The influence of market deregulation on fast food consumption and body mass index: a cross-national time series analysis

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Objective To investigate the effect of fast food consumption on mean population body mass index (BMI) and explore the possible influence of market deregulation on fast food consumption and BMI.

Methods The within-country association between fast food consumption and BMI in 25 high-income member countries of the Organisation for Economic Co-operation and Development between 1999 and 2008 was explored through multivariate panel regression models, after adjustment for per capita gross domestic product, urbanization, trade openness, lifestyle indicators and other covariates. The possible mediating effect of annual per capita intake of soft drinks, animal fats and total calories on the association between fast food consumption and BMI was also analysed. Two-stage least squares regression models were conducted, using economic freedom as an instrumental variable, to study the causal effect of fast food consumption on BMI.

Findings After adjustment for covariates, each 1-unit increase in annual fast food transactions per capita was associated with an increase of 0.033 kg/m^2 in age-standardized BMI (95% confidence interval, CI: 0.013–0.052). Only the intake of soft drinks – not animal fat or total calories – mediated the observed association (β: 0.030; 95% CI: 0.010–0.050). Economic freedom was an independent predictor of fast food consumption (β: 0.27; 95% CI: 0.16–0.37). When economic freedom was used as an instrumental variable, the association between fast food and BMI weakened but remained significant (β: 0.023; 95% CI: 0.001–0.045).

Conclusion Fast food consumption is an independent predictor of mean BMI in high-income countries. Market deregulation policies may contribute to the obesity epidemic by facilitating the spread of fast food.

Abstracts in عربي, 中文, Français, Русский and Español at the end of each article.

Introduction

In the last decades, there have been substantial increases in mean body weight in wealthy countries.[1,2] Such changes accompanied dramatic transformations in people's dietary patterns, most notably an increase in the consumption of ultra-processed foods, including fast food,[3] herein defined as "food that can be prepared quickly and easily and is sold in restaurants and snack bars as a quick meal or to be taken out".[4]

Although some authors argue that fast food consumption has played a negligible role in the obesity epidemic,[5,6] numerous studies have shown the opposite to be true.[7,8] A cohort study by Pereira et al. showed that participants who visited fast food restaurants more than twice a week at baseline and were still doing so at a follow-up 15 years later had gained an average of 4.5 kg.[9] Significant associations between the density of fast food restaurants and obesity have also been shown by neighbourhood-[10–12] and state-level analyses.[13–15] So far, little cross-national research has been conducted to investigate whether the spread of fast food has led to an increase in population-wide obesity rates over time.[16,17] However, in a recent ecological analysis, the density of Subway outlets, used as a marker of fast food penetration, was positively associated with the prevalence of obesity across 26 advanced economies.[18] Another cross-national ecological analysis revealed an association between increases in soft drink consumption and higher rates of overweight and obesity.[19] The research conducted to date has revealed little about the factors that drive or contain the spread of fast food and obesity.[16] Some authors argue that the rising consumption of unhealthy foods seen worldwide has been facilitated by trade liberalization[20] and foreign investment in the food and beverage industries,[8,21–23] which have resulted in the proliferation of large transnational food companies.[20,24,25] Offer et al. have found that high-income countries with market-liberal welfare regimes – most of which are also English-speaking – have a higher prevalence of obesity and easier access to fast food.[17] A study by Cutler et al. has shown that regulations in the agricultural sector are negatively correlated with obesity.[26]

In this article we use a novel measure – the number of per capita fast food transactions (local and transnational) – to test the hypothesis that rising fast food consumption has been a major determinant of population increases in body mass index (BMI) among high-income countries belonging to the Organisation for Economic Co-operation and Development (OECD). We also examine whether market deregulation may have contributed to higher BMI by facilitating the spread of fast food.

Methods

We conducted multivariate panel data analyses of 25 high-income OECD countries over the period from 1999 to 2008. Data on fast food consumption and age-standardized mean BMI were available for only 27 of the 31 high-income OECD members. Such data were missing for Estonia, Iceland, Luxembourg and Slovenia. To limit biases in international comparisons between Asians and Caucasians due to different interpretations of BMI in Asian populations,[27] we excluded Japan and the Republic of Korea. However, we ran additional analyses including these

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countries as robustness checks. We also developed separate models excluding Anglo-Saxon economies (Australia, Canada, Ireland, New Zealand, the United Kingdom of Great Britain and Northern Ireland and the United States of America) that, as previous studies showed, have a higher prevalence of obesity and easier access to fast food.[17]

Data sources

Fast food consumption

Data on per capita fast food transactions were taken from Euromonitor's Passport Global Market Information Database (GMID), 2012 edition. The data comprise industry records of annual sales of meals and refreshments delivered in local and transnational fast food outlets,[28] including chain restaurants, independent eateries and convenience stores (Appendix A, available at: http://goo.gl/36c7ai). This measure is the most comprehensive indicator of fast food consumption for comparisons across nations. Appendix B (available at: http://goo.gl/gThiG5) shows the scatterplot and strong correlation coefficient ($r = 0.8501$; $P < 0.001$) for the association between fast food transactions per capita, as obtained from the GMID, and Subway restaurants per 100 000 population, an indicator used in a previous paper as a proxy measure of the density of fast food restaurants at the country level.[18]

Age-standardized mean body mass index

Our main dependent variable, age-standardized mean BMI (in kg/m^2), was obtained from the Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group, which produced comparative estimates of cross-country differences and changes over time in BMI for adults aged 20 years or older.[1] Although data on BMI are reported separately for men and women, we developed an overall indicator by estimating the female to male ratio using the proportion of female population from the World Development Indicators from 1999 to 2008.[29] We also ran sex-specific analyses as robustness assessments.

Market deregulation

Market deregulation is the degree to which market forces are allowed to operate without interference from outside intervention, especially in the form of government ownership, regulations and taxes.[30] We used the index of economic freedom (IEF) created by the Heritage Foundation and the *Wall Street Journal*, which is based on a scale from 1 to 100. The score indicates the extent to which a country has adopted market deregulation policies. The index is calculated as the mean of 10 subcomponents measuring different aspects of economic freedom, as determined from national laws and regulations as well as written questionnaires completed by experts and investors (Appendix C, available at: http://goo.gl/M76H7I).[31]

Covariates

We included in our analyses several potential confounders of the association between fast food and BMI: gross domestic product (GDP) per capita (expressed logarithmically in constant 2005 United States dollars, adjusted for purchasing power parity for comparability between countries); the proportion of the population living in urban areas; national population size; openness to trade (imports and exports as a percentage of GDP); foreign direct investment (FDI, or net inflows as a percentage of GDP); and a time-invariant (2008) measure of motor vehicles per 1000 people. All these measures were taken from the World Bank's World Development Indicators database.[29] We also included as confounders time-invariant (2008) measures of the percentage of the population doing insufficient physical activity (i.e. less than 30 minutes of moderate activity five times per week or less than 20 minutes of vigorous activity three times per week, or their equivalent) and consumption of fruits and vegetables (in kilograms per capita per year). These two values were obtained from the World Health Organization Global Infobase[32] and from the GMID, respectively.[28] Finally, as previous studies have revealed that obesity and the availability of cheap, energy-dense food tend to be higher in societies with greater economic inequality,[33,34] we adjusted for the Gini index, a measure of inequality in household disposable income. Data on the Gini index were taken from the Standardized World Income Inequality Database.[35,36]

Our analyses also include three potential mediators of the association between fast food and BMI: consumption of animal fats (in kcal per capita per day); total caloric intake (in kcal per capita per day); and soft drink consumption (in litres per capita per year). The first two values were obtained from the Statistics Division of the Food and Agriculture Organization;[37] the last one came from the GMID.[28]

Statistical analyses

To study the association between fast food consumption and BMI we used longitudinal panel analyses, which allow the dynamics of change over time to be explored.[38] Our regression models included corrections for fixed aspects of initial country conditions and other characteristics that could influence the level of fast food consumption – and hence average BMI – in a given country.[39,40] By assessing within-country annual variations in fast food and obesity over time and adjusting for fixed, country-level characteristics, these conservative models effectively address the problem of confounding of study results. Robust standard errors –– clustered by region to adjust for the non-independence of time series data – were calculated in all models.[8] Regressions were analysed using Stata version 12.0 (StataCorp. LP, College Station, United States of America).

We formulated the following fixed effects models:

$$BMI_{it} = \alpha + \beta_1 \text{FAST FOOD}_{it} + v_i + \varepsilon_{it} \quad (1)$$

$$BMI_{it} = \alpha + \beta_1 \text{FAST FOOD}_{it} + \beta_2 \text{GDP}_{it} + \ldots + v_i + \varepsilon_{it} \quad (2)$$

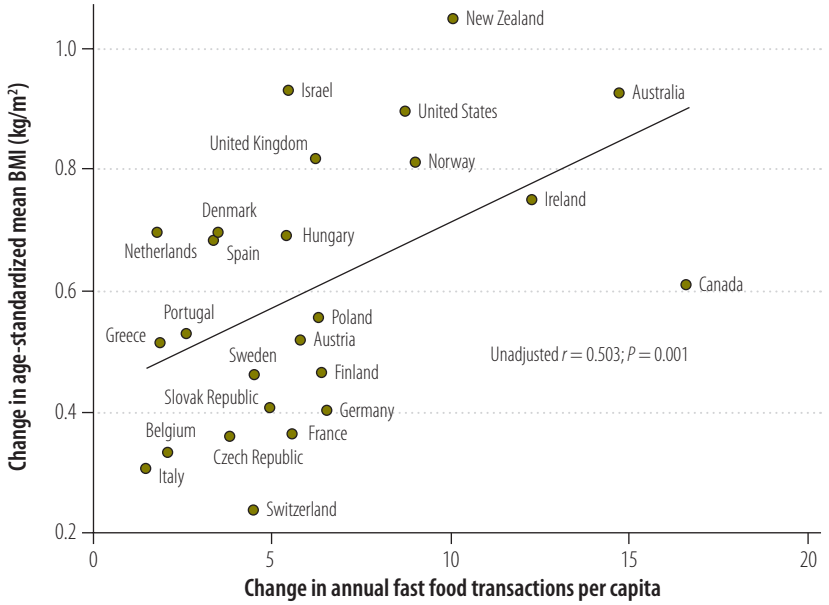
where i is the country, t is the year, β_1 is the regression coefficient for per capita fast food transactions, β_2 is the regression coefficient for GDP, v_i is an error term denoting country-specific heterogeneity, ε_{it} indicates an identically distributed random error term or measurement error and α is a constant.

Results

Fast food consumption and BMI

As shown in Table 1 (available at: http://www.who.int/bulletin/volumes/92/2/13-120287), between 1999 and 2008, the average number of annual fast food transactions per capita increased from 26.61 to 32.76. During the same period, age-standardized mean BMI increased from 25.8 to 26.4 kg/m^2. There was a strong and positive association between fast food consumption and

Fig. 1. **Change in age-standardized mean body mass index (BMI) as a function of change in average annual fast food transactions per capita[a] in 25 high-income countries of the Organisation for Economic Co-operation and Development, 1999–2008**



United Kingdom, United Kingdom of Great Britain and Northern Ireland; United States, United States of America.

[a] Meals and refreshments sold annually per capita in local and transnational fast food outlets, including chain restaurants, independent eateries and convenience stores.

Note: The figure illustrates the positive correlation between changes in age-standardized mean BMI and changes in the number of annual fast food transactions per capita between 1999 and 2008.

Sources: Age-standardized mean BMI: Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group;[1] average annual fast food transactions per capita: Euromonitor's Passport Global Market Information Database.[28]

age-standardized mean BMI (unadjusted $r = 0.658$; $P < 0.001$). When considering changes between 1999 and 2008 (Fig. 1), the average annual number of fast food transactions per capita was positively associated with age-standardized mean BMI (unadjusted $r = 0.503$; $P < 0.01$). The highest increases in the average number of annual fast food transactions per capita were observed in Canada (16.6), Australia (14.7), Ireland (12.3) and New Zealand (10.1), while the lowest increases occurred in Italy (1.5), the Netherlands (1.8), Greece (1.9) and Belgium (2.1).

Table 2 presents the results of multivariate panel analyses in which age-standardized mean BMI was the dependent variable. Fast food consumption was positively and significantly associated with BMI (unadjusted β: 0.0657; 95% confidence interval, CI: 0.0433–0.0881). After correcting for income, urbanization, population size, openness to trade and FDI, the estimated relationship weakened but remained strongly significant (β: 0.0329; 95% CI: 0.0136–0.0522), so that each 1-unit increase in the average number of annual fast food transactions per capita was associated with an increase of 0.0329 kg/m² in age-standardized BMI.

Robustness checks

Before analysing the influence of market deregulation and the possible mediators between fast food consumption and BMI, we performed a series of robustness checks. When we excluded Anglo-Saxon economies from the model while controlling for the same confounders, we found no significant differences in the magnitude of the association between fast food consumption and BMI ($P > 0.05$ when testing effect heterogeneity). Similar results were found when we included Asian countries in the models. We then used first-difference methods to estimate the same basic model developed in Table 2, results confirmed the robustness of the fixed effects estimates (β: 0.0148; 95% CI: 0.0017–0.0279). We also disaggregated the analysis by sex and found no significant differences between males (β: 0.0294; 95% CI: 0.0077–0.0512) and females (β: 0.0360; 95% CI: 0.0183–0.0537) in the size of the estimated association ($P > 0.05$ when testing for effect heterogeneity). Similar results were obtained when we used per capita transactions only at chain food service outlets as an alternative measure of fast food consumption (β: 0.0271; 95% CI: 0.0114–0.0427). After the inclusion of three additional covariates – insufficient physical activity, motor vehicle use per 1000 people and fruit and vegetable consumption – the association between fast food and BMI remained statistically significant (β: 0.0140; 95% CI: 0.0058–0.0222). Finally, when we included the Gini index of within country income inequality in the model, the association between fast food consumption and BMI remained strongly significant (β: 0.0293; 95% CI: 0.0130–0.0456).

Soft drinks, animal fats and total calories

Table 3 shows the results of a series of separate regression models using mediators known to be associated with both fast food consumption and BMI. If the association between fast food consumption and BMI is mediated by soft drinks, animal fats and total calories, as we hypothesized, holding these mediators constant should attenuate the observed relationship. Only soft drink consumption, however, appeared to be a plausible partial mediator, by slightly reducing the effect size of the association between fast food consumption and BMI, after correcting for covariates (β: 0.0302; 95% CI: 0.0101–0.0504). Neither the intake of animal fats nor total caloric intake changed the effect size of the observed relationship substantially.

Market deregulation, fast food consumption and BMI

In spite of the robustness checks, our results could have been driven by third factors affecting both fast food consumption and BMI, such as changes in the macroeconomic environment. Although fixed effects models can cancel out the possible confounding effect of initial, time-invariant, country-specific characteristics, they do not correct for time-varying confounders. To address this problem, we employed two-stage least squares regression models using economic freedom as an instrumental variable. These models allowed us not only to put to further testing the robustness of the fixed-effects estimates in Table 2, but also to investigate the role of market deregulation as a determinant of BMI through fast food consumption. Instrumental variables are believed to

Table 2. **Associations between fast food consumption and age-standardized body mass index (BMI) before and after adjustment for selected covariates, 1999–2008**

Variable	Age-standardized mean BMI					
	Model 1[a]	Model 2[a]	Model 3[a]	Model 4[a]	Model 5[a]	Model 6[a]
Fast food transactions,[b] β (95% CI)	0.0657 (0.0433–0.0881)	0.0329 (0.0136–0.0522)	0.0907 (0.069–0.112)	0.042 (0.0249–0.0597)	0.06 (0.0439–0.0845)	0.0316 (0.0134–0.0498)
Log GDP per capita,[c] β (95% CI)	–	0.933 (0.4899–1.3774)	–	0.643 (0.2112–1.0762)	–	0.879 (0.4340–1.3257)
Per cent urban population	–	0.0856 (0.0551–0.1161)	–	0.07 (0.0483–0.0975)	–	0.0828 (0.0571–0.1086)
Population size	–	0.0116 (−0.0002–0.0236)	–	0.0514 (0.0121–0.0905)	–	0.0129 (0.0019–0.0239)
Openness to trade[d]	–	0.0006 (−0.0021–0.0035)	–	0.0011 (−0.0016–0.0039)	–	0.0004 (−0.0026–0.0035)
FDI[e]	–	−0.001 (−0.0033–0.00005)	–	−0.0009 (−0.0032–0.0013)	–	−0.0011 (−0.0037–0.0015)
No. of country–years	250	245	190	186	270	265

CI, confidence interval; FDI, foreign direct investment; GDP, gross domestic product.

[a] Model 1: all countries, unadjusted; Model 2: all countries, adjusted; Model 3: all countries except Anglo-Saxon economies (i.e. Australia, Canada, Ireland, New Zealand, the United Kingdom of Great Britain and Northern Ireland and the United States of America), unadjusted; Model 4: all countries except Anglo-Saxon economies, adjusted; Model 5: all countries plus Asian countries (i.e. Japan and the Republic of Korea), unadjusted; Model 6: all countries except Asian countries, adjusted.

[b] Meals and refreshments sold annually per capita in local and transnational fast food outlets, including chain restaurants, independent eateries and convenience stores.

[c] In constant 2005 United States dollars, adjusted for purchasing power parity for comparability between countries.

[d] Imports and exports as a percentage of GDP.

[e] Net inflows as a percentage of GDP.

Note: The table displays the increase in age-standardized mean BMI associated with a 1-unit increase in annual fast food transactions per capita and in other covariates and with a 10% increase in GDP per capita. All models used robust standard errors clustered by country to reflect non-independence of sampling and robustness to heteroskedasticity and serial correlation. The covariates that were adjusted for in Model 2, Model 4 and Model 6 were GDP per capita, urbanization, openness to trade, FDI and population size.

Sources: Age-standardized mean BMI: Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group;[1] annual fast food transactions per capita: Euromonitor's Passport Global Market Information Database;[28] GDP per capita, percentage of the population living in urban areas, national population size, openness to trade and FDI: World Bank's World Development Indicators database.[29]

simulate a natural experiment, and act as a randomization device in dealing with unobserved covariates that, in our case, may be correlated with both fast food consumption and BMI.[41] Valid instruments have at least two major properties. First, they affect the exposure variable we want to test, in this case fast food consumption. Second, they must have no direct effect on the outcome measure, in our case BMI.[41] Table 4 presents estimates of fixed-effects regression models investigating the associations between the IEF (market deregulation) and fast food consumption and BMI. After adjustment for fast food consumption, the association between the IEF and BMI weakened to non-significance ($P > 0.05$), qualifying the IEF as a valid instrument.

Table 5 shows the first-stage and two-stage least square regression models for the effect of fast food consumption on BMI, with the IEF used as an instrument, after adjustment for other covariates. The first-stage regression confirmed that market deregulation is a strong predictor of higher fast food consumption (β: 0.2714; 95% CI: 0.1644–0.3785), after correction for confounders. Each 1-unit increase in the IEF was associated with an increase of 0.2714 in the average number of per capita annual transactions at fast food outlets. The second-stage regression indicated that, when the IEF was used as an instrumental variable for fast food consumption and after correction for confounders, each 1-unit increase in fast food consumption was associated with an increase of 0.0232 kg/m^2 in BMI (95% CI: 0.0011–0.0452).

Discussion

Our study shows that fast food consumption is independently and positively associated with mean BMI in high-income countries. While the consumption of soft drinks explains a small proportion of the variation in the association between fast food consumption and BMI, the intake of animal fats and total caloric intake do not seem to be significant mediators of the association. This is puzzling. The fat and calories in fast food meals are usually blamed for the unhealthful effect of fast food.[42] Although we cannot exclude the possibility of measurement errors, factors other than calories and fat content may explain why fast food makes people fat. Researchers need to investigate, for example, the metabolic effects of long-

Table 3. **Soft drink, animal fats and total calorie intake as mediators of the association between fast food consumption and age-standardized mean body mass index (BMI), 1999–2008**

Variable	Age-standardized mean BMI					
	Model 1[a]	**Model 2[a]**	**Model 3[a]**	**Model 4[a]**	**Model 5[a]**	**Model 6[a]**
Fast food transactions,[b] β (95% CI)	0.0459 (0.0238–0.0680)	0.0302 (0.0101–0.0504)	0.0650 (0.0426–0.0874)	0.0328 (0.0135–0.0522)	0.0647 (0.0423–0.0871)	0.0327 (0.0131–0.0522)
Intake of soft drinks, β (95% CI)	0.0058 (0.0034–0.0082)	0.0026 (−0.0004–0.0057)	–	–	–	–
Intake of animal fats, β (95% CI)	–	–	−0.0008 (−0.0018–0.0001)	0.0001 (−0.0004–0.0007)	–	–
Total caloric intake, β (95% CI)	–	–	–	–	0.0003 (−0.0002–0.0008)	0.0006 (−0.0002–0.0003)
Fraction of effect due to mediator, %	11.3	8.2	1.2	0.3	1.6	0.6
No. of country–years	250	245	249	244	249	244

CI, confidence interval; GDP, gross domestic product.

[a] Model 1, 3 and 5 are unadjusted. Models 2, 4 and 6 are additionally adjusted for log GDP per capita, percentage of population living in urban areas, national population size, openness to trade and foreign direct investment.

[b] Meals and refreshments sold annually per capita in local and transnational fast food outlets, including chain restaurants, independent eateries and convenience stores.

Note: The table displays the increase in age-standardized mean BMI associated with a 1-unit increase in average number of annual fast food transactions per capita, average intake of soft drinks (in litres per capita per year), average intake of animal fats (in kcal per capita per day) and average total caloric intake (in kcal per capita per day). Models corrected for country-specific fixed effects.

Sources: Age-standardized mean BMI: Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group;[1] annual fast food transactions per capita: EuroMonitor Passport Global Market Information Database (GMID);[28] intake of soft drinks: GMID;[28] intake of animal fats and total caloric intake: Statistics Division of the Food and Agriculture Organization.[37]

term exposure to fast foods produced from the meat of animals fed on corn, kept in confinement and exposed to excessive fertilization.[43] Researchers should also examine the health effects of a poor diet, which can lead not only to obesity but also to the development of noncommunicable diseases. More research is also needed to study the effects of the degree of processing of food items and not just their nutrient and caloric content.[44]

In line with previous research,[17] our study shows that countries adopting what are considered market-liberal policies experience faster increases in both fast food consumption and mean BMI. These results are in accord with previous research showing that more stringent trade restrictions – including better protection of agricultural producers[45] – the frequency of price controls[26] and stricter government regulations[46] are negatively correlated with obesity. The mechanisms explaining the influence of economic freedom on fast food and obesity have not been sufficiently studied. One possibility is that indiscriminate market deregulation favours global food chains at the expense of smaller farmers and local food systems.[47] In effect, additional analyses (available from the corresponding author upon request) showed that, while per capita transactions at chain food service outlets were positively and significantly correlated with mean BMI, this was not the case for per capita transactions at independent food service outlets.

Our results must be interpreted with caution. First, the IEF reflects perceptual biases because it disproportionately relies on the perspective of investors and the business community.[48] Moreover, it does not necessarily reflect the extent to which market deregulation is applied to the agricultural sector. Our data show, however, that the most "market-friendly countries, including Australia, Canada, New Zealand and the United States have less restrictive agricultural regulations and provide substantially lower farm subsidies than European countries such as France, Italy and Greece.[45] Another limitation has to do with the dependent variable, age-standardized mean BMI, which is based on estimates from a Bayesian hierarchical model involving a complex dependence structure for which we could not adjust.[1] In spite of this, the correlation between the BMI measure used in this study and obesity prevalence

Table 4. **Associations between the index of economic freedom (IEF)[a] and fast food consumption and age-standardized mean body mass index (BMI), 1999–2008**

Variable	Fast food transactions[b] (Model 1)[c]	Age-standardized BMI	
		Unadjusted (Model 2)[c]	Adjusted for fast food transactions (Model 3)[c]
IEF, β (95% CI)	0.5501 (0.0238–0.8610)	0.0396 (0.0224–0.0569)	0.0048 (−0.0094–0.0190)
No. of country–years	250	250	250

CI, confidence interval.

[a] Created by the Heritage Foundation and the *Wall Street Journal*.[31]

[b] Meals and refreshments sold annually per capita in local and transnational fast food outlets, including chain restaurants, independent eateries and convenience stores.

[c] The table displays the increase in annual fast food transactions per capita associated with a 1-unit increase in the IEF (Model 1), the increase in age-standardised BMI associated with a 1-unit increase in the IEF (Model 2), and the increase in age-standardised BMI associated with a 1-unit increase in the IEF after adjustment for annual fast food transactions per capita (Model 3).

Note: Models were corrected for country-specific fixed effects. All models used robust standard errors clustered by country to reflect non-independence of sampling and robustness to heteroskedasticity and serial correlation.

Sources: Age-standardized mean BMI: Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group;[1] average annual fast food transactions per capita: Euromonitor's Passport Global Market Information Database.[28]

Table 5. **Association between fast food consumption and age-standardized body mass index (BMI) using the index of economic freedom (IEF) as an instrumental variable, 1999–2008**

Variable	Fast food transactions,[a] first stage (Model 1)	Age-standardized mean BMI, two-stage least squares (Model 2)
Fast food transactions, β (95% CI)	–	0.0232 (0.0011–0.0452)
IEF,[b] β (95% CI)	0.2714 (0.1644–0.3785)	–
No. of country–years	244	244

CI, confidence interval.

[a] Meals and refreshments sold annually per capita in local and transnational fast food outlets, including chain restaurants, independent eateries and convenience stores.

[b] Created by the Heritage Foundation and the *Wall Street Journal*.[31]

Note: The table displays the increase in annual fast food transactions per capita associated with a 1-unit increase in the IEF (Model 1), and the increase in age-standardized BMI associated with a 1-unit increase in the number of annual fast food transactions per capita (Model 2) when using the IEF as an instrument for such transactions. Models included country-specific fixed effects using the Stata 12.0 "xtivreg" command for two-stage least squares regression with panel data. Models were corrected for log gross domestic product (GDP) per capita (in constant 2005 United States dollars, adjusted for purchasing power parity), percentage of the population living in urban areas, national population size, openness to trade (imports and exports as a percentage of GDP), foreign direct investment (net inflows as a percentage of GDP), average intake of soft drinks (in litres per capita per year), average intake of animal fats (in kcal per capita per day) and average total caloric intake (in kcal per capita per day). All models used robust standard errors clustered by country to reflect non-independence of sampling and robustness to heteroskedasticity and serial correlation.

Sources: Age-standardized mean BMI: Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group;[1] average annual fast food transactions per capita: EuroMonitor Passport Global Market Information Database.[28]

as obtained from the Global Health Observatory database was very strong. ($r = 0.953$; $P < 0.001$) (Appendix D, available at: http://goo.gl/ElLR0z) Although mean BMI may be a biased measure of overweight and obesity, especially because the prevalences of underweight and malnutrition can influence its interpretation, such bias is more likely to affect BMI estimates for low- and middle-income countries. Moreover, a continuous variable like BMI is a more practical indicator than a categorical variable such as obesity because its associations with most health outcomes are continuous, rather than characterized by a specific threshold. An additional limitation relates to the ecological and observational nature of the data. Although confounding can never be completely ruled out, our findings remained robust following numerous estimation methods and statistical checks. Finally, although the magnitude of the association between fast food consumption and BMI weakened substantially under instrumental variable specification, it remained statistically significant.

Conclusion

Our study provides novel findings on the association between fast food consumption and mean population BMI and on the influence of market deregulation as a contributor to higher fast food consumption and BMI. The study has important implications for policy. In particular, they suggest that government regulations hindering the spread of fast food consumption might help to mitigate the obesity epidemic. Indeed, although all countries included in our sample have experienced increases in fast food consumption and mean BMI over the period studied (1999–2008), nations that have adopted more stringent market regulations have experienced slower increases in both. More research is needed to confirm whether deregulation is a significant contributor to body weight and to determine what types of government interventions could mitigate the obesity epidemic and curb the spread of transnational fast food companies. ■

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ملخص

تأثير إلغاء القيود التنظيمية للسوق على استهلاك الأغذية السريعة ومنسب كتلة الجسم: تحليل السلسلة الزمنية عبر الوطنية

الغرض تحري تأثير استهلاك الأغذية السريعة على منسب كتلة الجسم لمتوسط السكان واستكشاف التأثير المحتمل لإلغاء القيود التنظيمية للسوق على استهلاك الأغذية السريعة ومنسب كتلة الجسم.

الطريقة تم استكشاف الارتباط داخل البلد بين استهلاك الأغذية السريعة ومنسب كتلة الجسم في 25 بلداً من البلدان الأعضاء ذات الدخل المرتفع في منظمة التعاون والتنمية في الميدان الاقتصادي بين عامي 1999 و2008 من خلال نماذج ارتداد إحصائية متعددة المتغيرات، بعد التعديل لإجمالي الناتج المحلي للفرد، والتحول الحضري، والانفتاح التجاري، ومؤشرات نمط الحياة والمتغيرات المشتركة الأخرى. وتم أيضاً تحليل التأثير المتوسط المحتمل لمدخول الاستهلاك الفردي السنوي من المشروبات غير الكحولية، والدهن الحيواني، وإجمالي السعرات الحرارية على الارتباط بين استهلاك الأغذية السريعة ومنسب كتلة الجسم. وتم إجراء نماذج ارتداد للمربعات الدنيا على مرحلتين، باستخدام الحرية الاقتصادية كمتغير مساعد، لدراسة التأثير الاعتيادي لاستهلاك الأغذية السريعة على منسب كتلة الجسم.

النتائج بعد تعديل المتغيرات المشتركة، تم الربط بين كل زيادة بمقدار وحدة واحدة في معاملات الأغذية السريعة السنوية للفرد وبين زيادة قدرها 0.033 كجم/ م^3 في منسب كتلة الجسم حسب العمر (فاصل الثقة 95 ٪، فاصل الثقة: 0.013 – 0.052). وتوسط مدخول المشروبات الباردة فقط – وليس الدهن الحيواني أو إجمالي السعرات الحرارية – الارتباط الخاضع للملاحظة (بيتا: 0.030؛ فاصل الثقة 95 ٪، فاصل الثقة: 0.010 – 0.050). وكانت الحرية الاقتصادية منبئ مستقل لاستهلاك الأغذية السريعة (بيتا: 0.27؛ فاصل الثقة 95 ٪، فاصل الثقة: 0.16 – 0.37). وعند استخدام الحرية الاقتصادية كمتغير مساعد، ضعف الإرتباط بين الأغذية السريعة ومنسب كتلة الجسم ولكنه ظل كبيراً (بيتا: 0.023؛ فاصل الثقة 95 ٪، فاصل الثقة: 0.001 – 0.045).

الاستنتاج يعد استهلاك الأغذية السريعة منبئ مستقل لمتوسط منسب كتلة الجسم في البلدان ذات الدخل المرتفع. ومن الممكن أن تسهم سياسات إلغاء القيود التنظيمية للسوق في وباء السمنة من خلال تسهيل انتشار الأغذية السريعة.

摘要

市场放宽管制对快餐消费和体重指数的影响：跨国时间序列分析

目的 调查快餐消费对平均人口体质指数（BMI）的影响，探索市场放宽管制对快餐消费和 BMI 的可能影响。

方法 在针对人均国内生产总值、城市化、贸易开放、生活方式指标和其他协变量的调整之后，通过多元面板回归模型探究 1999 年至 2008 年经济合作与发展组织的 25 个高收入成员国的快餐消费和 BMI 之间的国内相关性。还分析了年度人均软饮料、动物脂肪和总热量摄入量对快餐消费和 BMI 之间关联可能的中介效应。使用经济自由度作为工具变量，执行两步最小二乘法回归模型，研究快餐消费对 BMI 的因果效应。

结果 在调整协变量之后，年度人均快餐交易每增加一个单位与年龄标准化 BMI 增加 0.033 kg/m^2 相关联（95% 置信区间，CI：0.013-0.052）。只有软饮料的摄入（非动物脂肪或总热量）对所观察到的关联具有中介效应（β：0.030；95%，CI：0.010-0.050）。经济独立性是快餐消费的独立预测指标（β：0.27；95%，CI：0.16-0.37）。使用经济独立性作为工具变量时，快餐和 BMI 之间的关系弱化，但是依然具有显著性（β：0.023；95%，CI：0.001-0.045）。

结论 快餐消费是高收入国家平均 BMI 的独立预测指标。市场放宽管制政策促进快餐推广，助长肥胖症流行。

Résumé

Influence de la déréglementation du marché sur la consommation de services de restauration rapide et sur l'indice de masse corporelle: analyse d'une série chronologique transnationale

Objectif Étudier l'effet de la consommation de services de restauration rapide sur l'indice de masse corporelle (IMC) moyen d'une population et examiner l'influence possible de la déréglementation du marché sur la consommation de services de restauration rapide et sur l'IMC.

Méthodes La corrélation, dans un même pays, entre la consommation de services de restauration rapide et l'IMC dans 25 pays à revenu élevé membres de l'Organisation de coopération et de développement économiques entre 1999 et 2008 a été étudiée en utilisant des modèles de régression sur données de panels à plusieurs variables, après ajustement pour le produit intérieur brut par habitant, l'urbanisation, l'ouverture des marchés, les indicateurs de mode de vie et d'autres covariables. L'effet médiateur possible de la consommation annuelle par habitant de boissons sans alcool, de graisse animale et de calories totales sur la corrélation entre la consommation de services de restauration rapide et l'IMC a également été analysé. Des modèles de régression par la méthode des moindres carrés à deux degrés ont été appliqués, en utilisant la liberté économique comme variable instrumentale, pour étudier l'effet de causalité de la consommation de services de restauration rapide sur l'IMC.

Résultats Après ajustement des covariables, chaque augmentation de 1 unité dans les transactions annuelles liées aux services de restauration rapide par habitant est associée à une augmentation de 0,033 kg/m^2 de l'IMC normalisé en fonction de l'âge (intervalle de confiance de 95%, IC: 0,013-0,052). Seule la consommation de boissons non alcoolisées – pas de graisse animale ou de calories totales – a eu un effet

médiateur sur l'association observée (*β*: 0,030; IC à 95%: 0,010-0,050). La liberté économique était un indicateur prévisionnel indépendant de la consommation de services de restauration rapide (*β*: 0,27; IC à 95%: 0,16-0,37). Lorsque la liberté économique a été utilisée comme variable instrumentale, l'association entre la restauration rapide et l'IMC est moindre mais reste significative (*β*: 0,023; IC à 95%: 0,001-0,045).

Conclusion La consommation de services de restauration rapide est un indicateur prévisionnel indépendant de l'IMC moyen dans les pays à revenu élevé. Les politiques de déréglementation du marché peuvent contribuer à l'épidémie d'obésité en facilitant le développement de services de restauration rapide.

Резюме

Влияние отмены государственного регулирования рынка на потребление блюд быстрого питания и на индекс массы тела: межнациональный анализ временных рядов

Цель Исследовать влияние потребления блюд быстрого питания на среднепопуляционный индекс массы тела (ИМТ), а также изучить возможное влияние отмены государственного регулирования рынка на потребление блюд быстрого питания и ИМТ.

Методы В 25 странах-членах Организации экономического сотрудничества и развития с высоким уровнем доходов было проведено исследование взаимосвязи в пределах одной страны между потреблением блюд быстрого питания и ИМТ за период с 1999 по 2008 гг. Исследование проводилось с помощью многопараметрических моделей панельной регрессии, после внесения корректировок для таких параметров как валовой внутренний продукт на душу населения, уровень урбанизации, свобода торговли, показатели образа жизни и другие ковариаты. Также было проанализировано возможное опосредующее влияние ежегодного потребления на душу населения безалкогольных напитков, животных жиров и суммарного количества калорий на связь между потреблением блюд быстрого питания и ИМТ. Для изучения причинно-следственного влияния потребления блюд быстрого питания на ИМТ были произведены расчеты для двухэтапной модели наименьшей квадратической регрессии с использованием экономической свободы в качестве инструментальной переменной.

Результаты После внесения корректировок для ковариат, каждое увеличение на 1 единицу ежегодных транзакций на душу населения в области быстрого питания было связано с увеличением на 0,033 кг/м^2 для стандартных по возрасту ИМТ (95% доверительный интервал, ДИ: 0,013–0,052). Только потребление безалкогольных напитков – а не животных жиров или суммарного количества калорий – опосредованно влияло на наблюдаемую связь (*β*: 0.030; 95% ДИ: 0,010–0,050). Экономическая свобода была независимой переменной для прогнозирования потребления блюд быстрого питания (*β*: 0.27; 95% ДИ: 0,16–0,37). Когда экономическая свобода использовалась в качестве инструментальной переменной, связь между быстрым питанием и ИМТ ослабевала, но все равно оставалась значительной (*β*: 0,023; 95% ДИ: 0,001–0,045).

Вывод Потребление блюд быстрого питания является независимой переменной, прогнозирующей среднее значение ИМТ в странах с высоким уровнем дохода. Политики отмены государственного регулирования рынка могут усугубить проблему ожирения, поскольку способствуют распространению ресторанов быстрого питания.

Resumen

La influencia de la desregulación del mercado en el consumo de comida rápida y el índice de masa corporal: un análisis de series temporales entre países

Objetivo Investigar el efecto del consumo de la comida rápida en el índice de masa corporal promedio de la población (IMC) y explorar la posible influencia de la desregulación del mercado en el consumo de comida rápida y el IMC.

Métodos Entre 1999 y 2008, se exploró la relación dentro de los países entre el consumo de comida rápida y el IMC en 25 países de ingresos altos, miembros de la Organización para la Cooperación y el Desarrollo, a través de modelos de regresión de panel multivariante, tras ajustar el producto interior bruto per cápita, la urbanización, la apertura comercial, los indicadores de estilo de vida y otras covariables. También se analizó el posible efecto mediador del consumo anual per cápita de refrescos, grasa animal y calorías totales en la relación entre el consumo de comida rápida y el IMC. Se realizaron modelos de regresión de mínimos cuadrados de dos etapas, usando la libertad económica como variable instrumental, para estudiar el efecto causal del consumo de comida rápida en el IMC.

Resultados Tras corregir las covariables, cada aumento de 1 unidad de transacciones anuales de comida rápida per cápita se asoció con un aumento de 0,033 kg/m^2 del IMC normalizado por edad (intervalo de confianza del 95 %, IC: 0,013–0,052). Solo la ingesta de bebidas (no la grasa animal ni las calorías totales) interfirió en la asociación observada (*β*: 0,030; IC del 95 %: 0,010–0,050). La libertad económica funcionó como indicador independiente del consumo de comida rápida (*β*: 0,27; IC del 95 %: 0,16–0,37). Cuando se usó la libertad económica como variable fundamental, la relación entre comida rápida e IMC fue más débil, pero siguió siendo significativa (*β*: 0,023; IC del 95 %: 0,001–0,045).

Conclusión El consumo de comida rápida es un indicador independiente del índice de masa corporal promedio en países de altos ingresos. Las políticas de desregulación del mercado pueden contribuir a la epidemia de obesidad, al facilitar la difusión de la comida rápida.

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Table 1. **Age-standardized mean body mass index (BMI), per capita fast food transactions and other covariates in 25 high-income countries of the Organisation for Economic Co-operation and Development, 1999, 2002, 2005, 2008**

Variable	1999			2002			2005			2008		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Age-standardized mean BMI (kg/m^2)	25.84	0.66	24.87–27.50	26.04	0.71	24.94–27.82	26.23	0.75	25.01–28.13	26.44	0.79	25.11–28.39
Fast food transactions, no.[a]	26.61	27.27	6.9–109.5	28.56	28.38	9.1–114.10	30.68	29.49	10.5–121.70	32.76	30.20	12.13–126.10
GDP per capita[b]	26 045.57	7853.44	11 212.92–42 866.46	27 966.32	7979.83	12 137.23–45050.22	29 665.49	8071.49	13 784.16–47 626.28	31 272.20	7792.31	16 454.81–48583.24
Per cent urban population	74.01	11.78	53.74–97.04	74.47	11.69	55.68–97.18	74.96	11.58	56.2–97.30	75.50	11.44	56.56–97.36
Population size (millions)	31.60	56.10	3.7–279.00	32.30	57.70	3.9–287.80	32.90	59.2	4.10–295.70	33.70	60.8	4.26–304.30
Openness to trade[c]	78.72	34.49	24.09–164.58	82.75	37.07	22.97–170.77	86.72	37.76	26.49–157.16	94.88	41.58	30.79–169.09
FDI[d]	13.00	7.35	1.00–25.00	4.02	3.12	−0.56–12.97	2.03	3.34	−5.88–12.28	7.97	10.49	0.64–52.05
IEF[e]	67.63	6.89	54.20–81.70	70.00	6.75	58.00–80.70	69.86	7.28	59.00–82.30	72.12	7.08	60.30–82.50
Intake of soft drinks[f]	133.69	40.80	74.40–231.00	148.64	43.35	79.40–241.80	159.49	44.84	88.00–258.00	167.24	42.45	100.30–259.50
Intake of animal fat[g]	212.25	105.47	26.00–439.00	218.20	108.46	28.00–426.00	208.76	104.61	30.00–421.00	205.56	101.84	31.00–401.00
Total caloric intake[g]	3392.29	238.25	2876.00–3791.00	3432.04	251.66	2794.00–3829.00	3426.52	225.21	2843.00–3799.00	3437.04	225.02	2866.00–3826.00

FDI, foreign direct investment; GDP, gross domestic product; GMID, Global Market Information Database; IEF, index of economic freedom; SD, standard deviation.

[a] Meals and refreshments sold annually per capita in local and transnational fast food outlets, including chain restaurants, independent eateries and convenience stores.

[b] In constant 2005 United States dollars, adjusted for purchasing power parity for comparability between countries.

[c] Imports and exports as a percentage of GDP.

[d] Net inflows as a percentage of GDP.

[e] Created by the Heritage Foundation and the *Wall Street Journal*.[31]

[f] In litres per capita per year.

[g] In kcal per capita per day.

Sources: Age-standardized mean BMI: Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group;[1] annual fast food transactions per capita: Euromonitor's Passport Global Market Information Database (GMID);[28] GDP per capita, percentage of the population living in urban areas, national population size, openness to trade and FDI: World Bank's World Development Indicators database;[29] intake of soft drinks: GMID;[28] intake of animal fat and total caloric intake: Statistics Division of the Food and Agriculture Organization.[37]