

Article

Intelligence, Income and Their Relation to Nutrition

Rodrigo Focosi Mazzei ^{1,*}, Mayra Antonelli-Ponti ¹ , Sebastião de Sousa Almeida ¹,
Tania Regina Riul ² and José Aparecido Da Silva ¹

¹ Psychobiology Unit, University of São Paulo at Ribeirão Preto, 14040-901 Ribeirão Preto, Brazil; antonelli.may@gmail.com (M.A.-P.); sebasalm@usp.br (S.d.S.A.); jadsilva@ffclrp.usp.br (J.A.D.S.)

² Faculty of Biological and Health Sciences, Federal University of Jequitinhonha and Mucuri Valleys, 39100-000 Diamantina, Brazil; taniriul@yahoo.com.br

* Correspondence: rodrigomazzei@usp.br

Received: 21 October 2019; Accepted: 17 December 2019; Published: 20 December 2019



Abstract: The aim of this study was to investigate the effects of intelligence and income on nutrition in Brazil, by means of large-scale secondary data. The cognitive abilities of students were used as a measure of intelligence. In order to evaluate the nutritional quality of the population, the state hunger and undernutrition index (SHUI) was created. The intelligence explained 34% of the SHUI variation in the country. The development of the population's intelligence influences the decrease in the rates of hunger and undernutrition.

Keywords: intelligence; cognitive abilities; income; undernutrition

1. Introduction

1.1. Intelligence and Their Effects on Social Indicators

General intelligence was defined as a global factor, explanatory of the common variability found in the performance of an individual or of a group of people in different mental tests [1]. In each area of knowledge evaluated, in order for someone's intelligence to be measured, there are several specific tests, which are considerably correlated with each other. It should be highlighted that general intelligence has a positive and high correlation with academic and social performance indicators, either at the individual or collective level [2–5].

The intelligence was estimated by the school achievement of an individual or population [2,3,5]. The average school achievement of the nations' inhabitants correlated positively with the population's intelligence in 187 countries ($r = 0.93$) [6]. In this sense, some authors use the students' cognitive abilities (CAs), represented by the students' scores in the Programme for International Student Assessment (PISA), as intelligence estimates [7,8].

In addition to studies that compared intelligence between countries, the differences in intelligence were studied inside of a nation [8–12]. In this context of comparing different populations' intelligences, the research on this theme and its implications for the social indicators in Brazil's states and the Federal District (FD) of Brasilia are important since the country has an extensive territorial dimension; these states contain areas similar to the areas of several nations.

The evidence suggests that intelligence explains a portion of the variations in social indicators. People's cognitive traits could be responsible for the environments that they created [3,13] and are related to a better quality of life [7]. From this perspective, Meisenberg [14] affirmed that intelligence is the greatest force influencing the socioeconomic development of a nation. Da Silva [2,3] explained that a high intelligence does not determine whether a person or social group will have good social indicators. However, it does increase the possibility of this happening.

Among the fundamental social indicators which are representative of the quality of life of different states or nations, one is food and nutrition. The countries with greater CA population averages had a greater likelihood of having better social indicators when compared to countries with lower CA population averages [6,15].

1.2. Factors That Can Influence Intelligence

Due to the centrality of intelligence in explaining the variability of a country's living conditions, it is necessary to investigate the factors that can modify intelligence. There are economic, familial, biological, geographic, sociocultural, psychological, gender and school variables, among others, that can influence the intelligence of human beings and, consequently, provide positive results in their lives, as measured by social indicators [16].

Lynn et al. [7], using spatial analysis, did not find statistically significant correlations between students' intelligence, estimated by the PISA, and the per capita income in the 26 states and the FD of Brazil. However, positive and statistically significant correlations between per capita income and population intelligence were found by other authors when spatial analysis was not used; in Turkey [8], in the United Kingdom [11] and also in Brazil [7].

The country's quality of life is fundamental for the nation's progress. Better sanitation, health and nutrition rates positively influence a country's progress in income, employment, life expectancy and schooling [15,17]. In a study in Brazil, socio-environmental factors such as increased cognitive stimulation and better nutrition of children were identified as explanatory variables of the major intelligence increase [18].

An incident of malnutrition at the beginning of a person's life can affect their entire body development, with negative consequences for their biological development, even with subsequent nutritional recovery [17,19]. If people without enough nutrition perform below their real potential, the society suffers the consequences. Lynn et al. [7] pointed out that people or social groups with greater intelligence create a better world to live in and this can be measured by social indicators, here estimated by nutritional measures [3,7,13].

Malnutrition remains a key cause of poor health and mortality. The nutrition-related targets of the Millennium Development Goals (MDGs) were not fully achieved: nearly 800 million people remain chronically undernourished. In 2015, over 156 million children under five years of age were stunted and 51 million were wasted. A solid nutritional start has an impact for life on the child's cognitive, social and physical development [20].

The 2018 Global Nutrition Report tracked a country's progress against the targets regarding "child obesity, child wasting, child stunting, exclusive breastfeeding, diabetes among women, diabetes among men, anemia in women of reproductive age, obesity among women and obesity among men". Brazil is on track for none of the nine targets. In this report, "a country was considered 'burdened' by a malnutrition indicator depending on whether the national prevalence was greater than a certain cut-off. Stunting was measured in children aged under five and its burden limit was 20% or more. Anemia among women of reproductive age (15–49 years) had the same 20% or more cut-off, and for overweight women (18 or more), this was 35% or more". Countries were analyzed over the three malnutrition indicators. Brazil suffers from two burdens of malnutrition: anemia and obesity [21].

To achieve a society with equity, inclusion, peace and stability, we have to achieve the basic access to quality nutrition [22], and, for this, real actions must be made [20], as well as maybe more motivations and data that prove the importance of good nutrition for social development.

A review study about malnutrition and cognitive abilities (CAs) highlighted the associations between economic development, CAs and good nutrition [17]. Another review study emphasized intelligence as the central construct for explaining the variation of social indicators, and is considered a cause of a country's economic progress [6].

Therefore, this research focused on the relationships between the intelligence, income and malnutrition of Brazilians. The aim of this study was to evaluate the reciprocal influences between

these three variables. The hypotheses of the present study considered that intelligence and income per capita are positively associated in Brazilian states, but intelligence explains a greater variation in malnutrition than per capita income. On the other hand, the last hypothesis considered that nutritional variables may explain the variation of the intelligence of a country's population.

2. Material and Method

2.1. The Programme for International Student Assessment (PISA) Indexes

One of the instruments used as a measure of intelligence, the PISA, evaluated the cognitive abilities (CAs) of students from 15 years and two months of age to 16 years and three months of age who did not necessarily aim to attend university. The PISA consists of an assessment applied by the Organization for Economic Co-operation and Development (OECD), an international body, composed of 34 nations and based in Paris, France. The OECD aims to propose policies that promote the economic development and the social well-being of people around the world [23]. The main objective of the PISA is to develop indicators that contribute to the debate on the quality of basic education and that serve as parameters for national policies to improve education. The National Institute of Studies and Research (INEP) is responsible for the application of the PISA tests in all the states and the FD of Brazil. As was previously mentioned, the students' scores on the PISA tests were used by several authors as intelligence estimates of the population to which the students belonged [7,8].

It was only in the years 2006, 2009, 2012 and 2015 that the PISA results were made available in regard to the 26 states and the FD of Brazil, and therefore the average CAs of each state's population could be compared with each other [23]. With the data from this international evaluation from these four years, the PISA indexes were prepared for the states and the FD in order to estimate the general intelligence of the states and FD inhabitants. These indexes consisted of the proportions of the average scores of each state or the FD's students in relation to the students' average scores with the students' best average in the PISA. Therefore, for each state or the FD, a PISA index was developed, which consisted of a weighted average (by the number of students participating in the PISA, in each year analyzed) of the students' scores in three subjects (Mathematics, Science and Reading). Such a PISA index estimates the average general intelligence of the states' and the FD's populations.

The advantage of working with index numbers was that the average scores of the states' and the FDs' students could be compared proportionally, having as a reference (or base) the state (or the FD) with the highest average of students in the PISA. The index's base 100 for the state (or the FD) was arbitrated with the highest average student score. The PISA indexes of the other states (or the FD) were calculated in relation to this common base.

For the construction of the PISA indexes, the students' average scores in the years 2006, 2009, 2012 and 2015 were used, in plausible values (PV), which allowed the sample size of the states' (or the FD's) students that participated in the evaluation to be increased. This was done as a way to validly and reliably estimate the intelligence of the states' (and the FD's) inhabitants. These scores were obtained through the OECD's email address [23]. From 2006 until 2012, five PVs were made available by the OECD triennially, and, in 2015, 10 PVs for each state (and the FD) were made available [23].

In the construction of the PISA indexes, first, for the year 2006, the students' average scores in each state and the FD of Brazil were used, in PVs, in each one of the specific subjects that make up the PISA, considered individually: Mathematics, Reading and Science. After this, the general average of the students' scores in the three subjects, taken together, were calculated through a simple arithmetic mean. This procedure was also carried out for the years 2009, 2012 and 2015. Finally, taking into account the PVs, it was calculated:

1. A weighted average, by the number of the sample in each year, considering one set of years: (2006, 2009 and 2012) for each one of the specific PISA disciplines considered individually (Mathematics, Science and Reading). Thus, an average score of each PISA discipline was obtained.

2. A weighted average, by the number of the sample in each year, of the general averages of the students' scores in Mathematics, Reading and Science in one set of years: (2006, 2009 and 2012). In this way, a general score was obtained for each set, which estimated the average general intelligence of the states and the FD's inhabitants.

In 2006, 2009, 2012 and 2015, considering the PVs, the number of students who participated in the PISA in Brazil was 8,542,044, due to the use of PV, which increased the sample size. The mean and standard deviation of student performance in the three PISA disciplines in Brazil in the same four years were 388.28 and 82.63, respectively. The PISA consists of a standardized evaluation with an expected mean and standard deviation of 500 and 100, respectively [23]. The students' average scores in the PISA over several years were calculated to be related to the income and nutritional indicator averages of the states and the FD from the respective years. The exception was the indicator related to exclusive infant breastfeeding until the child's 30th day of life, which was used in 2008. This was the most recent date in which data on breastfeeding was published in all Brazilian states (and the FD).

2.2. The per Capita Income

The per capita income was converted into index numbers in order to facilitate the comparison of this data from the states and the FD in proportions and leave them with variations similar to the PISA indexes for the multiple linear regression calculations. In the calculations of per capita income in 2006 and 2009, the average monthly income, in Reais (R\$), was used for all workers aged 10 years or older working during the reference week, with income from work in the states. In 2012, the average monthly real income, in R\$, was used for all the workers aged 15 years or older, working during the reference week, with income from work. In 2015, the monthly nominal household per capita income was used, in R\$, from the resident population in the Brazilian states [24].

2.3. The State Hunger and Undernutrition Index (SHUI)

A World Health Organization Global Database on Child Growth and Malnutrition [25,26] emphasized that three concepts can be highlighted when studying the malnutrition indexes: hunger, undernutrition and malnutrition (including overnutrition). For the composition of the SHUI, food and nutritional indicators estimated the inequalities related to hunger and undernutrition among Brazil's states and the FD.

In order to form a SHUI for each Brazilian state and the FD, the average of the three food and nutritional indicators was calculated. The various indicators initially had different metrics, since their percentages varied only in the decimal places of a number in the ones or the tens place. To solve this problem, each food and nutritional indicator of the states and the FD was multiplied by a constant so that they ranged among the states and the FD on a scale from zero to 100, approximately, and thus received the same weight in the SHUI composition, as suggested by Vanhanen [15].

In the SHUI, the states (including the FD) with the lowest rates had fewer problems related to hunger and undernutrition in their populations. In this way, in the indicator that analyzed the infant breastfeeding in the Brazilian states and the FD, the percentage of infant breastfeeding in each Brazilian state or the FD was subtracted from 100 so that the states with the highest percentages of infant breastfeeding had the lowest scores. The three nutritional indicators that made up the SHUI and its detailed definitions were:

1. Inverted percentage of exclusive breastfeeding among the capitals of Brazil's states in the first 30 days of the child's life in 2008 [27]. For the calculation of the inverted breastfeeding, ranging from zero to 100 in the states, the following formula was used: $\text{inv. breastfeeding} = 100 - \{[(\text{breastfeeding \%}) - 39] \cdot 2.5\}$.

2. Proportion of malnourished children under the age of two in 2006. This variable consisted of the percentage of children under age two with a low weight for their age [28]. For this indicator's data to range from zero to 100, approximately, the percentages of malnourished children from each state

were converted with the following formula: malnourished children = (malnourished children %) 100 / 7).

3. Sum of the percentages of people who were at the poverty line and at the extreme poverty line related to caloric needs, in each Brazilian state in 2006, 2009 and 2012 [13]. The extreme poverty line (half of the poverty line), based on caloric needs, consisted of the percentage of people in the total population with per capita household income lower than the poverty line, which was an estimate of the value of a food basket with the minimum calories needed to adequately supply a person, based on FAO and WHO recommendations [29]. In order for this indicator's data to range from zero to 100, approximately, they were converted with the following formula: population with caloric deficiency = (population with caloric deficiency %) 100 / 67.17.

2.4. Variables That can Influence Intelligence: Infant Breastfeeding, Child Malnutrition and Poverty Related to Caloric Needs

In order to investigate the factors that can influence the intelligence of the Brazilian states' (and the FD's) inhabitants, the correlations of the three variables that made up the SHUI (infant breastfeeding, child malnutrition and poverty related to caloric needs) were calculated with the population's intelligence in each state and the FD.

3. Analysis of the Data

Spatial analysis was used to compare the indexes (from the PISA, from income and from the SHUI) of a Brazilian state and the FD with the index averages from neighboring (or bordering) states. In the spatial analyses, to calculate an index representative of a state, the indexes of the neighboring states were considered—that is, those that had a territorial border between them. In order to obtain an index of Rio de Janeiro's PISA, for example, the gross social indicator of this state was considered in the spatial analysis, which was subtracted from the average of the neighboring states, which in this case were Espírito Santo, Minas Gerais and São Paulo. Thus, in relation to the students' scores, the differences in the PISA index of each state and the FD were investigated in relation to the average of the PISA indexes of the neighboring states. Spatial analysis was used to clarify at what geographic scale these correlations arise [7]. The spatial analysis was used to compare the other variables (per capita income, SHUI, infant breastfeeding, child malnutrition and poverty based on caloric needs).

4. Results and Discussion

4.1. The Associations Among Intelligence, Per Capita Income and Undernutrition

In a model of linear regression, after the conversion of the variables analyzed with spatial analysis, the intelligence and the per capita income of the population of Brazil's states (and the FD) predicted, together, 35.3% of the variation of the state hunger and undernutrition index (SHUI) in Brazil's states and the FD, and the effect size (n^2p) was too large for intelligence and income per capita ($p = 0.005$; $n^2p = 1$; $n^2p = 1$), but only the intelligence alone explained, in a statistically significant way, the 34% variability of the SHUI in Brazil's states and the FD. For each unit of variation in the PISA index, there was a decrease of more than 0.5 points in the SHUI when the effects of per capita income on the SHUI of the states were controlled ($b = -0.528$; $p = 0.008$; $n^2p = 1$). On the other hand, per capita income, when its effects were controlled by the intelligence, did not explain the variation of the SHUI ($p = 0.494$; $n^2p = 1$). This means that there is a strong association between nutrition, per capita income and intelligence, but that intelligence is a better predictor than the per capita income of SHUI variation in Brazil. Lynn et al. [7] concluded that people with higher intelligence are more likely to be knowledgeable about nutrition. They explained that "successful efforts at raising the average cognitive level of the population can produce multiple benefits, even independent of their effects on economic growth".

According to Nisbett [16] low income, associated with the lowest intelligence, enhances the effect of elevated rates of population hunger and undernutrition, corroborating with Meisenberg's [14]

conception about the relevance of intelligence. Other studies have also highlighted the strong correlations, including in Brazil, between intelligence and social phenomena [7,15]. In summary, there is, in Brazil, an inversely proportional relationship between intelligence and the SHUI. In general, the states with the highest PISA indexes have higher income indexes and lower SHUIs (Table 1). It should be highlighted that the associations between per capita income, intelligence and social indicators are probabilistic and not deterministic, or rather, the increase in intelligence provided (not determined) a higher probability of an elevation of per capita income and of other social indicators [7].

Table 1. Programme for International Student Assessment (PISA) indexes, income indexes, and state hunger and undernutrition indexes (SHUIs) in Brazil's 26 states and the Federal District (FD) of Brasília. Base (PISA and income indexes): FD = 100.

States and FD	PISA Indexes	Income Indexes	SHUIs
Rondônia	91.32	49.79	38.21
Acre	85.35	49.06	73.67
Amazonas	85.92	43.23	49.64
Roraima	86.94	48.62	42.67
Pará	88.22	37.27	43.01
Amapá	87.10	50.58	35.05
Tocantins	87.02	43.04	48.83
Maranhão	84.41	36.23	80.20
Piauí	89.56	30.18	65.55
Ceará	88.13	31.75	81.32
Rio Grande do Norte	87.04	38.11	53.90
Paraíba	91.57	35.95	56.09
Pernambuco	85.87	35.60	61.77
Alagoas	83.00	35.24	90.47
Sergipe	89.14	38.47	62.37
Bahia	87.01	35.22	75.90
Minas Gerais	94.04	47.84	38.59
Espírito Santo	91.39	49.91	24.66
Rio de Janeiro	93.81	61.85	30.61
São Paulo	93.97	72.60	26.83
Paraná	96.78	57.46	28.22
Santa Catarina	99.20	61.75	10.65
Rio Grande do Sul	98.11	55.35	30.23
Mato Grosso do Sul	92.89	54.52	23.87
Mato Grosso	90.57	55.04	47.82
Goiás	90.81	50.97	37.78
Brasília (FD)	100.00	100.00	15.56

Sources: [23,24,27–31].

Another important result of this study was the positive and statistically significant correlations between intelligence and per capita income, both for the mean of the years 2006, 2009 and 2012 ($r = 0.44$; $p = 0.011$; $n^2p = 1$) and for the mean of the years 2009, 2012 and 2015 ($r = 0.50$; $p = 0.004$; $n^2p = 1$). Flores-Mendoza et al. [32], although they did not use spatial analysis, calculated the impacts of adult cognitive performances in four Brazilian states: Amazonas, Bahia, Minas Gerais and São Paulo and inferred, in opposition to the results of the present research, that intelligence is not a good indicator of economic factors.

Lynn et al. [7] also did not find statistically significant correlations between per capita income and the intelligence in Brazil's states and the FD. Although spatial analysis was used, they only calculated the correlations between income and intelligence in a single year. This is probably the reason why they did not find statistically significant correlations. The present study, however, made the comparisons between these two variables for four different years. This allowed for greater assertiveness in the result about the correlations between the economic variable and the cognitive variable.

4.2. Nutritional Quality Explains Variations in the Intelligence of a Country's Population

The population's intelligence in Brazil's states and the FD correlated with the following variables in a statistically significant way: (a) exclusive breastfeeding in children with up to 30 days of life % ($r = 0.46$; $p = 0.015$; $n^2p = 0.99$), (b) malnourished children, from zero to two years old % ($r = -0.42$; $p = 0.029$; $n^2p = 0.98$) and (c) the sum of people living in poverty and extreme poverty related to caloric needs % ($r = -0.41$; $p = -0.034$; $n^2p = 1$). This means that the increasing breastfeeding rates, the decreasing child malnutrition rates and the decreasing poverty related to caloric needs can have positive effects on the development of intelligence among a nation's inhabitants.

Nisbett [16] pointed out that individual or socio-environmental conditions must be in an optimal state so that the development of each individual's or population's genetic potential can be developed in the most efficient way. Rushton and Jensen [33] emphasized that during the critical period of brain development, undernutrition can decrease the number of neurons and synapses, which are the biological bases of cognitive abilities (CAs). These studies consider social factors such as undernutrition, poor sanitary conditions and health, parasitic diseases, lack of hospitals, electricity, educational institutions and low rates of schooling, which are commonly found in countries with low socioeconomic status, to impede the full development of people's CAs [16,17,25,33,34].

Levitsky and Barnes [35], despite not considering the structural modifications caused by undernutrition, such as the decrease in number and size of cerebral brain cells, considered the functional isolation hypothesis. This hypothesis claims that the cognitive *deficit* found in malnourished individuals originates from behavioral influences, since malnutrition produces apathetic behavior in order for the individual to conserve energy, which impairs their ideal cognitive development. In people, this affected behavior is defined by apathy and social isolation. Laus et al. [17], in a review on the subject, explained that malnourished children have insufficient energy to benefit from learning processes and social contacts because they were more apathetic and took advantage of the environment with less enthusiasm when compared to well-nourished children.

In this sense, the goal of sustainable development that advocates the eradication of hunger must be achieved so that others can be achieved [20,22,36]. Countries will not grow their educational scores by neglecting the proper nutrition of their population, especially children.

5. Conclusions and Final Considerations

The average general intelligence and the income per capita of the states and the FD populations in Brazil and their respective rates of infant breastfeeding, hunger and undernutrition have reciprocal influences, besides being strategic factors that, if improved, can contribute to the improvement of people's living conditions. The rates of infant breastfeeding and malnutrition correlate in a statistically significant way with the intelligence of the students in Brazil's states and the FD. If access to food does not satisfactorily take place in terms of minimum nutrients and calories for a healthy diet in a state of the country, the intelligence of the individuals from this state is not fully developed. The reverse path also occurs. In a state where the inhabitants have low general intelligence averages, people have, on average, less access to the minimum amount of food, in calories and nutrients, recommended for a healthy diet.

In this way, the poor food and nutritional conditions found in poor populations in Brazil are responsible for reproducing the conditions of poverty related to caloric needs, hunger and undernutrition in the country. These situations of indigence, by not allowing the minimum food and nutrition conditions necessary for the full cognitive development of individuals, help to keep these people's CAs far below what is necessary for them to leave these vulnerable conditions of caloric and nutritional poverty.

It should be emphasized that equality should not be pursued, both in cognitive abilities (CAs) and in social indicators, since there are no individuals and, consequently, social groups that are identical, either genetically or socially. However, decent conditions can be provided to people in terms of food, nutrition and education, so that they are not impaired in their cognitive development and, consequently,

in other social indicators. Therefore, it is necessary to know what social investments are most effective in improving a population's quality of life.

Investments in the early years of schooling, for example, correlate positively with the better educational quality of a country. Brazil's investment per primary school student annually is 45% of the average investment of the OECD nations. This may explain, at least in part, why Brazilian students have one of the worst performances in the PISA, considering all the countries participating in this assessment in the years 2006, 2009, 2012 and 2015 [37].

Other studies may broaden the understanding of the variables that explain the variation of intelligence, which is a better predictive factor than income in the reduction of hunger and undernutrition in Brazil. In a study that analyzed an African country, for example, it was found that children's school performance, an estimate of intelligence, was strongly influenced by the school's positive appreciation by families. That is, parents who valued and encouraged their children's education positively influenced their children's school performance [38].

This present study has limitations, mainly related to differences among samples, despite being representative of the population. Besides that, other studies outlined with compatible samples will be useful and welcome to confirm these results. Nevertheless, it allowed us to highlight the centrality of the intelligence construct to explain the variation of nutritional indicators related to hunger and undernutrition among the country's states. In addition, because we worked with the average of the indicators over several years and with spatial analysis, it was possible to identify statistically significant relationships between intelligence and per capita income in the 27 Brazilian states, which were not found in previous studies in Brazil. Thus, the current research contributed to the understanding of intelligence, income and nutritional associations in the Brazilian scenario, where these three variables are strongly related and are key to explaining the country's social development.

Author Contributions: Conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing—original draft preparation, writing—review and editing, visualization, supervision, project administration, R.F.M., M.A.-P., S.d.S.A., T.R.R. and J.A.D.S. All authors have read and agree to the published version of the manuscript.

Funding: This research received no external funding.

Acknowledgments: The authors appreciate João Luís Segala Borin, Alexander Wolff Rossato, Lívia Romano Mendes, Telma Maria Braga Costa, Daniela Saes Sartoreli, Jair Lopes Junior, Maria Fernanda Laus, João Marôco, Naiany Faustino da Silva and Aaron Michael Kuczmarski de Oliveira by technical support.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Spearman, C.E. General intelligence, objectively determined and measured. *Am. J. Psychol.* **1904**, *15*, 201–293. [CrossRef]
2. Da Silva, J.A. *Inteligência: Resultado da genética, do ambiente ou de ambos?* Lovise: São Paulo, Brazil, 2005.
3. Da Silva, J.A.; Ribeiro-Filho, N.P.; Santos, R.C. Inteligência humana e suas implicações. *Temas em Psicologia* **2012**, *20*, 155–187. Available online: <http://pepsic.bvsalud.org/pdf/tp/v20n1/v20n1a12.pdf>. (accessed on 27 May 2019).
4. Deary, I.J.; Strand, S.; Smith, P.; Fernandes, C. Intelligence and educational achievement. *Intelligence* **2007**, *35*, 13–21. [CrossRef]
5. León, F.R.; León, A.B. Why complex cognitive ability increases with absolute latitude. *Intelligence* **2014**, *46*, 291–299. [CrossRef]
6. Lynn, R.; Vanhanen, T. National IQs: A review of their educational, cognitive, economic, political, demographic, sociological, epidemiological, geographic and climatic correlates. *Intelligence* **2012**. [CrossRef]
7. Lynn, R.; Antonelli-Ponti, M.; Mazzei, R.F.; Da Silva, J.A.; Meisenberg, G. Differences in Intelligence and Socio-Economic Outcomes across the Twenty Seven States of Brazil. *Mank. Q.* **2017**, *57*, 519–584.
8. Lynn, R.; Sakar, C.; Cheng, H. Regional differences in intelligence, income and other socio-economic variables in Turkey. *Intelligence* **2015**, *50*, 144–149. [CrossRef]

9. Almeida, L.S.; Lemos, G.; Lynn, R. Regional differences in intelligence and per capita incomes in Portugal. *Mank. Q.* **2011**, *2*, 213–221.
10. Bakhiet, S.F.A.; Lynn, R. Regional differences in intelligence in Sudan. *Intelligence* **2015**, *50*, 150–152. [[CrossRef](#)]
11. Carl, N. IQ and socioeconomic development across regions of the UK. *J. Biosoc. Sci.* **2016**, *48*, 406–417. [[CrossRef](#)] [[PubMed](#)]
12. Lynn, R.; Yadav, P. Differences in cognitive ability, per capita income, infant mortality, fertility and latitude across the states of India. *Intelligence* **2015**, *49*, 179–185. [[CrossRef](#)]
13. Jones, G. *Hive Mind: How Your Nation's IQ Matters So Much More Than Your Own*; Stanford University Press: Stanford, CA, USA, 2015.
14. Meisenberg, G. Cognitive human capital and economic growth in the 21st century. In *Economic Growth in the 21st Century: New Research*; Abrahams, T., Ed.; Nova Publishers: New York, NY, USA, 2014; pp. 49–106.
15. Vanhanen, T. *Global Inequality as a Consequent of Human Diversity: A New Theory Tested by Empirical Evidence*; Ulster Institute for Social Research: London, UK, 2014.
16. Nisbett, R.E. Schooling Makes You Smarter: What Teachers Need to Know about IQ. *Am. Educ.* **2013**, *37*, 10–39.
17. Laus, M.F.; Vales, L.D.M.F.; Braga Costa, T.M.; Almeida, S.S. Early Postnatal Protein-Calorie Malnutrition and Cognition: A Review of Human and Animal Studies. *Int. J. Environ. Res. Public Health* **2011**, *8*, 590–612. [[CrossRef](#)] [[PubMed](#)]
18. Flores-Mendoza, C.E.; Nascimento, E.D. Condição cognitiva de crianças de zona rural. *Estudos de Psicologia* **2007**, *24*, 13–22. [[CrossRef](#)]
19. Almeida, S.S.; Nascimento, P.C.B.D.; Quaioti, T.C.B. Quantidade e qualidade de produtos alimentícios anunciados na televisão Brasileira. *Revista de Saúde Pública* **2002**, *36*, 353–355. [[CrossRef](#)] [[PubMed](#)]
20. World Health Organization. *Ambition and Action in Nutrition 2016–2025*; World Health Organization: Geneva, Switzerland, 2017; Available online: <https://globalnutritionreport.org/reports/2017-global-nutrition-report/> (accessed on 19 November 2019).
21. Global Nutrition Report. 2018. Available online: <https://globalnutritionreport.org/reports/global-nutrition-report-2018/> (accessed on 15 November 2019).
22. Global Nutrition Report. 2017. Available online: <https://globalnutritionreport.org/reports/2017-global-nutrition-report/> (accessed on 13 March 2019).
23. OCDE. 2016. Available online: <http://www.OCDE.org> (accessed on 12 May 2019).
24. Rio de Janeiro, R.J.; IBGE. *Pesquisa Nacional por Amostra de Domicílios*; 2015. Available online: <https://biblioteca.ibge.gov.br/visualizacao/livros/liv98887.pdf> (accessed on 18 November 2019).
25. Braga, N.N.; Almeida, S.D.S.; Lachat, J.J. Efeitos da desnutrição proteica precoce pós-natal no desenvolvimento comportamento, aprendizagem e memória de ratos (*Rattus norvegicus*). Ph.D. Thesis, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, USP, Ribeirão Preto, SP, Brazil, 2014.
26. World Health Organization. The World Health Organization Database on Child Growth and Malnutrition. 2011. Available online: <http://www.who.int/nutgrowthdb/en> (accessed on 17 May 2019).
27. DATASUS. Prevalência de Aleitamento Materno exclusivo. 2017. Available online: <http://tabnet.datasus.gov.br/cgi/ibd2012/g14.htm> (accessed on 26 May 2019).
28. Situação Mundial da Infância 2008. In *Caderno Brasil—Unicef*; UNICEF: Brasília, Brazil, 2008; Available online: <https://www.unicef.org/lac/cadernoBrasil2008.pdf> (accessed on 10 May 2019).
29. IPEA. Instituto de Pesquisa Econômica Aplicada. 2014. Available online: <http://www.ipeadata.gov.br/> (accessed on 12 May 2019).
30. Rio de Janeiro, R.J.; IBGE. *Pesquisa Nacional por Amostra de Domicílios, 2008–2009*; 2010. Available online: <https://biblioteca.ibge.gov.br/visualizacao/livros/liv45767.pdf> (accessed on 18 November 2019).
31. Rio de Janeiro, R.J.; Instituto Brasileiro de Geografia e Estatística (IBGE). Pesquisa de orçamentos familiares 2008–2009: Antropometria e estado nutricional de crianças, adolescentes e adultos no Brasil. 2010. Available online: http://www.ibge.gov.br/home/presidencia/noticias/noticia_visualiza.php?id_noticia=1699&id_pagina=1 (accessed on 16 March 2019).
32. Flores-Mendoza, C.; Widaman, K.F.; Rindermann, H.; Primi, R.; Mansur-Alves, M.; Pena, C.C. Cognitive sex differences in reasoning tasks: Evidence from Brazilian samples of educational settings. *Intelligence* **2013**, *41*, 70–84. [[CrossRef](#)]

33. Rushton, J.P.; Jensen, A.R. Race and IQ: A Theory-Based Review of the Research in Richard Nisbett's Intelligence and How to Get It. *Open Psychol. J.* **2010**, *3*, 9–35. [CrossRef]
34. Salahodjaev, R.; Azam, S. IQ and the Weight of Nations. *Personal. Individ. Differ.* **2015**, *87*, 105–109. Available online: <http://mpira.ub.uni-muenchen.de/66144/> (accessed on 11 May 2019). [CrossRef]
35. Levitsky, D.A.; Barnes, R.H. Nutritional and environmental interactions in the behavioral development of the rat: Long-term effects. *Science* **1972**, *176*, 68–71. [CrossRef] [PubMed]
36. World Health Assembly. Global Strategy on Healthy Eating, Physical Activity and Health. 2004. Available online: <http://189.28.128.100/nutricao/docs/geral/ebPortugues.pdf> (accessed on 12 March 2019).
37. Brasília, D.F.; INEP. Ministério da Educação. Panoramas da Educação. Destaques do Education at a Glance 2016. 2016. Available online: http://download.inep.gov.br/acoes_internacionais/eag/documentos/2016/panorama_da_educacao_2016_eag.PDF (accessed on 15 May 2019).
38. Jeong, M.K. In Search of Resilience in Learning Variables Mediating the Effects of ESCS on Mathematical Literacy Performance of Adolescents in Macao: Through the Lens of PISA 2012. Ph.D. Thesis, IEONG, Man Kai, Faculty of Education, University of Macal, Bacolod, Negros Occidental, 2015.



© 2019 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).