Association between obesity and selected morbidities: A study of BRICS

Ankita, Ankita Shukla and Kaushal, Kaushalendra Kumar and Abhishek, Abhishek Singh

International Institute for Population Sciences Mumbai,
International Institute for Population Sciences Mumbai,
International Institute for Population Sciences Mumbai

19 July 2013

Association between obesity and selected morbidities: A study of BRICS countries

Ankita Shukla
MPS Student
International Institute for Population Sciences
Mumbai
email: ankita17shukla@gmail.com

Kaushalendra Kumar
PhD Student
International Institute for Population Sciences
Mumbai
email: kaushlendrakumar.1983@gmail.com

Abhishek Singh
Assistant Professor
International Institute for Population Sciences
Mumbai
email: abhi_iips@yahoo.co.in

Abstract

Context: Over the past few decades, obesity has reached epidemic proportions, and is a major contributor to the global burden of chronic diseases and disability. There is little evidence on obesity related co-morbidities in BRICS countries.

Objectives: The first objective is to examine the factors associated with overweight and obesity in four of the five BRICS countries (China, India, Russia and South Africa). The second is to examine the linkage of obesity with selected morbidities.

Methods: We used data from the Study on Global Ageing and Adult Health (SAGE) survey conducted in China, India, Russia and South Africa during 2007-10. Respondents with a body mass index (BMI)>= 25 but <30 were coded as overweight, and those with BMI>= 30 as obese. Bivariate analysis, binary logistic regression and multinomial logistic regression are used in the analysis. The morbidities included in the analysis are Hypertension, Diabetes, Angina, Stroke, Arthritis and Depression.

Results: The prevalence of obesity was highest in South Africa (35%) followed by Russia (27%), China (5%) and India (3%). The prevalence of obesity was significantly higher in females as compared to males in all the countries. While the wealth quintile was significantly associated with obesity in India, Russia and South Africa, engaging in work requiring physical activity was significantly associated with obesity in China and South Africa. Overweight/obesity was significantly associated with morbidities such as Hypertension, Angina, Diabetes and Arthritis in all the four countries. In comparison, overweight/obesity was not associated with Stroke and Depression in any of the four countries included in the analysis.

Conclusion: The data demonstrates a high prevalence of obesity in South Africa and Russia. Overweight/obesity was significantly associated with Hypertension, Angina, Diabetes and Arthritis.

Keywords: overweight, obesity, hypertension, diabetes, angina, stroke, arthritis, depression, BRICS

Introduction

Over the past few decades obesity has emerged as a global health challenge, with every sixth person being obese (Mudur, 2005, Caballero, 2005). According to recent WHO estimates, the number of obese around the globe has doubled compared to the number in 1980. In 2008, more than 1.4 billion adults aged 20 or more years were overweight (WHO, 2013). Of these, 500 adult million men and women were obese. Projections by Kelly et al (2008) suggest that the number of obese is expected to increase to 1.12 billion by 2030. Statistics suggest significant variations in the prevalence of obesity across the globe. The prevalence of obesity ranges from below 5% in China, Japan and African countries to over 75% in urban Samoa (WHO, 2003, Curtis, 2004). The growing proportion of obese adults calls for immediate attention by way of detailed study of behavioral risk factors, accurate analysis of trends, effective policy and timely intervention.

Obesity is known to affect the overall health of a population. According to WHO (2013), overweight and obesity are the fifth leading risk for global deaths. About 2.8 million adults die of overweight or obesity every year. Obesity is also found to be associated with a number of non-communicable diseases such as cardiovascular diseases, diabetes, musculoskeletal disorders and

some forms of cancers (WHO, 2013). Statistics indicate that 44% of the diabetic burden, 23% of the heart disease burden and between 7% and 41% of certain cancer burdens can be attributed to overweight and obesity (WHO, 2013).

Given the serious consequences of overweight and obesity, our study aims to examine the factors associated with overweight and obesity in four of the five BRICS countries (China, India, Russia and South Africa). Our study explores the linkages between obesity and selected morbidities in these countries. BRICS is an international association of emerging national economies: Brazil, China, India, Russia and South Africa. The member countries represent a mix of economies with developing countries like Brazil, India, China and South Africa and a developed country like Russia. The share of China, India, Russia and South Africa together in the total world population is approximately 40%. In terms of population aged 18 years or older, these comprise 41% of the world's population (UN, 2009). These countries are at different stages of demographic and epidemiological transition. Hence this study helps understand obesity and its consequences from a wide perspective.

Past Research

Studies suggest that 10% of India's population was either overweight or obese in 2006; 13% of women and 9% of men in the age-group 15-49 were obese (IIPS, 2007). In China, 15% of the adults were overweight, and 3% were obese (Wu et al., 2005). In South Africa, 21% of men and 28% of women were overweight, and 9% of men and 27% of women were obese (Puoane et al., 2003). In Russia, about 41% of men and 49% of women were overweight in 2000, and 16% of the adults in Russia were obese (Jahns et al., 2003). Recent statistics suggest that, in Brazil,

about 14% of the adults were obese, and nearly 47% were overweight (Yapp, 2010). Moreover, obesity among adults has increased from 11% in 2006 to 14% in 2009 (Moura and Claro, 2012).

Increasing urbanization, changing lifestyle, low physical activity, occupational pattern and high calorie intake are known causes of obesity (Misra and Khurana, 2008, Nugent, 2008, Prentice, 2006, Crawford and Ball, 2002). Obesity is also associated with age, gender, socioeconomic condition, smoking status, and urban-rural residence (Rampal et al., 2007, Puoane et al., 2003, Reynolds et al., 2007).

Obesity is not only a problem in itself, but is also known to contribute to a variety of health conditions. Studies have shown a significant association between obesity and major health risks such as diabetes, high blood pressure, high cholesterol levels, asthma and arthritis (Field et al., 2001, Mokdad et al., 2003). Studies have identified a direct relationship between weight gain and total stroke risk. These studies have shown that respondents with increased BMI levels have a significantly higher risk of ischemic stroke (Rexrode et al., 1997). Interestingly, findings of the studies on obesity and mental illness/disorders are mixed. While some studies have found a significant relationship between obesity and mental illness/disorders (Becker et al., 2001, Guo et al., 2013), there are others that find no relationship (Yu et al., 2011).

Literature search yielded only a few studies that have examined the linkages between obesity and selected morbidities in BRICS countries. To our knowledge, there is only one study that has examined the linkage between obesity and hypertension in four of the five BRICS countries (Basu and Millett, 2013). We came across one study from India (Venkatramana and Reddy, 2002), four studies from China (Li et al., 2002, Wang et al., 2007, Cai et al., 2013, Chen et al., 2005) one study from South Africa (Peltzer and Phaswana-Mafuya, 2013) and two studies from

Russia (Kalichman et al., 2006, Mozheyko et al., 2012) that have examined the association between obesity and hypertension/heart disease and have found a significant positive association between them. With reference to studies on obesity and diabetes, we came across three studies from China (Cai et al., 2013, Li et al., 2002, Wang et al., 2007). The association between obesity and stroke was examined in a study conducted in China (Cai et al., 2013), which reported that the obese were more likely to suffer from stroke than normal respondents. Likewise, the association between obesity and arthritis was examined in a study conducted in rural Russia (Kalichman et al., 2006). It is important to note that, except for Basu and Millett (2013) and Peltzer and Phaswana-Mafuya (2013), all the studies listed above were either based on small-scale datasets (and hence are not representative at the national level) or referred to specific population subgroups. We did not come across any study that examined the association between obesity and depression in these countries.

Hence, our aim is to examine the factors associated with overweight and obesity in China, India, Russia and South Africa using a more recent and population-based large-scale dataset. Further, we examine the association between obesity and selected morbidities – hypertension, diabetes, angina, stroke, arthritis, and depression. We hope to provide more robust and comparable evidence on the association between obesity and selected morbidities in four of the five BRICS countries.

Data and Methods

Data

The present study uses data from the Study on Global Ageing and Adult Health (SAGE) surveys implemented in six countries – China, India, Ghana, Mexico, Russia and South Africa – during

2007-2010. The target population in the SAGE survey is adults, 18 years and older. A multistage stratified clustered sample design was used uniformly in all the countries included in the SAGE. SAGE collected information about self–reported morbidities and health conditions based on interview and health measurement, anthropometric measurements and blood tests (Kowal et al., 2012). Since our analysis is restricted to BRICS countries, we included China, India, Russia and South Africa in the analysis. Brazil could not be included in our analysis because the SAGE survey was not conducted in Brazil. SAGE interviewed 11,230 adults (18 years or older) in India, 14,811 in China, 4,225 in South Africa, and 4,335 in Russia (Kowal et al., 2012). Adults for whom weight and height measurements were not available were excluded from the analysis. Hence, the final sample for the analysis was 10,915 for India, 13,989 for China, 3,994 for South Africa, and 3,889 for Russia.

Variables

In this study, body mass index (BMI) is taken as an indicator of obesity, calculated as weight in kilograms divided by the square of height in meters. Measured weight and height are used to calculate BMI. Respondents are classified as Underweight (BMI <18.5), Normal ($18.5 \leq BMI < 25$), Overweight ($25 \leq BMI < 30$) and Obese ($BMI \geq 30$) (WHO, 2006).

The inclusion of morbidities in our analysis was based on two criteria – first, the morbidities must be influenced by obesity; and second, information on the morbidities was collected by the SAGE survey. Accordingly, we included hypertension, diabetes, angina, stroke, arthritis, and depression in our analysis. The SAGE survey collected three readings each of systolic and diastolic measures of blood pressure. Any respondent whose systolic measure was 140 or more or whose diastolic measure was 90 or more was coded as ‘suffering from hypertension’. The rest

were coded as 'not suffering from hypertension'. These cut-offs for hypertension have been recommended and used in a number of studies (WHO/ISH, 1999, Whitworth, 2003).

For the remaining five morbidities, we used self-reports to code respondents as those having or not having morbidities. The following questions were used to address the remaining five morbidities:

1. Have you ever been diagnosed with diabetes (high blood sugar)? (Yes, No)
2. Have you ever been diagnosed with angina or angina pectoris (a heart disease)? (Yes, No)
3. Have you ever been told by a health professional that you have had a stroke? (Yes, No)
4. Have you ever been diagnosed with/told you have arthritis (or by other names rheumatism or osteoarthritis)? (Yes, No)
5. Have you ever been diagnosed with depression? (Yes, No)

All the morbidities were coded into dummy variables. For example, those reporting 'yes' to diabetes were coded as '1' and others were coded as '0'. The other morbidities were also coded along similar lines.

Since BMI and selected morbidities are known to be affected by other risk factors, several individual and lifestyle factors have been included in the analysis. The variables included in the analysis are: age (less than 50 years, 50 years or older), gender (male, female), schooling (up to primary, secondary, higher secondary and above), wealth quintiles (lowest quintile, 2nd quintile, 3rd quintile, 4th quintile, top quintile), place of residence (rural, urban), current smoking status (no, yes), current alcohol use (no, yes), and engaged in work that involves physical activity (no,

yes). The economic status of household was measured in terms of household assets based wealth quintile. The wealth quintiles, which were already computed in the SAGE, were generated through a principal components analysis conducted on a set of variables based on the ownership of household assets (Deon and Pritchett, 2001, Vyas and Kumaranayake, 2006, Howe et al., 2009, Rutstein, 2008).

We identified respondents engaged in work that involved physical activity using the following two questions:

1. Does your work involve any type of vigorous-intensity activity? (Yes, No)
2. Does your work involve any type of moderate-intensity activity? (Yes, No)

Respondents who reported 'yes' to any of the two questions were coded as '1' and the rest were coded as '0'.

Statistical Analysis

Bivariate and multivariate analyses have been used to fulfill the objectives of the paper. Since BMI had four categories (underweight, normal, overweight and obese), we used multinomial logistic regression analysis to examine the factors associated with overweight and obesity. As the selected morbidities were coded as dummy variables, binary logistic regression was used to examine the association of obesity with selected morbidities. Appropriate sampling weights were used to generate the bivariate estimates. The analysis presented in the paper was conducted in STATA 12.0.

Results

The percentage distribution of sample by selected characteristics is shown in Table 1. Among the four countries analyzed, smoking was highest in India (39%) and lowest in Russia (19%). In comparison, drinking alcohol was highest in Russia (26%) and lowest in India (6%). More than three-fourths of the respondents in India and Russia reported that they were engaged in work that involved physical activity. Engagement in work that involved physical activity was reported least in South Africa (43%). The Indian sample was significantly different from the other three countries in terms of age structure. Only 58% of the Indian sample was 50 years or older. This compares with 89% in China, 91% in South Africa and 90% in Russia. Higher education was more common in the Russian sample; about 73% of the respondents reported that they had high school education or more. This percentage was 17% in India, 19% in China and 11% in South Africa. Rural-urban residence varied considerably across the countries. The percent urban ranged between as low as 25% in the Indian sample to as high as 75% in the Russian sample.

The prevalence of overweight and obesity in the four countries is shown in Figure 1. The percentage of respondents who were overweight ranged between as low as 9% in India and as high as 37% in Russia. Similarly, the percentage of respondents who were obese ranged between 3% in India and 35% in South Africa. Nearly 5% and 27% of the respondents in China and Russia respectively, were obese. The results clearly indicate lower prevalence of overweight and obesity in India in comparison to the other three countries.

Multinomial logistic regression results for factors associated with overweight and obesity are shown in Table 2. Age was significantly associated with overweight and obesity in India, China and Russia. 50 years or older respondents were 1.2-2.4 times as likely as respondents below 50 years of age to be overweight than being normal. Likewise, 50 years or older respondents were

1.5-3.7 times as likely as respondents below 50 years of age to be obese than being normal. While gender was significantly associated with overweight and obesity in India and South Africa, it was significantly associated with obesity in China and Russia. Females, when compared to males, were significantly more likely to be overweight or obese than normal. Wealth was significantly associated with overweight in India and China. However, no consistent association was found between wealth and obesity in any of the countries considered in the analysis. Similarly, no association was found between educational level and overweight/obesity. Smoking was significantly associated with both overweight and obesity in China, South Africa and Russia. Smokers were significantly less likely than non-smokers to be either overweight (odds ratio: 0.58-0.68) or obese (odds ratio: 0.42-0.75) than normal. In India, smoking was significantly associated only with overweight; smokers were only 0.78 times as likely as non-smokers to be overweight than being normal. Drinking alcohol was significantly associated with overweight and obesity in China and South Africa. While engaging in work that involved physical activity was significantly associated with both overweight and obesity in China, it was associated only with obesity in South Africa. Respondents whose work involved physical activity were significantly less likely to be obese than respondents whose work did not involve physical activity in these countries (Odds ratio for China – 0.83; Odds ratio for South Africa – 0.76).

Table 3 shows the prevalence of selected morbidities in India, China, South Africa and Russia. The prevalence of hypertension was highest in South Africa (49%) and lowest in India (20%). The prevalence of diabetes ranged between 3% in China to 6% in Russia. Nearly 24% of the respondents in Russia reported angina compared to only 3%-4% in India, China and South Africa. Of the four countries considered in the analysis, the prevalence of arthritis was the

highest in Russia (22%) and the least in South Africa (8%). The prevalence of depression ranged between 0.4% in China and 5% in South Africa.

Table 4 shows the results of the logistic regression assessing the association between overweight/obesity and selected morbidities. Results, adjusted for selected demographic, socioeconomic, lifestyle and residence related characteristics, suggest that obesity was significantly associated with hypertension and diabetes in all the four countries included in the analysis. The obese were 1.4-3.0 times as likely as those normal to report hypertension or diabetes. Obesity was also associated with angina and arthritis in China, South Africa and Russia. The obese were 1.5-2.0 times as likely as the normal to report angina or arthritis in these countries. Obesity was not associated with either stroke or depression in any of the selected countries.

Like obesity, overweight was also significantly associated with hypertension and diabetes in all the four selected countries. Overweight respondents were 1.4-2.0 times more likely than normal respondents to report hypertension. Likewise, overweight respondents were 1.5-1.9 times more likely than normal respondents to report diabetes. The association between overweight and arthritis was significant in India, China and South Africa (odds ratio: 1.5, 1.2 and 1.4 in India, China and South Africa respectively). Overweight was found to be a risk factor for angina only in China.

Discussion

Overweight and obesity varied considerably across four of the five BRICS countries included in the analysis. The percentage overweight ranged between as low as 9% in India to as high as 37%

in Russia. The percentage of obese ranged between as low as 3% in India to as high as 35% in South Africa. Age and gender were significantly associated with obesity in all the four countries. Respondents aged 50 years or older and female respondents were more likely to be obese compared to their respective counterparts. These findings are in keeping with the findings of earlier studies. Interestingly, engaging in work that involved physical activity was associated with obesity only in China and South Africa. The association between obesity and engagement in work requiring physical activity in India and Russia might have been affected by issues related to measuring the extent of physical activity in work.

The prevalence of selected morbidities also varied considerably across the four countries. The prevalence of hypertension, angina, stroke and diabetes were considerably higher in Russia compared to the other three countries included in the analysis. The prevalence of hypertension was substantially high in South Africa. To account for the differences in the age-structure of the sampled respondents in four countries, we also estimated age-standardized prevalence for each health condition in each country. The age-standardized rates also suggested a considerably high burden of hypertension, angina, stroke and diabetes in Russia compared to the other three countries (results not shown).

Overweight/obesity was also found to be significantly associated with hypertension and diabetes in all the four countries. Overweight/obese respondents were more likely to report hypertension and diabetes. Interestingly, overweight/obesity was also significantly associated with diabetes in all the four countries– overweight/obese respondents were more likely to report diabetes. Our findings confirm the findings of the three small-scale studies conducted on a similar topic in China (Cai et al., 2013, Li et al., 2002, Wang et al., 2007). Obese respondents were also more

likely to report arthritis in China, South Africa and Russia. In contrast to our findings, Kalichman et al. (2006) found no association between obesity and arthritis in rural Russia. Angina was also more likely to be reported by obese respondents in China, South Africa and Russia. Unlike earlier studies, stroke was not associated with overweight/obesity in our study. Depression was also not associated with overweight/obesity in our study. Earlier studies on association between overweight/obesity and depression have remained inconclusive.

One of the strengths of the SAGE survey is that it also allows for estimation of symptom based prevalence of selected morbidities such as angina, arthritis and depression. To examine whether the association between overweight/obesity and these morbidities was robust, we also estimated binary logistic regressions using symptom based prevalence as the dependent variable. The associations of overweight/obesity with arthritis and depression were similar to those obtained in self-reported prevalence. When we used the symptom based prevalence of angina, the association between overweight/obesity and angina became statistically significant even in India (results not shown). These findings provide additional evidence in support of our findings based on self-reports.

The strengths and limitations of our study must be noted. One of the strengths of our study is the use of a large-scale population based dataset for examining the consequences of overweight/obesity in four of the five BRICS countries. Our study, perhaps for the first time, has provided robust and comparable evidence on the association between overweight/obesity and selected morbidities at the national level. The large sample sizes allowed us to control for a number of pertinent covariates in the multivariate statistical models. Notably, our study provides comparable evidence in four different socioeconomic settings. The limitations of our study are that our study only establishes an association between overweight/obesity and selected

morbidities and does not provide any evidence for causality. Second, the prevalence of morbidities reported in our study are based on self-reports. Hence, our prevalence estimates must be taken as lower bounds on the actual prevalence. However, it should not have a substantial effect on the association between overweight/obesity and selected morbidities as discussed earlier. Third, the association between overweight/obesity and certain morbidities might get affected by reporting errors. This could happen particularly in the case of depression. Finally, the choice of control variables was limited to only those variables that were available for each of the four countries considered in the analysis.

To conclude, overweight/obesity was found to be an important risk factor for hypertension, angina, diabetes and arthritis. It is important that public health programs must focus their attention towards the growing epidemic of obesity before it reaches alarming levels. Interestingly, obesity is preventable (WHO, 2013). A healthy lifestyle and increased involvement in physical activity might help prevent the growing burden of obesity.

Conflict of interest: None declared

Reference

BASU, S. & MILLETT, C. 2013. Social Epidemiology of Hypertension in Middle-Income Countries: Determinants of Prevalence, Diagnosis, Treatment, and Control in the WHO SAGE Study. *Hypertension,* 62**,** 18-26.

BECKER, E. S., MARGRAF, J., TURKE, V., SOEDER, U. & NEUMER, S. 2001. Obesity and mental illness in a representative sample of young women. *Int J Obes Relat Metab Disord,* 25 Suppl 1**,** S5-9.

CABALLERO, B. 2005. A Nutrition Paradox — Underweight and Obesity in Developing Countries. *New England Journal of Medicine,* 352**,** 1514-1516.

CAI, L., HE, J., SONG, Y., ZHAO, K. & CUI, W. 2013. Association of obesity with socio-economic factors and obesity-related chronic diseases in rural southwest China. *Public Health,* 127**,** 247-51.

CHEN, J., ZHAO, X. L., WU, F., CUI, Y. L. & HU, D. Y. 2005. Epidemiology of obesity and overweight and relation thereof to the prevalence of hypertension in 14 provinces/municipality in China. *Zhonghua Yi Xue Za Zhi,* 85**,** 2830-4.

CRAWFORD, D. & BALL, K. 2002. Behavioural determinants of the obesity epidemic. *Asia Pac J Clin Nutr,* 11 Suppl 8**,** S718-21.

CURTIS, M. 2004. The Obesity Epidemic in the Pacific Islands. *Journal of Development and Social Transformation,* 1**,** 37-42.

DEON, F. & PRITCHETT, L. H. 2001. Estimating Wealth Effects without Expenditure Data-or Tears: An Application to Educational Enrollments in States of India. *Demography,* 38**,** 115-132.

FIELD, A. E., COAKLEY, E. H., MUST, A., SPADANO, J. L., LAIRD, N., DIETZ, W. H., RIMM, E. & COLDITZ, G. A. 2001. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Arch Intern Med,* 161**,** 1581-6.

GUO, X., ZHANG, Z., ZHAI, J., WU, R., LIU, F. & ZHAO, J. 2013. The relationship between obesity and health-related quality of life in Chinese patients with schizophrenia. *Int J Psychiatry Clin Pract,* 17**,** 16-20.

HOWE, L. D., HARGREAVES, J. R., GABRYSCH, S. & HUTTLY, S. R. 2009. Is the wealth index a proxy for consumption expenditure? A systematic review. *J Epidemiol Community Health,* 63**,** 871-7.

IIPS 2007. National Family Halth Survey 3 (NFHS3) 2005-06. Mumbai, India: International Institute for Population Sciences and Macro International.

JAHNS, L., BATURIN, A. & POPKIN, B. M. 2003. Obesity, diet, and poverty: trends in the Russian transition to market economy. *Eur J Clin Nutr,* 57**,** 1295-302.

KALICHMAN, L., LIVSHITS, G. & KOBYLIANSKY, E. 2006. Indices of body composition and chronic morbidity: a cross-sectional study of a rural population in central Russia. *Am J Hum Biol,* 18**,** 350-8.

KELLY, T., YANG, W., CHEN, C. S., REYNOLDS, K. & HE, J. 2008. Global burden of obesity in 2005 and projections to 2030. *Int J Obes (Lond),* 32**,** 1431-7.

KOWAL, P., CHATTERJI, S., NAIDOO, N., BIRITWUM, R., FAN, W., LOPEZ RIDAURA, R., MAXIMOVA, T., AROKIASAMY, P., PHASWANA-MAFUYA, N., WILLIAMS, S., SNODGRASS, J. J., MINICUCI, N., D'ESTE, C., PELTZER, K., BOERMA, J. T. & COLLABORATORS, S. 2012. Data resource profile: the World Health Organization Study on global AGEing and adult health (SAGE). *Int J Epidemiol,* 41**,** 1639-49.

LI, G., CHEN, X., JANG, Y., WANG, J., XING, X., YANG, W. & HU, Y. 2002. Obesity, coronary heart disease risk factors and diabetes in Chinese: an approach to the criteria of obesity in the Chinese population. *Obes Rev,* 3**,** 167-72.

MISRA, A. & KHURANA, L. 2008. Obesity and the metabolic syndrome in developing countries. *J Clin Endocrinol Metab,* 93**,** S9-30.

MOKDAD, A. H., FORD, E. S., BOWMAN, B. A., DIETZ, W. H., VINICOR, F., BALES, V. S. & MARKS, J. S. 2003. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA,* 289**,** 76-9.

MOURA, E. C. & CLARO, R. M. 2012. Estimates of obesity trends in Brazil, 2006-2009. *Int J Public Health,* 57**,** 127-33.

MOZHEYKO, M., EREGIN, S., VIGDORCHIK, A. & HUGHES, D. 2012. A cross-sectional survey of hypertension diagnosis and treatment practices among physicians in Yaroslavl Region, Russia. *Adv Ther,* 29**,** 1016-25.

MUDUR, G. 2005. World needs fresh research priorities and new policies to tackle changing patterns of chronic disease. *BMJ,* 331**,** 596.

NUGENT, R. 2008. Chronic diseases in developing countries: health and economic burdens. *Ann N Y Acad Sci,* 1136**,** 70-9.

PELTZER, K. & PHASWANA-MAFUYA, N. 2013. Hypertension and associated factors in older adults in South Africa : cardiovascular topics. *Cardiovascular Journal of Africa,* 24**,** 66-71

PRENTICE, A. M. 2006. The emerging epidemic of obesity in developing countries. *Int J Epidemiol,* 35**,** 93-9.

PUOANE, T., STEYN, K., BRADSHAW, D., LAUBSCHER, R., FOURIE, J., LAMBERT, V. & MBANANGA, N. 2003. Obesity in South Africa: The South African Demographic and Health Survey. *OBESITY RESEARCH,* 10**,** 1038-1048.

RAMPAL, L., RAMPAL, S., KHOR, G., ZAIN, A., OOYUB, S., RAHMAT, R., GHANI, S. & KRISHNAN, J. 2007. A national study on the prevalence of obesity among 16,127 Malaysians. *Asia Pacipic Journal Clinical Nutrition,* 16**,** 561-566.

REXRODE, K., HENNEKENS, C., WILLETT, W., COLDITZ, G., STAMPFER, M., RICH-EDWARDS, J., SPEIZER, F. & MANSON, J. 1997. A prospective study of body mass index, weight change, and risk of stroke in women. *JAMA,* 277**,** 1539-45.

REYNOLDS, K., GU, D., WHELTON, P., WU, X., DUAN, X., MO, J., HE, J. & GROUP, I. C. 2007. Prevalence and Risk Factors of Overweight and Obesity in China. *OBESITY,* 15**,** 10-18.

RUTSTEIN, S. O. 2008. The DHS Wealth Index: Approaches for Rural and Urban Areas. *DHS Working Papers,* 60.

UN 2009. World Population Prospects: The 2008 Revision. New York: United Nations Population Division, Department of Economic and Social Affairs.

VENKATRAMANA, P. & REDDY, P. C. 2002. Association of overall and abdominal obesity with coronary heart disease risk factors: comparison between urban and rural Indian men. *Asia Pac J Clin Nutr,* 11**,** 66-71.

VYAS, S. & KUMARANAYAKE, L. 2006. Constructing socio-economic status indices: how to use principal components analysis. *Health Policy Plan,* 21**,** 459-68.

WANG, Y., MI, J., SHAN, X. Y., WANG, Q. J. & GE, K. Y. 2007. Is China facing an obesity epidemic and the consequences? The trends in obesity and chronic disease in China. *Int J Obes (Lond),* 31**,** 177-88.

WHITWORTH, J. A. 2003. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. *J Hypertens,* 21**,** 1983-92.

WHO 2003. Obesity and Overweight. *Global Strategy on Diet, Physical Activity and Health.* Geneva: World HealthOrganisation.

WHO 2006. The International Classification of adult underweight, overweight and obesity according to BMI. *BMI classification, Global Data Base on Body Mass Index.* Geneva: World Health Organisation.

WHO 2013. Obesity and Overweight. *Fact Sheet Number 311.* geneva: World Health Organisation.

WHO/ISH 1999. 1999 World Health Organization-International Society of Hypertension Guidelines for the Management of Hypertension. Guidelines Subcommittee. *J Hypertens,* 17**,** 151-83.

WU, Y., MA, G., HU, Y., LI, Y., LI, X. & CUI, Z. 2005. The current prevalence status of body overweight and obesity in China: data from the China nutrition and health survey. *Chin J Prev Med,* 39.

YAPP, R. 2010. Brazil's obesity rate could match US by 2022. *The Telegraph*, 15 Dec 2010.

Table 1: Percentage distribution of sample by selected characteristics, India, China, Russia and South Africa, 2007-10

Characteristics	India		China		South Africa		Russia	
	Frequency (N=10,915)	Percentage	Frequency (N=13,898)	Percentage	Frequency (N= 3,994)	Percentage	Frequency (N= 3,889)	Percentage
Currently smoking								
No	6,685	61.25	10,071	72.46	2,946	73.76	3,137	80.66
Yes	4,230	38.75	3,827	27.54	1,048	26.24	752	19.34
Currently using alcohol								
No	10,305	94.41	11,215	80.70	3,461	86.65	2,869	73.77
Yes	610	5.59	2,683	19.30	533	13.35	1,020	26.23
Physical activity								
No	2,525	23.14	6,212	44.81	2,209	56.63	836	21.56
Yes	8,388	76.86	7,651	55.19	1,692	43.37	3,042	78.44
Age group								
<50 years	4,543	41.62	1,563	11.25	385	9.12	385	9.90
50+	6,372	58.38	12,335	88.75	3,836	90.88	3,504	90.10
Gender								
Male	4,249	38.93	6,429	46.26	1,704	42.66	1,400	36.00
Female	6,666	61.07	7,469	53.74	2,290	57.34	2,489	64.00
Educational level								
Upto Primary	2,818	25.82	5,159	37.12	1,606	40.23	368	9.47
Secondary	1,357	12.43	3,048	21.93	507	12.70	688	17.70
HS and above	1,813	16.61	2,607	18.76	458	11.47	2,832	72.84
Wealth quintile								
Lowest quintile	1,986	18.20	2,755	19.82	688	17.23	738	18.98
2nd quintile	2,087	19.12	2,888	20.78	810	20.28	773	19.88
3rd quintile	2,207	20.22	2,747	19.77	797	19.95	732	18.82
4th quintile	2,293	21.01	2,709	19.49	827	20.71	824	21.19
Top quintile	2,342	21.46	2,799	20.14	872	21.83	822	21.14
Place of residence								
Rural	8,164	74.80	7,191	51.74	1,335	33.43	978	25.15
Urban	2,751	25.20	6,707	48.26	2,659	66.57	2,911	74.85

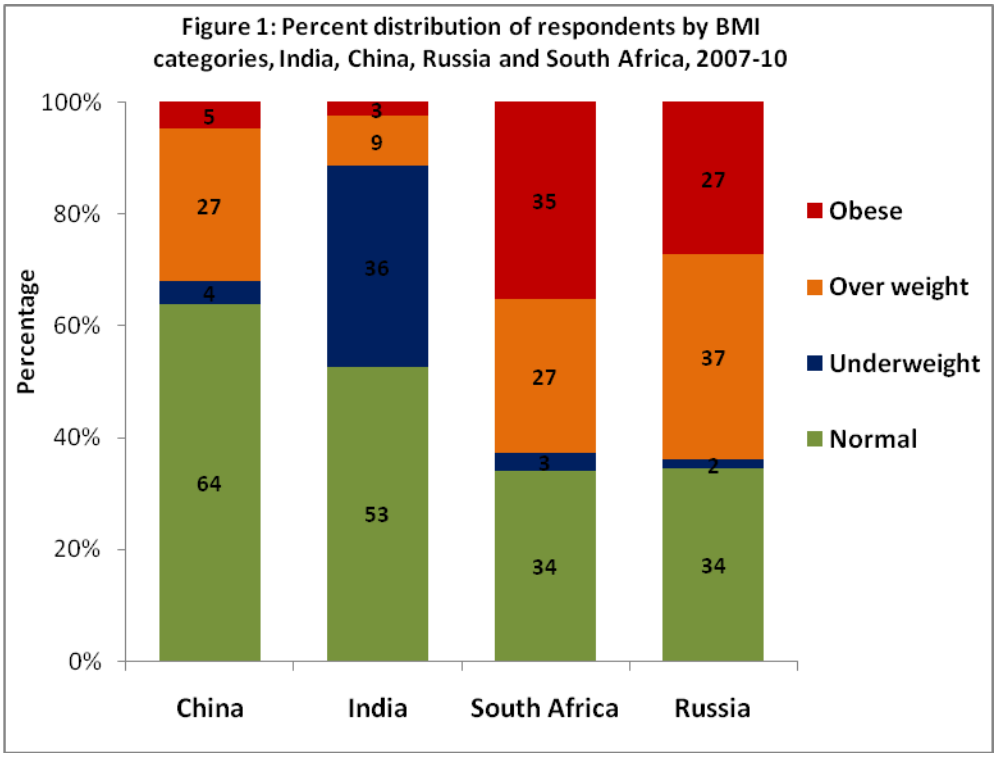
Figure 1: Percent distribution of respondents by BMI categories, India, China, Russia and South Africa, 2007-10
100%
80%
60%
40%
20%
0%
Percentage
5
27
4
64
3
9
36
53
35
27
3
34
27
37
2
34
China
India
South Africa
Russia
Obese
Over weight
Underweight
Normal

Table 2: Relative risk from Multinomial logistic regression assessing association between categories of BMI and selected characteristics, India, China, Russia and South Africa, 2007-10

Characteri-stics	India			China			South Africa			Russia		
	Underweight	Over weight	Obese	Under weight	Over weight	Obese	Under weight	Over weight	Obese	Under weight	Over weight	Obese
Currently smoking												
No ®												
Yes	1.38* (1.25,1.53)	0.78* (0.66,0.92)	0.79 (0.59,1.06)	1.33* (1.06,1.67)	0.68* (0.61,0.76)	0.75* (0.59,0.95)	1.50* (1.03,2.18)	0.68* (0.56,0.83)	0.42* (0.34,0.51)	1.26 (0.56,2.84)	0.58* (0.47,0.72)	0.47* (0.36,0.61)
Currently using alcohol												
No ®												
Yes	0.95 (0.79,1.14)	1.38 (0.99,1.91)	1.25 (0.66,2.38)	0.81 (0.45,1.02)	0.87* (0.78,0.97)	0.66* (0.51,0.85)	1.61* (1.07,2.43)	0.67* (0.52,0.87)	0.54* (0.42,0.69)	1.20 (0.62,2.73)	1.20 (0.99,1.47)	1.09 (0.88,1.36)
Physical activity												
No ®												
Yes	0.82* (0.74,0.91)	1.15 (0.98,1.35)	0.85 (0.66,1.11)	0.93 (0.78,1.23)	0.89* (0.82,0.97)	0.83* (0.70,0.97)	0.51* (0.35,0.73)	0.98 (0.82,1.16)	0.76* (0.64,0.90)	1.90 (0.72,4.99)	1.06 (0.87,1.30)	1.04 (0.84,1.29)
Age group												
<50 years®												
50+	1.09 (0.99,1.20)	1.31* (1.12,1.52)	1.47* (1.13,1.91)	0.93 (0.70,1.23)	1.21* (1.06,1.38)	1.47* (1.12,1.94)	1.18 (0.64,2.19)	1.32 (0.97,1.78)	1.48* (1.11,1.98)	0.87 (0.37,2.04)	2.41* (1.86,3.13)	3.70* (2.71,5.07)
Gender												
Male®												
Female	1.18* (1.06,1.31)	1.64* (1.38,1.94)	2.72* (1.99,3.73)	1.19 (0.96,1.48)	1.02 (0.92,1.12)	1.58* (1.30,1.93)	0.89 (0.61,1.29)	1.37* (1.13,1.66)	1.92* (1.60,2.30)	1.50 (0.67,3.35)	0.97 (0.80,1.19)	2.44* (1.95,3.05)
Educational level												
Upto Primary®												
Secondary	0.87 (0.76,1.00)	1.16 (0.94,1.41)	0.95 (0.66,1.38)	0.74* (0.58,0.95)	0.98 (0.89,1.09)	1.20 (0.99,1.45)	0.37* (0.16,0.86)	1.19 (0.90,1.57)	1.14 (0.88,1.49)	2.88 (0.62,13.44)	1.06 (0.76,1.47)	1.00 (0.71,1.41)
HS and above	0.70*(0.60, 0.81)	1.19 (0.99,1.43)	1.25 (0.91,1.72)	0.76 (0.58,1.02)	0.91 (0.81,1.02)	0.79 (0.62,1.01)	0.73 (0.35,1.52)	1.26 (0.93,1.72)	0.98 (0.73,1.31)	1.77 (0.39,3.60)	1.29 (0.96,1.73)	1.16 (0.86,1.58)
Wealth quintile												
Lowest quintile®												
2nd quintile	0.82* (0.72,0.93)	1.49* (1.06,2.11)	0.84 (0.52,1.36)	0.65* (0.51,0.82)	1.48* (1.30,1.68)	1.47* (1.14,1.89)	1.07 (0.67,1.72)	0.88 (0.67,1.17)	1.07 (0.83,1.40)	0.76 (0.31,1.86)	0.86 (0.66,1.11)	1.13 (0.86,1.49)
3rd quintile	0.62* (0.54,0.70)	2.34* (1.70,3.21)	0.94 (0.60,1.48)	0.67* (0.51,0.88)	1.55* (1.33,1.78)	1.14 (0.85,1.53)	0.94 (0.55,1.60)	1.27 (0.95,1.69)	1.30 (0.99,1.72)	0.43 (1.44,1.30)	0.98 (0.75,1.28)	1.11 (0.83,1.48)
4th quintile	0.48* (0.42,0.56)	3.53* (2.60,4.79)	1.17 (0.76,1.81)	0.48* (0.34,0.67)	1.50* (1.28,1.77)	0.80 (0.58,1.12)	0.70 (0.37,1.33)	1.58* (1.15,2.16)	1.90* (1.41,2.56)	0.68 (0.26,1.80)	1.13 (0.86,1.48)	1.70* (1.27,2.28)
Top quintile	0.36* (0.30,0.42)	5.27* (3.83,7.26)	2.65* (1.71,4.10)	0.47* (0.33,0.68)	1.72* (1.46,2.04)	0.99 (0.71,1.38)	0.65 (0.31,1.36)	1.88* (1.34,2.64)	2.42* (1.75,3.32)	0.49 (0.17,1.43)	0.99 (0.75,1.30)	1.51* (1.12,2.03)
Place of residence												
Rural®												
Urban	0.80* (0.71,0.91)	1.24* (1.07,1.44)	1.06 (0.80,1.37)	1.10 (0.84,1.42)	1.12 (0.99,1.25)	1.81* (1.44,2.28)	1.21 (0.81,1.81)	0.99 (0.81,1.23)	1.17 (0.96,1.43)	1.17 (0.52,2.64)	0.93 (0.76,1.15)	0.50* (0.40,0.62)

*Here * indicates values significant at 5% level of significance. ® indicates reference category. Normal BMI is taken as reference category for dependent variable BMI categories. Marital status was controlled in the model*

Table 3: Prevalence of selected morbidities by BMI categories, India, China, Russia and South Africa, 2007-10

BMI	Hypertension	Diabetes	Angina	Stroke	Arthritis	Depression
India						
Normal	20.5	2.9	3.1	1.2	9.3	3.4
Underweight	14.9	2.0	2.9	0.6	7.6	2.8
Overweight	31.3	8.8	3.9	1.1	18.2	6.0
Obese	29.8	5.1	3.1	0.6	9.1	3.1
Total	19.8	3.2	3.1	1.0	9.5	3.4
China						
Normal	31.6	1.6	3.0	0.7	12.4	0.1
Underweight	24.9	0.5	2.9	2.0	9.0	0.2
Overweight	50.8	4.6	4.9	1.1	14.3	0.7
Obese	65.2	11.0	6.5	0.9	21.9	2.0
Total	38.3	2.8	3.7	0.9	13.2	0.4
South Africa						
Normal	33.4	1.4	1.1	0.9	3.9	6.3
Underweight	45.1	0.6	0.2	3.1	5.1	1.9
Overweight	47.4	3.0	2.1	1.4	7.1	0.9
Obese	66.8	5.3	4.8	1.7	14.0	6.6
Total	49.4	3.2	2.6	1.4	8.4	4.8
Russia						
Normal	27.8	2.6	15.2	4.2	15.4	4.4
Underweight	11.0	3.3	4.3	7.9	1.0	2.2
Overweight	46.0	5.0	21.5	2.6	18.7	2.7
Obese	63.8	12.4	39.4	6.3	34.6	4.1
Total	44.2	6.2	24.0	4.2	21.6	3.7

Table 4: Odds ratio from Logistic regression analysis assessing association between selected morbidities and selected characteristics, India, China, Russia and South Africa, 2007-10

BMI	Hypertension	Diabetes	Angina	Stroke	Arthritis	Depression
India						
Normal®						
Underweight	0.66* (0.60-0.74)	0.52* (0.40,0.68)	0.89 (0.71,1.13)	0.82 (0.57,1.18)	0.78* (0.69,0.89)	0.83 (0.66,1.04)
Overweight	1.51* (1.31-1.74)	1.53* (1.21,1.94)	1.16 (0.86,1.57)	0.80 (0.47,1.37)	1.48* (1.25,1.76)	1.03 (0.72,1.47)
Obese	1.40* (1.10-1.79)	2.24* (1.55,3.21)	1.09 (0.63,1.87)	0.67 (0.24,1.85)	1.17 (0.86,1.60)	1.21 (0.66,2.21)
China						
Normal®						
Underweight	0.51* (0.43-0.61)	0.37*(0.19,0.70)	0.84 (0.60,1.19)	0.59 (0.32,1.09)	0.87 (0.70,1.08)	0.58 (0.08,4.32)
Overweight	2.02* (1.86-2.20)	1.57*(1.34,1.84)	1.22* (1.07,1.41)	1.20 (0.97,1.49)	1.16*(1.06,1.28)	1.08 (0.54,2.18)
Obese	2.56* (2.18-3.02)	2.20*(1.71,2.83)	1.67*(1.33,2.10)	1.10 (0.72,1.67)	1.53*(1.29,1.81)	1.23 (0.37,4.14)
South Africa						
Normal®						
Underweight	0.67* (0.47-0.96)	0.47 (0.14,1.53)	0.44 (0.13,1.45)	1.44 (0.61,3.38)	1.65*(1.04,2.61)	0.98 (0.33,2.88)
Overweight	1.41* (1.17-1.71)	1.67*(1.16,2.40)	1.04 (0.68,1.59)	0.94 (0.55,1.59)	1.42*(1.11,1.81)	0.88 (0.51,1.50)
Obese	1.57* (1.31-1.88)	2.01*(1.43,2.82)	1.55*(1.06,2.25)	1.24 (0.77,1.99)	2.38*(1.91,2.98)	1.13 (0.70,1.81)
Russia						
Normal®						
Underweight	0.94 (0.46-1.92)	1.42 (0.32,6.21)	0.68 (0.29,1.61)	1.54 (0.35,6.72)	0.31*(0.11,0.91)	0.47 (0.06,3.48)
Overweight	1.68* (1.41-2.00)	1.89*(1.28,2.76)	1.14 (0.94,1.38)	1.09 (0.73,1.62)	1.13 (0.93,1.36)	0.67*(0.46,0.99)
Obese	2.96* (2.45-3.59)	2.97*(2.04,4.33)	1.58*(1.30,1.94)	1.36 (0.91,2.04)	1.81*(1.49,2.20)	0.74 (0.49,1.11)

*Here * indicates values significant at 5% level of significance. ® indicates reference category. Marital status, age, gender, alcohol consumption, physical activity, smoking, educational level, wealth quintile and residence were controlled in the model.*