Criteria for assessing food consumption patterns in the brics countries in accordance with sustainable development goals

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Abstract. Achieving quality nutrition, food security, ending hunger, combating climate change and other challenges facing the world. These problems can be solved by building a sustainable food pattern. The aim of the article was to assess food patterns in accordance with sustainable development goals (2,3,12): the level of energy consumption and the structure of consumption (WHO recommendations gap), sustainable pattern gap, the share of imported food, the amount of harmful emissions. From the results obtained, the BRICS countries have not yet reached the goals of sustainability in the food system and require measures to change the food pattern: development of local farming, reducing the consumption of ultra-processed products, increasing organic products, reducing poverty and unemployment in the country, reducing the consumption of products that polluted the environment, reducing food waste and losses, buying rational quantities of products for eliminated the risk of product spoilage. These changes will help move towards sustainable food consumption.

1 Introduction

Achieving food security and improved nutrition - the second of the UN Sustainable Development Goals by 2030 - remains one of the most pressing development challenges in the world today [1]. Even before the pandemic, about 690 million people worldwide suffered from hunger, which is 8.9% of the world's population. This means that if the level of food security does not rise in the near future, then by 2050 the proportion of the population starving will increase several times. Daily energy consumption decreases below the norm, if vegetables and fruits do not become more accessible, then their consumption will also fall, as the population will prefer more high-calorie and affordable food (potatoes, cereals, sugar).

National policies and international programs aimed at providing quality and safe food necessary for a healthy and fulfilling lifestyle are becoming important [2,3]. In this regard, the focus of the study and subsequent adjustment is directed to the individual diet.

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Researchers Kearney J., Lowe B., Fraser I., Souza-Monteiro D. Vasileska A., Rechkoska G identify patterns of nutrition in individual countries [4-6]. The level of development of the food industry and the income of the population are named as key determinants. Thus, it is found that low-income consumers make the decision to replace the lack of calories (energy) with cheaper and more affordable products. Substitutes are potatoes, bread or pasta, that is, foods high in carbohydrates. [7].

Some studies show that increasing income does not always lead to quality nutrition [2]. For example, in China, when economic reforms took place, as a result of which income increased by 4 times, consumption of foods high in fat increased along with income. Consumption of animal products (meat products) increased by 30%, while consumption of traditional products (rice, wheat, vegetables) decreased.

It should be noted that urbanization has led to the dominance of large supermarkets with a wider range of products, leading to the globalization of food consumption patterns. The activity of the urban population is on average 10-15% lower than in rural areas. High-calorie eating patterns are more common in cities than in rural areas. Climate is one of the most important determinants of the food basket. In every country in the world the climate is different and, even in one country in different parts of the weather conditions may vary. Countries can be dominated by droughts, floods, hurricanes, storms, fires, thunderstorms and more. As for the climate, in some countries it is cold, in some hot, somewhere humid, and in some arid. F. Karpena found out that dry shock reduces the level of calorie intake and, consequently, macronutrients: fats, proteins and carbohydrates. The dietary pattern becomes poorer during a drought, and the population does not consume enough calories. [8].

In accordance with the above determinants, we can observe the dependence of the diet model on agriculture, productivity, economic development and the level of the country's welfare. This leads to the formation of food patterns characteristic of individual countries of the world. It should be recognized that it is important not only to consider the characteristics of dietary patterns, but also to what extent they correspond to the goals of sustainable development.

The **aim** of the study: to determine the nutritional patterns of the BRICS countries based on the proposed assessment criteria that meet the goals of sustainable development.

2 Materials and methods

The theoretical basis of the work was formed by the main provisions of the theory of consumer choice, the theory of food systems, a resource-saving approach to food production, and modeling of food recipes. The research is based on the method of ranking, systematization, comparison, generalization and interpretation of the results. The information base of the study is presented by the official statistics of the World Health Organization, the Food and Agriculture Organization of the United Nations, and the Ministry of Health of the Russian Federation.

3 Results and discussion

Evaluating the nutrition models of the Brics, which differ in climate, the level of development of agriculture, the economy as a whole, cultural and historical traditions, we saw their differences and the dependence of the models on the identified nutritional determinants.

Sustainable development is becoming more and more a part of every country, business, and household every year. Deteriorating environmental conditions, depletion of natural resources, climate change, and declining biodiversity are forcing the whole world to change its daily behavior for the well-being of the world as a whole. This also applies to the nutrition

of the population. The challenges of sustainability in the food system are also massive. The consequences of production and consumption affect the ecological, social and economic spheres of life.

A sustainable food system can be defined as a system that provides healthy food to meet current food needs while maintaining healthy ecosystems, that can also provide food for future generations with minimal negative impacts on the environment, and that rewards local production infrastructure and distribution, makes nutritious food available to all [9-12].

Thus, a sustainable eating model is a system that provides healthy food to meet current food needs while maintaining healthy ecosystems.

Let's single out the indicators according to which the power model can be considered sustainable: (1) a healthy and balanced diet; (2) affordable food; (3) local food, production and distribution infrastructure (short food supply chains); (4) minimal negative impact on the environment of the agricultural and food industries; (5) a healthy ecosystem for future generations.

It should be noted that a universal diet for each person is not called. The exact composition of a healthy, balanced, varied diet depends on individual characteristics such as lifestyle, level of physical activity, as well as on determinants (religion, income, climate, place of residence, etc.). All this influences the individual approach to the choice of the composition of the grocery basket.

The World Health Organization, the Ministry of Health of the Russian Federation recommend a balanced consumption structure bleaching of individual food items. A rational, sustainable model must be based on more than health-promoting recommendations. In connection with the aggravated situation related to pollution of water resources, climate change, deterioration of marine and terrestrial ecosystems, it is worth taking into account environmental problems. One of the solutions to the problem is organic (ecological) products.

Much of the work on sustainable models is focused on foods such as meat and dairy products. The main reason for the emission of greenhouse gases is due to natural causes. Namely, in the process of digestive activity of ruminants, methane is released. Therefore, special attention is paid to meat and dairy products. In earlier sources, meat is a food that should be limited for reasons of religion, health concerns, animal welfare concerns. Now, in more recent literature, the emphasis is increasingly shifting towards increasing sustainability by reducing the consumption of meat and dairy products. The authors also suggest reducing the consumption of these products in several ways. The first form is to reduce the portion size of meat and dairy products, the second form is to reduce the frequency of these foods by eating lean meals several times a week. To reduce your meat intake, you can replace it with other foods with unsaturated fats (fish, soy, lentils, beans, etc.). But there is also a risk that fish will replace meat in people's diets, thereby increasing pressure on fish stocks.

The food balance is a comprehensive picture of a country's food supply structure during a given reporting period. In the balance of food products for each type of food, sources of supply should be identified. The total quantity of food produced in a country, added to the total imported and adjusted for any changes in stocks that may have occurred since the beginning of the reporting period, gives the supply available during that period.

Thus, based on the above, we will propose key criteria for assessing a diet that meets the goals of sustainable development: 1) the level of energy consumption (calories) per day (comparison with the diet according to WHO recommendations); 2) consumption structure; 3) the gap in achieving a sustainable eating pattern; 4) the share of imported food products; 5) the amount of emissions of harmful substances.

Let's estimate the average amount of energy consumed by the population. The norm for the number of calories is 2800-3000. We will offer criteria for assessing the nutritional model on a scale from 0 to 1, where the highest score (1) is awarded to those countries that are included in the recommended norm. In accordance with this rating, the BRICS countries are

assessed according to the first criterion, namely the level of energy consumption (see Table 1).

Table 1. Estimation of total energy consumption in BRICS countries [7,9,13-17]

Country	Energy consumption (ccal)	Rang
Brazil	3215	0,7
China	3199	0,8
India	2425	0,6
Russia	3212	0,7
South Africa	2838	1

According to the results of evaluating the first criterion, it should be said that South Africa is in the normal zone, China is in second place, whose indicator tends to the norm. Brazil and Russia are rated the same. And India has the worst rate of all. India is in a calorie deficit per person per day.

The second assessment criterion is the level of consumption of food groups, which are presented in the recommendations from the Ministry of Health. 11 food groups represent approximately 90% of the diet. Unfortunately, the recommendations do not say anything about such products as nuts and legumes, so these groups are not included in the analysis and will not affect the rating of the BRICS countries.

The grading scale is also presented from 0 to 1, where 1 is the best grade (awarded to those countries that are included in the recommended norm, that is, the difference from the norm in percentage terms does not exceed 5%) and 0 is the worst. The data obtained are presented in table 2.

Table 2. The difference in food consumption from the sustainable model [1,13,14,18-21]

Product	Recommended kg / year / person	Sustainable pattern gap (%)				
		Brazil	China	India	Russia	South Africa
Wheat products	96	42,4	33	35,7	36,4	38,3
Cereals	29	172,4	345,8	303,7	40,4	318,4
Potato	90	45,5	29,7	66,5	12,3	64,0
Sugar	24	167,9	66,2	47,8	217,5	71,9
Butter	7	194,1	20,1	42,1	176,1	85,9
Vegetables	140	63,3	159,6	37,0	26,5	71,7
Fruits	100	0,3	0,1	39,1	37,4	77,3
Meat	76	33,7	12,5	94,2	5,0	8,7
Eggs	16	33,1	23,4	79,6	3,3	63,3
Milk	340	58,3	93,2	68,5	57,5	85,3
A fish	24	62,5	61,1	71,5	16,3	73,5

Comparing the countries, we can see that Brazil, China, India and South Africa are similar in that they consume a large amount of cereals, especially rice and corn. Russia stands out among other countries for the excessive consumption of flour products and potatoes. At first glance, China has the healthiest model among the BRICS countries due to the minimum consumption of sugar and butter, but at the same time consuming enough or even more vegetables. Russia and Brazil are different in that they consume more oil, sugar and alcohol

than other countries. India is characterized by the fact that it consumes in excess only those foods that really should be limited, namely, butter, sugar and cereals.

If countries are ranked according to the rating reflecting the quality of food, then the following conclusions can be drawn. China seems to be in the most advantageous position with an adequate consumption of vegetables and fruits, as well as a low consumption of butter and sugar. The second place is Russia, despite the high consumption of flour products and potatoes, Russia has good indicators of consumption of fruits, vegetables and dairy products. Then South Africa and Brazil, but Brazil loses in that it consumes more butter and sugar than South Africa (SA). India is short of the norm for almost all the necessary food products, at the same time, it consumes in excess of sugar, cereals and oil. These facts suggest that India has the worst nutritional model.

Table 3 presents calculations reflecting the difference between real consumption and the recommended rate (in percent), and regardless of whether the product is consumed in deficit or surplus, in any case the difference has a negative effect.

Table 3. Assessment of food supply for food groups in BRICS countries

Food partten	Brazil	China	India	Russia	SA
Ccal/day	0,7	0,8	0,6	0,7	1
Wheat products	0,6	0,7	0,6	0,6	0,6
Cereals	0	0	0	0,6	0
Potato	0,5	0,7	0,3	0,9	0,4
Sugar	0	0,3	0,5	0	0,3
Butter	0	0,8	0,6	0	0,1
Vegetables	0,4	1	0,6	0,7	0,3
Fruits	1	1	0,6	0,6	0,2
Meat	0,7	0,9	0,1	1	0,9
Eggs	0,7	0,8	0,2	1	0,9
Milk	0,4	0,1	0,3	0,4	0,2
A fish	0,4	0,4	0,3	0,8	0,3
Total	5.4 (0.45)	7.5 (0.63)	4.7 (0.39)	7.3 (0.61)	5.2 (0.43)

To understand whether the populations of countries can afford to eat sustainably, it is necessary to calculate the costs of real diets and compare them with sustainable ones. It is worth noting that if a population eats within an amount that is equal to or close to the sum of the rational model, then it can be concluded that a sustainable diet is available for a given country.

By calculating the cost of the diet for each country, it is possible to determine not only how much money is needed for a rational sustainable diet, but also to compare in which country food is more affordable (see Table 4).

Table 4. Comparative table of the cost of food models in the BRICS countries [13-14]

Product	Russia	South Africa	China	Brazil	India
Wheat	20,79	16,75	21,93	14,38	57,42
Eggs	19,06	9,78	26,02	22,68	0,62
Potato	16,48	7,24	20,44	26,69	12,67
Vegetables	63,66	40,89	359,66	30,92	46,13
Fruits	59,44	38,30	108,46	62,79	67,45
Cereals	3,11	17,13	56,41	17,43	84,28

Table 4. Continued

Meat	147,49	194,64	202,23	180,22	14,76
Milk	55,57	16,50	11,61	47,08	73,95
Sugar	88,38	1,41	1,76	1,32	
Cost of real food model	475,07	342,65	808,52	403,5	357,28
Cost of a rational food model	535,21	717,68	748,95	509,61	804,42
Accessibility assessment	0,9	0,5	1	0,8	0,4

Comparing the cost of a rational food model and the current food model, it became clear that the model is absolutely affordable for China, less available for Russia and Brazil. Estimates for South Africa and India show that among the BRICS countries, a sustainable diet is virtually unavailable.

Further, to assess the level of imported food products, data on the share of food imports were used. The amount of emissions of harmful substances is estimated by the volume of emissions of CH4, CO2, NO2. These emissions are calculated from the following activities: growing crops, using synthetic fertilizers, introducing manure into the soil, manure residues on pasture and burning plant residues. Since these indicators do not have a specific rational norm, they will be calculated from the maximum number among the BRICS countries. That is, the largest number of imports and emissions will be estimated at 0 points.

Table 5. Assessment of imports and emissions of the BRICS countries [13-14,18-25]

Country	Food imports (%)	Estimated level of imports	Emissions	Estimated level of emissions
Brazil	5,8	0,5	155221,4	0,6
Russia	11,7	0	25020,18	0,9
India	3,9	0,7	304327,9	0,3
China	6,64	0,4	404692,3	0
South Africa	7,23	0,4	12806,59	1

After evaluating all the criteria defined earlier, we get the following results. The total is also displayed on a scale of 0 to 1 based on averages. The Russian model turned out to be the best model of food consumption and was estimated at 0.60. Brazil (0.59) and South Africa (0.58) are practically on a par with Russia. Then China (0.51) and India (0.45), which are also close to each other in terms of nutrition. As the assessment shows, India has the worst performance among the BRICS countries.

Table 6. Total assessment of food patterns accordance with sustainable pattern

Criteria for evaluating food pattern	Rang				
	Brazil	China	India	Russia	SA
Calories per day	0.45	0.63	0.39	0.61	0.43
Sustainable pattern gap	0,8	1	0,4	0,9	0,5
Import level	0,5	0,4	0,7	0	0,4
Emission level	0,6	0	0,3	0,9	1
Final grade	0,59	0,51	0,45	0,60	0,58

Thus, after analyzing the food indicators of each of the BRICS countries, it was possible to assess the current situation with regard to the nutritional status of the population [26]. Weaknesses have been identified, namely food groups that are more detrimental to the diet and thereby reduce the level of sustainability of the food system. These foods include vegetables and fruits [27]. Also, it turned out to assess the availability of food in the BRICS countries, the level of imported food and the level of emissions from agriculture.

4 Conclusion

Achieving quality nutrition, food security, ending hunger, combating climate change and many other challenges facing the UN and the world. Part of these goals can be solved by creating a sustainable dietary pattern. Diet changes are essential for a sustainable future.

Thus, based on data on food consumption in the BRICS countries, it was possible to draw conclusions about the prevailing patterns of food consumption. It became clear that Brazil, China, India and South Africa consume excessive amounts of cereals such as rice and corn, while Russia attaches great importance to wheat products and potatoes in its model. All countries, except China, do not consume enough vegetables, thereby reducing the level of the country's nutritional model. China stands out among the rest for the minimum consumption of butter and sugar. And India, in comparison with other BRICS countries, consumes the smallest amount of energy compared to the recommended amount.

From the results obtained, it is clear that the BRICS countries have not yet reached the goals of sustainability in the food system and require significant measures to change the nutritional model. Such as the development of local farming, reducing the consumption of ultra-processed products, policies aimed at reducing poverty and unemployment in the country, reducing the consumption of products that have a burden on the environment, or completely abandoning them in the direction of organic products, it is also worth reducing the level of food waste and losses, that is, to reduce waste when transporting food, and consumers to buy rational quantities of products in order to reduce the risk of product spoilage [28]. All of these changes will help move towards sustainable food consumption.

References

1. WHO. Malnutrition (2020). https://www.who.int/
2. WHO. Healthy eating (2018). https://www.who.int/
3. A. Prosekov, S. Ivanova, Geoforum, **91**, 73-77 (2018)
4. J. Kearney, *Food consumption trends and drivers, Philosophical Transactions of the Royal Society*, 365 (2010)
5. A. Kolesnyak, I. Kolesnyak, IOP Conference Series: Earth and Environmental Science, 315 (2019)
6. ROSPOTREBNADZOR. Recommendations for citizens: healthy eating (2019). https://www.rospotrebnadzor.ru/
7. L. R. G. Guilhermea, A. S. Lopes, A. P. Corguinha, *Challenges and opportunities for a sustainable agriculture in Brazil* (2018)
8. J. Guthrie, L. Mancino, C. Lin, Psychology & Marketing, **32**, 501-511 (2015)
9. Ministry of Health. Information on the permissible norms for the consumption of alcoholic beverages (2017). https://minzdrav.gov.ru/

10. T. Allen, P. Prosperi. Modeling Sustainable Food Systems, Environmental Management, **57**, 956-975 (2016)
11. S. Coderoni, M. Perito, Journal of Cleaner Production, 252 (2020)
12. A. Azzurra, A. Massimiliano, M. Angela, Sustainable Production and Consumption, **17**, 95-107 (2019)
13. FAO and WHO. Sustainable Healthy Eating. Guidelines (2020)
14. FAO. http://www.fao.org/
15. Yu. G. Bendersky, I. V. Varfolomeev, A. P. Lopatin, *Problems of the Economic Assessment of the Natural Resource Potential of the Krasnoyarsk Territory* (2001)
16. M. Verain, H. Dagevos, G. Antonides, Appetite, **91**, 375-384 (2015)
17. X. Jiao, N. Mongoi, Journal of Integrative Agriculture, **17**, 755-764 (2018)
18. X. Liu, S. Zhang, J. Bae, Applied Energy, 204, 489-496 (2017)
19. P. N. Lomakin, Ensuring food security in Russia: internal and international aspects (2017)
20. L. F. Pinto, R. Hajjar, P. Newton, A. Agrawal, D. Adshead, D. Bini, M. Bogaerts, L. Cirhigiri, V. Maguire-Rajpaul, A. Chaves, C. Dermott, J. Milder, P. Pinho, I. Robinson, M. Rodkin, E. Wollenberg. *Transitioning to more sustainable, low emissions agriculture in Brazil, Climate Change, Agriculture and Food Security* (2016)
21. P. Priyadarshini, P. Abhilash, Land Use Policy, **96** (2016)
22. L. Ronquest-Ross, N. Vink, G. Sigge, South African Journal of Science (2015)
23. L. Reisch, U. Eberle, S. Lorek, Sustainability: Science, Practice and Policy, **9**, 7-25 (2013)
24. C. Tobler, V. Visschers, M. Siegrist, Appetite, **57**, 674-682 (2011)
25. J. Aertsens, W. Verbeke, K. Mondelaers, G. Huylenbroeck, British Food Journal, **111**, 1140-1167 (2009)
26. A. Vasileska, G. Rechkoska, Procedia – Social and Behavioral Sciences, **44**, 363-369 (2012)
27. K. Rask, N. Rask, Food Policy, **36**, 186-196 (2011)
28. B. Lowe, I. Fraser, D. Souza-Monteiro, Psychology & Marketing, **32**, 481-485 (2015)
29. S. Haggblade, N. Ne-Nsope, J. Staatz, Food Policy, **71**, 27-38 (2017)