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Section 1. Machinery construction

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USING OF EVAPORATIVE CONDENSERS FOR COMBINED POWER PLANT

Abstract. An evaporative condenser is used to remove excess heat from a cooling system when the heat cannot be utilised for other purposes. The excess heat is removed by evaporating water. The evaporative condenser has a cabinet with a water-sprayed condenser, and it usually has one or more fans.

Keywords: Evaporative condensers, Combined power plant, Cooled condenser, Condenser, Steam Condenser.

Introduction

One of the factors affecting on the production and development of energy is the amount of water used in equipment in power plant. Especially if it is combined power plants, which the heat of the exhaust gas is used to generate steam for operating of steam turbines.

In a number of Iraqi regions, there are certain problems with water [1], which a large extent hinders of development the energy industry.

One of the ways to solve the problem of water shortage for the operation of combined power plants is to use the air cooled condenser in power plants. However, air condenser are less efficient than water one [2].

It is possible to increase the efficiency of the air cooled condenser by using (evaporative condensers with atomizing spray nozzles) with water on the heat exchanger surface [3]. But the use of water from natural reservoirs has disadvantages. Water from natural reservoirs has some salinity, which negatively effects on the surface of the heat exchanger.

At the same time, the main units of combined power plants use fuel which made up of mostly carbon and hydrogen atoms. The combustion of hydrogen produces water in a fairly large amount.

The object of the research is to evaluate the possibility of using an evaporative steam condenser with atomizing spray nozzles for combined power plants in the climatic conditions of Iraq.

Combined power plant

In the power generation method characterized by the standalone operation of a gas turbine, known as the simple or open cycle, releases exhaust gas at temperatures of around 600 °C into the atmosphere.

Combined cycle power generation improves the general thermal efficiency of the plant by recovering this high temperature exhaust gas. Many combined cycle power generation plants adopt a waste heat recovery cycle in which exhaust gas from the gas turbine is led to the waste heat recovery boiler to generate steam using recovered heat to drive the steam turbine [4].

One of the important components in power plants is the condenser

Steam Condenser

A steam condenser is a closed vessel in which steam is condensed by abstracting the heat by cooling it with water and where the pressure is maintained below atmospheric pressure.
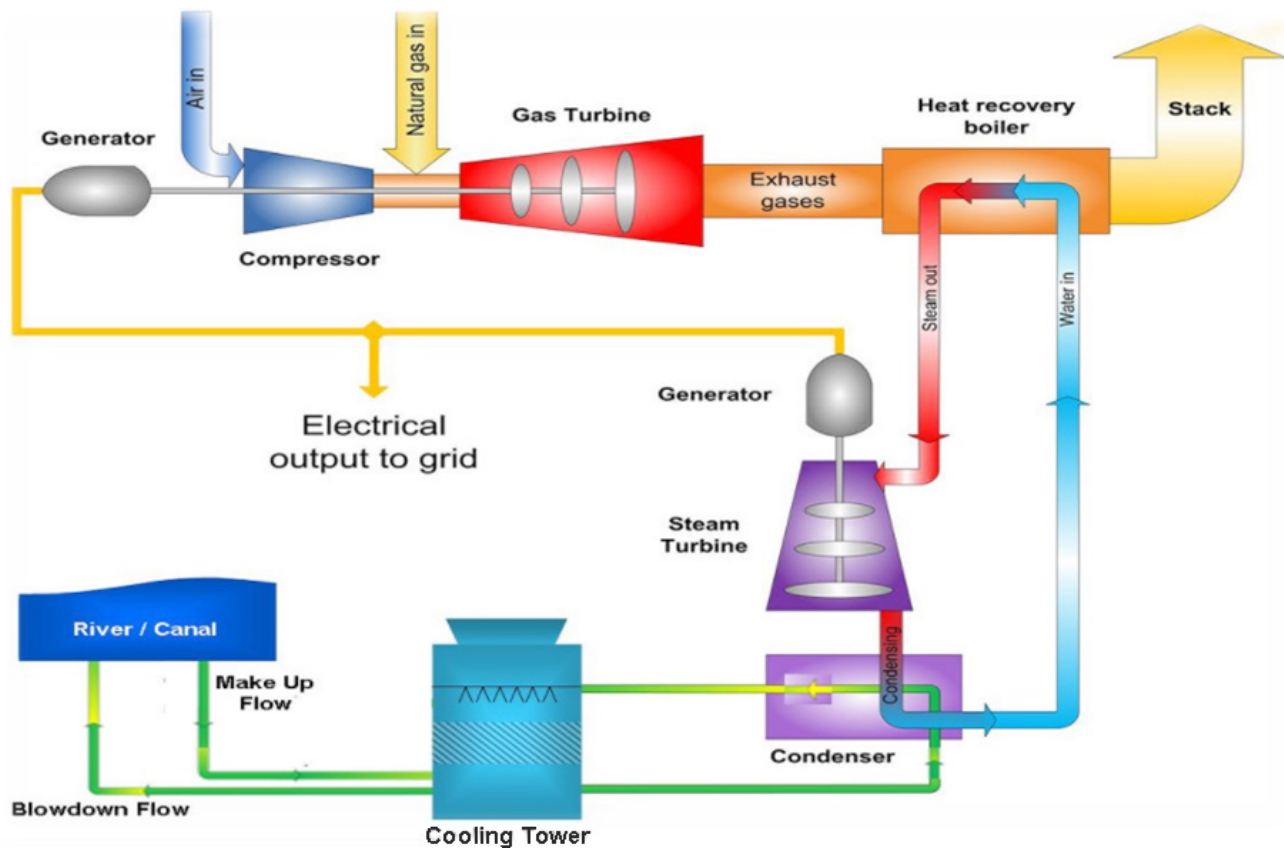
Figure 1. Combined power plant

The condensed steam is known as condensate. The efficiency of the steam power plant is increased by the use of a condenser. The steam condenser is an essential component of all modern steam power plants.

Objectives of the Steam Condenser

A steam condenser has the following two objectives:

1. The primary objective is to maintain a low pressure (below atmospheric pressure) so as to obtain the maximum possible energy from steam and thus to secure a high efficiency.

The secondary objective is to supply pure feed water to the hot well, from where it is pumped back to the boiler.

Types of Steam Condenser

There are two main types of steam condenser:

1. Jet condensers (mixing type condensers)

1. Parallel flow jet condenser

2. Counterflow or Low-level jet condenser

3. Barometric or High-level jet condenser

4. Ejector Condenser

2. Surface condensers (non-mixing type condensers)

1. Downflow surface condenser

2. Central flow condenser

3. Regenerative condenser

4. Evaporative condenser [5].

On this article we will focus on evaporative condenser

Evaporative condenser

An evaporative condenser is used to remove excess heat from a cooling system when the heat cannot be utilised for other purposes. The excess heat is removed by evaporating water.
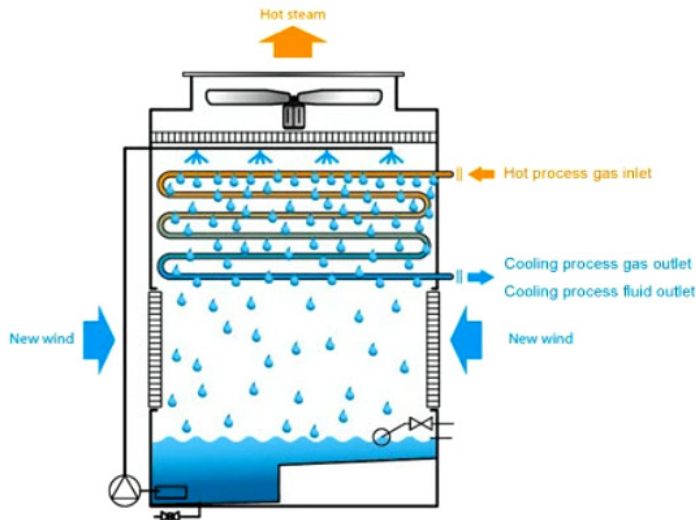
Counter Flow Evaporative Condenser
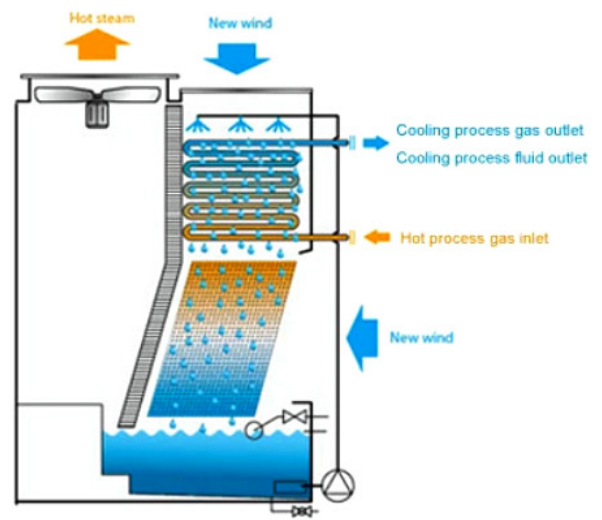
Cross Flow Evaporative Condenser

Figure 2. Evaporative condensers

The evaporative condenser has a cabinet with a water-sprayed condenser, and it usually has one or more fans. The excess heat is removed by evaporating water. In an evaporative condenser the primary coolant of the cooling system is cooled, which is the opposite of a cooling tower. Evaporator condensers are more expensive than dry coolers and are primarily used in large cooling systems or systems where the outdoor temperature is high. In many locations around the world, regulations limit the physical size of a cooling system and this in turn limits the use of evaporative condensers [6].

Spraying a condenser with water exploits the fact that the dew point temperature is lower than the air temperature and that a wet surface transfers heat more efficiently.
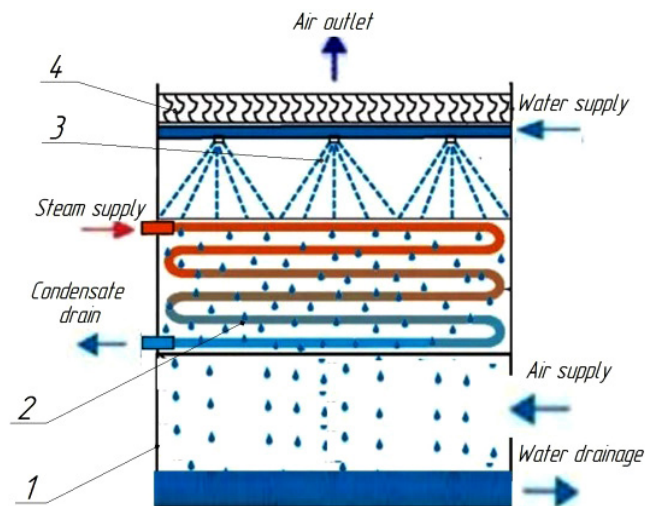
(a)

Figure 3. Technological scheme of evaporative condenser: 1 – Body; 2 – Heat exchanger; 3 – Nozzles; 4 – Drop separator;

The technological scheme in which the atomization water is collected in the sump of the condenser and is again returned to the system of nozzles, then for the upper rows and as a result of the relatively high cooling water temperature and air enthalpy, part of the heat lost by the cooling water is stored in the sprayed water [7].

The temperature of the spray water varies significantly with the height of the evaporative condenser, for outdoor air temperature range 10…45 °C, the temperature of the cooling water is in the range from 18 to 55 °C, this significantly affects the process of condensation of water vapor inside the tube.

The useful power of the steam turbine in a combined power plant depends significantly on the ambient temperature and the steam condensation pressure, we estimate the change in the specific power of a steam turbine in a combined power plant depending on the indicated parameters in the climatic conditions of Iraq.

In the calculations, it was assumed that the ambient air temperature varied from 10 to 45 °C. Change of water vapor condensation pressure from 8 to 25 kPa. The calculation data are shown in (Fig. 4).
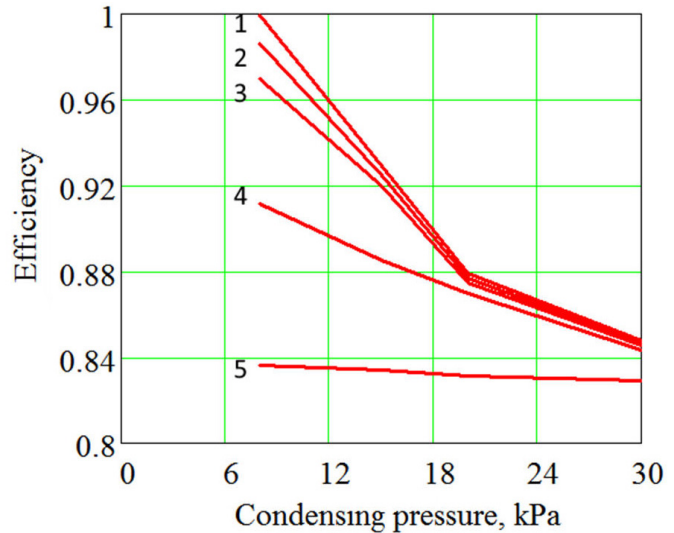
Figure 4. The specific power of a steam turbine in a combined power plant depending on the ambient temperature and the pressure of condensation of water vapor for the climatic conditions of Iraq

For the temperature of the outside air used as the cooler in the evaporative condenser, 10…45 °C, the average temperature of spray water 18…55 °C Evaporative condenser efficiency does not exceed 80% of the nominal value.
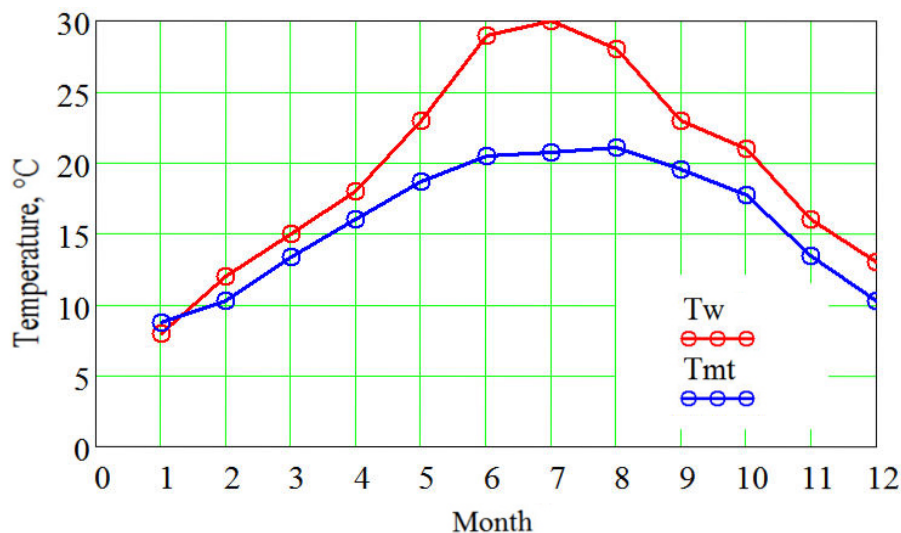
Figure 5. Change in water temperature in reservoirs in the middle part of Iraq (*Tw*) and wet bulb temperature (*Tmt*) during the year

(Ambient temperature: 1–5 °C; 2–15 °C; 3–25 °C; 4–35 °C; 5–45 °C).

In connection with the above, it is necessary to search for technical solutions that could improve the

efficiency of the evaporative condenser in the climatic conditions of the central part of Iraq.

The efficiency of the evaporative condenser of combined power plants depends on the average water temperature, atomizing on the heat exchanger surface, comparison of water temperatures in the middle region of Iraq (Tw) and wet-bulb temperature (Tmt) according to $[9; 10]$ is shown in (Fig. 5).

Calculation data show that the temperature of the wet bulb is below the average water temperature in open reservoirs in the central region of Iraq, this is due to the low humidity of the air in the area, the low temperature value of the wet bulb is a important for a significant increase in the efficiency of the condenser, temperature close to (Ttm).

It is possible to achieve an atomization water temperature that is close to the temperature of the "wet" bulb if there is a source of water with low salinity.

Gas turbines generally use excess air values to $\alpha = 6$. But most gas turbines are designed for an excess air ratio of $\alpha = 3$ $[11]$. Excess air ratio in high power internal combustion engines is in the range of $\alpha = 2.6...3$ $[12]$. For a preliminary estimate, we take the redundancy factor in the main engines of combined-cycle power plants to be $\alpha = 3$.

The hydrogen content in fuels: gaseous – up to 16%, in heavy – up to 11% $[13]$.

According to $[14]$, the amount of water vapor during fuel combustion can be determined in the first approximation using the following equation.

$$V^0_{H_2O} = 0.111H^P + 0.0124W^P + 1.6dV^0_B \rho^0_B$$

Where H^P – hydrogen content in fuel; W^P – water content in the fuel; $1.6dV^0_B \rho^0_B$ – is the water content in the air.

Numerical simulation of the process of condensation of water vapor from the exhaust gases of a combined power plant with an excess air coefficient $\alpha = 3$ shows
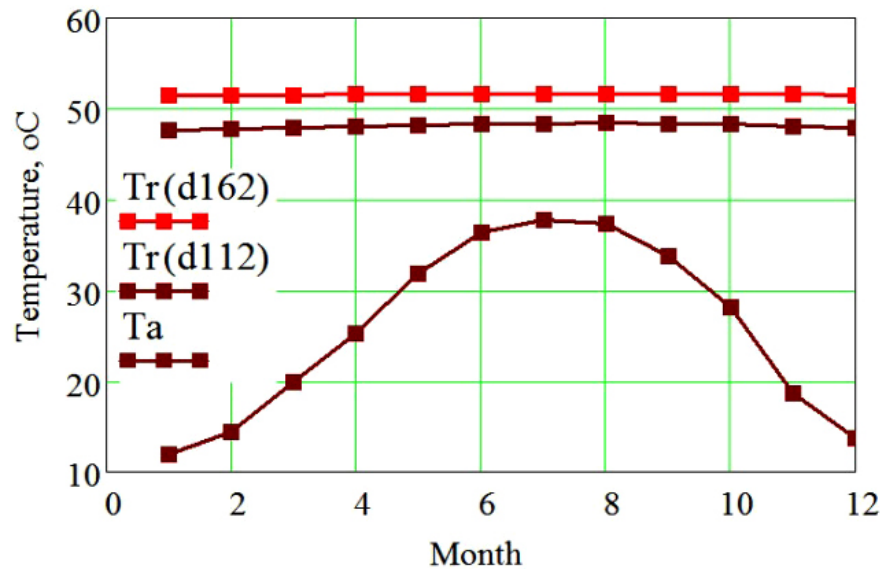
Figure 6. Temperature distribution "dew" of flue gases (exhaust gases) with $\alpha = 3$ by months of the year ($Tr(d162)$ – for gas fuel, $Tr(d112)$ – for heavy fuel, Ta – ambient temperature)

Calculation data show that the achievement of the exhaust gases temperature of combined power plants is 5 °C lower than the "dew" temperature, allows to condense up to 0.02 kg of water from each kg of flue gases. However, the temperature of the condensate will be in the range of 43 ... 46 °C.

Therefore, to use the condensate obtained in the evaporative condenser, it must be cooled. One of the possible technological schemes for cooling condensate obtained from exhaust gases is shown in (fig. 7).
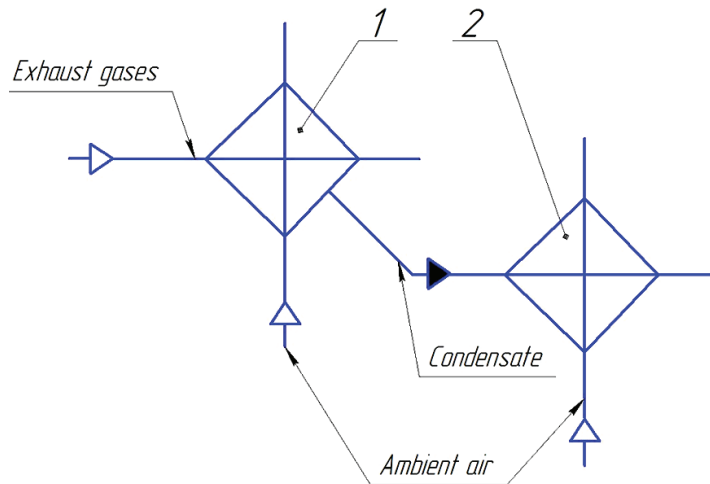
Figure 7. Technological scheme for obtaining and cooling condensate: Surface cooler of flue gases (exhaust gases); Contact condensate cooler

According to the given technological scheme (Fig. 7), the exhaust gases are cooled by ambient air in a surface cooler 1. In this case, up to 0.02 kg of water is condensed out of each kilogram of exhaust gases, the resulting condensate enters the contact cooler 2, where, due to the evaporation of part of the water, the condensate is cooled to the temperature of the "wet" thermoment.

This amount of water can be used as an additional source of water in the evaporative condenser

Conclusion

As a result of mathematical modeling, the possibility of operation of evaporative condensers of combined power plants in the conditions of hot and dry climate of the central part of Iraq is substantiated.

As cooling water in the evaporative condenser, it is advisable to use the condensate of water vapor contained in the exhaust gases of combined power plants.

The temperature of the condensate reaches a sufficiently low temperature of the "wet" thermometer in the contacts of the coolers due to the evaporation of part of the water into the outside air flow with a low moisture content.

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Section 2. Medical science

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SLEEP DEPRIVATION OF INDONESIAN ADOLESCENTS: EFFECTS ON MENSTRUAL CYCLE DISORDERS

Abstract. The need for sleep for adolescents is ± 8 hours/day. Menstrual cycle varies in women and 90% of them have a cycle of 25–35 days and 10–15% have a cycle length of 28 days. The purpose of the study was to determine the relationship between sleep deprivation and its effect on adolescents' menstrual cycle disorders. This type of research is descriptive associative analytic. The sample included all young women in Dusun 'hamlet' III, Bakaran Batu Village. The results showed that abnormal sleep needs interfered with the menstrual cycle of 44 respondents (88%). The need for sleep on menstrual cycle disorders is obtained by the value-added ratio (OR) = 6.417. 95% IC = =1.705–24.149 P value 0.007 < 0.05, which means that there is a significant relationship between sleep needs and menstrual cycle disorders.

Keywords: sleep needs, menstrual cycle disorders, adolescents, sleep deprivation Aa.

Introduction

Women has different menstrual cycles and almost 90% of women have cycles of 25–35 days and only 10–15% have cycles of 28 days, but some of them have irregular cycles and this is an indication of fertility problems. Length of menstrual period is marked from the first day of the period [1]. Sleep is a process to restore a person's condition to its original state. The delayed recovery process causes the body's organs to not work optimally; as a result, people who lack sleep will get tired quickly and experience a decrease in concentration [2]. The normal sleep process begins with the drowsy stage, which is a state when there is a connection between awareness and the surrounding environment [3].

Literature Review

There is a significant relationship and statistically low correlation of variables between sleep quality and menstrual cycle [4]. Veronika's research (2020) showed that out of 97 female students who met the inclusion criteria, 51(52.6%) of them had poor sleep quality, while 46(47.4%) had good sleep quality [5]. Physiologically, menstruation occurs when follicle stimulating hormone releasing hormone (LH-RH) stimulates the interior pituitary to secrete follicle stimulation hormone and luteinizing hormone which causes the production of estrogen and progesterone which will then provide feedback containing levels of gonadotropic hormones to the hypothalamus [6].

The average menstrual cycle lasts about 21––35 days. Although this is generally accepted, but not all women have the same menstrual cycle. Sometimes menstrual cycles occur every 21 to 30 days. Generally, menstruation lasts for 5 days. However,

sometimes menstruation can also occur around 2 to 7 days. The cycle varies from 18 to 40 days, and the average being 28 days [6]. At the end of menstruation, almost the entire wall sheds, mixed with blood and comes out and the menstrual cycle is divided into 4 phases, namely menstruation, proliferation, secretion or luteal and ischemic premenstrual [7].

Menstrual cycle disorders are: oligomenorrhea and amenorrhea (which includes primary amenorrhea, secondary amenorrhea, and polymenorrhea). Cycle abnormalities are characterized by the length of the menstrual cycle of less than 21 days. Bleeding is more or less the same as your normal period. Polymenorrhea can be caused by hormonal disorders that result in ovulation disorders, or a shortened luteal period, ovarian congestion due to inflammation, and endometriosis [1]. Menstrual cycle abnormalities are caused by the length of the follicular and luteal stages due to psychological influences and tuberculosis disease in oligomenora, by hormonal system disorders, other diseases, emotional instability, lack of nutrients that have more nutritional value in amenorrhoea, by hormonal disorders with age of the corpus luteum. shortened or short proliferative stage or short secretory stage or both in polymenorrhea. Menstrual cycle abnormalities can be treated with several things [8].

Sleep is part of the body's biological rhythm to restore stamina [9] or an unconscious condition in which individuals can be awakened by appropriate stimuli or sensors. Sleep has characteristics, namely minimal activity, varying awareness, changes in physiological processes, and decreased response to external stimuli. Sleep can be considered as a protection for the body to avoid adverse health effects due to lack of sleep [3]. There are 4 main variables that affect sleep, namely circadian rhythm, melatonin, activity level, and previous wakefulness [9]. Factors that affect the quality and quantity of sleep, including disease, environment, fatigue, lifestyle, emotional stress, stimulants and alcohol, diet, smoking, medication and motivation. The problems of sleep needs

in adolescents are insomnia, hypersomnia, parasomnia, enuresis, narcolepsy, and apnea.

Materials and Methods

This research was conducted from May to September 2021. The design of this study was descriptive analytic with a cross sectional approach. The population and samples included 65 young women aged 10–19 in Dusun III, Bakaran Batu Village, Percut Sei Tuan Sub-district, Deli Serdang Regency; The sample was carried out using a purposive sampling technique [10]. Data analysis was univariate by calculating the frequency in the form of a percentage of the variables studied and bivariate with the formula $X2 = \Sigma \, () \, [11]$.

Result and Discussion

Based on univariate analysis [10], regarding menstrual cycle disorders, as many as 52 respondents (80.0%) experienced disturbances but as many as 13 respondents (20.0%) did not experience menstrual cycle disorders. Regarding sleep needs, 50 respondents (76.9%) had abnormal sleep needs and 15 respondents (23.1%) had normal sleep needs. From bivariate analysis [10], respondents whose menstrual cycle is less than 21 days or more than 35 days experience menstrual cycle disorders caused by stress, genetics, hormones, nutritional status, and sleep needs are met but disturbed sleep patterns caused by by the use of an android cellphone that they misused [5; 12]. As many as 50 respondents (76.9%) experienced abnormal sleep needs and 15 respondents (23.1%) received normal sleep needs. Bad sleep habits. due to excessive mobile phone playing and not attending school. Without them knowing the consequences of bad sleep result in disruption of the menstrual cycle [9; 5].

Of the 50 respondents, 44 respondents (88%) experienced menstrual cycle disorders and 6 respondents (12%) did not experience menstrual cycle disorders. Of the 15 respondents, 8 (53.3%) of them experienced menstrual cycle disorders and 7 respondents (46.7%) did not experience menstrual cycle disorders and had nor-

mal sleep needs. The results of the analysis of the relationship between sleep needs and menstrual cycle disorders show that the value of the statistical test results is the Odd Ratio $(OR) = 6.417$. 95% $CI = 1.705–24.24.149$ and P value $0.007 < 0.05$, which means that there is a significant relationship between sleep needs and menstrual cycle disorders in adolescent girls (compare researches carried out by Deaneya et al. and Luthfi [4; 13].

Research by Deaneva et al. shows the value of $X2 = 4.912$ with a significant level of $a = 0.05$ so that $p = 0.027$ or smaller than a; while the result of the contingency coefficient test is 0.331. Thus, there is a significant relationship and statistically low correlation between variables between sleep quality and menstrual cycle in young doctors at RSUD Dr. Moewardi Surakarta [4]. Luthfi's research shows that 52.1% of female students experience poor sleep quality and 29.9% of them experience abnormal menstrual cycles [14]. Of the 117 research subjects, the p-value is 0.002 with an Odd Ratio value of 3.879. Analysis using Chi-square shows that sleep quality has a significant relationship with the menstrual cycle.

It is assumed that the research of Deaneva et al. and Luthfi [4; 13] is in accordance with the results of this study where the statistical test results obtained an Odd Ratio (OR) value of 6.417 (95%) and the CI value was 1.705–24.24,149 and P value 0.007 < 0.05, which means that there is a significant relationship between sleep needs and menstrual cycle disorders in adolescent girls. The results of this study indicate that there is an abnormal need for sleep and 6 (12%) respondents who do not experience menstrual cycle disorders; This is due to the fulfillment of nutritional factors (carbohydrate, protein, fat, mineral and water needs), and by normal sleep needs. Respondents who experienced menstrual cycle disorders were 8 (53.3%); This disorder is caused by stress factors, genetics, hormones, and poor nutritional status.

Conclusion

The study concluded that based on the sleep needs of 65 respondents, as many as 50 (76.9%) respondents experienced abnormal sleep needs. Based on the relationship between sleep needs and menstrual cycle disorders, 50 respondents with abnormal sleep needs experienced menstrual cycle disorders as many as 44 respondents (88%). Of the 15 respondents with normal sleep needs, 8 respondents (53.3%). From the statistical test results, the Odd Ratio (OR) value is 6.417 (95%) and the CI is 1.705–24,149 and P value is 0.007 < 0.05, which means that there is a significant relationship between sleep needs and menstrual cycle disorders in adolescents.

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MOLECULAR GENETIC FEATURES OF VULVA SQUAMOUS CELL CARCINOMA DEPENDING ON HPV STATUS

Abstract. The study included materials from 76 operations (110 paraffin blocks), which did not undergo neoadjuvant treatment methods, since preoperative exposure to tumors could significantly affect the results of the study, which is why these samples were not included in the study. It was found that a high viral load of HPV in VC correlates with the presence of metastases in the lymph nodes, invasion of the stroma, the degree of differentiation, and lymphovascular invasion, while it is not associated with the stage of the disease. Expression of PD-L1 receptors was more frequently observed in HPV negative VC patients compared to HPV positive ones (7.8 vs 3.7 p=0.03), while STK11 mutation was more common in HPV positive patients. At the same time, the PIK3CA E545 mutation occurred with the same frequency between the two groups of VC patients.

Keywords: mutation, signaling pathway, epigene, apoptosis receptor, cell cycle, transcription.

According to WHO, over the past few decades, there has been a rejuvenation of VC, in the direction of its increase among young women. Due to the variety of symptoms of vulvar cancer and the wide range of benign diseases of this localization, it is still difficult to diagnose, especially in the early stages. In addition, most research in the field of vulvar cancer is currently focused on innovative treatment regimens, including biological agents and immunotherapy, which require a deep understanding of the main molecular mechanisms involved in the pathogenesis of VC, and the development of new combination and complex therapy regimens is relevant. Direction of research in modern oncology [1; 2; 3; 4].

With the discovery and identification of new predictive biomarkers, approaches to the treatment of vulvar cancer will change from standard radical resections to personalized approaches. Since the identification of new prognostic variables may lead to further individualization of the treatment of vulvar cancer, research in the search for new biomarkers is an important area of modern oncology [5; 6; 7].

Materials and methods. We examined the materials of 76 operations (110 paraffin blocks) that did not undergo neoadjuvant treatment methods, since preoperative exposure to tumors could significantly affect the results of the study, which is why these samples were not included in the study. Prior to molecular and IHC examination, all tissue samples were reviewed by experienced pathologists. Clinical data were obtained from patients and their medical records, after approval by the ethics committee.

Pathological anatomical diagnosis was confirmed on the basis of the study of histological sections stained with hematoxylin and eosin. The sections were coarsely dissected as needed to achieve >20% of the estimated percentage of the nucleus in each tumor sample. From 2210 formalin-fixed tumor samples from tissue paraffin blocks, 40 μm sections, ≥60 ng DNA were excised for genomic analysis. Materials were analyzed with CGP using adapter tethering, and using hybrid capture. All genomic alteration sequences were sequentially analyzed, including minor variant alterations, copy number alterations, and gene fusion and rearrangement.

Tumor mutation load (TBM; mutations/Mb) was determined on 0.8–1.1 megabase pairs of sequenced DNA. Microsatellite instability (MSI) was determined by 114 loci.

Mutation marks were evaluated for all tumor samples. When the tumor sample had at least 40% concordance with the mutation process, including overexpression of AROBEC, hypofunction of the tumor suppressor BRCA, and in the presence of a repair match defect, the mutation label was considered positive. Immunohistochemical study was performed with the determination of programmed cell death ligand 1 (PD-L1) without fail with CGP, for the selection of patients for immunotherapy. PD-L1 protein expression was determined on 5-micron tissue sections using a Dako PD-L1 IHC22C3 pharm Dx analyzer (Agilent, Santa Clara, CA) or Ventana (Oro Valley, AZ) according to each manufacturer's instructions. Expression of Ventana PD-L1 is expressed as a percentage of tumor area, positively stained tumor and immune cells, and Dako PD-L1 as an indicator of tumor proportion. Tissue staining of less than 1% was rated as negative, up to 49% as slightly positive, and 50% or more staining as positive [1; 6; 7; 8]. Total RNA was extracted from frozen tissue by macro-dissection. RNA was extracted from tissues cut and lysed using the RNeasy Mini Kit (QIAGEN) and Precellys according to the manufacturer's instructions. DNA pellets were incubated for 18 hours from the start of tissue lysis at 55 °C using cell lysis solution (Gentra Puregene Blood Kit, QIAGEN). The resulting mass was centrifuged and phenol – chloroform – isoamyl alcohol was added, which was alternated with glycogen 20 mg/ml. The alcohol was removed, the samples were dried after washing in distilled water. After evaluating the quantity and quality of DNA and RNA samples, further analysis was carried out (for a detailed description of isolation, molecular and IHC analysis, see the special literature).

Table 1. – Gene Mutations Studied for Comprehensive Analysis of the Genetic Profile of Vulvar Tumors

№	Functional class of mutant genes	Mutations
1	2	3
1.	Pi3K/AKT/mTOR pathway	PIK3CA PIK3CA T545K KMT2D PTEN STK11 FBXW7SOX2amp PIK3R1 AKT1 MTOR
2.	Epigenetic regulator	EP300 BAP1 PBRM1

1	2	3
2.	**Epigenetic regulator**	*KDM6A* *KMT2C* ARID1A
3.	**Cell cycle regulator**	RB1
4.	**Transcription regulator**	*CDK12 inactivating* *AR*
5.	**Tyrosine kinase receptor**	FGFR3
6.	**Cytokeratin**	CR
7.	**Programmed cell death receptor 1 (PD-1) ligand**	PD-L1
8.	**Mismatch repair gene (microsatellite instability)**	MSI-H/dMMR
9.	**Vascular Endothelial Growth Factor**	VEGF
10.	**Epidermal growth factor**	HER1/EGFR
11.		P53

Results. As in the general group, squamous cell carcinoma (56.9%) and intraepithelial neoplasia (27.9%) were most frequently diagnosed.

We also conducted a correlation study of the relationship between human papillomavirus and the genetic profile of vulvar cancer. Staining 1 apoptosis ligand (PD-L1) of vulvar squamous cell carcinoma, negative for human papillomavirus, showed a higher frequency of this ligand, while the incidence of PD-L1 was significantly low in HPV positive (Table 2).

Table 2. – Gene Mutations Studied for Comprehensive Analysis of the Genetic Profile of Vulvar Tumors

№	Genes	HPV+	HPV–	p
1	2	3	4	5
1.	PIK3CA	32.6	14.7	0.005
	PIK3CA T545K	13.9	3.1	0.0005
	KMT2D	16.3	7.9	0.05
	PTEN	11.9	1.5	<0.0001
	STK11	11.8	1.5	<0.0001
	FBXW7	10.1	3.6	0.02
	SOX2amp	4.4	1.3	0.0218
	PIK3R1	3.1	0.8	0.18
	AKT1	2.1	0.8	0.61
	MTOR	2.1	0.9	0.59
2.	EP300	14.1	1.4	<0.0001
	BAP1	5.2	0.9	0.02
	PBRM1	5.4	1.5	0.07
	KDM6A	6.6	2.7	0.01
	KMT2C	6.6	3.4	0.40
	ARID1A	3.1	2.9	0.07
3.	RB1	5.5	1.3	0.09

1	2	3	4	5
4.	CDK12 inactivating	5.5	1.6	0.07
	AR	4.6	0.3	0.002
5.	FGFR3	4.7	0.1	0.003
6.	CR	4.2	0.3	0.09
7.	PD-L1	7.8	3.5	0.03
8.	MSI-H/dMMR	21.3	3.7	0.0001
9.	VEGF	27.3	41.1	0.005
10.	HER1/EGFR	11.2	18.2	0.0013
11	P53	15.9	39.7	0.0021

Although the median TBM for HPV+ vulvar squamous cell carcinoma was generally higher than the HPV- result (7.8 vs 3.7; p = 0.03), a complicating factor was the higher percentage of HPV- vulvar squamous cell carcinoma sequenced from the primary tumor.

STK11 in HPV+ was significantly higher than HPV test results.

When comparing mutation rates between HPV positive and HPV negative groups for vulvar squamous cell carcinoma (VSC), a difference in mutations between HPV+ and HPV– tumors was observed. Most CCND1-amplified VSC have shown amplification of other genes, such as in 11q13, including FGF3, FGF4, and FGF19. A major specific point mutation with a significant difference between HPV+ and HPV– tumors, which was saturated with the PIK3CA E545K activating mutation.

Thus, this study showed that the presence or absence of human papillomavirus dramatically affects tumor differentiation. With a positive test for human papillomavirus, mutations in the PI3K/mTOR pathway increased, on the contrary, with a negative test, GA was more often detected in TP53, TERTp, CDKN2A, CCND1, FAT1, NOTCH1, EGFR.

HPV status and type were determined in all samples of 186 patients. 86 of 186 patients had HPV, predominantly types 16 and 18. Mostly HPV+ result was found in younger patients than in the group of elderly patients. Eighty-six patients (46.2%) were infected with HPV, of which 23.3% had very little infection, 31.4% had a clinically significant lesion, and 45.3% had a high viral load.

The viral load does not depend on the stage of the disease, but such indicators as the presence of metastases in the lymph nodes, invasion into the stroma, tumor gradation, lymphovascular and vascular invasion had a natural relationship with viral invasion. In the presence of metastases in the lymph nodes, HPV infection was detected in all 61 cases (100%), in the presence of distant metastases in 94.1%, with G3–87.5%, lymphovascular and vascular invasion 94.4 and 92.6% respectively (p=0.95).

In our study among patients with vulvar cancer, the greatest number of viral lesions was observed in younger patients, while in elderly patients, vulvar cancer was the result of degenerative-dystrophic changes in the vulva.

Of the 86 HPV positive patients, 76 (88.4%) patients were under the age of 60 years. At the same time, among patients with vulvar cancer up to 40 years, about 82%, up to 50 to 93% of cases of infection with the human papillomavirus. Among the patients in the age group up to 60 years old, infected with the human papillomavirus, 32 patients were under 55 years old. Given this fact, 76.7% of patients with HPV were under the age of 55 years. As in the general group, squamous cell carcinoma (56.9%) and intraepithelial neoplasia (27.9%) were most frequently diagnosed. Although the median TBM for HPV+ vulvar squamous cell carcinoma was generally higher than the HPV- result (7.8 vs 3.7; p = 0.03),

a complicating factor was the higher percentage of HPV– vulvar squamous cell carcinoma sequenced from the primary tumor. STK11 in HPV+ was significantly higher than HPV test results.

When comparing mutation rates between HPV positive and HPV negative groups for vulvar squamous cell carcinoma (VSC), a difference in mutations between HPV+ and HPV- tumors was observed. Most CCND1-amplified VSC have shown amplification of other genes, such as in 11q13, including FGF3, FGF4, and FGF19. A major specific point mutation with a significant difference between HPV+ and HPV– tumors, which was saturated with the PIK3CA E545K activating mutation.

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It was found that a high viral load of HPV in VC correlates with the presence of metastases in the lymph nodes, invasion of the stroma, the degree of differentiation, and lymphovascular invasion, while it is not associated with the stage of the disease. Expression of PD-L1 receptors was more frequently observed in HPV negative RV patients compared to HPV positive ones (7.8 vs 3.7 p=0.03), while STK11 mutation was more common in HPV positive patients. At the same time, the PIK3CA E545 mutation occurred with the same frequency between the two groups of VC patients.

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INGUIN-PELVIC LYMPHODISSECTION IN THE TREATMENT OF METASTATIC LESION OF REGIONAL LYMPH NODES IN VULVA CANCER

Abstract. Knowledge of the prevalence of the cancer process and its microscopic signs helps to establish the stage of development of the disease helps to assess the likelihood of tumor recurrence and provides information that will allow the doctor to predict the therapeutic effect. In vulvar cancer, the tumor often spreads along the length and by metastasizing to regional lymph nodes (inguinal, femoral), and then to the pelvic lymph nodes. In malignant tumors, the level of lymph node damage, which can be determined by lymph node dissection, is of great importance for the choice of treatment method.

Keywords: lymph node dissection, lymphovascular invasive lesion.

Introduction

The incidence of RC is less than half of one percent of the global incidence of malignant tumors. In 2018, there were 44.000 new cases of vulvar cancer worldwide, while the number of deaths was about 15.000 cases. It should be noted that the incidence of RV is higher in high-income countries such as Europe, North America and Oceania [1; 2; 3].

The most important prognostic features of vulvar carcinoma are tumor size, depth of invasion, lymph node status, and the presence of distant metastases. Historically, the assessment of the status of the inguinal nodes required the performance of a standard inguinal lymphadenectomy for all types of vulvar cancer. However, this procedure is associated with a high risk of developing lower extremity lymphedema (approximately 30–70%) in patients undergoing total groin-femoral lymph node dissection, especially in combination with radiation therapy [4; 5; 6]. In this connection, it is necessary to conduct research in the field of developing criteria for conducting lymph node dissection in RC [7].

Materials and methods. An analysis was made of the results of examination and treatment of 186 patients with vulvar cancer who were treated at the RSSPMCO&R, MSRC named after P. A. Herzen – the branch of the Federal State Budgetary Institution "NMITs Radiology" of the Ministry of Health of Russia (Moscow, Russian Federation), as well as the clinic of Istinye University (Istanbul, Turkey) from 2011 to 2020.

In vulvar cancer, the tumor often spreads along the length and by metastasizing to regional lymph nodes (inguinal, femoral), and then to the pelvic

lymph nodes. In malignant tumors, the level of damage to the lymph nodes is of great importance for the choice of treatment method. Regional spread occurred in the adjacent areas of the lower third of the vagina, in the rectal ligament. Later, invasion into the anorectal region developed.

Table 1. – Clinical features of vulvar cancer in patients included in the study

№		Clinical features	Number of patients
1.	Tumor stage	pT_{1a}	17(9.1%)
		pT_{1b}	27(14.5%)
		pT_2	73(39.2%)
		pT_3	63(33.9%)
		pT_4	6(3.2%)
	Metastases to lymph nodes	Yes	76(40.9%)
		No	110(59.1%)
2.	Distant metastases	M_0	169(90.9%)
		M_1	17(9.1%)
2.	Stroma invasion:	≤1mm	29(15.6%)
		≥1mm	130(69.9%)
		No data	27(14.5%)
3.	Tumor gradation	1	22(11.8%)
		2	124(66.7%)
		3	40(21.5%)
4.	Lymphovascular invasion	Yes	18(9.7%)
		No	139(74.7%)
		No data	29(15.6%)
5.	Vascular invasion	Yes	27(14.5%)
		No	143(76.9%)
		No data	16(8.6%)
6.	Stage FIGO	I stage	69
		II stage	60
		III stage	36
		IV stage	21

Spread to the lymph nodes occurred first in the direction of the inguinal lymph nodes. In 32.8% of cases, metastases were diagnosed in regional, femoral and inguinal lymph nodes. Palpation of the inguinal region may reveal involvement of the lymph nodes, but histological findings are positive in only 40% of cases with palpable tumors. Of the 61 lymph nodes affected by metastases, 36(59%) of the cases were inflamed and fixed, in this case, although rare, adenopathy was a warning symptom. In a large number of cases, the nodes were palpated, often bilaterally, and were displaced.

Patients with a tumor limited only to the vulva or vulva and perineum, 2 cm or less in size in the largest dimension with invasion of the underlying tissues up to 1 mm, occurred in 26.3% of cases.

Isolated lesions of the pelvic lymph nodes are possible with the localization of the tumor in the clitoris and areas adjacent to the clitoris. Lymphovascular invasion was detected in 74.7% of patients, vascular in 76.9% of patients. In more than half, the tumor grade corresponded to G2.

More than 90% of vulvar cancer had a squamous histological form (VSCC – vulvar squamous cell car-

cinoma), in other cases, glandular, adenosquamous and other forms (Table 2).

Table 2. – Histological structure of vulvar cancer

№	Histological structure	Number of patients
1.	Bartholin gland carcinoma.	1 (0.5%)
2.	Warty carcinoma.	5 (2.7%)
3.	Squamous cell carcinoma.	109 (58.6%)
4.	Squamous intraepithelial neoplasia, Grade 3.	39 (20.9%)
5.	Basal cell carcinoma.	17 (9.1%)
6.	Adenocarcinoma.	9 (4.8%)
7.	Paget's disease.	4 (2.2%)
8.	Adenosquamous cell carcinoma	2 (1.1%)

Inguinal-femoral lymph node dissection. This type of operation is one of the most common types of lymphadenectomy used in oncological practice. In addition to tumors of the vulva, this operation is also performed for various tumors of the lower extremities, genital organs, and other localizations. The technique for performing this type of operation is well developed. In the traditional version, the operation is started with two semi-oval incisions from the anterior superior surface of the ilium, parallel to the inguinal fold, with a dissection of the skin and subcutaneous fat. The incision was completed near the tendon of the external oblique muscle of the abdomen. The skin and adipose tissue were separated from the aponeurosis of the external oblique muscle to the center of the Scarpov's triangle. Pupartov's ligament was transected, while the fascia of the oblique muscle was removed. Gradually dissecting the tissue from the tubercle of the pubic bone to the top of the femoral triangle, a tissue block was isolated from the tissue and lymph nodes of the femoral triangle and femoral canal. The block was removed by crossing the legs.

The indication for lymph node dissection was a tumor located in the clitoral region, a tumor larger than 2 cm, invasion into the surrounding tissues of more than 5 mm, multifocal tumor growth, and poorly differentiated G-4 intraepithelial carcinoma.

Results. The operation was performed in 61(32.8%) patients (Table 3). Of the 61 patients, 23 patients underwent bilateral lymph node dissection, which accounted for 37.7% of the total number of patients with inguinal-femoral lymph node dissection. Thus, 84 operations were performed to remove lymph nodes from the regional pool.

Table 3. – Distribution of patients with vulvar cancer subjected to radical inguinal-femoral lymph node dissection

№	Clinical characteristics	HPV-27	HPV+34
1	*2*	*3*	*4*
1.	**Stage FIGO**		
	II stage	19(%)	14
	III stage	8(%)	13(%)
	IV stage		7(%)
2.	**Tumor localization**		
	Large labia	9(%)	11(%)
	Posterior commissure	3(%)	3(%)
	Periurethral zone	1(%)	2(%)

1	2	3	4
2.	Clitoris	2(%)	1(%)
	Several anatomical zones	4(%)	8(%)
		8(%)	9(%)
3.	**Histological type**		
	Squamous cell carcinoma.	19 (%)	22 (%)
	Squamous intraepithelial neoplasia,	7 (%)	12 (%)
	Grade 3	1 (%)	–
	Adenocarcinoma		

35 of these (18.8%) patients underwent surgery in the standard, traditional technique, with a wide excision of the skin of the inguinal-femoral zone. In 26 patients (13.9%), the operation was performed using endoscopic technique. The operations were performed according to the standard technique, using equipment for endoscopic surgery manufactured by Karl Storz Endoscopie (Germany). When accessing the space of adipose tissue, a retractor for subcutaneous endoscopic surgery Bird and Emory (Snowden Pericer, USA) was used.

The operation to remove the lymph nodes from the inguinal – femoral zone is not very difficult to perform. Despite the development of all aspects of this operation, in the postoperative period, as in other operations, complications were observed associated with the peculiarity of surgical aggression, the characteristics of the patient's body (Table 4).

Table 4.– Postoperative complications after inguinal-femoral lymph node dissection (n=84)

№	Postoperative complications	Number of cases
1.	Suppuration of the wound	17(20.2%)
2.	Divergence of seams	3(3.6%)
3.	Lymphostasis	9(10.7%)

The operation was performed in 61(32.8%) patients (Table 4.8). Of the 61 patients, 23 patients underwent bilateral lymph node dissection, which accounted for 37.7% of the total number of patients with inguinal-femoral lymph node dissection. Thus, 84 operations were performed to remove lymph nodes from the regional basin.

When analyzing the long-term results of lymph node dissection, the following features were revealed: in patients with a poorly differentiated histological form of the tumor, with lesions of several anatomical tumors, with lesions of the clitoris, in the presence of lymphovascular invasion in 7(18.4%) of 38 patients who underwent unilateral lymph node dissection within the next 8 months after operations, metastases occurred in the opposite inguinal zone.

Conclusion. Thus, the indication for bilateral inguinal-femoral lymph node dissection should be, in addition to confirmed metastases in the inguinal region, a low-grade histological form of vulvar cancer, damage to several anatomical zones, lymphovascular invasion, and clitoris lesion.

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TUMOR MICROENVIRONMENT AND BREAST CANCER FORECAST

Abstract

Goal: to study the effect of the tumor microenvironment on the course and outcome of breast cancer.

Material and methods. To improve the diagnosis and treatment of breast cancer by studying the tumor microenvironment, its impact on the course and prognosis, we analyzed a group of 457 breast cancer patients.

Results. High LVI was detected in the group of patients with an unfavorable outcome (76.8%), in the group with a favorable outcome, lymphovascular invasion was diagnosed in 33.8% of cases. Tumor infiltration by lymphocytes was diagnosed in 229 patients (50.1%), of which in the group of patients with a favorable outcome of the disease, this sign was detected in 61.6%, with an unfavorable outcome in 38.4% of cases ($\chi2=7.49$, $p < 0.001$).

Conclusion. Thus, in breast cancer, the presence, severity, and cellular components of lymphocytic infiltration in combination with IHC status and molecular genetic markers play an important role in determining the prognosis of the tumor process. Also, this factor is an indicator of the likely positive effect of immunotherapy.

Keywords: breast cancer, tumor microenvironment, prognosis.

Introduction

Recently, many studies have been devoted to the study of the tumor microenvironment and its interaction with it. Stromal cells (fibroblasts, immunocompetent, endothelial cells, etc.) extracellular matrix, soluble factors not only have a complex effect on the behavior of the tumor (proliferation of tumor cells, the ability to invade and metastasize), but also play an important role in the response of tumor cells to antitumor agents.

Tumor infiltrating lymphocytes are also of great prognostic and predictive value in breast cancer. In hormone-negative, HER2-neu-positive tumors, a high content of tumor-infiltrating lymphocytes increases the effect of chemotherapy and patient survival. Increased content of CD8 lymphocytes in the tumor, and anthracycline chemotherapy has a synergistic positive effect, increasing the level of pathologically complete response to neoadjuvant chemotherapy.

Goal: to study the effect of the tumor microenvironment on the course and outcome of breast cancer.

Materials and methods

To improve the diagnosis and treatment of breast cancer by studying the tumor microenvironment, its impact on the course and prognosis, we analyzed a group of 457 breast cancer patients.

Patients were divided into two groups: the main group, patients with a favorable outcome of the dis-

ease were selected, and the control group consisted of patients with progression of the pathological process during the follow-up period (7 years).

1491 histological preparations belonging to 457 breast cancer patients were examined.

Results

At lafter an imfovascular invasion, tumor cells enter the blood or lymphatic vessels, which indicates a high tumor activity and the probability of its metastasis. Lymphovascular invasion (LVI) is basically the initial stage of metastasis. High LVI was detected in the group of patients with an unfavorable outcome (76.8%), in the group with a favorable outcome, lymphovascular invasion was diagnosed in 33.8% of cases. This sign is a highly reliable prognostic sign, since in patients without lymphovascular invasion, local control for seven years was observed in 83.6% of cases and only 16.4% of cases in patients without LVI, the progression of the tumor process was detected (χ^2=4.67, p < 0.001).

Table 1. – Distribution of patients by prognostic groups depending on the differentiation of tumors in breast cancer

Presence of the attribute	Main group		Control group	
	abs	%	Abs	%
Lymphovascular invasion				
There are n=225	99	33.8	126	76.8
No n=232	194	66.2	38	23.2
Extensive intra-current component				
There are n=202	71	24.2	131	79.9
No n=255	222	75.8	33	20.1
Ratio of stroma to tumor parenchyma				
Scanty stroma n=266	230	78.5	36	21.9
Pronounced stroma n=191	63	21.5	128	78.1
Infiltration of the tumor by lymphocytes				
There are n=229	141	48.1	88	53.7
No n=228	152	51.9	76	46.3
Total	293		164	

Extensive intraductal component, as well as LVI, indicate an aggressive growth of breast cancer. In 64.8% of patients with the presence of extensive intraductal component in histological preparations, the outcome was not favorable. In the absence of this feature, 87.1% of patients lived up to seven years and are currently under close monitoring (χ^2 = 6.94 p < 0.001).

Phenotypic features of any tumor are formed as a result of the interaction of tumor cells and its stroma. The tumor stroma consists of It consists of cellular elements of connective tissue, blood vessels, nerves and extracellular matrix.

Out of 293 patients, the tumor with scanty stroma was detected in 78% of patients, with severe stroma in 21.9% of patients. Rich stroma was more often diagnosed in the group of patients with an unfavorable outcome of the disease, which was 78.1% of the total number of patients (χ^2 = 4.58, p < 0.001). When analyzing the effect of stroma on life expectancy, the following data were revealed – patients with a scanty tumor stroma had a greater chance of recovery than patients with a rich tumor stroma.

Thus, the stroma provides vital communications necessary for tumor growth and for the spread of tumor cells. In our study, in patients with scanty tumor stroma, the seven-year survival rate was 86.5%, and in patients with severe advanced tumor stroma, more than 67% continued to progress despite comprehensive treatment measures, after some remission (χ^2 = 5.98, p < 0.001).

During lymphocytic infiltration of the tumor, the latter is populated by immunocompetent cells, such as T-lymphocytes with specific antitumor activity, natural killers (NK) or TIL cells that are capable of lysing tumor cells. According to literature data, infiltration of tumor tissue by lymphocytes is a favorable prognostic sign.

Tumor infiltration by lymphocytes was diagnosed in 229 patients (50.1%), of which in the group of patients with a favorable outcome of the disease, this sign was detected in 61.6%, with an unfavorable outcome in 38.4% of cases ($\chi^2 = 7.49$, $p < 0.001$).

Conclusion

Thus, in breast cancer, the presence, severity, and cellular components of lymphocytic infiltration in combination with IHC status and molecular genetic markers play an important role in determining the prognosis of the tumor process. Also, this factor is an indicator of the likely positive effect of immunotherapy.

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ROLE OF LOCAL IMMUNE SYSTEM IN BREAST CANCER

Abstract

Objective: to study the correlation between the expression of tumor microenvironment receptors and molecular biological subtypes of breast cancer, as well as their effect on prognosis.

Keywords: breast cancer, tumor, microenvironment.

Introduction

It is obvious that tumor cells do not function independently, but in close interaction with the microenvironment consisting of many cells and structural complexes. Currently, the crucial role of the tumor microenvironment in its progression and drug resistance has become apparent. ME consists of many non-tumor cells, such as endotheliocytes, pericytes, fibroblasts, enzymes, hormones, extracellular matrix, etc. immunological ME consists of cells and soluble mediators.

Materials and methods

To improve the diagnosis and treatment of breast cancer by studying the tumor microenvironment, its impact on the course and prognosis, we analyzed a group of 457 breast cancer patients.

1491 histological preparations belonging to 457 breast cancer patients were examined.

We studied the following immune cell phenotypes: CD3+ CD4+, CD8+, PD-L1, EGFR, CK5/6, SMA, and E cadherin.

The process of immunohistochemical staining included: making a cut from a tissue matrix 4 microns thick, its dewaxing and rehydration, unmasking the antigen, immunohistochemical staining, dehydration and stabilization with a filling medium, inspection and evaluation of the obtained glasses.

The immunohistochemical study was conducted according to this method on the basis of the diagnostic clinic Mediofarm LLC "PREMIUM DIAGNOSTICS". Immunohistochemical examination (IHC) of the surgical material was performed on serial paraffin sections in the laboratory of LLC "Premium Diagnostics" at 618A Uygur Street, Uchtepa district, Tashkent; license No. 1260–00 series A No. 005951. The drug has a registration certificate No. Tv/X 00058/03/15, registration date 13.03. 2015 with the registration certificate period 13.03.2020: manufacturer Dako Denmark A/S, Dania Dakoproduktionsvej 42, DK-2600 Glostrup Denmark.

Results

First, to get a general idea of the MO tumor phenotype, we present general indicators of the presence of certain markers depending on the stage of breast cancer (Table 1).

Table 1. – Distribution of patients depending on the presence of
markers depending on the stage of breast cancer

Markers	Breast cancer stage			
1	*2*	*3*	*4*	*5*
CD3+ n=162	30(32.6%)	65(34.2%)	41(32.5%)	27(55.1%)
CD4+ n=120	23(25%)	46(24.2%)	33(26.2%)	18(36.7%)

1	2	3	4	5
CD8+ n=180	34(36.9%)	78(41.1%)	49(38.9%)	19(38.8%)
PD-1 n=202	41(44.6%)	83(43.7%)	55(43.7%)	23(46.9%)
PD-L1 n=125	25(27.2%)	51(26.8%)	35(27.8%)	14(28.6%)
EGFR n=119	21(22.8%)	48(25.6%)	33(26.2%)	17(34.7%)
CK5/6 n=101	20(21.7%)	41(21.6%)	27(21.4%)	13(26.5%)
SMA				
Total	92(20.1%)	190(41.6%)	126(27.6%)	49(10.7%)

Tumor markers have a weak correlation with the stage of the tumor process, which indicates an independent potential of the tumor that does not depend on the stage of the process. Most of the indicators had a slight difference depending on the stage, only the CD3+, CD4+, EGFR and CK5/6 indicators at the fourth stage of the tumor process had a slight difference from the other stages ($\chi^2 = 3.84$, $p < 0.05$). The increase in these indicators is most likely associated with macrophage infiltration and severe hypoxia, which could play a stimulating role in these indicators. In the first, second and third stages of the tumor process, these indicators did not have a significant difference, depending on the size or expansion of the tumor.

Thus, the expression of the above markers does not depend on the stage of the process, but is an indicator of the biological activity and potential of the tumor.

Table 2. – Distribution of patients depending on the presence of markers depending on the morphological structure of breast cancer

Markers	Morphological structure of breast cancer			
	1	2	3	4
CD3+ n=162	22(24.2%)	92(40.2%)	30(31.25%)	18(43.9%)
CD4+ n=120	18(19.8%)	65(28.4%)	23(23.9%)	14(34.1%)
CD8+ n=180	21(23.1%)	103(44.9%)	37(38.5%)	19(46.3%)
PD-1 n=202	49(53.8%)	93(40.6%)	45(46.9%)	15(36.6%)
PD-L1 n=125	34(37.4%)	53(23.1%)	30(31.3%)	8(19.5%)
EGFR n=119	35(38.5%)	51(22.3%)	24(25%)	9(21.9%)
CK5/6 n=101	24(26.4%)	49(21.4%)	24(25%)	4(9.8%)
α – SMA n=39	25(27.5%)	8(3.5%)	6(6.3%)	–
Total patients	91(19.9%)	229(50.1%)	96(21.1%)	41(8.9%)

Note: 1-lobular cancer, 2-ductal cancer, 3-lobular ductal cancer, 4-other forms of breast cancer

CD3+, CD4+, and CD8+ were more likely to show high levels in mixed forms and ductal, which correlated with a favorable tumor course and the best therapeutic response of neoadjuvant cancer therapy ($\chi^2 = 6.04$, $p < 0.001$).

PD-L1 was expressed in breast cancer, which correlated with the presence of lymphocyte infiltration, younger age, high malignancy, lack of ER, overexpression of HER2, clinical subtypes of TNBC, as well as basal-like and HER2-rich molecular subtypes ($\chi^2 = 7.51$, $p < 0.001$).

EGFR was more often expressed in the lobular and ductal lobular forms of breast cancer, which indicated an unfavorable course of these tumors, a worse response to treatment, and early metastasis ($\chi^2 = 5.98$ $p < 0.001$).

– SMA, being a marker of myofibroblasts in invasive breast cancer, was an unfavorable factor regardless of the tumor subtype. Expression ranged up to 27.5% and averaged 8.5%. It is a predictor of regional and long-term metastasis ($\chi^2 = 6.71$, $p < 0.001$).

Table 3. – Distribution of patients depending on the presence of
markers depending on the breast cancer subtype

Markers	Subtypes of tumors			
	1	2	3	4
CD3$^+$ n=162	80(52.3%)	43(40.2%)	17(26.6%)	22(16.5%)
CD4$^+$ n=120	63(41.2%)	38(35.5%)	9(14.1%)	10(7.5%)
CD8$^+$ n=180	95(62.1%)	53(49.5%)	17(26.6%)	15(11.3%)
PD-1 n=202	46(30%)	41(38.3%)	33(51.6%)	82(61.7%)
PD-L1 n=125	27(17.7%)	24(22.4%)	21(32.8%)	53(39.8%)
EGFR n=119	9(5.9%)	14(13.1%)	25(39.1%)	71(53.4%)
CK5/6 n=101	5(3.3)	11(10.3)	18(28.1%)	67(50.4%)
α – SMA n=39	–	1(0.9%)	9(14.1%)	28(21.1%)
Total	153	107	64	133

Note: 1-subtype: luminal A, 2-subtype: luminal B, 3-subtype: Her-2 neu positive, 4-subtype: triple negative

As we can see from the data provided in the table, in luminal type A breast cancer, CD3$^+$ was found in 52.3%, CD4$^+$ in 41.2% and CD8$^+$ in 62.1%, while in triple-negative breast cancer, these indicators were 16.5%, 7.5% and 11.3%, respectively. Given the fact that triple-negative cancer has a poor prognosis, these markers are highly reliable prognostic factors. A higher expression of these parameters in breast cancer is a convincing sign of a more favorable course of this pathology $(\chi^2 = 4.58, p < 0.01)$.

In contrast, PD-1, PD-L 1, EGFR, and CK 5/6 in luminal tumors were lower than triple-negative values. In luminal type A, PD–1 = 30%, PD-L 1–17.7%, EGFR – 5.9%, and CK 5/6–3.3%, whereas in triple-negative cancers, these indicators were 61.7%, 39.8%, and 53.4%, respectively.

a-SMA in luminal type A was absent, in luminal type B it was only 0.9%, in Her-2 neu it was positive 14.1%, and in triple-negative 21.1%, which once again, based on highly reliable statistical data, proves that this factor is not favorable as a prognostic predictor.

Conclusion

Data analysis showed that there is a strong correlation between the expression of the above markers and molecular biological subtypes of breast cancer.

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Section 3. Technical sciences

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GEOLOGICAL AND TECHNICAL ANALYSIS FOR THE DEVELOPMENT OF THE DEPOSIT BY THE METHOD OF DUAL COMPLETION

Abstract. the article highlights the geological structure, stratigraphy, tectonics and reservoir properties of rocks of the Northern Goturdepe field. Hydrodynamic analyses of the reserves of horizontal wells at the Goturdepe field and productive layers extracted from previously operating wells, as well as the presence of several productive layers in them and their properties, were carried out. In order to successfully implement the method of dual completion (DC) of several layers, calculations were carried out for the correct development of the well design and the difference in drilling technology by the method of dual completion of several layers in its structural composition from other simple wells.

Keywords: seismic exploration, well design, colmatation, shoe, conductor, hydraulic fracturing, oil and gas manifestation, emulsified system.

The results of seismic work carried out by the Western Geophysical Expedition (currently the Balkan Geophysical Expedition of the State Corporation "Turkmengeologiya") served as the basis for exploration drilling in the Ovvaltoval and Bankaly areas.

For the development of the North Goturdepe multi-layer deposit, the general information of the deposit has been studied and scientifically analyzed. The geological structure, stratigraphy, tectonics of the Northern Goturdepe deposit and reservoir properties of the rocks of this deposit have been fully studied. Hydrodynamic analyses of reserves of horizontal wells at the Goturdepinskoye field and productive layers extracted from previously operating wells were carried out.

The analyses carried out in the work on the geology and hydrodynamic reserves of the formations, as well as on the productivity of these formations of the Goturdepinsky field, forming the deep essence of future work, laid the foundation for a highly effective correct development of the well design for the method of DC of several layers, successful drilling of wells to the design depth, selection of appropriate solutions for the purpose of uncolluting in the discovery of productive layers, achieving their high productivity in the process of development [1].

The geology of the deposit and the hydrodynamic reserve of productive layers, as well as the analyses carried out on the productive capacity of these layers, the successful drilling of 4 wells to the design depth and their commissioning during testing for

the method of DC of several layers according to the results of the work proved their correct execution.

The technical and technological differences of the method of DC of several layers from the currently operating method of development of productive layers are scientifically analyzed, and detailed theoretical and practical materials about this method are also collected and the results are obtained.

In order to introduce into production the method of DC of several layers, the necessary exact geological and expected during operation parameters of each layer of the developed field have been fully studied.

In the work with the calculations, the correct design of wells has been developed for the method of DC of several horizons.

The calculation of the depth of the installation of the conductor's shoe in the conditions of preventing hydraulic fracturing during the liquidation of oil and gas occurrences is made according to the following formula (1):

$$H = 100 \times \frac{P_W + P_{W1}}{\gamma_{b.m.} - \gamma_{f.1}}. \qquad (1)$$

Hydraulic fracturing pressure is determined by the following formula:

$$P_{grad.} = 0.0083H + 0.66P_{layer.} \qquad (2)$$

Based on the parameters of changes in reservoir pressures at the corresponding depths, calculations were made separately for wells № 147, № . 37, № 200 and № 156 of the values of the equivalents of reservoir pressure gradients according to the formula (3):

$$P_{grad·layer} = \frac{P_{layer}}{0.01 \times H}. \qquad (3)$$

The hydraulic fracturing coefficient for each well under study is determined separately according to the following formula (4):

$$K_{grad.} = \frac{P_{gid.}}{0.01 \times H}. \qquad (4)$$

Based on the calculation results, combined graphs were compiled separately for each well under study and their designs were developed.

A special distinguishing feature of the developed structure from previously used structures is that in order to secure several productive layers, an increase in the depth of descent of a technical column with a diameter of Ø244.5 mm was achieved and this technical column was used as an operational column [2].

The fastening of the lower productive layers in the two tested wells in the form of an operational shank without cementing was achieved by packers equipped externally on special filters, inflating under the influence of the solution used, and in the other two tested wells by cementing the production column Ø139.7 mm and Ø177.8 mm in the form of an operational shank.

The economic calculations carried out based on their results showed high economic efficiency.

The main essence of this technology was the purpose of descent into the operational column of 2-row parallel tubing, differing in length, short and long types. In this case, the productive layers were separated by a packer device, which ensured their separate operation and separate accounting of well products for each reservoir used.

For the opening of productive formations, a hydrocarbon-based drilling mud "Wersadril" was used. Due to its resistance to high temperature, the Wersadril hydrocarbon-based drilling mud was chosen for the purpose of crushing unstable clay formations in the lower red-colored thickness to maintain them in a stable position without movement and, when opening productive formations, to prevent their contamination and stabilize the wellbore [3].

The choice of a hydrocarbon drilling mud consisting of diesel fuel with a highly emulsified system used in scientific work was chosen taking into account high temperature resistance and at the same time does not lose the stabilizing properties of the solution and is successfully used for drilling deep wells in world practice.

Hydrocarbon-based drilling fluids provide the possibility of drilling unstable, swelling or expanding rocks in the aquatic environment. And also, prevent oil seal formation and tool grabs due to the pressure drop between the well and the formation. They have

the best lubricating properties, protect the tool from corrosion [4].

The state of modern foreign experience, directional and multi-barrel (downhole) drilling for DC of many layers is studied, and, having collected practical, technical and Internet materials, the task is analyzed on a scientific basis.

The difference between the drilling technology by the method of DC of several layers in its structural composition from other simple wells in the following factors:

– the presence of many productive layers;

– availability of compatible drilling conditions;

– stability of drilled rocks for the descent of the operational filter of the shank;

– it is necessary to connect two-lift pumping and compressor pipes at the wellhead with a casing string of at least Ø244.5 mm and use it as an operational column;

– after full establishment, the presence of several layers in all drilled wells, the possibility of commissioning with the first (short) two-lift tubing, necessarily produces the fastening of several upper layers with casing pipes Ø244.5 mm;

– after fixing the remaining lower productive layers with casing columns Ø177.8 mm, Ø139.7 mm or filters, the possibility of commissioning a second (long) two-lift pump and compressor pipe.

All of the above factors were performed on the basis of analyses conducted on geological and geophysical materials obtained during drilling, on previously operating wells and tested in all four drilled wells.

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Section 4. Physics

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POLARIZATION DEPENDENCES OF SINGLE-PHOTON INTERBAND LINEAR-CIRCULAR DICHROISMS IN TETRAHEDRAL SYMMETRY CRYSTALS

Abstract. The polarization dependence of the coefficient of linear-circular dichroism of single-photon absorption of polarized radiation in crystals of tetrahedral symmetry due to optical transitions from the subbands of light and heavy holes, as well as from the spin-orbit splitting zone to the conduction band, is calculated. In this case, the contribution of the coherent saturation effect to the coefficient of single-photon linear-circular dichroism of light absorption is taken into account.

Keywords: polarization, spectral, and temperature dependence of the coefficient of single-photon absorption of light, linear-circular dichroism, crystal of tetrahedral symmetry, effect of coherent saturation of optical transitions.

Nonlinear absorption of light in a semiconductor with a degenerate valence band, which is due to direct optical transitions between heavy and light hole subbands and depends on the state of radiation polarization, was studied in [1–8]. In these papers, it is assumed that the nonlinearity in the intensity dependence of the single-photon absorption coefficient arises due to resonant absorption saturation. This saturation is due to the photoinduced change in the distribution functions of light and heavy holes in the region of momentum space near the surface corresponding $E_{hh}(\vec{k}) - E_{hl}(\vec{k}) - \hbar\omega = 0$ to the resonance condition. Here, $E_{hh}(\vec{k})\left(E_{hl}(\vec{k})\right)$ is the energy spectrum of heavy (light) holes, and ω is the frequency of light.

In [9; 10], four-photon processes in semiconductors due to optical transitions between subbands of the valence band were studied. However, interband single-photon linear-circular dichroism, as well as intraband two-photon linear-circular dichroism,

where the intermediate states are in the conduction band or in the spin-orbit splitting zone in crystals of tetrahedral symmetry, taking into account the effect of coherent saturation, remained open, to which this article is devoted.

Here we consider one- or two-photon linear-circular dichroism of the absorption of polarized radiation, taking into account the effect of coherent saturation [3; 4] in direct-gap crystals, which is due to direct optical transitions between subbands of the valence band, where we take into account the fact that intermediate states of current carriers can is located not only in the light and heavy subbands, but also in both the conduction band and the spin-orbital splitting zone. When calculating intraband single-photon light absorption, we assume that the photon energy satisfies the conditions $\hbar\omega \geq E_g$, $E_g + \Delta_{SO}$, and for intraband two-photon light absorption $2\hbar\omega << E_g, \Delta_{co}$, where E_g is the band gap, Δ_{SO} is the spin-orbit splitting of the valence band.

In case $\hbar\omega \geq E_g$, $E_g + \Delta_{SO}$, there are two variants of interband optical transitions, the first of which satisfies the condition $E_g \leq \hbar\omega \langle E_g + \Delta_{SO}$, and in the second case the condition $\hbar\omega \geq E_g + \Delta_{SO}$ is satisfied. Therefore, in the first case, optical transitions occur between the subbands of light and heavy holes in the valence band and the conduction band, and in the second case, optical transitions occur between the spin-orbit splitting and conduction bands, which we will analyze separately.

Let the initial states be in the heavy-hole subband of the valence band, then, in the Luttinger-Kohn and Kane approximation [11; 12], the matrix element of the single-photon optical transition from the heavy-hole subband $|V, \pm 3/2\rangle$ to the conduction band $|c, \pm 1/2\rangle$, those $M^{(1)}_{C,\pm 1/2; \pm V, 3/2}$, which is schematically depicted as, is determined by the relations:

$$M^{(1)}_{C,+1/2; V+3/2} = \left(\frac{eA_0}{c\hbar}\right) pe'_+, \quad M^{(1)}_{C,-1/2; V-,3/2} = -i\left(\frac{eA_0}{c\hbar}\right) pe'_-$$

and an optical transition of type 66 is forbidden, where $e'_\pm = e'_x \pm ie'_y$, e'_α $(\alpha = x, y, z)$ are the projections of the light polarization vector, with respect to the coordi-

nates the Oz axis of which is directed along the wave photoexcited current carriers $(\vec{k})$, A_0 is the amplitude of the potential vector of the electromagnetic wave, p is the parameter Kane [11; 12], the rest are well-known quantities. The energy conservation law for this transition is described by $\delta\left(E_c(\vec{k}) - E_{hh}(\vec{k}) - \hbar\omega\right)$ functions, where $E_{c,\vec{k}} = \frac{\hbar^2 k^2}{2m_c} + E_g$ is the energy spectrum of electrons in the conduction band, $E_{L,\vec{k}} = \frac{\hbar^2 k^2}{2m_L}$ is the energy spectrum of holes in the subband of light $(L = lh)$ and heavy $(L = hh)$ holes.

Then the square of the modulus of these optical transitions is expressed as:

$$\left|M^{(1)}_{C,\pm 1/2; V,\pm 3/2}\right|^2 = \left(\frac{eA_0}{c\hbar}\right)^2 p^2 \left|e'_\pm\right|^2, \quad \left|M^{(1)}_{C,\mp 1/2; V,\pm 3/2}\right|^2 = 0.$$

Based on the last relations, one can obtain the polarization dependence of the probabilities of the considered optical transitions. In particular, for optical transitions of the type, the polarization dependence of the probability of a given transition, determined by the polarization dependence $\left|M^{(1)}_{C,\pm 1/2; V,\pm 3/2}\right|^2 = \left(\frac{eA_0}{c\hbar}\right)^2 p^2 \left|e'_\pm\right|^2$, has an oscillatory character for both linear and linear polarizations. In this case, the coefficient of interband linear-circular dichroism is equal to unity, i.e. linear-circular dichroism is not observed.

If the initial states are in the light hole subband of the valence band, then the matrix element of the single-photon optical transition from the light hole subband $|V, m\rangle$ $(m \pm 1/2)$ to the conduction band $|c, m'\rangle$ $(m' = \pm 1/2)$, i.e. $M^{(1)}_{C,m'; V,m}$, which is schematically depicted as $|V, m\rangle \to |c, m'\rangle$, is defined as the ratios:

$$M^{(1)}_{c,+1/2; V,+1/2} = \left(\frac{eA_0}{c\hbar}\right)\frac{1}{\sqrt{3}} pe'_z, \quad M^{(1)}_{c,-1/2; V,-1/2} = \left(\frac{eA_0}{c\hbar}\right)\frac{-i}{\sqrt{3}} e'_+ p$$

$$M^{(1)}_{c,+1/2; V,-1/2} = \left(\frac{eA_0}{c\hbar}\right)\frac{1}{\sqrt{3}} e'_z p, \quad M^{(1)}_{c,+1/2; V,-1/2} = \left(\frac{eA_0}{c\hbar}\right) i\sqrt{\frac{2}{3}} e'_z p.$$

Then the square of the modulus of the matrix elements of the considered optical transitions is expressed as: $\left|M^{(1)}_{c,\pm 1/2; V,\pm 1/2}\right|^2 = \left(\frac{eA_0}{c\hbar}\right)^2 \frac{1}{3} p^2 \left|e'_\mp\right|^2$,

$\left|M_{c,\mp1/2;V,\pm1/2}^{(1)}\right|^2 = = \left(\frac{eA_0}{c\hbar}\right)^2 \frac{2}{3} p^2 \left|e_z'\right|^2$. The energy conservation law of these transitions is described by the $\delta\left(E_c(\vec{k}) - E_{lh}(\vec{k}) - \hbar\omega\right)$ function. Then the wave vector of photoexcited current carriers is determined by the relation: $k_{c,lh}^{(1\omega)} = \sqrt{\frac{2\mu_+^{(c,lh)}}{\hbar^2}\left(\hbar\omega - E_g\right)}$, where $\mu_+^{(c,lh)} = = \frac{m_c m_{lh}}{m_c + m_{lh}}$ is the reduced effective mass relative to the effective mass of electrons in the conduction band and light holes.

Taking into account the polarization dependence of the matrix elements $M_{c,\pm1/2;V,\pm1/2}^{(1)}$ and $M_{c,\mp1/2;V,\pm1/2}^{(1)}$ for optical transitions of the $|V,\pm1/2\rangle \to |C,\pm1/2\rangle$ and $|V,\pm1/2\rangle \to |C,\mp1/2\rangle$ type, it is possible to determine the polarization dependence of the probability of this transition. A quantitative calculation shows that this polarization dependence of the probability of the considered optical transition for both linear and circular polarizations has an oscillatory character with respect to the angle between the polarization vectors and the wave vector of the current carriers, but with an increase in the parameter of the coherent saturation effect, the amplitude of the oscillations decreases: by 20% for linear, by 15% for circular polarization.

Above we have considered optical transitions that satisfy the conditions $E_g \leq \hbar\omega \leq E_g + \Delta_{SO}$ where optical transitions between the subbands of the valence band and the conduction band are allowed. Next, we determine the polarization dependence of the transition probability, where the initial states are in the spin-split band; then, the matrix elements of single-photon optical transitions from the light-hole subband $|V,m\rangle$ $(m\pm1/2)$ to the conduction band $|c,m'\rangle$ $(m' = \pm1/2)$, $M_{C,m';V,m}^{(1)}$ which are schematically depicted as $|V,m\rangle \to |c,m'\rangle$, are defined as the ratios:

$M_{C,+1/2;SO,+1/2}^{(1)} = \left(\frac{eA_0}{c\hbar}\right)\frac{1}{\sqrt{3}} pe_z'$, $M_{C,-1/2;SO,+1/2}^{(1)} = \left(\frac{eA_0}{c\hbar}\right)\frac{1}{\sqrt{3}} pe_-'$

$M_{c,+1/2;V,-1/2}^{(1)} = \left(\frac{eA_0}{c\hbar}\right)\frac{1}{\sqrt{3}} e_z' p$, $M_{C,-1/2;SO,-1/2}^{(1)} = \left(\frac{eA_0}{c\hbar}\right)\frac{-i}{\sqrt{3}} pe_z'$.

The law of conservation of energy for these transitions is described by a $\delta\left(E_c(\vec{k}) - E_{SO}(\vec{k}) - \hbar\omega\right)$ func-tion, where $E_{SO,\vec{k}} = \frac{\hbar^2 k^2}{2m_c} + \Delta_{SO}$ is the energy spectrum of holes in the spin-orbital splitting zone, and is the energy of the spin-orbital splitting. Whence we have $\left|M_{C,\pm1/2;SO,\pm1/2}^{(1)}\right|^2 = \left(\frac{eA_0}{c\hbar}\right)^2 \frac{1}{3} p^2 e_z'^2$, $\left|M_{C,\mp1/2;SO,\pm1/2}^{(1)}\right|^2 = = \left(\frac{eA_0}{c\hbar}\right)^2 \frac{1}{3} p^2 e_\pm'^2$. In this case, the wave vector of photoexcited current carriers is defined as $k_{c,SO}^{(1\omega)} = \sqrt{\frac{2\mu_+^{(c,SO)}}{\hbar^2}\left(\hbar\omega - E_g - \Delta_{SO}\right)}$, $\mu_+^{(c,SO)}$ is the reduced effective mass with respect to the current carriers in the conduction bands and the spin of the orbital splitting.

Taking into account the polarization dependences of the squares of the moduli of the matrix elements $\left|M_{C,\pm1/2;SO,\pm1/2}^{(1)}\right|^2$ and $\left|M_{C,\mp1/2;SO,\pm1/2}^{(1)}\right|^2$ for optical transitions of the $|V,\pm1/2\rangle \to |C,\pm1/2\rangle$ and $|V,\pm1/2\rangle \to |C,\mp1/2\rangle$ type, it is possible to determine the polarization dependence of the probability of this transition. Quantitative calculations show that the polarization dependences of the probabilities of optical transitions for both linear and circular polarizations have an oscillatory character with respect to the angle between the polarization vector and the wave vector of current carriers, but the oscillations for linear polarization are approximately twice as large as those for circular polarization. For both polarizations, the oscillation amplitude decreases with increasing coherent saturation effect parameter.

Thus, we have defined the following:

1. The polarization dependence of the squares of the moduli of matrix elements for interband optical transitions for both linear and circular polarization has an oscillatory character with respect to the angle between the polarization vector and the wave vector of current carriers.

2. For a single-photon optical transition between the spin-orbit splitting zone and the conduction band, the oscillation for linear polarization is approximately twice as large as for circular polarization. For both polarizations, the oscillation amplitude decreases with increasing coherent saturation effect parameter.

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INTERBAND SINGLE-PHOTON ABSORPTION OF POLARIZED LIGHT IN CRYSTALS WITH ALLOWANCE FOR THE EFFECT OF COHERENT SATURATION. 1-PART

Abstract. The spectral-temperature dependence of the coefficient of single-photon absorption of light in crystals of tetrahedral symmetry, due to optical transitions occurring from the subbands of light and heavy holes to the conduction band, is calculated. In this case, the contribution of the coherent saturation effect to the single-photon light absorption coefficient is taken into account.

Keywords: polarized light, spectral and temperature dependence of the single-photon light absorption coefficient, crystal of tetrahedral symmetry, coherent saturation effect.

As indicated in the first part of this work, the nonlinear absorption of light in a semiconductor with a degenerate valence band, which is due to direct optical transitions between the subbands of heavy and light holes and depends on the state of radiation polarization, was studied in $[1-8]$. In these papers, it is assumed that the nonlinearity in the intensity dependence of the single-photon absorption coefficient arises due to resonant absorption saturation. This saturation is due to the photoinduced change in the distribution functions of light and heavy holes in the region of momentum space near the surface corresponding $E_{hh}(\vec{k}) - E_{hl}(\vec{k}) - \hbar\omega = 0$ to the resonance condition. Here, $E_{hh}(\vec{k}) \left(E_{hl}(\vec{k}) \right)$ is the energy spectrum of heavy (light) holes, and ω is the frequency of light.

In $[1-10]$, the spectral-temperature dependence of the single-photon light absorption coefficient was not calculated. This work is devoted to the solution of this issue. For this, we consider various variants of single-photon interband absorption of polarized light, which differ from each other by intermediate states. In particular, in the case of single-photon interband absorption of light, these intermediate states can be located both in the subbands of the valence band, and in the conduction band, or in the spin-orbital splitting band. And also, depending on the energy of photons, optical transitions can occur, which differ from each other by initial states. In particular, in the frequency range $E_g \leq \hbar\omega \leq E_g + \Delta_{SO}$, optical transitions are allowed between subbands of light or heavy holes, but in the frequency range $\hbar\omega \geq E_g + \Delta_{SO}$, optical transitions from the spin-orbit splitting zone to the conduction band are allowed. Therefore, we will consider them separately,

where $\hbar\omega$ is the photon energy, E_g is the band gap, Δ_{SO} is the spin-orbit splitting energy.

Let us first consider the one-photon absorption of light between the subbands of the valence band and the conduction band (at $E_g \leq \hbar\omega \leq E_g + \Delta_{SO}$). Following [5–10], in further calculations of the spectral and temperature dependence of the single-photon light absorption coefficient, we neglect the light wave vector, i.e. we assume that the wave vector of current carriers in the final (initial and intermediate) state). Then

$$K^{(1)}_{C,\pm1/2;V,\pm3/2} = \frac{2\pi}{\hbar} \hbar\omega \frac{1}{I} \rho(\hbar\omega) F(\beta,1,\omega) \times$$

$$\times \left(\left\langle \frac{\left| M^{(1)}_{C,\pm1/2;V,\pm3/2}(\vec{k}) \right|^2}{\sqrt{1 + 4\frac{\alpha_\omega}{\hbar^2\omega^2} \left| M^{(1)}_{C,\pm1/2;V,\pm3/2}(\vec{k}) \right|^2}} \right\rangle + \left\langle \frac{\left| M^{(1)}_{C,\pm1/2;V,\mp3/2}(\vec{k}) \right|^2}{\sqrt{1 + 4\frac{\alpha_\omega}{\hbar^2\omega^2} \left| M^{(1)}_{C,M1/2;V,\mp3/2}(\vec{k}) \right|^2}} \right\rangle \right), \quad (1)$$

where $I, (\omega)$ is the intensity (frequency) of light, $\rho(\hbar\omega)$ is the density of states of current carriers involved in optical transitions, where the law of conservation of energy is taken into account, $F(\beta,1,\omega)$ is the distribution function of current carriers in the initial state, k_B is the Boltzmann constant, T is the sample temperature, $F(\beta,1,\omega) = \left[1 - \exp(1\beta\hbar\omega) \right]$

$$\exp\left[\beta \left(\mu - E_{L=hh}(k^{(\omega)}_{c,L=hh}) \right) \right], \quad E_{L=hh}(k^{(\omega)}_{c,L=hh}) =$$

$$= \frac{m_c}{m_c + m_{hh}} (\hbar\omega - E_g), \quad \rho(\hbar\omega) = \frac{\mu^* k_\omega}{(\pi^2\hbar^2)}, \quad \mu^* \text{ is the}$$

reduced effective mass of current carriers, the form of which depends on the type of optical transitions. Now we need to calculate

$$\left\langle \frac{\left| M^{(1)}_{C,\pm1/2;V,\pm3/2}(\vec{k}) \right|^2}{\sqrt{1 + 4\frac{\alpha_\omega}{\hbar^2\omega^2} \left| M^{(1)}_{C,\pm1/2;V,\pm3/2}(\vec{k}) \right|^2}} \right\rangle =$$

$$= \left(\frac{eA_0}{c\hbar} \right)^2 p^2 \left[\Re_1(I) + \Re_2(I) \right], \quad (2)$$

(it is these integrals that determine the averaged values of the matrix elements of the considered optical transitions) where $\Re_1(I) = \left\langle \frac{\left| e'_\pm \right|^2}{\sqrt{1 + \zeta_\omega \left| e'_\pm \right|^2}} \right\rangle$,

$$\Re_2(I) = \left\langle \frac{\left| e'_z \right|^2}{\sqrt{1 + \zeta_\omega \left| e'_z \right|^2}} \right\rangle, I = \left| \vec{S} \right| = \frac{n_\omega \omega^2 A_0^2}{2\pi c} \text{ is the light}$$

intensity, $\left\langle \left| M^{(N)}_{n'k',nk} \right|^2 \right\rangle$ is the square of the absolute value of the matrix element $M^{(N)}_{n'\vec{k}',n\vec{k}}$ averaged over the solid angles of the vector $\vec{k}$, $\zeta_\omega = 4\frac{\alpha_\omega}{\hbar^2\omega^2} \left(\frac{eA_0}{c\hbar} \right)^2 p^2$, the wave vector k_ω is determined from the energy conservation law. In particular, for the optical transition considered above $k_\omega = k_{c,L} = \sqrt{\frac{2\mu^{(c,L)}_+}{\hbar^2} (\hbar\omega - E_g)}$,

$\mu^{(c,L)}_+ = \frac{m_c m_L}{m_c + m_L}, E_c(\vec{k}) = \frac{\hbar^2 k^2}{2m_c} + E_g, E_L(\vec{k}) = -\frac{\hbar^2 k^2}{2m_L}$ $m_c(m_L)$ are the effective masses in the conduction band and in the valence band, $L = lh$ (hh) are for the subband of light (heavy) holes.

Calculation of single-photon absorption of polarized light due to optical transitions from the subband of light and heavy holes to the conduction band is performed by the formula

$$K^{(1)} = \frac{4\pi e^2}{c\omega m_0^2 n_\omega} \sum_{nn'\vec{k}} \left| \vec{e}\vec{p}_{nn'}(\vec{k}) \right|^2 \left(f_{n\vec{k}} - f_{n'\vec{k}} \right) \delta\left(E_{n'}(\vec{k}) - E_n(\vec{k}) - \hbar\omega \right) \quad (3)$$

or

$$K^{(1)}_{c,SO} = \frac{4\pi e^2}{c\hbar n_\omega} \left\{ \iiint \frac{1}{2} p_{cV}^2 \left| e'_\pm \right|^2 \left(f_{hh,\vec{k}} - f_{c,\vec{k}} \right) \delta\left(E_c(\vec{k}) - E_{hh}(\vec{k}) - \hbar\omega \right) + \right.$$

$$\left. + \left\{ \iiint \left(\frac{2}{3} p_{cV}^2 \left| e'_z \right|^2 + \frac{1}{6} p_{cV}^2 \left| e'_\pm \right|^2 \right) \left(f_{lh,\vec{k}} - f_{c,\vec{k}} \right) \delta\left(E_c(\vec{k}) - E_{lh}(\vec{k}) - \hbar\omega \right) \right\} \right. \quad (4)$$

where $E_{c,\vec{k}} = \dfrac{\hbar^2 k^2}{2m_c} + E_g$ is the energy spectrum of electrons in the conduction band, $E_{L,\vec{k}} = \dfrac{\hbar^2 k^2}{2m_L}$ is the energy spectrum of holes in the subband of light $(L = lh)$ and heavy $(L = hh)$ holes, $E_{SO,\vec{k}} = \dfrac{\hbar^2 k^2}{2m_c} + \Delta_{SO}$ $E_{SO,\vec{k}} = \dfrac{\hbar^2 k^2}{2m_c} + \Delta_{SO}$ is the energy spectrum of holes in the spin-orbital splitting zone.

Then, from the energy conservation law, we have expressions for the wave vectors of photoexcited current carriers involved in interband optical transitions as

$$k_{c,lh}^{(1\omega)} = \sqrt{\frac{2\mu_+^{(c,lh)}}{\hbar^2}\left(\hbar\omega - E_g\right)}, k_{c,hh}^{(1\omega)} = \sqrt{\frac{2\mu_+^{(c,hh)}}{\hbar^2}\left(\hbar\omega - E_g\right)},$$

where $\mu_+^{(c,lh)} = \dfrac{m_c m_{lh}}{m_c + m_{lh}}$, $\mu_+^{(c,hh)} = \dfrac{m_c m_{hh}}{m_c + m_{hh}}$ is the reduced effective mass of electrons and holes.

The spectral-temperature dependence of the coefficient of interband single-photon absorption of light, taking into account the latter relations, has the form

$$K_{c,V}^{(1)} = \frac{1}{3}p_{cV}^2 \frac{e^2 p_{cV}^2}{c\hbar^3 n_\omega}\left\{\left(f_{hh,k_{c,hh}^{(1\omega)}} - f_{c,k_{c,hh}^{(1\omega)}}\right)\mu_+^{(c,hh)}k_{c,hh}^{(1\omega)} + \left(f_{lh,k_{c,lh}^{(1\omega)}} - f_{c,k_{c,lh}^{(1\omega)}}\right)\mu_+^{(c,lh)}k_{c,lh}^{(1\omega)}\right\} \tag{5}$$

or

$$K_{c,V}^{(1)} = \frac{1}{6}\frac{e^2 p_{cV}^2}{c\hbar^3 n_\omega}\left[f_{hh,k_{c,hh}^{(1\omega)}}k_{c,hh}^{(1\omega)}\mu_+^{(c,hh)} + f_{lh,k_{c,lh}^{(1\omega)}}\mu_+^{(c,lh)}k_{c,lh}^{(1\omega)}\right]\left\{1 - \exp\left[\frac{E_g}{k_B T}(x-1)\right]\right\}, \tag{6}$$

where $x = \dfrac{\hbar\omega}{E_g}$, the distribution functions of photoexcited light and heavy holes are defined as

$$f_{lh,k_{c,lh}^{(1\omega)}} = \exp\left[\frac{E_F}{k_B T}\right]\cdot\exp\left[-\frac{1}{k_B T}\frac{\mu_+^{(c,lh)}}{m_{lh}}\left(\hbar\omega - E_g\right)\right], \tag{7}$$

$$f_{hh,k_{c,hh}^{(1\omega)}} = \exp\left[\frac{E_F}{k_B T}\right]\exp\left[-\frac{E_{hh}\left(k_{c,hh}^{(1\omega)}\right)}{k_B T}\right] = \exp\left[\frac{E_F}{k_B T}\right]\cdot\exp\left[-\frac{1}{k_B T}\frac{\mu_+^{(c,hh)}}{m_{hh}}\left(\hbar\omega - E_g\right)\right], \tag{8}$$

and the Fermi energy is determined by the relation

$$e^{\frac{\mu}{k_B T}} = \frac{1}{2}p\left(\frac{k_B T}{2\pi\hbar^2}\right)^{-3/2}\left(m_{hh}^{3/2} + m_{lh}^{3/2}\right)^{-1}. \tag{9}$$

Calculations show that the spectral and temperature dependences of the coefficient of single-photon absorption of polarized light in *GaAs*, due to optical transitions between the subbands of light $\left(K_{c,lh}^{(1)}\right)$ and heavy holes $\left(K_{c,hh}^{(1)}\right)$ and the conduction band, as well as the resulting single-photon absorption of light, first increases with increasing temperature and photon energy and reaches a maximum, then falls. This behavior $K_{c,lh}^{(1)}$ and $K_{c,hh}^{(1)}$ is due to the peculiarity of the temperature Fermi energy, as well as the temperature and spectral dependences of the distribution function of current carriers in the initial state.

Above, the temperature dependence of the band gap is not taken into account, the inclusion of which will lead to a noticeable change in the spectral and temperature dependence of the single-photon absorption coefficient of polarized light.

Thus, we have received:

1. Spectral-temperature dependence of the coefficient of single-photon absorption of polarized light in *GaAs*, due to optical transitions between the subbands of light holes and the conduction band, where the contribution of the coherent saturation effect to the coefficient of single-photon light absorption is not taken into account.

2. Results are obtained both with and without allowance for the temperature dependence of the band gap.

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INTERBAND SINGLE-PHOTON ABSORPTION OF POLARIZED LIGHT IN CRYSTALS WITH ALLOWANCE FOR THE EFFECT OF COHERENT SATURATION. 2-PART

Abstract. The spectral-temperature dependence of the coefficient of single-photon absorption of light in crystals of tetrahedral symmetry, due to optical transitions occurring from the spin-orbit splitting zone to the conduction band, is calculated. In this case, the contribution of the coherent saturation effect to the single-photon light absorption coefficient is taken into account.

Keywords: nonlinear light absorption, semiconductor, valence band, conduction band, direct optical transitions, interband light absorption.

In the first part of this work, it is indicated that the nonlinear absorption of light in a semiconductor with a degenerate valence band, which is due to direct optical transitions between the subbands of heavy and light holes and depends on the state of radiation polarization, was studied in [1–9]. In these papers, it is assumed that the nonlinearity in the intensity dependence of the single-photon absorption coefficient arises due to resonant absorption saturation.

We note here that the question of the spectral-temperature dependence of the single-photon absorption coefficient of light in the frequency range $\hbar\omega \geq E_g + \Delta_{SO}$, when optical transitions from the spin-orbit splitting zone to the conduction band, where $\hbar\omega$ is the photon energy, E_g is the band gap, and is Δ_{SO} the spin-orbit splitting energy, has remained open. Therefore, we further consider one-photon absorption of light between the spin-orbital splitting zone and the conduction band (at $E_g + \Delta_{SO} \leq \hbar\omega$).

Then the spectral-temperature dependence of the single-photon light absorption coefficient due to optical transitions between the spin-orbital splitting zone and the conduction band is determined as

$$K_{c,SO}{}^{(1)} = \frac{4\pi e^2}{c\hbar n_\omega}\frac{1}{3}p_{cV}^2\iiint\left(\left|e_z'\right|^2+\left|e_+'\right|^2\right)\left(f_{SO,\bar{k}}-f_{c,\bar{k}}\right)\delta\left(\frac{\hbar^2 k^2}{2m_c}+E_g+\Delta_{SO}-\left(-\frac{\hbar^2 k^2}{2m_{SO}}\right)-\hbar\omega\right)$$

or

$$K_{c,SO}^{(1)} = \frac{1}{3}\frac{e^2}{c\hbar n_\omega}\frac{p_{cV}^2}{\hbar^2}\mu_+^{(c,SO)}k_{c,SO}^{(1\omega)}f_{SO,k_{c,SO}^{(1\omega)}}\left\{1-\exp\left[\frac{E_g}{k_B T}\left(x-1-\frac{E_{SO}}{E_g}\right)\right]\right\}, \tag{1}$$

where $\mu_+^{(c,SO)} = \dfrac{m_c m_{SO}}{m_c + m_{SO}}$ is the reduced effective

mass, $k_{c,SO}^{(1\omega)} = \sqrt{\dfrac{2\mu_+^{(c,SO)}}{\hbar^2}\left(\hbar\omega - E_g\right)}$ is the wave vector

of current carriers,

$$f_{SO,k_{c,SO}^{(1\omega)}} = \exp\left[\frac{E_F}{k_B T}\right].$$

$$\cdot \exp\left[-\frac{1}{k_B T}\frac{\mu_+^{(c,SO)}}{m_{SO}}\left(\hbar\omega - E_g - E_{SO}\right)\right] \quad (2)$$

is the distribution function of current carriers in the spin-orbit splitting zone involved in optical transitions between the spin-orbit splitting zone and the conduction band.

The Fermi energy for current carriers located in the zone of spin-orbital splitting is determined by the formula for the concentration of current carriers, i.e.

$$p_{SO} = \iiint f_{SO,\bar{k}}k^2 dk =$$

$$= \exp\left[\frac{E_F - \Delta_{SO}}{k_B T}\right]\iiint \exp\left[-\frac{1}{k_B T}\left(\frac{\hbar^2 k^2}{2m_c}\right)\right]k^2 dk. \quad (3)$$
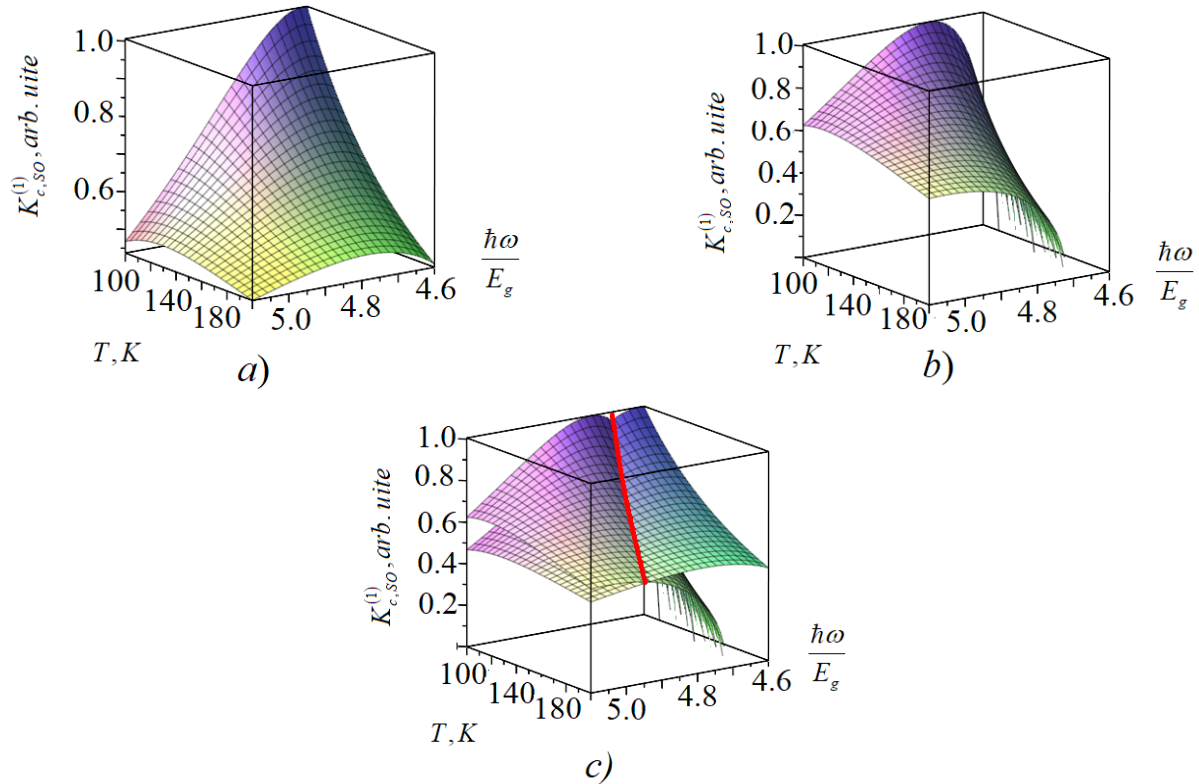
Where do we get

$$\exp\left(\frac{E_F}{k_B T}\right) =$$

$$= \frac{1}{2}\left(\frac{k_B T}{2\pi\hbar^2}\right)^{-3/2} m_{SO}^{-3/2} p_{SO} \exp\left(\frac{\Delta_{SO}}{k_B T}\right). \quad (4)$$

On (fig. 1) shows the spectral-temperature dependence of the coefficient of single-photon absorption of polarized light, due to optical transitions between the spin-orbital splitting subband and the conduction band in *InSb* without taking into account (*a*) and taking into account (*b*) the temperature dependence of the band gap and their ratio (*c*), where not the contribution of the coherent saturation effect to the single-photon light absorption coefficient is taken into account. The red line marks the intersection of the spectral and temperature dependences of the single-photon absorption coefficient of polarized light, shown in (Figs. 1 *a* and *b*). From (fig. 10) shows that in the spectral – temperature dependence of the single-photon absorption coefficient of polarized light, a maximum is observed.

Figure 1.

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Section 5. Economics and management

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THE CURRENT STATE OF HUMAN RESOURCES MANAGEMENT AND WAYS TO PERFECT IT IN GEORGIA

Abstract. Human resource management is a function of the organization that focuses on the people employed in the company and involves the processes of organizational development, employee motivation, and training. Effective human resource management in the organization helps to achieve the goals and objectives effectively. Human resource is the most expensive capital, and its effective management is the main factor in the country's economic growth. That is why the perfection of human resources management is of particular importance at the current stage of society's development.

The main challenge for all organizations today is the need for professional staff. In this process the human resources manager has been assigned a decisive responsibility. It ensures the management of labor relations between employees and the company, coordinates the administrative functions of the organization, and the fluency of communication, which affects the overall productivity and results of the company.

In the paper, using quantitative and qualitative research methods, the analysis of human resources management systems in public and private sectors of the Georgian economy was carried out; The main challenges of human resources management got studied, and opinions got presented in order to improve it.

Keywords: human resources, qualification, private sector, state sector, staff motivation.

Introduction. Human resource management is a continuous cycle that includes human resource planning, selection, performance management, and development. The effectiveness of human resources management mainly depends on how it is in accordance with the level of development of the organization. Distinctly, along with the growth and development of organizations, human resource management programs, practices and procedures must change and evolve. Otherwise, there will be a disproportion in the development of personal and material factors of production, which will negatively affect the effectiveness of the human activity.

Literature review. In order to develop the organization, it is necessary for the labor team to be organizationally well-knit and for people to have a relationship based on mutual respect. In such collectives, new ideas are born more often, costs get significantly reduced, and, accordingly, the organization develops [1].

Institutions included in the public service system differ significantly in terms of specific programs

implemented within the framework of human resources management. The value framework includes:

- Merit-based approach – decision-making (employment, promotion) is based on the competence of employees and taking into account their merits before the organization;
- Justice – the decision is made based on a fair argument and criteria;
- Diversification – the composition of employees is diverse, and it takes into account the diversity of society according to social, religious, gender, ethnic and other factors;
- Expediency – the most appropriate decision made from the alternatives available to the organization on financial and other rational grounds;
- Transparency – the use of open and public approaches in the planning and implementation of the human resources management function;
- The supremacy of public interests – any decision and process in the organization is aimed at offering high-quality services.

As in the entire economy, one of the decisive directions of human resource management in state structures is personnel development. In order to fulfill this function of human resources management, it is necessary to have a professional development plan for employees. Every educated person is considered as the wealth of the nation, and in the near future, this should become a priority in our country. Education is only a potential factor of development, which will become a source of growth if it is used productively [2].

The personnel development planning process includes the evaluation of the employee's capabilities, the need to increase their knowledge, and the determination of specific ways and means of increasing the professional training of employees. Unfortunately, the situation in the public sector of Georgia is not favorable. That got evidenced by the fact that only 25% of services have a personnel development plan.

The working ability of a civil servant can be evaluated by several factors: knowledge-competency of work, quality of productivity, initiative, leadership ability, supervisory ability, hierarchical attitude, etc. It is noteworthy that job evaluation systems exist in only 38% of the public institutions in Georgia. These systems are competency-based assessment, self-assessment, peer review, feedback, interviews, etc. In the public service, the more highly qualified and capable personnel gets selected, the stronger the human resources management system will be, and it will offer better programs and services to the population.

Discussion/Results. In public services of different countries, human resources management is implemented in different ways. In some, a peculiar agency has been created to centrally manage the human resources of all government agencies. In some countries, it is thoroughly decentralized, and each agency manages personnel individually. A mixed system is mainly used in Georgia: there is a central agency for human resources management, which determines the general strategy of human resources management, and the implementation of specific activities, for example, such as personnel selection, evaluation, etc. Individual agencies are in charge. The rules for public service competition are centralized and supervised by the Civil Service Bureau.

Personnel policy and human resources management services in the local self-governments of Georgia cannot ensure the proper management of officials, and their function is mainly exhausted by signing contracts with employees. In addition, the professional skills and qualifications of workers often do not correspond to professional requirements [3]. For the effective functioning of human resources management at the level of local self-government, it is necessary to carry out several practical measures that ensure the correct management of personnel. Especial attention should be paid to the qualifications of employees in the field of human resources management.

In the public sector of Georgia, less attention is paid to the optimization of workplaces. Along with the

optimization of workplaces, in the public sector, the exact scope of obligations and rights of each employee and the limits of personal responsibility should be defined, so that there is no room for irresponsibility and duplication in the performance of work [4].

As for the private sector of the Georgian economy, the management of human resources here is characterized by certain peculiarities. At the modern stage of economic development, a business is considered successful if it has the right human resources management strategy. In the development of the human resources development strategy, it is essential to involve a wide circle of the organization's leaders, because the human resources management strategy must be integrated with the business strategy. In the Georgian reality, unfortunately, less attention is paid to the issues of human resources management and provision of related services with highly qualified specialists [5].

At the current stage of society's development, private sector organizations should pay special attention to the issues of personality development of workers. It is necessary for the employee to have motivation for self-development, to work more on himself, to find ways and methods for the development of professional and personal skills, and to plan and implement appropriate concrete steps. He must be sure that these results will get properly valued. At the same time, the company must ensure the planning of the employee development process and its proper management. The study of employee motivation methods showed us that financial incentives have a concrete place in Georgian companies. Today, the use of monetary remuneration and compensation remains one of the most important methods for motivating staff [6].

Raising the knowledge of employees in both the public sector and the private sector can be done through training, self-awareness, professional and work meetings, and other events. The mentioned knowledge-raising measures should be reflected in the personnel development plan. 90% of large companies have a staff development plan in the private sector of the country's economy. A general course of training gets used here, which is not relevant either in terms of content or duration. The trial period for new recruits is quite long, and often, before being appointed to a certain position, the work of job seekers is used in a completely different direction.

The analysis of human resources management systems in the private sector of the Georgian economy showed us that the roles, power, and responsibilities are incorrectly distributed among the performers, which leads to a low degree of use of the abilities and skills of the personnel, and the strategic tasks of management and development remain unresolved.

Conclusion and recommendations. In order to improve the management of human resources in the private sector of the Georgian economy, we consider it expedient to bring the strategy of human resources management into line with the business strategy in all those organizations where this is not the case today; The organizational structure should be established on the basis of a deep understanding of the purpose of the company and the correct planning of the main processes, to ensure the maximum use of the capabilities of the personnel, for the effective management of the current processes and the implementation of the company's strategies; Implementation of such an effective human resources management policy, which will have a positive effect on the employee's qualities, such as involvement in management processes, increasing motivation, rational distribution of responsibility among managers, etc., which will contribute to the organization (firm, company, etc.), raising the quality of general leadership.

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METHODICAL FOUNDATIONS AND CHALLENGES OF GENDER BUDGETING IN GEORGIA

Abstract. On the basis of the latest literary sources and rich factual information, the present scientific article refers to the consistent discussion of such topical issues of the financial theory and practice as methodical foundations and challenges of gender budgeting in Georgia.

Based on the current legislative guidelines in Georgia, considering the gender aspect is discussed as one of the components of result-oriented budgeting, it is considered one of the most effective mechanism of gender budgeting for the budgeting system of Georgia as it ensures the maximum integration of gender equality policy goals in the decision-making process at all levels of the budget system and at all stages of the process.

Keywords: gender Budgeting, gender significance index, program budget, gender perspective, gender mainstreaming, gender equality**.**

Introductions: Gender budgeting means the involvement of the aspects of gender equality in the budgeting process of the country and distribution of budgetary resources that will facilitate the integration of gender mainstreaming in all areas or sectors. According to the complexity of the gender budgeting, there is no universal approach to it and the used approach and institutional framework are based on the specific features, as a rule (Vanishvili & Lemonjava [10]).

More detailed, due to the definition of the Council of Europe "gender budgeting includes considering of gender mainstreaming in the process of budgeting. It covers the assessment of the budget in terms of gender, integration of gender perspectives at all the levels of budgeting process and distributing of in-comes and expenses for facilitating of gender equality" (Gender budgeting: Final report of the Group of specialists on gender budgeting [2]).

Similarly, the Organization for Economic Co-operation and Development (OECD) explains that "gender budgeting involves integrating a clear gender vision into the overall context of the budget process through appropriate procedures and analytical approaches to support gender equality policies" (Gender budgeting in OECD countries, by Ronnie Downes, Lisa von Trapp and Scherie Nicol [1]).

It should be noted that gender budgeting does not mean the creation of different budgets for women and men or the division of beneficiaries in the gender context, but it is the formation of a gender-oriented budget process, which implies compliance

of budget allocations with gender equality policies in the country (Vanishvili & Sreseli [12]).

Finally, in addition to the fact that gender budgeting is one of the most important components of an effective budget policy, its macroeconomic significance is also essential. This, as well as the country's budget policy as a whole, is directly related to the impact of gender budgeting on the level of productivity of the economy, growth and equitable /fair distribution of resources. Besides this, gender budgeting is one of the important preconditions for evaluating the efficiency of budget spending and it significantly contributes to the creation or refinement of relevant statistical databases (Vanishvili & Lemonjava [9]).

Materials and Methods: The specific methodology of analysis in the field of gender budgeting is not provided by the budget framework in Georgia. However, according to the existing legislative guidelines, regarding the gender aspect is considered as one of the components of result-oriented budgeting (Order № 385 of the Minister of Finance, 08/07/2011) [3].

In view of the above, the first stage of our analysis aims to present a unified framework for assessing the level of gender significance of Georgian state budget programs in the form of a gender significance index proposed by the Budget Office of the Parliament (The significant index of gender of programs proposed by the Parliamentary Budget Office is based on a capability approach that considers five categories of gender equality: equal opportunity in the formation of public and private life, equal opportunity when forming a political and social system, an equal opportunity in living and working in a protected and clean environment, equal opportunity for in terms of physical inviolability. The index, based on an assessment of the impact of the capabilities of each program in the state budget on the above categories, provides an opportunity to identify programs of high and substantial importance for ensuring gender equality).

The second phase of the analysis aims to analyze the existing objectives of the programs and the evaluation indicators of the results / outcomes of the programs for high gender importance programs and to present the recommended indicators that can be used by the spending agencies to evaluate the gender achievement of the specific program.

Results and discussion: According to the secondary data analysis, the Ministry of Finance approved amendments to the Program-Budget Methodology Regulation (Order № 265 of the Minister of Finance of Georgia, 14/08/2015) [4], which states that "Due to the specifics of the program, concerning gender-sensitive programs, it is important to include an evaluation indicator in the gender aspect of the program as one of the indicators for evaluating the program".

According to the Resolution № 125 of the Government of Georgia (February 28, 2019, within the priorities of the Medium Term Action Plan for 2020–2023, while describing measures of planning factors to be implemented by state budget spending agencies, it is desirable to consider the gender assessment indicators of all program or sub-program (Resolution № 125 of the Government of Georgia, 28/02/2019) [5].

Based on these records, it is clear that under the current legal framework, there is no obligation to take into account gender aspects at all stages of the budget process, which therefore does not consider the stages as a whole and requires gender aspects (if it is necessary) only when developing indicators. While the indicator is a measure of results evaluation, the result is derived from the goal, and the goal, in turn, should be an integral part of the strategic policy.

According to the program budgeting methodology: (1) "Performance appraisal indicator is defined as the achievement of the result expressed in measurable (quantitative or / qualitative) indicators, determines the effectiveness of the implementation of the program / sub-program / event". (2) "Expected outcome is the result of programs, it is global in content. This is the situation that must arise as a result of the implementation of a pre-planned and analyzed policy".

It is clear from the above that the process should start mainly with policy planning and analysis, gender mainstreaming should be integrated at each stage of the budget process and not just during the development of the indicator.

The main issue that arises in the analysis of state budget programs today is how and by what criteria this or that program is considered gender sensitive or what is meant by such general records as "according to the specifics of the programs" and "according to necessity".

Consequently, this general record in the methodology does not guarantee that the development of relevant gender indicators will be mandatory for gender-important programs. This is necessary in order to better identify the target groups of the programs and to implement the programs in accordance with the relevant gender needs in the state-funded fields such as education, health, social protection, economy, infrastructure and almost all spheres of public life (Shanava & Vanishvili) [6].

The second issue that is important for the gender analysis of budget programs is the relevant and appropriate indicators in the programs. The above mentioned methodology states that "the outcome indicator should measure a goal that is realistic and achievable. When developing evaluation indicators, it should be taken into consideration that they should be: specific, measurable, achievable, relevant and timed. In addition, it is stated that "performance evaluation indicators can be quantitative, cost-based, qualitative, effictive and all of them must meet the principle of verifiability".

This issue can be regulated by collecting the necessary data in order to achieve the implimentation of realistic measurable indicators. To ensure this, at the initial stage it is possible to plan appropriate measures to create the necessary databases for the development of a system of indicators in the medium term (Vanishvili, Katsadze, et al. [11]).

Consequently, when talking about gender indicators, it is important to produce gender statistics, as gender statistics is an important tool for ensuring gender equality. Gender statistics are the most reliable source for making evidence-based decisions. Statistics are evidence, information that allows policymakers to see and recognize the real picture of the difference between women and men and its impacts in all areas and pushes them to make appropriate, gender-sensitive decisions and also to make legislation more gender-sensitive. As for a gender indicator is a statistical measure that shows a change in a particular context over a period of time (Vanishvili, Lemonjava, et al. [11]).

Gender indicators can be *quantitative* (based on the statistics processed due to gender and related to the number or percentage of people or organizations of a particular gender involved in a particular activity), as well as *qualitative* (in addition to the information on the number of members of a particular gender, the quality of their involvement and service is also important). Accordingly, this indicator is based on the evaluation of experiences, attitudes, thoughts, feelings due to gender. This is an analysis of gender inequality where quantitative processes cannot be explained.

Quantitative and qualitative indicators allow to evaluate the gender results of the relevant project activities during the monitoring and evaluation phase to achieve the goals of gender equality. In addition, gender indicators make it possible to assess changes in relationships between women and men, their status or condition within a specific policy, program or actions (Vanishvili & Katsadze [11]).

183 state budget programs were evaluated according to the Gender Index developed by the Budget Office of the Parliament of Georgia. Out of this, based on the calculation of the Gender Importance Index, 9 budget programs were identified as having the highest scores and therefore classified as essentially high on gender equality, while 17 programs were classified as high importance on gender equality (Research Publication of the Budget Office of the Parliament of Georgia [13]).

It is important to note that the document prepared by the Budget Office also included an analysis of the

goals, expected outcomes and evaluation indicators of the programs of substantially high and significant importance based on the index. The document also provided as a proposal the indicators for the evaluation of possible final and intermediate results in the gender aspect for the above-mentioned programs according to the budget priorities and information about the basic data needed for the evaluation of these indicators.

In view of all the above, the analysis of all the programs envisaged in the 2020 state budget, which according to the index were considered to be essentially high and high importance programs was carried out. The relevant programs were also compared to 2019 for comparison.

Analysis of the information provided in the budget format of the program reveals that the picture has not changed substantially in relation to the respective programs and in most of them the gender aspects are still not presented according to the program description as well as the purpose, results and evaluation indicators. This confirms the fact that during the development of the program, these programs were not considered and discussed in the context of gender-sensitive programs by the relevant agencies, accordingly, the evaluation indicator in the aspect of gender of the program was not highlited as one of the indicators of the program evaluation.

The analysis showed that out of the programs of high importance, the evaluation indicator in the gender aspect is not presented in any of them, the individual programs include a fragmentary record about gender. The following four programs might be named as examples: Develop and manage state policies to provi-de legislative and legal support to the country's interests, including criminal justice reform (26 01), development/enhancement of public order and international coope-ration (30 01), managing of IDP, labor, health and social protection programs from the occupied territories (27 01), Office of the Public Defender of Georgia (41 01).

As for the programs of high importance according to the Gender Importance Index, it should be noted that in 2020 and 2019 only three programs [crime prevention, probation system development and re-socialization of ex-prisoners (26 06), vocational education (32 03) and the Labor and Employment Reform Program (27 05)] include a gender-based assessment indicator. The Labor and Employment System Reform Program (27 05), in addition to the indicator, also includes gender aspects in the description and purpose, as well as within the expected final outcome.

Also noteworthy are the programs that were not considered as essentially high and high importance programs according to the Gender Office Index of Budget Office, but they include separate gender aspects themselves in both 2020 and 2019. In particular, these programs are: election activities (06 04), social protection of the population (27 02), pension provision of the population (27 02 01), social assistance to target groups (27 02 02), state care, victims of human trafficking provision of protection and assistance (27 02 05), livelihood program (27 06 05), health protection of the population (27 03), public health protection (27 03 02), early detection and screening of diseases (27 03 02 01), maternal and child health (27 03 02 08), retention of IDPs in settlements and improvement of their living conditions (27 06 03), promoting the development of the agricultural sector (31 05 12), dairy modernization and market access program (DiMMA) (IFAD) (31 05 12 03), development of infrastructure of general education institutions (32 07 01).

Conclusion: The following main conclusions are formed as a result of the research:

1. According to the current legal framework in Georgia, the obligation to take into account gender aspects does not apply to all stages of the budget process, which therefore does not consider the stages of the process as a whole and requires taking into account gender aspects (if it is necessary) only when developing indicators.

2. Gender indicators can be both quantitative and qualitative. Quantitative and qualitative indicators enable the assessment of gender outcomes of the relevant project activities at the monitoring

and evaluation stage and the achievement of gender equality goals. In addition, gender indicators provide an opportunity to assess the relationship between women and men, changes in their status or status within a specific policy, program or action.

3. Out of 183 state budget programs evaluated by the Gender Index developed by the Budget Office of the Parliament of Georgia, based on the calculation of the Gender Index, 9 budget programs were identified as having the highest evaluation and, therefore, are classified as essentially high quality and 17 to ensure a program of high importance.

4. The analysis of all the programs envisaged by the 2020 state budget of Georgia, which were considered to be essentially high and important programs according to the index and the comparison of the respective programs with 2019, showed that the picture has not changed substantially and the programs / sub-programs fragmentaly include records on gender. In most of them, the record is found only in the description and purpose, therefore it is not presented in the result and the result evaluation indicator and in some cases the record is only at the indicator level.

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DEVELOPMENT DIRECTIONS OF THE INNOVATIVE STARTUP ECOSYSTEM IN POST-PANDEMIC GEORGIA

Abstract. To restore the economy of post-pandemic Georgia, it is essential to solve problems in creative and innovative ways, and build an economy based on knowledge and innovation. The paper analyzes the impact of the global pandemic and other negative factors on the development of the startup ecosystem in Georgia, the main challenges, and the measures taken.

The work is based on the review of statistical data, the anti-crisis policy of the state, and the assessment of the main directions of the government program 2021–2024 "For the construction of the European state".

Opinions got expressed about the mobilization of existing opportunities for the development of the startup ecosystem in Georgia in the post-pandemic period and the introduction of innovative technologies and products in the new reality.

Keywords: COVID-19 pandemic, innovation, startup ecosystem.

Introduction. As a result of the COVID-19 pandemic, significant damage got done to almost all sectors of the Georgian economy, and businesses faced new challenges. Utilization of the latest technologies and national innovative potential has become a necessary condition for raising the economic competitiveness of our country and achieving universal well-being. Post-pandemic Georgia faced new challenges: the establishment of a national innovative ecosystem was defined as a strategic task; Internet infrastructure development; Development of electronic communications, entrepreneurship and competition, electronic commerce, and others [1].

Aim of research. The purpose of the paper is to study the impact of the global pandemic and other negative factors on the development of the innovative startup ecosystem in Georgia and evaluate and develop recommendations to overcome the existing challenges. The object of research is the innovative startup ecosystem in Georgia, which represents a connecting link between the results of scientific research and investors, entrepreneurs, and the state. A plurality of experts in the innovative startup ecosystem considers the range of public and private structures that ensure the development and maintenance of all stages of the innovation process.

Research methodology. A systematic approach was used in the research process, and to identify the main challenges of the innovative ecosystem, in-depth analysis of the current situation, scientific studies and state programs, statistical data got studied, and certain conclusions and recommendations got developed.

Results and discussion. Startups are the main generator of new jobs nowadays: on the one hand, the more companies of this type get created, the

more jobs will get created, and on the other hand, in the future, successful companies will become taxpayers. The practice of developed countries has shown how the presence of startups has developed urban regions. However, this is not only the merit of a good idea, the creation of new startups and the development of existing startups also require appropriate environmental conditions, and creating and developing startup ecosystems is essential.

A startup ecosystem is made up of people, startups at different stages, and organizations that exist in a particular space or city. However, the first and foremost ingredient for startup success is innovation. Innovation in everything from agriculture to public administration, justice, and defense should all be involved in this process, and public policy should be built around it. According to the Law of Georgia "On Innovations", the innovation ecosystem is defined as – a combination of the national and regional innovation system, which promotes the cooperation of the state, educational, industrial, scientific and private sectors in the field of innovations and technologies and is aimed at the creation, development, dissemination, and use of scientific and technological knowledge, in order to build an economy based on knowledge and innovation in the country and to increase the competitiveness of the private sector [2].

The basis of the innovative startup ecosystem is such forms of organization of innovative activity as technoparks, "Fablabs," innovation laboratories, innovative-technological centers, and business incubators. The process that creates and strengthens this ecosystem is multifaceted and involves organizations directly focused on building the ecosystem, including higher education institutions, incubators, accelerators, co-working spaces, startup event organizers, and others. In this process, new ideas, inventions, and researches emerge, which means the possibility of forming new startup teams.

Entrepreneurs who have already achieved success and have become startup mentors play a big role in the process of building a startup ecosystem;

Investors interested in new projects; Investor clubs, venture capital funds, and loan and grant-giving organizations, from which additional capital raising opportunities got created.

The goal of the Government of Georgia is to create a basis for long-term inclusive economic growth and increase the well-being of the population, to achieve which one of the priority directions is the development of the field of innovations and technologies. That is why, back in 2014, under the Ministry of Economy and Sustainable Development of Georgia, the "Innovations and Technologies Agency" was established, the purpose of which is to: form the necessary ecosystem for the development of innovations and technologies in the country; Promotion of commercialization of knowledge and innovation; Stimulating the use of innovations and technologies in all sectors of the economy [3].

"Startup Georgia" was founded by JSC's "Partnership Fund", the purpose of which is to promote the development of startup businesses (startups) in Georgia. Any Georgian citizen or group of individuals who have an innovative business idea can obtain financing in the innovative component of "Startup Georgia". It is allowed to finance any field/sector that is not prohibited by the legislation of Georgia.

The COVID-19 pandemic has become a challenge and also an opportunity to generate innovative ideas. In the first stage of the pandemic, the share of new innovative products introduced to the markets increased from 48.1% (2019) to 52.6% (2020). However, in 2021, the share of enterprises that implemented innovations in products decreased: this indicator was 3% in 2019, increased to 7.3% in 2020, and decreased to 6.4% in 2021 [4].

During the pandemic, the main financial supporter of innovative activity was the Government of Georgia. 55.4% of the financial support received by enterprises for innovative activity in 2020, and 50.7% in 2021 will come from the Government of Georgia. The share of local and regional authorities is also important: respectively, 12.5% (2020) and

15.6% (2021); EU institutions account for 5.9% (2020) and 4.2% (2021); on other financial institutions – 26.2% (2020) and 29.6% (2021). In total, 4.6% of enterprises received financial support in 2020, and 2.2% of enterprises in 2021 [4].

Based on research, a number of factors were identified that became an obstacle to innovative activities in 2020–2021: lack of internal financial resources, lack of credit or private capital, difficulties in obtaining state grants and subsidies, high costs, lack of qualified personnel in the enterprise, difficulty in finding partners, external Difficulty in accessing knowledge, high competition in the market and others.

The main goal of the 2021–2024 government program – "Building a European State" created for the purpose of rapid recovery from the economic crisis caused by the Covid-19 pandemic is the recovery and development of the economy, creating a stable and safe environment for each citizen [5]. The most important thing for post-pandemic Georgia is the promotion of the entrepreneurial sector, which is implemented with a wide variety of projects and accelerators. At present, 43 projects are underway throughout Georgia, of which 7 are current startup projects: "Hardware Startup Incubator 2022", Small grant program up to 15.000 GEL (prototyping), Shark Tank Georgia, Startup Leasing – TBC Bank, Startup Agro Loan – TBC Bank, Startup hotel, loan – TBC Bank, Startup loan – TBC Bank [6].

A new era of business discovery has begun in post-pandemic Georgia, and it is called "Shark Tank". What sets it apart from other projects is that it is a reality show, and all business ideas are evaluated publicly. This is a new investment in Georgian business, a joint project of the First Channel and Stanley Show – the mega-popular show of SONY Pictures, owner of 4 Emmys, and many other television awards – "Shark Tank" Georgia. "Through the show, 250 million dollars got invested in more than 40 countries of the world. Originally, it was founded in Japan under the name "Money Tigers" in 2001. With its 20-year history, "Shark Tank" has financed completely different businesses and individuals in more than 40 countries of the world, thanks to which many people have become their own business owners and entrepreneurs [6].

One of the main supporters of the Georgian startup ecosystem is the "Startup Bureau". The Startup Bureau works closely with the private and public sectors to successfully implement hackathons, business camps, pre-acceleration and acceleration programs, trainings, conferences, and other skills and capacity development programs for entrepreneurs, innovators, and creatives in the country [6]. All this helps startups and innovation-oriented entrepreneurs to go from idea to market with less risk and more confidence. Also, already established businesses – get new knowledge, finance and expand contacts.

Conclusion. Thus, in our country special attention is paid to the development of innovative startup infrastructure. However, we consider a necessary condition for the further innovative and technological development of the country: increasing the stimulation of innovative activities from both the state and the private sector, more activities and involvement of both private and state or donor organizations is needed, more mutual cooperation and support-strengthening of organizations focused on the development of the startup ecosystem, increasing financing of innovative startups of national importance; In order to create an environment conducive to innovative activities, more involvement of local and international organizations; revision of the tax policy for innovative enterprises; Promotion of the emergence of export-oriented scientific-technological innovations and information technology products, development of electronic services, electronic commerce from the side of the state; promotion of utilization of technologies created in other states in Georgia, as well as introduction and export of intellectual property and technologies created in Georgia; Taking care of cyber and information security, providing a legislative and normative base stimulating the innovative economy.

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