Article

Regional Living Conditions and Individual Dietary Characteristics of the Russian Population

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Abstract: The goal of our study was to examine the effect of regional characteristics of living environment on individual a priori and a posteriori dietary patterns of the Russian population. For the analysis, we used cross-sectional data from the Epidemiology of Cardiovascular Diseases in the Regions of the Russian Federation study of 2013-2014. The sample included 18,054 men and women 25-64 years of age from 12 regions. Based on the frequency of consumption of basic foods, four a posteriori empirical dietary patterns (EDPs), along with an a priori cardioprotective dietary pattern (CPDP) were identified. To describe the regional living environment, 5 regional indices were used. The adherence to the meat-based EDP was directly associated with deterioration of social living conditions and the more northerly location of the region of residence. The probability of CPDP increased with deterioration of social living conditions, an aggravation of demographic crisis, higher industrial development of the region, as well as with a decline in the economic development of the region, income and economic inequality of the population. We detected some gender-dependent differences in associations. The revealed patterns reflect the national dietary preferences of Russians, and regional indices characterize the effect of living environment.

Keywords: diet; living environment; dietary patterns; characteristics of regions; Russia

1. Introduction

Global differences in the structure of human nutrition by regions and countries worldwide are apparent [1-2]. Furthermore, even within groups of countries with similar cultures, there are significant differences in the structure of human nutrition. Formerly, the European Prospective Investigation into Cancer and Nutrition (EPIC) study demonstrated geographical differences in food consumption among European countries: fruit and vegetables [3], fish [4], dairy products [5], meat [6]. This was also confirmed by later studies [7]. Going further down the geographic scale gradient, the EPIC study [8] and other nationwide studies [9-11] demonstrated gradations of variation in food consumption not only between countries considered as a whole but also between different regions within some particular country.

However, it is clear that specific geographic locations are not predictors of different diets per se. The systemic approach considering the interaction of genetic, biological, behavioral, psychological, social, and environmental factors of health, recognizes a significant role of the so-called social production of diseases [12-13]. The theoretical concept of environmental impact is based on the fact that the essential characteristics of life (social inequality, economic inequality) influence intermediate factors, in turn, affecting psychoemotional and behavioral predictors that are direct (smoking) or indirect (physical activity or diet) health risk factors [13]. In the field of dietetics, environmental factors can have a specific effect, since following the behavior of others is adaptive, while social norms inform people about the behavior that may be optimal in a particular environment: "If everyone else is doing it, I should probably do it too" [14-15].

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At a small geographic scale (city blocks, districts, census tracts), environmental impact on individual diet, expressed in specific characteristics, is conceptually justified [16]. Numerous studies demonstrated the impact of various factors on dietary preferences: e.g., of population characteristics of areas, including its socioeconomic status [17-19] and unemployment rate [20]. Besides, just a few studies have considered the impact of environmental factors on nutrition at the scale of large national regions (state, province, etc.). A Swiss study confirmed substantial differences in dietary patterns between three language regions of the country, i.e., the predictor in this case represented either German, or French, or Italian cultural living environment [21]. In a Canadian study of adolescents, the Gini index and the mean household income in the province were considered as environmental predictors of the quality of breakfasts (as a behavioral factor of child health), but no associations were revealed [22]. However, it is clear that understanding the environmental predictors of eating behavior provides an opportunity to recognize the underlying causes of uneven distribution of population health and, accordingly, can offer promising approaches to diminishing such dissimilarity.

In Russia, regional aspects of nutrition were most fully studied within the framework of the epidemiological study, Epidemiology of Cardiovascular Diseases in the Regions of the Russian Federation (ESSE-RF), conducted in 2013-2014. The study established a high degree of correspondence of the a posteriori regional dietary pattern to the nationwide Russian pattern just in 7 out of 13 regions participating in the study [23]. Besides, regional differences in the a priori cardioprotective dietary pattern of healthy eating have been demonstrated [24].

However, in this study, as in most similar studies abroad, regional characteristics of the living environment of the population, which could possibly affect individual food preferences, were not examined. Consequently, the goal of our study was to examine the effect of regional characteristics of the living environment on individual a priori and a posteriori dietary patterns in the Russian population.

2. Materials and Methods

2.1 Study sample

For the analysis, we used data from the cross-sectional epidemiological study, Epidemiology of Cardiovascular Diseases in the Regions of the Russian Federation (ESSE-RF), conducted in 2013–2014 [25]. In total, 21,923 people aged 25-64 years old from 13 regions of the Russian Federation participated in the study. The Kish selection grid was used for forming the sample providing a systematic multistage random sampling according to the territorial principle on the basis of medical institutions. The study was approved by the ethics committees of three federal centers: State Research Center for Preventive Medicine, Russian Cardiology Research and Production Complex and V.A. Almazov Federal Medical Research Center. The study was performed in compliance with good clinical practice (GCP) and the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their enrollment in the study. The response rate to the survey was approximately 80%, varying across the study regions.

Participants with missing data on diet (n=2,403) and smoking (n=6) were excluded from the final sample. Besides, a subsample of St. Petersburg (n=1,460 subjects) was excluded as significantly different in its regional characteristics from the other 12 regions. The city of St. Petersburg is classified in the Russian Federation as a separate administrative territorial unit, while the other 12 regions are large areas including both cities and countryside. Therefore, the final analytical sample included 18,054 people from 12 regions, including 6,814 men and 11,240 women.

2.2 Methods for assessing and analyzing the dietary patterns

Dietary preferences were assessed based on the results of face-to-face interviews on the frequency of consumption of 10 food groups: meat (beef, pork, lamb, etc.), fish and

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seafood, poultry (chicken, turkey, etc.), sausages and offal (tongue, liver, heart, etc.), pickled foods, cereals and pasta, fresh fruit and vegetables, legumes (beans, lentils, peas, etc.), sweets and pastries (candies, jams, cookies, etc.), and dairy products (milk, kefir and yogurt; high-fat varieties: sour cream, cream, cottage cheese and cheese). Since the goal of this study was to analyze the impact of regional living conditions on both a priori and a posteriori dietary patterns, the nutritional characteristics were determined using two corresponding methodological approaches [26].

For a posteriori assessment of nutrition, we used four empirical dietary patterns (EDPs), previously identified via the principal component method [23]: prudent EDP involving high consumption frequency of cereals and pasta, fruit and vegetables, sweets and confectionery, and dairy products; salt-rich EDP including frequent consumption of sausages and pickled products; meat-based EDP presuming high consumption frequency of red meat, fish and seafood, and poultry; mixed EDP involving frequent consumption of fish and seafood, pickled foods, and legumes. For each study participant, an individual assessment of predisposition to each of the four EDPs was calculated, with a normal distribution, mean equal 0 and standard deviation equal 1. Thus, the a posteriori assessment was characterized by an individual quantitative coefficient of predisposition to each of the four EDPs.

For a priori assessment of nutrition, a cardioprotective dietary pattern (CPDP) was used, which included the presence of the following eating habits: daily consumption of vegetables and fruit, eating fish at least 1-2 times a week, the exclusive use of vegetable oils for cooking, and consumption of dairy products with reduced fat content. A detailed description of CPDP was presented elsewhere [24].

2.3 Individual covariates

Characteristics that could potentially affect the examined relationships were taken as covariates for individual variables. Gender, age, and place of residence (urban/rural) were identified from the survey data. Some data were obtained through interviews: education level (higher/other than higher), family status (family/none), professional employment (employed/unemployed), smoking status (never smoked, quit smoking, current smoker), the presence of some diseases according to self-assessment (diseases of the liver, gallbladder, gastrointestinal tract, gastric or duodenal ulcer, diabetes mellitus). Body mass index was calculated as the body mass (in kg) divided by the square of the body height (in m2).

2.4 Regional variables

To describe regional living conditions, an integral index assessment was used, which was previously performed using the principal component analysis [27]. To identify regional indices, publicly available data from the official website of the Federal State Statistics Service of Russia (www.gks.ru) for 2010-2014 were used. In total, we identified five regional indices, which were quantitative indicators reflecting a negative (negative index values) or positive (positive index values) ratio in a particular region.

The socio-geographical index combines ten characteristics: (a) mean per capita consumption of vodka; (b) mean per capita consumption of wine; (c) mean per capita consumption of low alcohol beverages; (d) mean per capita consumption of cognac; (e) mean annual air temperature (negative load on the factor); (f) forested area in the region; (g) per capita crime rate; (h) the geographical latitude of the regional center location; (i) share of dilapidated housing; (j) shares of school students studying in the morning shift and afternoon shift. In general, an increase in this index value reflects the deterioration of the social environment and, simultaneously, the more northerly location of the region, implying its worse climatic conditions.

The demographic index is formed by five characteristics: (a) natural population growth (negative load); (b) total fertility rate (negative load); (c) crude death rate; (d) the proportion of retirement age people among the population; (e) mortality from respiratory

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diseases. A growth of this index value characterizes an increased demographic crisis in the region with depopulation and changes in the population age structure in favor of older age groups.

The industrial index includes eight characteristics: (a) the volume of mining; (b) electricity generation level; (c) tuberculosis mortality; (d) death rate from infectious diseases; (e) mortality rate from external causes; (f) the proportion of people in the region working in hazardous conditions; (g) population numbers in the region; (h) atmospheric emissions. An increase in this index value is indicative of the industrial development growth in the region, primarily due to mining and energy production, with a corresponding exposure of the workforce and inactive population to adverse anthropogenic effects.

There are five components incorporated into the mixed index: (a) the number of workers in fish farms; (b) the mean per capita volume of paid services; (c) the mean per capita number of motor vehicles; (d) ratio of men to women (negative load); (e) the geographical longitude of the regional center location. The mixed index is the most difficult to interpret, since, in general, it does allow unambiguous characterization based on the entirety of its constituent indicators.

The economic index is formed by five characteristics: (a) per capita retail trade volume; (b) mean per capita household consumption; (c) Gini index; (d) mean per capita income of the population; (e) the level of manufacturing industries in the region. An increase in this index value reflects the growth of economic development, income, and population economic inequality in the region.

2.5 Methods of statistical analysis

Categorical variables are presented as frequencies, while quantitative variables are presented as mean and its standard deviation. The examined data constituted a complex two-level sample with individual and regional characteristics. Hence, a generalized estimating equation with robust standard errors, taking into account the nested data structure (study subjects in regions, n=12), was used to measure associations. Since EDPs (prudent, salt-rich, meat-based, mixed) represent normally distributed scores, their associations with regional indices were estimated via linear regression models. CPDP represents a binary response; consequently, a logistic regression model was used for it. In linear models, associations are expressed by B-coefficient and level of statistical significance (p-value); in logistic models, they are characterized by odds ratio (OR) and 95% confidence interval (CI). All statistical models were adjusted for individual covariates: gender, age, place of residence, education level, family status, professional employment, smoking status, body mass index, and the presence of diabetes mellitus, gastric or duodenal ulcer, and diseases of the liver, gallbladder and gastrointestinal tract. Regional indices were entered into the regression models all together. During the pilot study, some interactions of gender with regional indices were revealed; therefore, in addition to the analysis in the general sample, we also performed separate analyses for men and women. To compare the significance of regional indices with confirmed individual predictors of dietary patterns, the values of effect parameters in Wald chi-squared models were calculated. The critical level of statistical significance was assumed at the value of 0.05. All statistical procedures were carried out in SPSS version 22 (IBM Corporation, USA).

3. Results

The analyzed sample was dominated by urban residents, with family, with education other than higher, professionally employed, non-smokers who never smoked (Table 1). Diseases of the liver, gallbladder and gastrointestinal tract were typical for 38.2%; gastric or duodenal ulcers were characteristic for 12.9%; diabetes mellitus was present in only 4.6%. The mean age in the sample was 46.4±11.6 years, while BMI was 28.1±5.9 kg/m2. For many parameters, there were differences between male and female study participants. Among women, the share of those a family, professionally employed and

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smokers was smaller, whereas the proportion of those with diseases of the liver, gallbladder, and gastrointestinal tract was higher.

Table 1. Main characteristics of the study sample.

Characteristics		Entire sample, 18,054	Men, 6,814	Women, 11,240
Place of residence, city		79.5% (14,351)	80.1% (5,459)	79.1% (8,892)
Family		64.7% (11,680)	76.1% (5,186)	57.8% (6,494)
Education, higher		42.2% (7,619)	43.0% (2,928)	41.7% (4,691)
Employment		75.7% (13,661)	83.3% (5,678)	71.0% (7,983)
Gastrointestinal diseases		38.2% (6,902)	27.7% (1,888)	44.6% (5,014)
Peptic ulcer disease		12.9% (2,325)	14.4% (979)	12.0% (1,346)
Diabetes mellitus		4.6% (833)	3.6% (243)	5.2% (590)
Smoking	Never	61.9% (11,165)	34.0% (2,316)	78.7% (8,849)
	Quit	16.6% (2,999)	27.7% (1,885)	9.9% (1,114)
	Smoker	21.5% (3,890)	38.3% (2,613)	11.4% (1,277)
Age		46.4±11.6	44.4±11.9	47.5±11.3
Body mass index		28.1±5.9	27.6±4.9	28.5±6.4
Socio-geographical index		0.015±0.943	0.110±0.903	-0.042±0.962
Demographic index		0.026±0.970	0.093±0.893	-0.014±1.011
Industrial index		-0.015±0.951	0.062±0.971	-0.062±0.936
Mixed index		0.045±1.055	0.077±1.090	0.026±1.032
Economic index		-0.021±0.951	-0.007±0.960	-0.030±0.946
Prudent dietary pattern (DP)		-0.011±1.001	-0.199±0.993	0.103±0.989
Salt-rich dietary pattern		0.021±0.991	0.223±0.960	-0.102±0.990
Meat-based dietary pattern		-0.004±1.008	0.104±0.962	-0.069±1.029
Mixed dietary pattern		0.003±1.007	-0.009±1.008	0.011±1.006
Cardioprotective dietary pattern		6.5% (1,169)	4.6% (312)	7.6% (857)

Table 2 demonstrates associations of full models in the general sample, including individual predictors and regional indices. In addition, Table S1-S2 presents the complete models separately for men and women.

Individual adherence to the prudent EDP increased with the growth of the mixed index, the B-coefficient was -0.054 at $p<0.001$. Besides, in women, but not in men, adherence to prudent EDP increased with deterioration of the social living conditions of the population and the more northerly location of the region of residence (socio-geographical index), the coefficient was 0.131 at $p=0.002$ (Table S1-S2).

The inverse association of individual adherence to salt-rich EDP with the mixed index was typical solely for men (B-coefficient value was -0.039 at $p<0.001$) but not for women (Table S1-S2).

Adherence to the meat-based EDP was directly associated with deterioration of the social living conditions of the population and the more northerly location of the region of residence (socio-geographical index), the coefficient was 0.103 at $p=0.046$.

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Table 2. Association of individual and regional characteristics with dietary patterns (n=18,054).

Characteristics		Prudent DP		Salt-rich DP		Meat-based DP		Mixed DP		Cardioprotective DP	
		B-coeff.	*p*-value	B-coeff.	*p*-value	B-coeff.	*p*-value	B-coeff.	*p*-value	OR	95% CI
Individual characteristics											
Gender (reference: women)		-0.221	<0.001	0.219	<0.001	0.083	<0.001	0.064	0.039	0.60	0.48-0.75
Place of residence (reference: city)		0.010	0.84	0.069	0.095	-0.056	0.34	-0.029	0.27	0.74	0.61-0.90
Family (reference: none)		0.057	<0.001	0.068	<0.001	0.150	<0.001	0.014	0.53	1.01	0.90-1.14
Education, (reference: other than higher)		0.117	<0.001	-0.168	<0.001	0.037	0.19	0.003	0.94	1.72	1.44-2.06
Employment (reference: unemployed)		0.039	0.067	0.091	<0.001	0.104	<0.001	-0.034	0.20	1.02	0.85-1.23
Gastrointestinal diseases (reference: none)		0.088	<0.001	-0.066	<0.001	0.017	0.63	-0.060	<0.001	1.01	0.89-1.14
Peptic ulcer disease (reference: none)		-0.023	0.50	0.011	0.67	0.041	0.028	-0.027	0.19	0.81	0.65-1.02
Diabetes mellitus (reference: none)		-0.507	<0.001	-0.364	<0.001	0.207	<0.001	0.18	<0.001	1.89	1.64-2.17
Smoking (reference: never)	Quit	-0.132	<0.001	-0.004	0.81	0.030	0.17	-0.062	0.006	1.07	0.93-1.23
	Smoker	-0.317	<0.001	0.158	<0.001	0.096	<0.001	-0.129	<0.001	0.67	0.55-0.81
Age		0.002	0.11	-0.010	<0.001	-0.001	0.28	0.008	<0.001	1.02	1.01-1.03
Body mass index		-0.008	<0.001	0.005	<0.001	0.012	<0.001	0.002	<0.001	1.01	0.99-1.02
Regional indices											
Socio-geographical index		0.095	0.076	-0.006	0.87	0.103	0.046	-0.063	0.18	1.23	1.08-1.41
Demographic index		0.039	0.37	0.043	0.22	0.039	0.42	-0.059	0.33	1.40	1.29-1.52
Industrial index		0.028	0.43	-0.025	0.31	0.059	0.12	-0.024	0.66	1.09	1.04-1.15
Mixed index		-0.054	<0.001	-0.025	0.051	0.018	0.21	0.086	<0.001	1.16	1.12-1.19
Economic index		0.009	0.86	0.013	0.67	0.077	0.20	-0.025	0.71	0.90	0.81-0.99

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Adherence to the mixed EDP increased with the growth of the mixed index, the B-factor value was 0.08, at $p<0.001$.

Associations with all regional indexes were typical for CPDP. The probability of CPDP was directly associated with socio-geographical (OR=1.23; 95% CI: 1.08-1.41), demographic (OR=1.40; 95% CI: 1.29-1.52), industrial (OR=1.09; 95% CI: 1.04-1.15), and mixed (OR=1.16; 95% CI: 1.12-1.19) indices. In other words, the probability of this dietary pattern increased with deterioration of social living conditions, aggravation of demographic crisis, and higher industrial development of the region. An inverse association of the CPDP probability was observed with the economic index (OR=0.90; 95% CI: 0.81-0.99): that is, with an increase in the economic development of the region, income and economic inequality of the population, the probability of CPDP declined.

Table 3 presents the significance of individual and regional predictors of dietary adherence. The contribution of a number of individual predictors was high, which complied with numerous published sources on the dependence of nutrition on individual biological and socioeconomic characteristics and health status. Against the background of confirmed individual predictors, the significance of regional indices in individual adherence to EDPs (prudent, salt-rich, meat-based and mixed) was rather low. Solely for prudent EDP and mixed EDP, we noted high contribution of the regional mixed index: 26.6 and 19.3, respectively. The contribution of regional indices (especially mixed and demographic) was rather high for CPDP: 84.2 and 64.2, respectively.

Table 3. The values of the model effect criteria (Type III Likelihood-Ratio Test, Wald Chi-Squared Test).

Characteristics	Prudent DP	Salt-rich DP	Meat-based DP	Mixed DP	Cardioprotective DP
Individual characteristics					
Gender	41.2	94.3	10.5	4.3	19.9
Place of residence	<0.1	2.8	0.9	1.2	9.4
Family	13.6	17.5	50.7	0.4	<0.1
Education	33.7	117.0	1.7	<0.1	34.8
Employment	3.3	15.8	61.3	1.6	<0.1
Gastrointestinal diseases	16.1	10.8	0.2	7.3	<0.1
Peptic ulcer disease	0.4	0.2	4.8	1.7	3.3
Diabetes mellitus	97.8	45.0	31.6	16.7	79.8
Smoking	181.0	38.7	24.3	25.5	23.7
Age	2.5	53.8	1.1	59.0	15.9
Body mass index	110.7	13.2	51.4	0.5	0.7
Regional indices					
Socio-geographical index	3.2	<0.1	4.0	1.8	9.7
Demographic index	0.8	1.5	0.6	1.0	64.2
Industrial index	0.6	1.0	2.4	0.2	11.0
Mixed index	26.6	3.8	1.5	19.3	84.2
Economic index	<0.1	0.2	1.6	0.1	4.6

4. Discussion

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Our results implied the impact of regional characteristics of the living environment on individual adherence to various dietary patterns, with some gender-based distinctions. EDPs (prudent, salt-rich, mixed) were predominantly associated with the mixed index. The latter is, regrettably, the most difficult to interpret. In addition, adherence to prudent EDP (for women) and meat-based EDP was associated with the socio-geographical index. Commitment to CPDP was connected with all regional indices.

From the standpoint of assessing diet as a behavioral risk factor affecting health, the dependence of population dietary patterns on regional living conditions was somehow surprising. As a rule, studies of dependence of eating habits on living environment at the scale of districts demonstrate the negative impact of the low socioeconomic status of the district (high unemployment rate, low income, low education level and low-paid jobs). For instance, a 2015 systematic review [18] discovered a positive association between low consumption of fruit and vegetables and living in disadvantaged neighborhoods, compared with prosperous areas, in two studies of the kind [28-29]. This finding was also confirmed by more recent studies. For example, in the Finnish population, cumulative socioeconomic disadvantage of neighborhoods was associated with poorer nutrition, whereas high population density exhibited relationship with better adherence to dietary recommendations [30].

In our study, adherence to the healthiest diet, CPDP, increased with deterioration of social and economic living conditions, aggravation of demographic situation, industrial development, and increased economic inequality. In women, similar associations with social living conditions were exhibited by prudent EDP, which was the healthiest of all EDP. On the other hand, adherence to the meat-based EDP involving frequent consumption of unprocessed red meat, fish and seafood, and poultry, was higher in socially disadvantaged regions as well. The discrepancy with the results of other studies within the framework of the health geography concept can be explained by two reasons. First, other studies operated on a smaller spatial scale representing the living environment; accordingly, the comparability of the effects on different geographic scales is one of the probable sources for detecting the multidirectional impact [31-33]. It is likely that patterns obvious at the level of districts do not manifest themselves, or manifest themselves differently, at a larger spatial scale (e.g., the national region).

Also (in our opinion, this was the crucial issue), other studies were carried out on samples of the population representing countries with a high level of economic development, and in addition, representing, in general, one cultural group (Western), while our results were quite expected from the standpoint of national Russian dietary preferences. A systematic analysis of dietary surveys around the world [1] showed that Russia fell into the category of rather low fruit consumption (100-124 g/day, grade 4 on the 10-grade scale) in the world rankings, but this was offset by a higher consumption of vegetables (200-250 g/day, grade 7). Consequently, the cumulative intake of fruit and vegetables in Russia was relatively high.

Furthermore, Russia is characterized by frequent consumption of dairy products and fruit juices [34]. In addition, Russia has the highest cumulative intake of animal products among the most populous countries (5.8 servings daily) [35]. E.g., there is traditionally high intake of unprocessed red meat (70-79 g/day, grade 8), processed meat (30-34 g/day, grade 7), and fish and seafood (30-34 g/day, grade 6) in Russia [1]. Overall, in Russia, against the background of a high frequency of cholesterol consumption with food, there is a rather high level of fat intake from vegetable products and seafood [36].

Since Russia belongs to countries with an average level of economic development, it is obvious that frequent consumption of such products is available to all segments of the population, including low-income households. That is to say, pursuing a healthy diet in Russia is not particularly expensive. For example, according to the PURE study, the absolute cost of various fruits in countries with an average level of economic development is the highest, while the cost of vegetables in such countries is the lowest (adjusted for parity of wholesale purchase prices) [37]. Another specific Russian feature is the tradi-

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tional development of personal subsidiary farms providing high all-season availability of vegetables, berries, and some fruits (primarily apples) for all segments of the population [38-39]. E.g., as of 2020, 27.4% of the total volume of agricultural production (in actual prices) in the entire Russian Federation was produced in personal subsidiary farms [38]. In certain federal districts, this figure exceeded 40%, reaching 60-70% in some regions. Furthermore, personal subsidiary plots and, consequently, augmented consumption of vegetables, berries and some fruit varieties prevailed among the most vulnerable population segments.

Thus, adherence to the healthy eating stereotypes and high intake of red meat are traditional and rather affordable to the Russian population. The results of our study confirmed that such traditional stereotypes of eating behavior were most characteristic of people in socially, economically, demographically and environmentally unfavorable living conditions (regions). Such regions host much higher proportions of the low-income, poorly educated, elderly, and socially vulnerable categories of the population. In adverse living environment, these population categories seem to prefer traditional stereotypes of eating behavior. In regression models, such patterns should supposedly manifest themselves via the effect of individual socioeconomic, rather than regional, characteristics on the adherence to dietary patterns. Consequently, we customized our analysis to individual characteristics (including those of a social nature) that could affect adherence to dietary patterns; and even then, the effect of regional living conditions was statistically significant. This finding implied that, regardless of individual characteristics, living environment affected individual eating behavior. Therefore, the behavioral habits of the predominant part of the population in disadvantaged regions were transferred onto the entire population of such regions, while individual differences were levelled off to a certain extent.

The theoretical substantiation of such environmental conditionality on nutrition is provided by numerous studies on the impact of perceived dietary norms on human eating behavior. As with other behaviors, perceived eating norms can act as behavioral cues of utility, “Everyone else behaves this way for some reason, so I should probably behave like this too” [14,40-41]. Despite the fact that behavioral cues exhibit the most pronounced influence on family members and socially close individuals [42-43], the perceived norms at the population level also affect health behaviors, including dietary preferences [14,44]. An interesting example of such influence is presented by Guendelman MD et al. [42]: two experiments confirmed that for the immigrants of Asian origin, the desire to prove their American identity motivated them to eat more typical American food, such as fast food.

It is worth noting that the augmented adherence to the meat-based EDP with the growth in the values of the socio-geographical index could be associated with the geographic component of the index rather than the social constituent alone. If we focus our attention on the geographic component, then the adherence to the meat-based EDP increases with the more northerly location of the region. Other studies also revealed a north-south gradient in the consumption of meat products [6] and animal products in general [45-46], which was associated with behavioral adaptation to cold environmental conditions [47-48].

It is not so easy to identify what exactly is the decisive regional factor, social matters or climatic/geographic conditions, because there is a strong interaction between the two. Hence, this issue will be a task for further analysis.

One of the advantages of our study is that for the first time an attempt was made to consider the dependence of individual dietary patterns on a wide range of living conditions of the population at the scale of national regions. The study was carried out on a large representative sample of the Russian population, which included 12 regions of all climatic and geographical zones nationwide (Central Region, Southern Region, Volga Region, Urals, Siberia, Far East), with the exception of the Far North.

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However, our results are somewhat limited. The main limitation is the use of the short version of the dietary pattern questionnaire lacking serving sizes. Albeit rare, such options for assessing diets, especially in the studies with large sample sizes, are carried out [49-50]. The food groups recognized in the study represent the foods most commonly consumed by the Russian population. They cover both healthy and unhealthy components of the diet. The cross-sectional nature of the study limits the results in terms of causal evidence for the findings. Another limitation of the study is represented by a relatively high proportion of missing data in the primary sample (11%). However, according to many authors, the strategy of removing missing data from the analysis with a sufficiently large sample size (listwise deletion) seems reasonable even if the gaps are not random [51]. This procedure was performed in the present study.

5. Conclusions

Thus, the results of our study showed that individual adherence to the healthiest dietary patterns in the Russian population increased with deterioration of social and economic living conditions, aggravation of demographic crisis, higher industrial development, and increased economic inequality. On the other hand, adherence to the meat-based EDP, which included a high frequency of consumption of unprocessed red meat, fish, seafood and poultry was higher in socially disadvantaged regions as well. The revealed patterns reflect the national preferences of Russians in the choice of food products. The effect of regional indices characterizes the environmental impact on the stereotypes of eating behavior: the behavioral habits of the predominant part of the regional population are transferred onto the entire population of this region, while individual differences are leveled off to a certain extent. The results of our study represent new fundamental knowledge in terms of the impact of the living environment on human behavior, complying with previously obtained data at the population level.

Supplementary Materials: The following supporting information can be downloaded at: www.mdpi.com/xxx/s1, Table S1: Association of individual and regional characteristics with dietary patterns in women (n=11,240); Table S2: Association of individual and regional characteristics with dietary patterns in men (n=6,814).

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