticals).

When determining the affordability of metformin HCL medicines based on the socio-economic indicator, it was established that all the studied pharmaceuticals have less affordability for people of retirement age compared to a similar indicator for able-bodied people. In a more detailed study of the affordability of metformin HCL medicines of Ukrainian production (full cycle), Metafora®, JSC “Kyiv Vitamin Factory” (0.26 for persons of working age and 0.89 for of retirement age) and Diaformin®, JSC “Farmak” (0.29 – for persons of working age and 0.99 for persons of retirement age), which indicates the economic feasibility of their use in the treatment of type II diabetes among the indicated categories of the population. Among the medicines of foreign production, the most affordable for working-age and pensioner-age people according to the socio-economic indicator of solvency adequacy is Metformin Sandoz®, “Lek S.A.”, Poland (0.98 for people of working age and 3.33 for people of retirement age). However, the most economically justified for all categories of the population is the Metformin medicine, “Kyivmedpreparat”, which is made from bulk tablets of foreign production and has the lowest indicators of solvency adequacy.

Conflicts of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

Financing

The study was financed by the Ministry of Health of Ukraine with funds from the state budget on the topic “Toxico-pharmacological Study of Nitrosamines and Related Risk Assessment for the Regulatory System of Metformin Medicines” (state registration No.: 0122U002056).

References

1. Cosentino, F., Grant, P. J., Aboyans, V., Bailey, C. J., Ceriello, A., Delgado, V. et al. (2019). 2019 ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. *European Heart Journal*, 41 (2), 255–323. doi: <http://doi.org/10.1093/eurheartj/ehz486>
2. Flory, J., Lipska, K. (2019). Metformin in 2019. *JAMA*, 321 (19), 1926–1928. doi: <http://doi.org/10.1001/jama.2019.3805>
3. Pro zatverdzhennia ta vprovadzhennia medyko-tekhnolohichnykh dokumentiv zi standartyzatsii medychnoi dopomohy pry TsD 2 typu (2012). Nakaz MOZ Ukrainy No. 1118. 12.12.2012. Available at: <https://zakon.rada.gov.ua/rada/show/v1118282-12#Text>
4. Type 2 diabetes: newer agents for blood glucose control in type 2 diabetes (2009). The National Collaborating Centre for Chronic Conditions. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK61842/>
5. Type 2 diabetes: National clinical guideline for management in primary and secondary care (2008). The National Collaborating Centre for Chronic Conditions. Available at: <https://www.ncbi.nlm.nih.gov/books/NBK53885/>
6. Dahlén, A. D., Dashi, G., Maslov, I. O., Attwood, M. M., Jonsson, J., Trukhan, V., Schiöth, H. B. (2022). Trends in Antidiabetic Drug Discovery: FDA Approved Drugs, New Drugs in Clinical Trials and Global Sales. *Frontiers in Pharmacology*, 12. doi: <http://doi.org/10.3389/fphar.2021.807548>
7. Litvinova, E., Posilkina, O., Kovalenko, S., Yeromenko, R., Bratishko, Y., Lisna, A. (2022). Status and analysis of trends in the metformin -based drug development: formation of the logistic system of scientific research. *ScienceRise: Pharmaceutical Science*, 2 (36), 37–45. doi: <http://doi.org/10.15587/2519-4852.2022.255536>
8. Lv, Z., Guo, Y. (2020). Metformin and Its Benefits for Various Diseases. *Frontiers in Endocrinology*, 11. doi: <http://doi.org/10.3389/fendo.2020.00191>
9. Vyshnytska, I. V., Trokhymchuk, V. V. (2018). Marketing analysis of some groups antidiabetic medicines, presented at pharmaceutical market of Ukraine. *Farmatsevychnyi Zhurnal*, 2, 3–11. doi: <http://doi.org/10.32352/0367-3057.2.17.01>
10. Salem, A., Men, P., Ramos, M., Zhang, Y.-J., Ustyugova, A., Lamotte, M. (2021). Cost–effectiveness analysis of empagliflozin compared with glimepiride in patients with Type 2 diabetes in China. *Journal of Comparative Effectiveness Research*, 10 (6), 469–480. doi: <http://doi.org/10.2217/cer-2020-0284>
11. Limwattananon, C., Waleekhachonloet, O. (2019). Access to and price trends of antidiabetic, antihypertensive, and antilipidemic drugs in outpatient settings of the Universal Coverage Scheme in Thailand. *PLOS ONE*, 14 (2), e0211759. doi: <http://doi.org/10.1371/journal.pone.0211759>
12. Derzhavnyi reiestr likarskykh zasobiv Ukrainy. Available at: <http://www.drlz.com.ua/ibp/ddsitesite.nsf/all/shlist?opendocument>
13. Prohramnyi kompleks «Apteka». Available at: <https://pharmbase.com.ua/ru/optovye-predlozheniya/>
14. Kotvitska, A. A., Volkova, A. V., Kubarieva, I. V., Cherkashyna, A. V., Korzh, Yu. V., Tereshchenko, L. V., Surikova, I. O.; Kotvitska, A. A. (Ed.). (2021). *Sotsialna farmatsiia*. Kharkiv: NFaU, 264.
15. Kotvitska, A. A., Prokopenko, O. S. (2019). Monitoring of indicators of physical and socio-economic availability of medicines used for Parkinson's disease treatment. *Management, economy and quality assurance in pharmacy*, 3 (59), 55–63. doi: <http://doi.org/10.24959/uekj.19.15>
16. Nemchenko, A. S., Nazarkina, V. M., Panfilova, H. L. et al.; Nemchenko, A. S. (Ed.) (2017). *Orhanizatsiia ta ekonomika farmatsii*. Ch. 1. Orhanizatsiia farmatsevychnoho zabezpechennia naseleennia. Kharkiv: NFaU: Zoloti storinky, 327.
17. Panfilova, H. L. Koefitsient adekvatnosti platospromozhnosti. Available at: <https://www.pharmacycyclopedia.com.ua/article/8076/koefitsiyent-adekvatnosti-platospromozhnosti>
18. Doslidzhennia farmatsevychnoho rynku Ukrainy analitychnoi kompanii «Farmstandart» kompanii «Morion». Available at: <http://www.pharmstandart.com.ua/login>
19. Kotvitska, A., Volkova, A., Korzh, I., Surikova, I. (2021). Comparative analysis of indicators that determine the effectiveness of the implementation of socio-economic determinants of health in Europe and Ukraine. *ScienceRise: Pharmaceutical Science*, 3 (31), 34–41. doi: <http://doi.org/10.15587/2519-4852.2021.235787>
20. Savych, A. O., Pavliuk, B. V. (2022). Marketing analysis of the pharmaceutical market of antidiabetic drugs in Ukraine. *Current Issues in Pharmacy and Medicine: Science and Practice*, 15 (1), 80–85. doi: <http://doi.org/10.14739/2409-2932.2022.1.252509>
21. Dermatis, Z., Lazakidou, A., Anastasiou, A., Liargovas, P. (2020). Analyzing Socio-Economic and Geographical Factors that Affect the Health of the Elderly. *Journal of the Knowledge Economy*, 12 (4), 1925–1948. doi: <http://doi.org/10.1007/s13132-020-00691-9>
22. Kovalevska, I., Ruban, O., Volkova, A., Kotvitska, A., Cherkashyna, A. (2022). The use of complex marketing analysis and QSPR methodology for the necessity of a drug development grounding for the treatment of type 2 diabetes mellitus with increased bioavailability. *Pharmacia*, 69 (2), 303–310. doi: <http://doi.org/10.3897/pharmacia.69.e79179>
23. Zhu, L., She, Z.-G., Cheng, X., Qin, J.-J., Zhang, X.-J., Cai, J. et al. (2020). Association of Blood Glucose Control and Outcomes in Patients with COVID-19 and Pre-existing Type 2 Diabetes. *Cell Metabolism*, 31 (6), 1068–1077.e3. doi: <http://doi.org/10.1016/j.cmet.2020.04.021>
24. Luo, P., Qiu, L., Liu, Y., Liu, X., Zheng, J., Xue, H. et al. (2020). Metformin Treatment Was Associated with Decreased Mortality in COVID-19 Patients with Diabetes in a Retrospective Analysis. *The American Journal of Tropical Medicine and Hygiene*, 103 (1), 69–72. doi: <http://doi.org/10.4269/ajtmh.20-0375>
25. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes – 2018 (2017). *Diabetes Care*, 41 (Supplement_1), S13–S27. doi: <http://doi.org/10.2337/dc18-s002>

26. Bramante, C. T., Ingraham, N. E., Murray, T. A., Marmor, S., Hovrsten, S., Gronski, J. et. al. (2021). Metformin and risk of mortality in patients hospitalised with COVID-19: a retrospective cohort analysis. *The Lancet Healthy Longevity*, 2 (1), e34–e41. doi: [http://doi.org/10.1016/s2666-7568\(20\)30033-7](http://doi.org/10.1016/s2666-7568(20)30033-7)

27. Mishchenko, O. Ya., Kalko, K. O., Ostashko, V. F., Borysiuk, I. Yu., Rokun, D.-M. B., Ryshchenko, O. O., Bezdetko, N. V. (2021). Range analysis, socio-economic accessibility and consumption of fibrates on the pharmaceutical market of Ukraine during 2017–2020. *Pharmacologyonline*, 2, 650–656.

28. Briukhanova, T., Lytkin, D., Zahaiko, A., Bondareva, A. (2021). The effect of nmda-receptor antagonist on carbohydrate and lipid metabolism markers in syrian golden hamsters under experimental insulin resistance syndrome and diabetes mellitus. *Problems of Endocrine Pathology*, 78 (4), 72–79. doi: <http://doi.org/10.21856/j-pep.2021.4.10>

29. Ghany, R., Palacio, A., Dawkins, E., Chen, G., McCarter, D., Forbes, E. et. al. (2021). Metformin is associated with lower hospitalizations, mortality and severe coronavirus infection among elderly medicare minority patients in 8 states in USA. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, 15 (2), 513–518. doi: <http://doi.org/10.1016/j.dsx.2021.02.022>

30. Wander, P. L., Lowy, E., Beste, L. A., Tulloch-Palomino, L., Korpak, A., Peterson, A. C. et. al. (2021). Prior Glucose-Lowering Medication Use and 30-Day Outcomes Among 64,892 Veterans With Diabetes and COVID-19. *Diabetes Care*, 44 (12), 2708–2713. doi: <http://doi.org/10.2337/dc21-1351>

Received date 17.03.2022

Accepted date 23.08.2022

Published date 29.08.2022

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