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Empirical Testing of Grossman's the Demand for Health Model: The Case of Russia

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Abstract. Healthcare services constitute one of the most important markets as they are used by all people regardless of age, wealth, and worldview. In order to effectively manage both private and public healthcare systems and to expand the scope of services provided in a timely manner, it is necessary to understand the nature of the demand for health, depending on the development of society and individuals. This paper is devoted to the empirical testing of one of the most influential models of health economics — Michael Grossman's model of health demand — by means of econometrical modelling. We used data from RLMS HSE (Russia Longitudinal Monitoring Survey of HSE) for 2019 and 2020. The paper tested the hypotheses that educational level positively affects the demand for health, that women invest in their health more responsibly than men, that the "age"- "demand for health" link has non-linear character, and the rate of health amortization is not constant during the life of an individual. We concluded that health demonstrates the features of both consumption and investment good. It was also found that income affects the demand for health just within the consumption interpretation of this construct, not within the investment one. The study showed that people with a low income tend to consume medical services more actively by spending more time in hospitals. It can be assumed that demand for medical services will increase during the economic crisis, job cuts, inflation, and a drop in real incomes of the population. The results of the study may help to predict the demand and consumption of medical services and to facilitate decision-making in Russia's healthcare system in the future.

Key words: Grossman's model; demand for health; health economics; Russia; healthcare system; RLMS HSE.

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1. Introduction[1]

The market of medical and healthcare services is one of the most important public services, which is used by all people worldwide without exception, regardless of age, wealth and other factors. The health itself is a valuable resource of any individual and the health capital is a part of human capital at all levels, from personal to macro economical.

Health capital at national level is a matter of government policy and is determined by its own factors of the demand. The understanding of these factors is essential for national healthcare systems authorities and policy makers. Developing national health-enhancing and health capital accumulation strategies requires understanding

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what factors affect the demand for health. Identifying these factors is important for national health systems and policymakers and rises the challenges for researchers to examine what are the determinants of the demand for health in the given country.

In order to effectively manage both private and public medicine and expand the scope of services provided in a timely manner, it is necessary to understand what the demand for medicine will be, depending on personal attitudes, the development of society and the situation in the country.

This research was inspired by several facts.

First, health industry is growing fast, and policy makers want to know what factors define the demand for health and medical care.

Second, there is no consent about such factors, their significance, and the direction of impact.

Third, the model which is most important for the explanation of the demand for health, Michael Grossman's model (further — MGM), was tested over and over again, with different and contradictory results. Despite of the variety of studies there are no consensus about the determinants of the demand for health across regions, countries, social groups etc. We observe the absence of certainty about the factors defining the demand for health in specific countries including Russia.

The purpose of this paper is to find the determinants of the demand for health in Russia and to test how MGM works on given country data. So, this paper presents an attempt to cover a lacuna in our knowledge and to reveal how some selected factors impact the demand for health in Russia basing on the data of Russian Longitudinal Monitoring Survey — Higher School of Economics (RLMS-HSE).

Our research is about to contribute to the domain of country-specific researches touching upon the demand for health rather than health as is. Education level and personal income will serve as the variables of our special interest.

The main question of our research is how the level of education and income level affect the demand for health in Russia.

The follow hypotheses were tested: is the demand for health stem from the twofold character of health as an investment and a consumption good? Do the individual's education and income level affect his/her demand for health?

The set of Russian data (RLMS HSE database) for 2019 and 2020 years is used.

We operationalized the demand for health as an investment and a consumption good by the variables of the frequency of visits to the doctor and the use of in-hospital care, respectfully. These (possible) nexuses will reveal the impact of social trends and the economic situation in the country on the demand for medical services. The results of the study may form an assumption about the consumption of medical services in Russia in the near future. It is assumed that trends in higher education and declining incomes may increase or decrease the demand for health.

The rest of the paper is organized as follow. The Section 2 presents research background and the review of MGM inspired approaches and empirical results of the demand for health, healthcare, and some related topics. Section 3 is devoted to how our research is organized and explains data, methods and variables used in the modelling. Section 4 details our models and results description. In section 5 we discuss our results and compare them with other authors' results. Section 6 summarizes our results, presents limitations and directions for future research, and notes practical implications.

2. Background literature

Michael Grossman's model and the very concept of the demand for health

were proposed firstly in the seminal paper in 1972 [1] and developed later. Within this model framework, demand for health means the demand for being healthy. The author described a model of "demand for health" as the demand for any other consumer good used to satisfy a need — in this case, the need to be healthy. At the same time, this product — "health" — has all the same properties as other products. Its stock decreases over time caused by depreciation, i. e., the individual's health status became worse with natural aging. Being a rational subject, a person can invest in his/her health — that is, to undergo preventive health examinations, communicate with a doctor, visit a doctor more often, take medication, follow doctor's recommendations, exercise fitness and proper nutrition, treat diseases in a timely manner and keep a healthy lifestyle, and do other things to keep his/her physical state from getting worse as long as possible.

The initial MGM was widened, deepen, reshaped and advanced by Grossman himself and a lot of his succeeders and critics. The first brief review of main "theoretical and empirical extensions and applications of the framework for studying the demand for health and medical care" [2, p. 1] and the expected findings was made by Grossman in 10 years after his seminal paper first publishing. Author outlined his 1972 model in [3] where he discussed the theoretical and empirical issues regarding the investment and consumption models withing the human capital framework of the demand for health. Later, Grossman investigated the link between health and education in [4] where he tested whether more schooling does cause better health, and in [5] where, while not doubting the significant link between education and health, he questioned its causal nature and the exogeneity of education variables.

Since its appearance, MGM became a starting point for the whole branch of economic research — the health economics. There are two domains of theoretical and empirical literature within health economics. One domain is devoted to the link between "health" and other variables, while the second examines "the demand for health". The boundary between these domains is rather vague. They both involve a list of factors and variables and use modelling to test hypotheses. What concept is used in each research project is defined by the underlying conceptual frameworks and how the variable of interest is operationalized in each particular study.

Mathematically, the demand for health in Grossman's model is presented by utility function and constraints. Health is seen as a consumer commodity [6] or as an investment commodity [7]. The third point of view presents health as a generalized good, no pure investment neither pure consumption one [8, 9]. Another dimension of the presentation of the demand for health noted by Cropper [10] who saw the dichotomy between preventive care and treatment of health problems when they already occurred.

As a consumer commodity, health directly enters into the individual's utility function, giving him healthy time, which is valuable itself. As an investment commodity, health determines the amount of time that the individual can spend on the production of other goods that he/she needs. When individuals invest into their health capital, they do it in anticipation of the benefits they could receive from the time spent healthy. It was also noted that an increase in the shadow price of health leads to both a decrease in the demand for medicine and an increase in the amount of resources that need to be invested in health.

The investment approach has a lot of adherents in the health economics and combines a large and growing body of research. Withing this "investment" approach the demand for health and the choices related to

it are studied through intertemporal models within a human capital framework.

Grossman "views health as a durable capital stock that yields an output of healthy time" [3, p. 348]. It rises the individual's productivity in job market and personal life. Potential productivity gains motivate persons to invest in their health.

As the results of the optimization analysis, Becker [11] derived models for the investments in health, lowering mortality and different aspects of health-related behavior. He distinguished three areas in the research domain "health as a human capital": (i) the modelling of optimal investments in health by individuals, companies, and governments; (ii) the analysis of the value of life and willing to pay for health and life improvements and longevity; (iii) the search for links and complementarities between health and other factors and other types of human capital investments such as education, gender etc. [11, p. 379]. According to Becker's description of health economics domain, our study is inside the third research area.

Treating health as an investment good, Galama & van Kippersluis [12] presented "an explicit theory of joint investment in skill capital, health capital, and longevity, with three distinct (and endogenous) phases of life: schooling, work, and retirement" [12, p. 3]. Distinguishing investments in health capital (e. g., medical care expenditures, fitness etc.) and investments in skill capital (e. g., expenditures on education and on-the-job training), authors found that "investment in skill capital raises the return to investment in health capital, and vice versa" [12, p. 1] that meant the complicated character of "health-education" nexus.

The "economical" approach to health as a human capital has been developing traditionally. Recently, the new approach raised within another paradigmatic frame, Bourdieusian sociological tradition of social capital which emphasizes social and cultural issues in individual's health care. Withing this "sociological" approach, health capital is defined "as the aggregate of the actual or potential resources possessed by a given agent that have the capacity to affect the position of agents in the social field of health" [13, p. 205].

So, "health capital" is seen by Grossman and his successors as one of the types of human capital with all its properties.

A lot of various socio-economic factors which could affect demand for health was tested and discussed within MGM since this model appearance. Some hypotheses were approved, others were declined. The interinfluence is studied between health capital and economic growth [14, 15], poverty and inequality [16, 17], children's human capital accumulation [18], life expectancy [19], individual's behavior [20, 21], etc.

Empirical testing of the demand for health model involves a lot of variables but the factor that attracts the widest interest of researchers is education. Great attention was paid to the impact of educational issues onto health, the demand for health and health-related behavior.

A lot of scholars recognize education as a fundamental cause for the health itself [22] and the demand for health [23]. Nevertheless, there are several specific explanations why education is so important. First, more educated people demonstrate better self-management of health state and maintain more effective communication with physicians during disease "comprehending what is being prescribed and then regimenting their daily routine to execute it" [24, p. 10934]. Moreover, the study [25] revealed that less educated people with low educational backgrounds are unable to understand what is useful and needed for their health. Educated people are more likely to spend lifetime in commendable activities like sports and healthy diet.

Second, education implies ability of a person to deal with information by more effective way, i. e., to process health and nutrition information and understand doctor's recommendations. There were reported the causal links between education and health-related behavior via the special health knowledge reception, information processing, and qualified evaluation of costs and benefits in life-long investments [26, 27]. More educated persons make healthier lifestyle choices, they are more likely to engage in health fostering activities, including amateur sports and active leisure time [28], they demand more health-oriented behavior and, finally, health.

Third, highly educated persons and whole nations spend a significant part of their higher incomes in consuming and pursuing a healthier standard of living [17], fighting against water and air pollution and for the betterment of the environment all around and for themselves personally. It's supposed that the more educated a person is, the more he/she realizes that it is more profitable to get sick as little as possible and work (and earn) as much as possible. It is assumed that getting an education reduces the shadow price of health, since more educated people reproduce the "health capital" more efficiently. The opportunity cost of time lost due to illness increases with education. As a consensus result, authors treat "education as a factor that increased one's efficiency in producing health and reducing the shadow price of investment at any given age" [29, p. 664].

Historically, "the demand for health" was focused on medical care or direct health services and was understood as "the service consisting of the control and/or management of diseases (or other unwanted physical or mental conditions) be they actual or potential" [30, p. 132]. Now, "the demand for health" concept also includes some preventive measures and costs such as fitness and sports, healthy food, wellness lifestyle etc. Such expanding of the concept shifted the focus of the demand for health researches from "disease-centered" to "healthy-life-centered".

Such wide modern approach leads to the variety of operationalizations of the demand for health using the monetary and non-monetary measures, medical-related and non-medical variables. Thus, it is possible to identify some measurable variables that define the demand for health. The proxies for the demand for health, healthcare and healthy products are used to be both subjective (self-estimated state of health as in [31], or choice of healthy food as in [20]) and more impartial (having health insurance, as in [32]). The results of meta-analysis [33] show that there are a bounded set of variables used in different researches and the variety if their operationalizations.

A considerable quantity of country-specific papers constitutes the special stream of the empirical researches inspired by MGM. Many years after the initial MGM publication, Grossman [3] explained some parts of the health demand model in more detail, and empirically tested the effect of education level on the demand for medicine. To test Grossman's model in practice, data were taken from US national representative survey conducted by the National Opinion Research Center and the Center for Health Administration Studies of the University of Chicago. The self-assessed level of health was taken as the health stock, and the demand for health was measured by the amount of money spent on medical services and goods. Age, number of years of education, salary and family income were used as independent variables. The first one, "Age", is found to have a negative effect on health, and the rest variables had a positive effect on the dependent variable "demand for health", which were in-line with common sense. As a result, the "net consumption" model

(health is a consumer good) was confirmed by the coefficients.

Other authors report other results. The non-linear character of the "age — demand for health" link is found in [34]. The results of Johes and coauthors support the concept of the demand for health as investment good. They also showed that "the demand for medical care also rises with the wage" [34, p. 15] that means the direct link between income and the demand for health.

The difference in demand for health among employed people and the general population was the main research question in the paper [35] where the authors took the probability of being healthy as a dependent variable used to measure health demand. The results show that income and education have a positive effect on the likelihood of being healthy, and other regressors have the same signs as in MGM.

One of the most comprehensive studies of the MGM relevance was carried out in [36]. Authors tested the influence of all possible explanatory variables used in previous studies; the dependent variable was spendings on medical services in different countries. Data were used for 24 developed countries of the OECD (Organization for Economic Cooperation and Development), which means that the results are typical for most Western countries, and not for any individual country. As a result, the direct dependence of the cost of medical services on wages was confirmed, just like the positive effect of the number of years of education among adults and the negative effect of tobacco consumption. In addition, it has been confirmed that health is a perfect consumption good (net consumption model) and not an investment good (net investment model). This result means that utility is achieved by reducing sickness time and increasing healthy time, rather than using health as a way to make more money.

Besides a great interest, Grossman's model had attracted a significant critique. Researchers see problems with the MGM itself and with its empirical testing. The problems with model reported by the researchers are the ambiguity and unlikeliness of presuppositions. Another wave of critique touches the observability and measurement of the variables included in the MGM. Firstly, it was noted in [37] that the desired level of health is not achieved instantly, which leads to incorrect signs of the coefficients. Secondly, the non-observability of health capital, which is a mandatory component of the health demand model, was proposed to be solved by an indicator of health status (categorical variable).

Zweifel [38] sees the main problem in the subjectivity of individual preferences and the fact that the Grossman model does not include stochastics. He criticized the implausibly long planning horizon in health planning and its economic benefits (whole life), firstly. Secondly, the fixed ratio of the costs of medical services and the prices of self-promotion activities (healthy lifestyle) is not applicable to real life. Thirdly, the author finds it wrong to think that in all circumstances it is equally possible to restore health to the desired level. The author of the article explains that healthy and sick people value healthy time differently, which means they are ready for different expenses for treatment and maintaining their health. In addition, the state of human health was proposed to be assessed using the random probability of being sick or healthy. At the same time, a person's choice regarding investments in his health depends on whether he/she is currently sick or healthy. In addition, the author concludes that the more medical care is provided to an individual, the faster health is restored, and the healthier person's life becomes, and the longer a person remains healthy, the less he/she cares about his/her health and becomes less motivated for this.

The authors of mentioned above and other articles came to consensus about the

irrelevance of the Grossman model in its original form.

A lot of other papers devoted to Grossman's model testing on real data from different countries to infer its plausibility. We've found some papers whose research questions and hypotheses were close to ours.

Fletcher & Frisvold [23] investigated what factors (with years of education as a focus) affected preventive health care on Wisconsin (USA) high school graduates' data. They use answers for some questions ("whether an individual has received a flu shot, cholesterol test, physical exam, and dental exam" [23, p. 5] during last 12 month) as proxies for the for the respondents' preventive health care use. Within the conceptual framework of health as an investment good, authors reported that "there are important spillover effects of increasing education in the context of increasing one domain of health — preventive health care choices" [23, p. 13]. Their main result was accompanied by other outputs of modeling, namely the significance of gender (positive link for the being woman variance) and age and general insignificance of family income (of all variables which denoted a demand for the demand for preventive care, only a "dental care" demonstrate a significant link with income variable).

The similar results were reported in [39] for Italian residents. Italy is a developed European country with the health system organized like Russian one: "The Italian National Health system (NHS) provides universal and largely free health care coverage to all residents" [39, p. 3]. Similar to our research, authors used investment-associating dependent variables (inter alia, visits to doctor, like in our research) and consumption-associating variable (dummy "Serious Health Problems"). Their main results were twofold: in the investment models they got a positive link with education and an absence of correlation with income, in the consumption models the education was insignificant and income found to have a negative link with dependent variable of health.

We've found just two studies closest to the topic of our research which are explored the demand for health in Russia and built on data of the Russia Longitudinal Monitoring Survey (the RLMS-HSE).

First of them, Burggraf et al. [40] analyzes Russian demand for health on 1996–2008 data. Authors took various factors that influence the frequency of visits to the doctor and the amount of money spent on treatment. The demand for health is treated to be same as the demand for medical care and prescriptions and "constructed by ranking various dichotomous indicators beginning with a score of zero for no demand for medical care and ending up with a score of six indicating a hospital stay and further prescribed medicine" [40, p. 47]. Their results confirmed most of the provisions of the Grossman model. Price level, income, age, level of education, and other factors were found affecting the dependent variable (the demand for medical care) with the sign, positive or negative, as it was predicted by MGM. The only regressor which demonstrated the reverse behavior comparing with the studies made for other countries was the state of health; as Burggraf et al. reported, for Russians, the state of health negatively affects the demand for medical services.

The second paper [41] used the RLMS-HSE data for 2006–2017 and estimate the income elasticity of spending on the healthcare services and medication in Russia assuming the non-linear relationship between income level and expenditure. They developed the demand for medical care as "household expenditure on healthcare services and/or medicines" [41, p. 346] and found the different income elasticity of total health spending between the high- and low-income groups. This result is con-

sistent with other studies for developing countries.

Both mentioned papers treated the demand for health via consumption of medical care and eliminated other health issues like healthy food consumption, physical exercises etc.

3. Data, Methods and Variables

We used RLMS-HSE database (Russian Monitoring of the Economic Situation and Health of the Population of the National Research University Higher School of Economics, further — RLMS-HSE), which contained the results of an annual survey of the Russian population on various social and economic aspects of life. The data was taken for two most recent available years — 2019 and 2020.

We should mention an important limitation of any health research within this period. 2020 was the starting year of the COVID19 pandemic, the year of great disturbances for the healthcare systems and population health all around the world.

As the RLMS-HSE survey contains the subjective responses of individuals we can suppose some biases in the respondents' awareness and feeling which could affect the model errors and even the change of the demand for health tendency, in short- or even long-term.

To investigate the demand for health and the factors that influence it, it is necessary to take data on the respondent's socioeconomic status (SES), i. e., information about a certain determinant of demand for medical services and information about the respondents themselves. First, their level of education and level of income are used as the variables of interest, and secondly, the variables which were chose as control variables are following: the respondent's gender, age, marital status, self-assessed level of health (as the "seed capital of health"), information about the presence of any disease recently, household size, social status, and some information about lifestyle or bad habits. These variables were chosen from the variety of parameters uses in other researches [42].

Demand for medical services can be measured in two ways: by total monetary expenditure on health and by the quantity of medical services consumed. The first way is not appropriate for us due to the nature of Russian health system and the character of our dataset. The medical services under the policy of compulsory health insurance are free for all citizens in Russia, so most people use free public medicine. Unlike the paid health services, the respondents of the RLMS-HSE cannot evaluate properly the share and cash amount of such services. Possible respondent's estimates would be too subjective and that is why database do not contain monetary evaluations of health expenditures.

Since there were no data on the costs of visiting doctors and buying medicines, we decided to take the results of the answer to two survey questions as a dependent variable. These questions are: "How often do you visit a doctor during the year?" and "How many days out of the last three months did you spend in the hospital?" since visiting doctors and being in the hospital can be seen as a consumption of medical services. The RLMS-HSE treats the first of those variables as categorical and subdivides it into 5 categories based on the approximate frequency of visits. The second variable is ordinal.

To measure first independent variable, the level of education, we took a categorical variable with information about the respondent's highest level of completed education. The variable contains 4 categories. The second independent variable is the respondent's income. The RLMS-HSE contains data on the household income, not personal. Since many people, like children, do not have their own income and live off their relatives, and many other people, on the con-

trary, support dependents who do not receive their own income, we had to transform the household income variable into the personal income variable. We did it by dividing the total household income into the number of household members. To eliminate the impact of inflation and wage increases, income per capita was taken at real prices.

Control variables were taken as is, unchanged. These are: the year within chosen period, type of the inhabited settlement where the respondent lives, age, gender, marital status, self-assessment of the degree of power and respect in the society, state of health according to the respondent, presence of any disease in the last month, preventive visits to the doctor without the urgent need, number of people in the household, number of cigarettes that a person smokes per day.

All categorical variables are coded in ascending order of their main feature, that is, for example, the settlement with the smallest population (village) is coded as 1, and with the largest population (regional center) as 4.

In total, the dataset under study consists of 35,749 observations over a total of 2 years.

Just like the authors [40] who analyzed the Russian demand for medicine our calculations and modelling were carried out in the STATA program.

Finally, the variables studied in our research are the following:

- visits — frequency of visits to the doctor (from 1 (rarely) to 5 (often));
- hospital — the number of days spent in the hospital in the last 3 months;
- graduate — level of education (from 1 (even the secondary school has not been completed) to 4 (bachelor's, master's or other degree got)));
- income — the logarithm of per capita income in real prices;
- gender — gender (0 — female, 1 — male);
- age — age, years;
- mar — marital status (1 — married, 0 — not married);
- year — the year of the survey;
- locality — the size of the settlement (from 1 (village) to 2 (urban settlement), 3 (city) and 4 (regional center));
- members — the number of people in the household;
- health_status — self-assessed health status (from 1 (very poor) to 5 (very good));
- regular_visit — self-assessed habit to visiting a doctor preventively, without urgent need (1 — attends, 0 — does not attend);
- health_problems — the presence of health problems in the last 30 days (1 — yes, 0 — no);
- cigarettes — the number of cigarettes a person smokes per day;
- power — degree of perception of how authoritative the respondent feels, as he/she perceives it (on a scale from 1 to 9);
- respect — the degree of perception how respected the respondent feels, as he/she perceives it (on a scale from 1 to 9).

Contingency analysis for the main variables was implemented. Pearson's chi-squared test for the pairs of variables "visits (frequency of visiting a doctor) and graduate (level of education)" and "hospital (number of days spent in the hospital in the last 3 months) and graduate (level of education)".

We were comparing the chi-squared value with the critical value from the chi-squared distribution with 12 and 270, respectively, degrees of freedom and the confidence level of 0,01. The hypothesis (H1 = = there is a difference between the distributions) can be accepted with the selected level of confidence. Hence, we can suspect the statistically significant link between the variables under the investigation.

We live aside the theoretical possibility of interdependence of some our variables [43] and count them as independent basing on our contingency analysis and the fact that the authors of previous papers on the healthcare in Russia [40, 41] treated variables as an independent as well.

4. Models and Results

The traditional way to evaluate the influence of any parameters on a dependent indicator is regression. We followed this way. All regressions are based on data from respondents over 17 years of age.

As mentioned above, the study considers two different dependent variables (frequency of visits to the doctor and number of days spent in the hospital in the last 3 months). First, consider how various factors affect the first of them.

4.1. Regression on doctor visits

The frequency of visits to doctor, within the RLMS-HSE, is the ordinal dependent variable, whose frequency ranges from rarely to often. So, we basically used to order logistic regression (OLR) to predict "visits" variable frequency. The supporting method to analyze the variables links was least-squares regression (LSR).

Two variations of the regressions were performed: with all 14 explanatory variables and with 15 ones (added a variable of the squared age). The regression equations took the following form:

$$\begin{aligned} visits' = {} & \beta 0 + \beta 1*graduate + \\ & + \beta 2*income + \beta 3*gender + \\ & + \beta 4*age + \beta 5*mar + \beta 6*year + \\ & + \beta 7*locality + \beta 8*members + \\ & + \beta 9*health\_status + \\ & + \beta 10*regular\_visit + \\ & + \beta 11*health\_problems + \\ & + \beta 12*cigarettes + \beta 13*power + \\ & + \beta 14*respect + \varepsilon i \end{aligned} \quad (1)$$

$$\begin{aligned} visits'' = {} & \beta 0 + \beta 1*graduate + \\ & + \beta 2*income + \beta 3*gender + \\ & + \beta 4*age + \beta 5*mar + \beta 6*year + \\ & + \beta 7*locality + \beta 8*members + \\ & + \beta 9*health\_status + \\ & + \beta 10*regular\_visit + \\ & + \beta 11*health\_problems + \\ & + \beta 12*cigarettes + \\ & + \beta 13*power + \beta 14*respect + \\ & + \beta 5*age\_squared + \varepsilon i \end{aligned} \quad (2)$$

Table 1 shows the regressions coefficients estimated using two methods: OLR and LSR.

In all cases (models (1) and (2), ordered logistic regressions and least-squares regressions), the level of education has a significant positive coefficient, which means that the more educated a person is, the more often he/she goes to the doctor, other things being equal. As the coefficients on income are not significant, hence nothing can be said about the level of income based on such a regression, it is impossible to say how wealth correlates with the frequency of visits to the doctor. This result is approved by Pearson's chi-squared, Cramer's V, and Kendall's tau-b tests.

4.2. Regression on the number of days spent in the hospital in the last 3 months

This part of research is devoted to the models that figured the second dependent variable — the number of days spent in the hospital in the last 3 months. As this variable is quantitative, simple least squares (OLS) regression can be used here.

Regressors are also evaluated using 2 regression options: with 14 explanatory variables and with 15 (a variable about age is added in the square). They look like (1) and (2) equations with the only difference: the dependent variable is "hospital" and counts days spent in the hospital in the last 3 months (Table 2).

Table 1. **Ordered logistic regression and least-squares regression coefficients on "visits" variable (t-statistics in parentheses)**

	Ordered logistic regression		Least-squares regression	
	Visits' (model 1)	Visits'' (model 2)	Visits' (model 1)	Visits'' (model 2)
graduate	0.117***	0.121***	0.0545***	0.0562***
	(4.54)	(4.69)	(4.49)	(4.65)
income	–0.0111	–0.0198	–0.00543	–0.00997
	(–0.33)	(–0.59)	(–0.35)	(–0.65)
gender	–0.413***	–0.447***	–0.197***	–0.212***
	(–7.46)	(–8.03)	(–7.54)	(–8.13)
age	–0.00388	–0.0692***	–0.00168	–0.0333***
	(–1.91)	(–6.06)	(–1.76)	(–6.22)
mar	0.0338	0.111	0.00626	0.0431
	(0.61)	(1.93)	(0.24)	(1.61)
year	-0.0746	-0.0736	-0.0472*	-0.0459*
	(–1.57)	(–1.55)	(–2.11)	(–2.06)
locality	0.106***	0.105***	0.0503***	0.0496***
	(5.10)	(5.04)	(5.15)	(5.09)
members	0.0244	0.0238	0.0117	0.0113
	(1.66)	(1.62)	(1.68)	(1.62)
health_status	–0.824***	–0.825***	–0.388***	–0.387***
	(–18.44)	(–18.43)	(–19.05)	(–19.04)
regular_visit	1.034***	1.043***	0.515***	0.519***
	(17.48)	(17.63)	(18.41)	(18.61)
health_problems	0.848***	0.823***	0.424***	0.410***
	(14.09)	(13.64)	(15.26)	(14.76)
cigarettes	–0.0193***	–0.0172***	–0.00813***	–0.00701***
	(–5.34)	(–4.73)	(–4.91)	(–4.21)
power	0.0792***	0.0791***	0.0341***	0.0337***
	(4.68)	(4.67)	(4.28)	(4.24)
respect	0.0761***	0.0751***	0.0297***	0.0292***
	(4.52)	(4.46)	(3.80)	(3.75)
age_squared		0.000702***		0.000338***

End of table 1

	Ordered logistic regression		Least-squares regression	
	Visits' (model 1)	Visits'' (model 2)	Visits' (model 1)	Visits'' (model 2)
		(5.81)		(6.00)
_cons			98.13*	96.31*
			(2.17)	(2.14)
cut1	–153.1	–152.4		
	(–1.60)	(–1.59)		
cut2	–151.7	–151.0		
	(–1.58)	(–1.57)		
cut3	–149.3	–148.6		
	(–1.56)	(–1.55)		
cut4	–147.8	–147.1		
	(–1.54)	(–1.53)		
N	6350	6350	6350	6350
LR chi2	1453.34	1487.08		
Pseudo R2	0.0880	0.0900		
F-statistics			123.27	118.09
R-squared			0.2141	0.2185

Note: *t* statistics in parentheses mean:* $p < 0.05$,** $p < 0.01$,*** $p < 0.001$
Source: authors' calculations

Table 2. **Least-squares regression coefficients on "hospital" variable (t-statistics in parentheses)**

	Hospital' (model 1)	Hospital'' (model 2)
graduate	0.0275	0.0289
	(0.87)	(0.91)
income	–0.137***	–0.141***
	(–3.40)	(–3.48)
gender	0.0572	0.0451
	(0.84)	(0.66)
age	–0.00200	–0.0257
	(–0.80)	(–1.83)
mar	0.0515	0.0792

End of table 2

	Hospital' (model 1)	Hospital'' (model 2)
	(0.75)	(1.13)
year	–0.101	–0.100
	(–1.73)	(–1.71)
locality	–0.00921	–0.00973
	(–0.36)	(–0.38)
members	–0.0151	–0.0154
	(–0.82)	(–0.84)
health_status	–0.386***	–0.385***
	(–7.23)	(–7.21)
regular_visit	0.346***	0.349***
	(4.72)	(4.76)
health_problems	0.633***	0.622***
	(8.69)	(8.52)
cigarettes	0.00642	0.00728
	(1.48)	(1.67)
power	–0.0133	–0.0135
	(–0.63)	(–0.65)
respect	0.00982	0.00948
	(0.48)	(0.46)
age_squared		0.000254
		(1.71)
_cons	206.9	205.4
	(1.75)	(1.74)
N	6376	6376
F-статистика	18.93	17.87
R-squared	0.0400	0.0404

Note: *t* statistics in parentheses mean:* $p < 0.05$,** $p < 0.01$,*** $p < 0.001$
Source: authors' calculations

We see a significant negative link between "income" and "hospital" variables and the insignificance of the "graduate" — "hospital" link. The later fact is confirmed also by Bartlett's equal-variance test (chi2 (3) = 96.58, Prob = = 0.000) for subsamples of persons with equal education.

5. Discussion

Our research is gone on the massive of empirical tests of Michael Grossman model of the demand for health [22, 29, 5]. The common points of this massive are:

1) MGM is generally confirmed on the samples from different countries and regions,
2) the demand for health is seen mainly as a demand for the investment good [44, 45] or, less often, the consumption good [46, 3, 32],
3) education level or years of schooling is a determinant of the demand for health in the overwhelming majority of researches,
4) the impact of income, age, marital status, place of residence, and other factors to the demand for health is controversial.

Do our results on Russia data correspond to the results on other countries data? Two our variables of interest can be seen as characteristics of investment and consumption nature of health as a good. "Visits to doctor" reflects mainly a preventive care and can be viewed as a proxy for the health as an investment good. "Days in hospital" pictures the pure consumption side of the demand for health whereas individuals are mostly admitted to the hospital in an emergency, not as part of a routine health check.

All models for both variables of interest are significant. It means that the demand for health in Russia demonstrate both sides and can be seen as an investment and consumption good at the same time. Nevertheless, models' explanatory power is not large. We can suppose that there are other variables, probably unobservable or hardly quantifiable, which could enhance models.

We guess that it might be, particularly, some characteristics of the state health care system, such as an access to medical services covered by compulsory (free of charge for the state citizens) or / and voluntary (paid by consumer) health insurance, the geographical distribution of medical institutions and others. It could be interesting to introduce such variables in models but, unfortunately, the database that we use does not permit it directly.

Table 3 compares results for the models that reflect to investment and consumption sides of MGM. 'Plus' in the cell of the table means the positive link, minus means negative link between the given variable and the demand for health.

Table 3. **The character of the links between different variables and the demand for health within investment and consumption models**

	Independent variables	Investment model	Consumption model
1	Education	+	insignificant
2	Income	insignificant	–
3	Gender (0 — female, 1 — male)	–	insignificant
4	Age	U-shaped	insignificant
5	Marital status (1 — married, 0 — not married)	insignificant	insignificant
6	Year of the survey	significant/insignificant	insignificant
7	Size of the settlement (from 1 (village) to 2 (urban settlement), 3 (city) and 4 (regional center))	+	insignificant

End of table 3

	Independent variables	Investment model	Consumption model
8	Number of people in the household	insignificant	insignificant
9	Self-assessed health status (from 1 (very poor) to 5 (very good))	–	–
10	Self-assessed habit to visiting a doctor preventively (1 — attends, 0 — does not attend)	+	+
11	Self-assessed presence of health problems in the last 30 days (1 — yes, 0 — no)	+	+
12	Number of cigarettes a person smokes per day	–	insignificant
13	Degree of perception of how authoritative the respondent feels, as he/she perceives it (on a scale from 1 to 9)	+	insignificant
14	Degree of perception how respected the respondent feels, as he/she perceives it (on a scale from 1 to 9)	+	insignificant

Source: authors' calculations

First, the significance of education (line 1, table 3) for the demand for health was almost obvious because such link was found in other researches on different samples and countries. People with higher education tend to go to the doctor more often. It might be caused by several (or all together) reasons. Perhaps this is a manifestation of the fact that people are afraid of losing part of their earnings and tend to get sick as little as possible, or this is a consequence of their awareness and responsibility. We found the same link just for the investment side of the demand for health. We see that everyone sometimes commits preventive visits to doctor (line 11, table 3) but the higher the level of person's education the more he/she is ready to undertake it more often. The insignificancy of the educational variable within consumption model could be explained by the way we operationalized it. Really, the hospital stay occurs mainly in the emergency, not as a part or planned or desired consumption of medical care services.

Second, as for the impact of income to demand for health (line 2, table 3), we got insignificance of income for the investment side of the demand for health ("visits to doctor" as proxy) and significance for the consumption part ("days in hospital" as proxy). The former result reaffirms the insignificancy reported in [45] within the pure investment MGM on data from the 2000 China Health and Nutrition Survey database. But the later part is quite surprising. Intuitively, it might be contrariwise assuming that hospitalization in Russia occurs mostly in an emergent case and is covered by state insurance funds, whereas the preventive visits to doctor are often paid by the consumer directly or covered by voluntary insurance. These results are to

be detailed and deeply explained in future researches. It should be noted that the initial Grossman's model [1] supposed income as a significant factor of the demand for health because of health affected the number of days an individual can work and get salary and not be sick. The cost of healthy time for the high-income persons are higher so they will invest more in health through spending on medical goods and services, comparatively with low-income individuals. We see on the RLMS-HSE database that Grossman's assumptions work only for the consumption side, not as an investment one.

Third, our models confirm the results of other researchers that woman care their health more respectfully than man [29, p. 10]. This result (line 3, table 3) is significant for the investment side of the demand for health (woman invest personal resources more actively and/or often than man) and insignificant for the consumption model (individuals consume hospital care equally, just in emergent cases). As a result of contingency analysis, the number of days spent in the hospital is negatively correlated with an individual's income. Again, this can occur if individuals do not want to miss the time that they could earn money while in the hospital.

Forth, the non-linear character of "age" — "demand for health" link (line 4, table 3) is observed in our research; this result is in line with many other papers [29]. Non-linearity of this link stems from the fact that the age was significant even in the models of (2) form, with Age_squared variable (see tables 1 and 2). There is a significant positive coefficient of age squared in the regression with 15 variables. If so, age seems to be in a quadratic relationship with the frequency of visits to the doctor. This means that the addiction has U-shape (parabola opens upwards), that is, in the first half of an individual's life, as a rule, visits to doctors become less and less, but after some point it begins to become more frequent. Our result means that the rate of health amortization is not constant during the life of individual: it falls in the early years and accelerates after some health-related optimal age as Grossman [5, p. 1810] supposed.

Fifth, for investment side of the demand for health, a significant negative coefficient for the year of the survey (line 6, table 3) were found with the OLS method and suggested that in 2020 (compared to 2019), people generally visited doctors less frequently. This result can be seen as effect of COVID-19 pandemic when the rigorous quarantine restrictions took place[1]. This effect was not caught by other models (tables 1 and 2), and the coefficient is significant at the 5 % level comparatively with 1 % and 0,1 % level for other variables in the same model. So, we can admit this link as not important for the short-term analysis like our one. Nevertheless, it would be interesting to trace the possible long-term changes which would be induced by COVID19 itself and quarantine regimes associated with it.

Sixth, we observed that the scale of the settlement and some other attributes of respondents are significant for the investment side of demand for health. Living in a community with a large population (line 7, table 3), the habit of visiting a doctor sometimes for preventive purposes (line 10, table 3), the self-recognition of health problems in the last 30 days (line 11, table 3), and the self-assessment of the degree of perception of how authoritative (line 13, table 3) and respectful (line 14, table 3) the person is positively affect the demand for health, that is, lead to more frequent visits to the doctor. This effect can be explained by several causes, mainly by the accessibility of medical care in the big cities and by the intentions

[1] https://стопкоронавирус.рф/news/ (https://xn-80aesfpebagmfblc0a.xn — p1ai/news/

Table 4. **The comparison of the results of our research with results of [39] and [36]**

	Our research, investment models	Our research, consumption models	(Ponzo, Scoppa, 2021), investment models	(Ponzo, Scoppa, 2021), consumption models	(Fletcher and Frisvold, 2009), investment model
Education	+	insignificant	+	mainly * insignificant	+
Income	insignificant	–	mainly * insignificant	–	insignificant **
Dependent variables	Frequency of visits to doctor during last year	How many days out of the last three months the respondent spent in the hospital	Specialist (Doctor) Visits is a dummy variable taking the value of 1 if an individual undertook at least one specialist medical visit in the most recent four weeks and 0 otherwise	Serious Health Problems is a dummy equal to 1 if an individual had some health problems that limited daily activities in the most recent four weeks (and 0 otherwise).	Whether an individual has received some preventive care exams or tests during last 12 month
Data base and scope	RLMS HSE (Russia Longitudinal Monitoring Survey of HSE); 2019 and 2020		The Survey "Italian Health Conditions and Use of Health Services" provided by the Italian National Statistical Office (ISTAT); 2012–2013		Wisconsin (USA) Longitudinal Study (WLS); 1957, 1964, 1975, 1992–1994, and 2003–2007

Note: * "Mainly" means "in most models with different specification" which were performed in the given research; ** With one exemption: "income" is positively significant for one of the preventive exams and tests under consideration — "the dental exam".

of big cities population to keep the healthy lifestyle, comparatively with the residents of small localities. These issues could be the effect of the more advanced education or higher income of big cities residents, but such links were not caught by our research.

Seventh, significant negative links with the dependent variables are observed with the state of health, self-assessed by the respondent (line 9, table 3), and the use of a large number of cigarettes (line 12, table 3). The former result is actual both for investment and for consumption sides of the demand for health, the later effect is seen just for investment side. We suppose these results to be quite expected. Under the general logics, healthy individuals visit doctors and begin treatment, i. e. make a demand for health, only when an urgent need is brewing, and do not think in advance about the importance of maintaining health, and vice-versa, the worse a person's state of health, the more often he goes to the doctor. This logic contradicts to the original Grossman model which assumes the opposite. We could explain this discrepancy by national cultural differences.

Eighth, our regressions do not give any results regarding the relationship of marital status (line 5, table 3), and number of people in the household (line 8, table 3).

These variables are occurred insignificant in all models.

To compare our results with the results on other country we should address to studies with similar model specifications and research questions. These are [39] and [36]. Both these studies are based on self-assessment data from the national or state surveys where the responses of individuals from the developed countries, Italy and USA, are presented.

The first paper [39] contains tests the hypotheses close to our ones, so we can distinguish "the investment models" part and "the consumption models" part, as in our research. Authors report the same results as ours respectfully to education (positive link for investment models of the demand for health and insignificance for the consumption models), income (insignificance for investment models and negative link for the consumption models), gender and age. The second paper [36] is carried out within investment representation of MGM and its results are in line with our research too.

The comparison of the results reported in our study and in these papers is presented in Table 4.

So, the main features of the demand for health in Russia are compared to the demand for health in other countries with similar health care system organization and similar level of economic development.

6. Conclusion

In this study, the Russian demand for health was studied in the Michael Grossman's model framework. We had tested two main hypotheses. The hypothesis about two-fold character of the demand for health was confirmed. It was shown on our database that health has the features of investment and consumption good at the same time. The second hypothesis was about the impact of the individual's education and income onto the demand for health and was confirmed partially. It was tested for the investment and consumption sides of health as a good, separately.

Considering health as an investment good, we found that more educated persons invest in their health more actively, especially if the person was woman and/or live in regional center, and/or non-smoker, and/or had high degree of self-perception. Looking at health as a consumption good, we found that income demonstrated a negative impact to the consumption of hospital treatment, whereas education was insignificant.

The assumption was confirmed that women invest in their health more responsibly than men, "age" — "demand for health" link has non-linear character, and the rate of health amortization was not constant during the life of individual.

Finally, we can say that not all our results coincide with the original MGM suppositions and the detailed results of other authors' research. This means that the Grossman model cannot be applied in Russia in its original form. Nevertheless, altogether, we can conclude that in Russia the demand for medical services works in the same way as in other countries. Thus, one can see how the Grossman model and its derivatives can predict the demand for medicine, and how this can be used to develop the healthcare system.

As a result of the study, several conclusions can be drawn regarding the future demand for medical services in Russia.

On the one hand, the social trend towards higher education for more and more people and the increase in the average number of education levels per person, will increase the demand for health, medical care and healthy lifestyle in the future (in the long term). Every year, on average, people in Russia will think more and more about the importance of maintaining health, about the timely treatment of diseases and the need for scheduled health checks. Expanding volume of provided medical services will be a real challenge for the healthcare system,

public and private, and a great opportunity for its expanded development.

On the other hand, the study showed that people with low income tend to consume medical services more actively by spending more time in hospitals. It can be assumed that the demand for medical services will increase during the economic crisis, job cuts, inflation, and a drop in real incomes of the population. It means that it is probably worth expanding quantity and availability of medical services and medical organizations in the short term.

The limitations of this study are seen as follows.

The firs one is the supposed endogeneity of the demand for health because the demand can largely depend on the personal qualities of the person (such as responsibility and foresight), which are difficult to assess and study. As a matter of fact, the demand for health is a complicated construct not only derived from the personal attitudes but also induced by person's surrounding, from the immediate circle of communication to government structures. We did not focus our research on state, communities, and institutions but we admitted that the results of modelling were highly dependent on the institutional features of national healthcare system, medical insurance system, structures of inequality, dispersal of country's residents across the territory, etc.

Second, we exploited just the use of medical services as proxies for the demand for health whereas the modern comprehending of health is much broader and relates to the demand for fitness activities, healthy food and lifestyle, and others.

The third severe limitation is the positivist approach itself and the search for causal relations between factors. The interrelations, mutual and joint influence of variables were not taken into account in our models but it can be possible, at least in some national or institutional conditions. These issues are left for the future comparative studies.

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Спрос на здоровье: эмпирическая проверка модели Майкла Гроссмана на российских данных

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Аннотация. Рынок услуг, связанных со здоровьем, представляет собой один из важнейших рынков, поскольку ими пользуются все люди независимо от возраста, социально-экономического статуса и других факторов. Чтобы эффективно управлять как частной, так и государственной системой здравоохранения и своевременно расширять объем предоставляемых услуг, необходимо понимать характер спроса на здоровье в зависимости от развития общества и граждан. Данная статья посвящена эмпирической проверке одной из самых влиятельных моделей экономики здоровья — модели спроса на здоровье Майкла Гроссмана — посредством эконометрического моделирования. Мы использовали данные РМЭЗ НИУ ВШЭ (Российский мониторинг экономического положения и здоровья населения НИУ ВШЭ) за 2019 и 2020 годы. В статье тестируются гипотезы о том, что здоровье как товар носит двойственный характер, одновременно инвестиционный и потребительский; уровень образования и доход индивида влияют на спрос на здоровье, женщины заботятся о своем здоровье более ответственно, чем мужчины, связь возраста и спроса на здоровье имеет нелинейный характер, а скорость амортизации здоровья непостоянна в течение жизни человека. Мы пришли к выводу, что здоровье демонстрирует черты как потребительского, так и инвестиционного блага. Было обнаружено, что образование определяет спрос на здоровье как инвестиционный товар, тогда как доход, наоборот, влияет на спрос на здоровье только в рамках потребительской трактовки этого конструкта, но не в рамках инвестиционной. Исследование показало, что люди с низким доходом, как правило, активнее потребляют медицинские услуги, проводя больше времени в больницах. Можно предположить, что спрос на медицинские услуги возрастет в период экономического кризиса, сокращения рабочих мест, инфляции, падения реальных доходов населения. Результаты исследования могут помочь спрогнозировать спрос и потребление медицинских услуг, а также облегчить принятие решений в системе здравоохранения России в будущем.

Ключевые слова: модель Гроссмана; спрос на здоровье; экономика здравоохранения; экономика здоровья; Россия; система здравоохранения; РМЭЗ НИУ ВШЭ.

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