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Research Article

Examining the Effects of Human Development, Unemployment, and Globalization on Obesity in the Community: Evidence from BRICS Countries

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Obesity is a social problem that needs to be carefully considered regarding its causes and consequences. This study examines the impact of human development, unemployment, and globalization on obesity in BRICS (Brazil, Russia, India, China, and South Africa) countries from 1991 to 2016. For this aim, the study uses Fourier causality and cointegration tests, which consider smooth structural breaks. The cointegration test results show that obesity and explanatory variables do not move together in the long run for all countries. According to the causality result of this study, there is a unidirectional causal relationship from obesity to unemployment in China. On the other hand, there is unidirectional causality from obesity to human development and globalization in India. Overall, India can lessen the negative effects of obesity on its population and improve its standing in the global economy if it promotes healthy lifestyles and controls the food and beverage industry. On the other hand, obesity may cause people to become unemployed, so it is recommended that policymakers fight obesity to control unemployment in China.

1. Introduction

Obesity, in general, can be defined as the body weight rising above the desired level compared to the body's height due to an excessive increase in the ratio between body fat and lean mass. The World Health Organization (WHO) briefly refers to obesity as excess fat accumulation in the body to the extent that it impairs health. It is clear from its definitions that obesity is a problem related to human health. The WHO's definition of obesity as an increasing global epidemic is an important indicator of the seriousness of the problem. Obesity and accompanying diseases are among the leading causes of increased mortality rates. Considering that more than 3 million people died in 2010 due to diseases caused by excess weight, obesity poses a great health risk for humanity. According to a WHO report from 2018, obesity has almost tripled worldwide since 1975 and continues to increase daily; it is a harbinger of more significant problems if the necessary measures are not taken. Considering that obesity is a health problem, taking the measures needed to mitigate it is possible by correctly determining the factors affecting obesity. At this point, when the factors affecting obesity are investigated, it is known that people become obese for various reasons, including genetic structure, environmental factors, demographic characteristics, behavioral factors, psychological factors, and prenatal factors [1, 2] (see Figure 1).

These factors, such as the effect of obesity on mortality rates, obesity being a health problem, and obesity being affected by economic and psychological factors, have raised the question of whether human development will impact obesity. Human development is increasing people's choices [3]. This process is also defined as enlarging people's choices, so they can live healthier, fuller, and longer lives [4]. In summary, human development refers to improving individual quality of life. The improvement in the quality of life of individuals is the increase in the income levels of individuals and the development of their educational status,

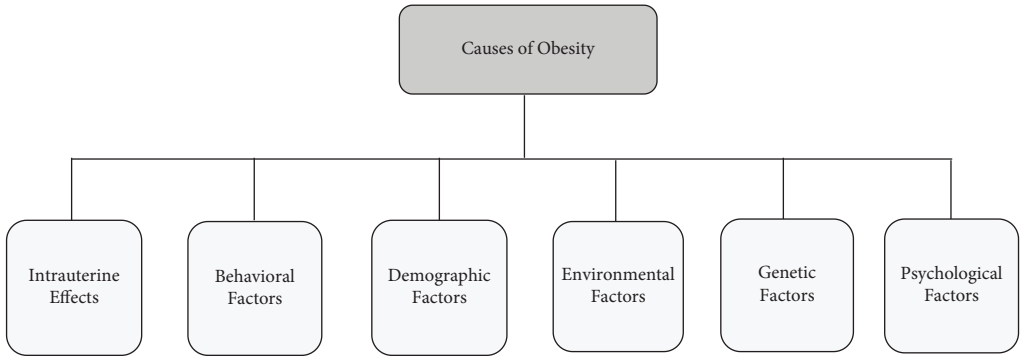

Figure 1: Causes of obesity. Source: [1, 2].

health services, food consumption, and other conditions [5]. Various indices measure human development. The most popular of these indices is the human development index published by the United Nations Development Program. This index evaluates three essential developments related to health, education, and income through a single combined index (see Figure 2).

Based on the definition and measurement of human development, the impact of human development on obesity can be explained in three different ways as follows: (i) through education: when people receive a better education, they are expected to be more aware that obesity is a serious disease. (ii) Through health: advances and innovations in health can be important in combating obesity. (iii) Through income: The fact that people have a better income level can be especially effective in reducing obesity caused by psychological and environmental factors. When all these characteristics of human development are evaluated together, human development can be considered to have a positive effect on obesity. However, it is also a fact that technological advances and comforts brought about by high human development cause people to reach with less effort, move less, and be lazier. One of the best examples of this situation is the United States. Despite the high humanitarian development of the United States, the fact that it is among the countries with the highest obesity rates can be explained by the reasons mentioned above. In summary, how human development has an impact on obesity is still a contentious issue. However, it is also a fact that this effect can be linked to the levels of development of countries. While the impact of human development on obesity is expected to be more pronounced in countries with lower development, increases in human development in developed countries may not have a clear effect on obesity.

Of the many factors that cause obesity, one of the most important is globalization. Globalization refers to the closeness of the people of the world in terms of economics, politics, communication, and other social aspects. Progress in these areas is making a whole formerly disparate world. When the reasons for globalization are investigated, factors such as free trade, outsourcing, the communication revolution, and liberalization come to the fore. These factors contribute to globalization and generally positively influence many countries. However, globalization can also have negative consequences, such as environmental pollution and obesity. The relationship between globalization and environmental pollution has been one of the most frequently researched topics in recent years [6–11]. In these studies, different results come to the fore between globalization and environmental pollution. Globalization is often cited as a cause of obesity in less developed and developing countries that are more susceptible to external influences [12]. Globalization increases obesity rates in low-income countries by improving access to obesogenic products and promoting fast food culture.

Globalization has profoundly influenced people's eating habits. Before globalization, many people ate a lot of local and seasonal foods. Today, the global economy has given people access to foods from around the world. Nutrition transition between countries, primarily through foreign trade and investment, is increasing daily, increasing the obesity burden [13]. As a result, the impact of globalization on obesity can be evaluated economically and culturally. Economic globalization has facilitated access to food and increased the demand for obesogenic products. Meanwhile, cultural globalization has spread fast-food culture throughout the world. From these details alone, it seems sensible to expect that globalization negatively affects obesity.

Another variable thought to be related to obesity is unemployment. It is well known that financial developments can affect human health positively or negatively. This also applies to unemployment. People with lower incomes and spending can turn to cheaper and unhealthy foods. Unemployed people with lower spending potential are expected to be negatively affected by the growing availability of unhealthy fast food. The effects of unemployment on obesity can be explained in financial and psychological terms. From a financial perspective, when a person's income decreases, the quality of their diet will also decrease accordingly. Psychologically, situations and factors such as smoking, alcohol use, irregular nutrition, and insomnia can lead to stress-related weight problems. When the effect of obesity on unemployment is analyzed, people with excess weight are more likely to be in weaker positions in the labor market and to have lower earnings [14]. Moreover, Hughes and Kumari [15] stated that the causal relationship between unemployment and obesity could be explained by the various

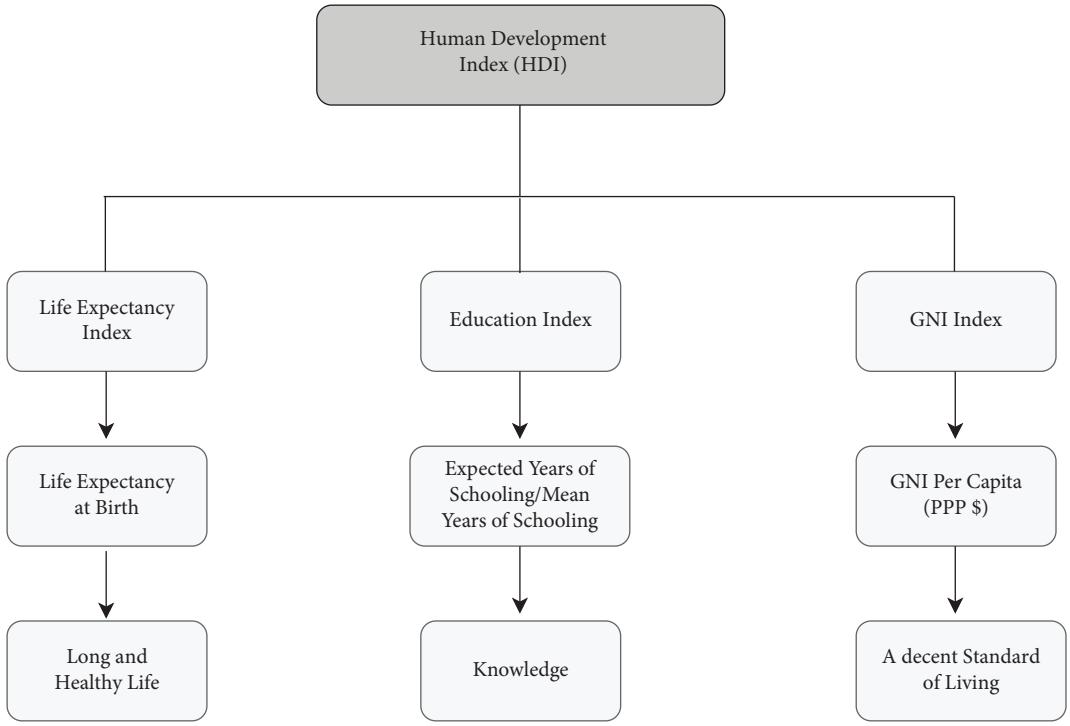

Figure 2: Human development index. Source: human development reports.

effects of both psychosocial stress and financial constraints on unemployment on energy balance. Individuals differ significantly in their propensity for "stress eating," with variations ascribed to psychological and genetic causes [16]. In terms of financial constraints, reduced overall energy intake for low-income men compared to the general population, suggesting a severely restricted income can result in less food consumed overall. Energy-dense, nutrient-poor foods are frequently purposefully chosen to stretch a limited food budget [17]. As a result, unemployment and obesity are concepts expected to influence each other. This influence can occur due to the stress or low income that unemployment brings.

When the literature on the factors affecting obesity is examined, it is seen that the causes and solutions of obesity are generally discussed. However, the scarcity of studies that empirically examine the factors affecting obesity is remarkable. If the relationships between obesity and the factors that affect it can be analyzed empirically, the measures to be taken according to these results can reduce the risk of obesity. Obesity is emerging as an important public health problem in the BRICS countries, representing a mix of developed and developing economies [18]. There are very few empirical studies examining the factors affecting obesity in these countries. This study aims to fill this gap by empirically revealing the relationships between human development, unemployment, globalization, and obesity. This study makes several significant contributions. First, it is the first study to examine the impact of human development, unemployment, and globalization on the obesity rates of BRICS countries. Second, the multivariate model was used for robust results instead of univariate ones. Accordingly, the results are expected to be a more solid guide for policymakers. Third, using two different methodologies, cointegration and causality, the relationship between the variables was examined in every aspect. Finally, structural breaks are another critical issue regarding the robustness of the results. The exclusion of structural breaks can lead to biased results. For this reason, this study uses econometric methods considering smooth structural breaks thanks to Fourier terms.

The following order is followed in the ongoing sections of the study. A brief literature review is in the second section. Data, model, and econometric methodology are in the third section. Empirical results are in the fourth section, and the conclusion and policy recommendations are presented in the fifth section.

2. Literature Review

In the literature, factors affecting obesity have been studied with various variables for a long time. In these studies, relationships between obesity and various variables such as education [19], gender [20], health [21], economic growth [22], environmental factors [23], psychological factors [24], demographic factors [25], genetic factors [26], behavioral factors [27], and intrauterine factors [28] were investigated. Another variable that is thought to affect obesity is human development.

There are very few studies in the literature that examine the relationship between obesity and human development. Dinsa et al. [29]; Ataey et al. [30]; and Khazaei et al. [31] studies come to the fore in terms of considering the impact of human development on obesity. Dinsa et al. [29] found that there is a positive relationship between socioeconomic status and obesity in countries with a low human

development index. They also found that obesity is more likely present in countries with higher human development. This was a study in which they examined the relationship between socioeconomic status and the epidemiology of obesity in developing countries. Ataey et al. [30] examined the degree to which the prevalence of obesity and overweight is affected by HDI and its components in the Eastern Mediterranean region countries with the correlation analysis. The results of the study show that there is a significant positive relationship between HDI and obesity. Khazaei et al. [31] investigated the relationship between human development and obesity between men and women in Asian countries with bilateral correlation and analysis of variance. The prevalence of obesity among men and women was higher in countries with a high HDI, leading to obesity-related factors in these countries. The authors reached a conclusion that pointed to the influence of obesity.

When examining the literature that discusses globalization and obesity, studies done by Goryakin et al. [32]; Miljkovic et al. [33]; Fox et al. [34]; Munir et al. [35]; and El-Sahli [36] come to the fore. Goryakin et al. [32] empirically examined the relationship between obesity and globalization. They studied 887,000 women. The women were between 15 and 49 years old and came from 56 countries. The study considered data gathered on these women from 1991 to 2009. The study demonstrated that globalization is significantly associated with obesity among women. The study also concluded that social and political globalization increases obesity. In another study, Miljkovic et al. [33] examined the relationship between globalization and obesity in 79 countries from 1986 to 2018. This study used panel data methods and quantile regression analysis to determine that social globalization has a positive and significant effect on global obesity rates. Finally, a study by Fox et al. [34] investigated the impact of globalization on global weight gain in 190 countries from 1980 to 2008. The study concluded that economic globalization does not significantly predict increases in mean BMI. The study also used two-way fixed-effect OLS regressions to determine that cultural globalization has mixed effects on obesity. Munir et al. [35] investigated how the political globalization index affects worldwide human obesity in relation to global human development levels, using second-generation panel data methods for 109 countries over the period 1990–2017. The results show that a low level of political globalization tends to increase global human obesity, whereas a high level of political globalization tends to decrease obesity. El-Sahli [36]; investigating the relations between globalization and obesity in Gulf Cooperation Council (GCC) countries using a dynamic panel econometric model, concluded that social and economic globalization had a positive and significant effect on obesity rates in GCC countries compared to the rest of the world.

When reviewing the literature that focuses on obesity and unemployment, studies that try to answer how unemployment and obesity influence each other draw one's attention. Härkönen et al. [14] investigated the effect of obesity on unemployment and earnings among Finnish men and women from 1998 to 2011. The study demonstrated that obese women have a higher risk of unemployment than nonobese women. On the other hand, for obese and nonobese men, there was no difference in terms of unemployment. Latif [37] investigated the effect of macroeconomic conditions, such as unemployment rates, on a population's obesity rates and BMI levels. The study examined Canadian data and used conditional fixed-effect logit and fixed-effect models. The study found that the unemployment rate has a significant positive effect on the probability of a person being severely obese and having a significantly increased BMI. Hughes and Kumari [15] investigated the relationship between a person's employment status and their likelihood of being underweight or obese. Hughes and Kumari used data from more than 400,000 households in the UK and analyzed the data using multinomial logistic regression models. The analysis revealed that unemployment is positively associated with being underweight and negatively associated with being overweight. Tobing [38] investigated the effect of unemployment on obesity during the great recession using panel data methods with cross-county US data for the period 2008–2011. The results of the study show that there is a procyclical relationship between unemployment and obesity. Groves and Wilcox-Gok [39] investigated the effect of obesity on unemployment duration using a data sample of young workers drawn from the National Longitudinal Survey of Youth (1997) for American workers. The study results revealed that, on average, overweight and obese job seekers experienced significantly longer periods of unemployment. This study aims to contribute to the literature by investigating whether human development, globalization, and unemployment are among the significant factors affecting obesity in BRICS countries.

3. Data, Model, and Methodology

3.1. Data. In this study, the relationship between obesity, unemployment, globalization, and human development was investigated for the period spanning from 1991 to 2016. The data sources were as follows: obesity (obs) measured as the prevalence of obesity among adults %, unemployment (unm) measured as a percentage of the total labor force, and globalization (glo) and human development (hdi) indexes. The data regarding obesity was sourced from World Health Organization's Global Health Observatory (GHO) database, the data regarding unemployment was sourced from the World Bank database, and the data regarding globalization and human development came from Dreher [40] and the United Nations Development Programme (UNDP), respectively. The logarithmic forms of variables were used.

3.2. Model. We also examined the impact of unemployment, globalization, and human development on obesity using the following model:

$$\ln obs_t = \beta_0 + \beta_1 \ln hdi_t + \beta_2 \ln unm_t + \beta_3 \ln glo_t + \varepsilon_t, \quad (1)$$

where β_1, β_2, and β_3 are the coefficients of $\ln hdi_t$, $\ln unm_t$, and $\ln glo_t$, respectively, and ε_t is the error term.

3.3. Methodology

3.3.1. Fourier ADF Unit Root Test. Enders and Lee [41] converted the augmented Dickey-Fuller (ADF) test into a form that uses Fourier terms to allow smooth structural breaks. Enders and Lee [41] consider structural breaks with the help of the deterministic term, defined as follows:

$$\alpha(t) = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right), \tag{2}$$

where k indicates the frequency number of Fourier terms. The model recommended for the Fourier ADF (FADF) test is as follows [41]:

$$\Delta y_t = \alpha_1 + \delta t + \beta y_{t-1} + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \sum_{i=1}^{p} \vartheta_i \Delta y_{t-i} + u_t. \tag{3}$$

Enders and Lee [41] propose a two-step method for the FADF unit root test. In the first step, Model 3 is estimated in the range of $1 \le k \le 5$, and the model with the lowest sum of squared residuals (SSR) is selected as the appropriate model. In the second step, the significance of the Fourier terms is tested with the help of the classical F test. If the Fourier terms are significant, the null hypothesis is tested with the help of the classical t-test. If the Fourier terms are not significant, the ADF unit root test is used.

3.3.2. Fourier Toda and Yamamoto Causality Test. Toda and Yamamoto [42] (TY) proposed a causality test based on the vector autoregressive (VAR) model, which eliminates short-term loss of information. Accordingly, for the TY causality test ($p + d\max$), the VAR model with the lag length is estimated and performs the causality analysis. The TY causality test does not take into account structural breaks. Therefore, the TY causality test can give biased results in the analysis made with a series containing structural breaks. Nazlioglu et al. [43] employed the deterministic term to address this issue:

$$\alpha(t) = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right). \tag{4}$$

The deterministic term is a function of time with the number of k frequencies. Nazlioglu et al. [43] extended the TY procedure using this deterministic term and proposed the following model:

$$y_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 y_{t-1} + \cdots + \beta_{p+d\max} y_{t-(p+d\max)} + \varepsilon_t, \tag{5}$$

where k indicates the length of the frequency. The Fourier TY causality test null hypothesis states that there is no causality between the variables.

3.3.3. Fourier Bootstrap ARDL Cointegration Test. Pesaran et al.'s [44] autoregressive distributed lag (ARDL) bounds testing approach has a weak power and size. McNown et al. [45] used the bootstrap method to overcome this problem, and they proposed the bootstrap ARDL bounds testing approach. While the standard ARDL method has assumptions about the degree of integration of the series, bootstrap ARDL does not have any assumptions. Furthermore, McNown et al. [45] reported that this method shows good size and power properties when there is more than one explanatory variable. The ARDL model used in this study is as follows:

$$\Delta \ln obs_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_1 \Delta \ln obs_{t-i} + \sum_{i=1}^{q-1} \alpha_2 \Delta \ln hdi_{t-i} + \sum_{i=1}^{u-1} \alpha_3 \Delta \ln unm_{t-i} + \sum_{i=1}^{k-1} \alpha_4 \Delta \ln glob_{t-i} + \sum_{i=1}^{s-1} \alpha_5 D_{t,i} + \beta_1 \ln obs_{t-1} + \beta_2 \ln hdi_{t-1} + \beta_3 \ln unm_{t-1} + \beta_4 \ln glob_{t-1} + \nu_t, \tag{6}$$

where α_0 shows the constant term, $\alpha_1, \alpha_2, \alpha_3, \alpha_4$ and $\beta_1, \beta_2, \beta_3, \beta_4$ represent the short and long-term coefficients, respectively, and $D_{t,i}$ and ν_t show the dummy variable for the sharp structural breaks and the error term, respectively. McNown et al. [45] proposed three test statistics, namely, the overall F statistics, t-dependent, and t-independent test statistics. The null hypothesis of these test statistics are $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = 0$, $\beta_1 = 0$, and $\alpha_2 = \alpha_3 = \alpha_4 = 0$, respectively.

The bootstrap ARDL method does not take into account smooth structural breaks. To overcome this problem, Solarin [46] proposed the new bootstrap ARDL method, which considers smooth structural breaks. They used the Fourier terms to catch the smooth structural breaks. The model for the Fourier bootstrap ARDL method is as follows:

$$\Delta \ln obs_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_1 \Delta \ln obs_{t-i} + \sum_{i=1}^{q-1} \alpha_2 \Delta \ln hdi_{t-i} + \sum_{i=1}^{u-1} \alpha_3 \Delta \ln unm_{t-i} + \sum_{i=1}^{k-1} \alpha_4 \Delta \ln glob_{t-i} + \sum_{i=1}^{s-1} \alpha_5 D_{t,i} + \beta_1 \ln obs_{t-1} + \beta_2 \ln hdi_{t-1} + \beta_3 \ln unm_{t-1} + \beta_4 \ln glob_{t-1} + \beta_5 \sin\left(\frac{2\pi kt}{T}\right) + \beta_6 \cos\left(\frac{2\pi kt}{T}\right) + e_t, \tag{7}$$

Table 1: Unit root tests results.

Countries	Variables	FADF				ADF		
		Test stat $I(0)$	Test stat $I(1)$	K $I(0)/I(1)$	F test	Test stat $I(0)$	Test stat $I(1)$	p $I(0)/I(1)$
Brazil	Lnobs	−5.462*	—	1	65.701*	—	—	—
	Lnglo	−3.939**	—	2	9.819**	—	—	—
	Lnunm	−1.542	—	4	0.899	−1.615	−2.762***	1/0
	Lnhdi	−1.757	—	2	0.364	−1.719	−4.470*	0/0
Russia	Lnobs	4.100	—	4	1.795	2.555	−5.886*	0/0
	Lnglo	−3.375**	—	4	7.368***	—	—	—
	Lnunm	−3.146	—	1	3.212	−1.351	−3.172**	0/0
	Lnhdi	0.579	—	1	2.818	−0.198	−2.975***	1/0
India	Lnobs	−0.096	−4.781*	3/2	12.753*	—	—	—
	Lnglo	−2.070	−3.708***	1/1	14.476*	—	—	—
	Lnunm	−2.290	—	3	3.118	−3.153**	—	1
	Lnhdi	−0.315	—	3	5.537	−0.503	−4.070*	0/1
China	Lnobs	−1.510	−3.764*	4/4	40.255*	—	—	—
	Lnglo	−1.941	−4.838*	4/1	11.328*	—	—	—
	Lnunm	−1.641	—	4	4.213	−2.905***	—	1
	Lnhdi	−3.268	—	1	4.886	−3.120**	—	0
South Africa	Lnobs	−3.748***	—	1	38.326*	—	—	—
	Lnglo	−2.271	—	1	2.269	−4.28*	—	3
	Lnunm	−3.129	—	1	0.493	−1.115	−3.764*	0/0
	Lnhdi	−3.161	—	1	0.968	−0.756	−3.197**	2/0

Note. *, **, and *** indicate the rejection of the null hypothesis at 1%, 5%, and 10% significance levels, respectively.

Table 2: Fourier bootstrap ARDL test results.

Countries	Statistics	Values	Critical values			Decisions	Diagnostic tests	
			10%	5%	1%		Tests	Statistics
Russia	F-stat	1.082	3.660	4.873	7.947	X	Serial correlation	1.079 (0.583)
	t-dep	−0.772	−1.809	−2.348	−3.466		Heteroscedasticity	11.761 (0.301)
	F-indep	1.239	3.864	5.070	8.517		Normality	0.578 (0.748)
India	F-stat	0.475	4.402	5.691	8.877	X	Serial correlation	1.905 (0.204)
	t-dep	−1.229	−2.141	−2.611	−3.708		Heteroscedasticity	9.333 (0.500)
	F-indep	0.476	4.725	6.027	10.012		Normality	0.157 (0.924)
China	F-stat	0.400	3.700	4.672	7.441	X	Serial correlation	3.948 (0.138)
	t-dep	−1.030	−2.046	−2.521	−3.502		Heteroscedasticity	5.671 (0.842)
	F-indep	0.342	3.932	5.116	8.301		Normality	0.846 (0.654)

Note. The probability values are reported in the parenthesis. The bootstrap used is 5,000. The optimal k is 1.

where k shows the frequency of the Fourier terms. When all three test statistics exceed the bootstrap critical values, the cointegration relationship exists.

4. Empirical Results

In the empirical analysis, first, we investigated the stationarity of the variables using the FADF unit root test for each country. Table 1 shows the FADF unit root test results. The results show that all variables have a mixed order of integration. Second, we investigated the long-run relationship for Model 1 using the Fourier bootstrap ARDL test.

Brazil and South Africa were excluded from the cointegration analysis as the dependent variable was stationary at the level. The cointegration test results are reported in Table 2. According to the results, there is no long-run relationship between obesity and independent variables for all countries. In the third step of the empirical analysis, we investigated the causal relationship between obesity and explanatory variables using the Fourier TY causality test.

The causality test results are shown in Tables 3–5. Table 3 shows the causality test results between obesity and human development. According to the results, there is unidirectional causality from obesity to human development in India. On the other hand, there is no causal relationship for other countries.

Table 4 shows the causality results between obesity and unemployment, and the results show that there is a unidirectional causality between variables only in China. The direction of the causality is from obesity to unemployment. The last causal relationship is between obesity and globalization.

Table 5 shows the causality between obesity and globalization for each country. According to the results, there is unidirectional causality from obesity to globalization in

Table 3: Fourier TY causality test results (lnobs–lnhdi).

Countries	*Lnobs* ⟶ *lnhdi*				*Lnhdi* ⟶ *lnobs*			
	Values	Prob	*k*	*p*	Values	Prob	*k*	*p*
Brazil	1.522	0.696	1	3	7.652	0.106	1	3
Russia	2.220	0.570	1	3	1.259	0.746	1	3
India	6.364***	0.058	1	2	5.541	0.112	1	2
China	0.039	0.846	1	1	0.173	0.664	1	1
South Africa	1.864	0.403	1	2	0.263	0.887	1	2

Note. *** indicates the rejection of the null hypothesis at a 10% significance level. *k* and *p* are optimal frequency and optimal lag numbers, respectively.

Table 4: Fourier TY causality test results (lnobs–lnunm).

Countries	*Lnobs* ⟶ *lnunm*				*Lnunm* ⟶ *lnobs*			
	Values	Prob	*k*	*p*	Values	Prob	*k*	*p*
Brazil	3.198	0.419	1	3	0.991	0.790	1	3
Russia	0.239	0.876	2	2	2.323	0.338	2	2
India	0.471	0.924	2	3	1.174	0.768	2	3
China	21.358*	0.008	1	3	7.511	0.111	1	3
South Africa	1.842	0.414	2	2	3.611	0.196	2	2

Note. * indicates the rejection of the null hypothesis at a 1% significance level. *k* and *p* are optimal frequency and optimal lag numbers, respectively.

Table 5: Fourier TY causality test results (lnobs–lnglo).

Countries	*Lnobs* ⟶ *lnglo*				*Lnglo* ⟶ *lnobs*			
	Values	Prob	*k*	*p*	Values	Prob	*k*	*p*
Brazil	1.249	0.755	1	3	5.570	0.198	1	3
Russia	6.877	0.145	2	3	5.036	0.223	2	3
India	9.095***	0.085	1	3	3.475	0.337	1	3
China	0.346	0.839	1	2	3.701	0.198	1	2
South Africa	7.326	0.113	3	3	6.026	0.163	3	3

Note. *** indicates the rejection of the null hypothesis at a 10% significance level. *k* and *p* are optimal frequency and optimal lag numbers, respectively.

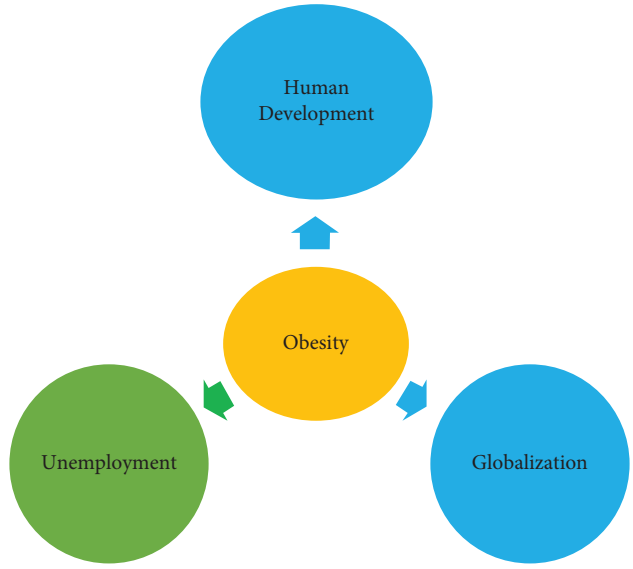

Figure 3: Graphical results. Note: green and blue show the result for China and India, respectively.

India. The summary of the causality test results are as follows: (1) for India, there is unidirectional causality from obesity to globalization and human development and (2) for China, the direction of the causal relationship is from obesity to unemployment. Figure 3 indicates the graphical results of the study. We summarized the results of obesity in the existing literature. Table 6 shows the literature summary for obesity and other explanatory variables.

Table 6: Literature summary for obesity.

Author(s)	Country/region	Period	Methods	Results
Devaux et al. [19]	Australia, Canada, England, and Korea	1989–2005	Correlation analysis	There is a correlation between education and obesity
Crosnoe [20]	USA	1995–2002	ANOVA	There is a relationship between gender, education, and obesity
Andreyeva et al. [21]	10 European countries	2004-2004	Multivariate regression analysis	The impacts of obesity on health are relatively consistent across nations
Aydin [22]	Ten most obese countries	1991–2016	ARDL	There is a relationship between economic growth and obesity
Giles-Corti et al. [23]	Australia	August 1995 and March 1996	Logistic regression	There is a relationship between the physical environment and obesity
Júlíusson et al. [25]	Norway	November 2003–December 2006	Logistic regression	There is a relationship between sociodemographic factors and obesity
Dinsa et al. [29]	Developing countries	1989–2007	Systematic review	There is a relationship between human development and obesity
Ataey et al. [30]	Eastern mediterranean region countries	2018-2018	Correlation analysis	There is a significant positive relationship between human development and obesity
Khazaei et al. [31]	Asian countries	2016–2016	Correlation analysis	There is a relationship between human development and obesity
Goryakin et al. [32]	56 different countries	1991–2009	Regression analysis	Social and political globalization increases obesity
Miljkovic et al. [33]	79 different countries	1986–2018	Quantile regression analysis	Social globalization has a positive and significant effect on global obesity
Fox et al. [34]	190 different countries	1980–2008	Regression analysis	Economic globalization does not significantly predict increases in obesity
Munir et al. [35]	109 different countries	1990–2017	Regression analysis	A low level of political globalization tends to increase global human obesity, whereas a high level of political globalization tends to decrease obesity
Härkönen et al. [14]	Global	1998–2011	Fixed-effect regression analysis	Obese women are much more likely to experience unemployment
Latif [37]	Canada	1994–2007	Fixed-effect logit regression	The likelihood of being substantially obese is significantly positively impacted by the unemployment rate
Tobing [38]	USA	2008–2011	Panel data analysis	There is a procyclical relationship between unemployment and obesity
Groves and Wilcox-Gok [39]	USA	1997–2011	Likelihood methods	The overweight and obese job seekers experienced significantly longer periods of unemployment
El-Sahli [36]	GCC countries	1975–2016	GMM estimator	There is a significant positive relationship between globalization and obesity

5. Conclusion and Policy Implications

In this study, we investigated the impact of human development, unemployment, and globalization on obesity in the BRICS countries for the period 1991–2016. To achieve this aim, we first investigated the integration degree of the variables using a FADF unit root test. Second, the long-run relationship between obesity and explanatory variables was examined using the Fourier bootstrap ARDL test. The results show that there is no cointegration in Model 1 for all countries. For this reason, we examined the causal relationship between variables using the Fourier TY test in the third step of the empirical analysis. The findings from the causality test show that there is a unidirectional causal relationship from obesity to human development in India. The findings show that in China, there is a unidirectional causal relationship from obesity to unemployment. On the other hand, there is unidirectional causality from obesity to human development and globalization in India. Meanwhile, in Brazil, Russia, and South Africa, there is no causal relationship between variables.

In recent years, obesity rates in China increased due to rapid economic growth, changing lifestyles, and other factors. The impact of these rising obesity rates on unemployment can explain empirical findings for China. This result supports the results of Härkönen et al. [14] and Groves and Wilcox-Gok [39]; which reveal the effects on unemployment. The results suggest that in China, obesity may cause people to become unemployed. Therefore, it is recommended that policymakers fight obesity in order to control unemployment. To prevent obesity, it can be recommended that China organize campaigns to promote healthy lifestyles and make regulations to facilitate healthy food choices and physical activity. These policies can reduce unemployment rates as well as fight obesity. Reducing China's obesity rates will be possible with the development of healthier lifestyles that will arise out of increases in welfare. Moreover, understanding the factors contributing to being overweight and obese can assist health officials in creating programs that advance health and fitness, and as a result, enhance the outcomes of associated labor. Overall, a comprehensive approach that combines education, economic incentives, healthcare, and community engagement may be effective in reducing obesity rates and improving employment outcomes in China.

Findings revealing a unidirectional causal relationship from obesity to human development in India support the Dinsa et al. [29]; Ataey et al. [30]; and Khazaei et al. [31] studies demonstrating the existence of a relationship between human development and obesity. The conclusion that obesity affects human development in India is a cause for concern as it shows that this health issue can adversely affect the country's overall development. In evaluating this situation, it is important to consider the underlying causes of obesity in India. Some factors contributing to obesity in the country include changes in dietary patterns, a lack of physical activity, and urbanization. In addition, socioeconomic factors may be at play, such as poverty, which can limit access to healthy food and opportunities for exercise. Given these factors, it is clear that addressing obesity in India will require a multifaceted approach. Some policy recommendations that could be considered include promoting healthy dietary patterns, encouraging physical activity, and addressing socioeconomic factors. Overall, addressing obesity in India will require a comprehensive approach to addressing underlying factors and promoting healthy behaviors. By taking action in these areas, India can improve the health of its population and support overall human development in the country.

Finally, the conclusion that obesity affects globalization in India may have negative implications for the country's economic development and competitiveness on the global stage. Obesity is associated with several health issues, including diabetes, and other chronic conditions, leading to increased healthcare costs and decreased productivity. In terms of globalization, the negative effects of obesity on the health of the population can lead to increased healthcare costs, reduced workforce productivity, and reduced life expectancy. This, in turn, can impact India's ability to attract foreign investment, compete in global markets, and engage in international trade. Overall, tackling the obesity problem in India is crucial for the country's economic development and competitiveness on the global stage. If India takes steps to promote healthy lifestyles and regulate the food and beverage industry, it can reduce the negative impact of obesity on its population and strengthen its position in the global economy.

The most important limitation of this study is that it does not consider the differences in obesity rates between the genders. For this reason, future studies can be designed to investigate the effects of gender differences on the obese unemployed.

Data Availability

Data used in this study are available upon request from the corresponding author.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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