Overweight and Underweight Coexist within Households in Brazil, China and Russia[1]

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ABSTRACT   The possibility that underweight and overweight coexist within households and understanding such an occurrence have not been studied sufficiently. In fact, underweight and overweight are thought of as resulting from very different environmental, behavioral and individual risk factors. This study identified households in which overweight and underweight coexist and explored household-level associations such as urban residence and income. Using three large national surveys from Brazil, China and Russia, the prevalence of such households ranged from 8% in China and Russia to 11% in Brazil. Even more important from the public health perspective is the finding that these under/over households accounted for a high proportion of all households with an underweight member in China (23%), Brazil (45%), and Russia (58%). The prevalence of the underweight/overweight household was highest in the urban environment in all three countries. There was no clear pattern in the prevalence of the underweight/overweight household type by income. Multivariable logistic regression was used to test the significance of the association of household type with urban residence and income while controlling for household size and household demographics by gender. Further analysis was done to consider the age relationships within the underweight/overweight pair. The underweight child coexisting with an overweight nonelderly adult was the predominant pair combination in all three countries. These findings illustrate the need for public health programs that are able to address underweight and overweight simultaneously.   J. Nutr. 130: 2965–2971, 2000.

KEY WORDS: • overweight • underweight • nutrition transition • China • Brazil

The possibility that underweight and overweight coexist within households and understanding this joint occurrence have not been sufficiently studied. From the nutrition perspective, the reasons for this are simple. First, underweight and overweight result from energy deficit and excess, respectively, and are generally thought to be associated with very different environmental, behavioral and individual risk factors. Second, the two conditions are underlying contributors to two distinct types of public health concerns; overweight is an important determinant of adult- onset diabetes (Lebovitz 1999) heart disease and adverse birth outcomes for pregnant women (Cnattingius et al. 1998, Howard 1999) whereas underweight has been associated with low bone mass (Ravn et al. 1999), and all-cause mortality (Sharp et al. 1998). However, the two conditions may not be opposite expressions of distinct behaviors and environmental conditions. If under- and overweight can occur in the same household, common underlying causes of both conditions may be identified.

Recent evidence indicates that underweight and overweight can and do occur in close proximity. The two conditions coexist at national, community and even household levels. A national survey from Egypt showed a high proportion of overweight and obesity among women, despite a high prevalence of stunting and underweight among children (Khorshid and Galal 1995). A smaller survey in Bahrain showed a similar prevalence of underweight (16–26%) and overweight (29–31%) among adults (al-Mannai et al. 1996). Additionally, a number of urban studies have shown rising obesity (al-Nuaim 1997, Delpeuch and Maire 1997) despite high undernutrition within the same city. High or rising overweight and obesity prevalence has been found in India, South Africa and Brazil among disadvantaged communities with highly prevalent underweight and undernutrition (Monteiro et al. 2000, Steyn et al. 1998). Several studies focusing on the association between growth retardation early in life and adult obesity have found coexisting overweight and stunting, which is related to a history of undernutrition (Popkin et al. 1996, Steyn et al. 1998). The coexistence of over- and underweight in close proximity suggests that common risk factors contribute to both conditions. If so, underweight and overweight may have to be considered as two expressions of very similar causal mechanisms related to diet, physical activity and sociodemographic environment. Looking at households with underweight and overweight together (henceforth to be referred to as under/over[3] households)

[3] Under/over households are those with at least one overweight and one underweight member and possibly normal weight members.

may help unravel these correlates and shed light on the causal mechanisms for both conditions.

The examples of underweight and overweight occurring in close proximity are from countries experiencing rapid changes in diet and physical activity. These changes have been characterized as the nutrition transition (Popkin 1994). The nutrition transition in developing countries is associated with an increased consumption of superior grains, more milled and polished grains, higher fat foods, animal products, sugar and ready-made foods, or foods prepared away from home (Popkin 1998). These changes are related to the quality and type of food consumed and may result in a very different diet composition of fat, protein and fiber. The changes in diet may be further compounded by dramatic and simultaneous changes in physical activity, such as the shift from manual labor to mechanized industry and service jobs, an increase in the availability of labor-saving devices and an increase in nonactive entertainment such as television viewing and computer use (Popkin and Doak 1998). The stage of nutrition transition in a country may explain differences in heterogeneity in body weight by age and gender, and hence the appearance of under/over households. The transition itself is not uniform; it occurs first among urban high income households and last among rural low income households, possibly contributing to an association between urban residence and being an underweight/overweight household.

This research was descriptive and sought to identify and enumerate under/over households, and to identify household factors associated with the occurrence of both extremes in body weight. We used nationally representative or nationwide surveys from Brazil, China and Russia to identify these households with coexisting over- and underweight. As part of this, we considered the prevalence of the classic underweight/overweight pair type, i.e., the underweight child coexisting with an overweight adult. In addition, we examined the factors associated with a household having both an overweight and underweight member. To do this, body mass index (BMI)[4] was used to classify individuals as underweight or overweight, and then to categorize households into one of four types; the household type of interest was one with both overweight and underweight members.

SUBJECTS AND METHODS

Few large nationally representative surveys collect anthropometry from all family members. The large longitudinal, national surveys from Brazil [Ó Pesquisa Nacional sobre Saúde e Nutrição (PNSN)], China [the China Health and Nutrition Survey (CHNS)] and Russia [the Russia Longitudinal Monitoring Survey (RLMS)] were ideal for a multinational comparison of the phenomenon of intrahousehold coexistence of over- and undernutrition. These surveys had comparable data of sufficient detail; they included household level information as well as individual body weight, height and age. The Brazil and Russia surveys were nationally representative, whereas the China survey was representative of the eight provinces included in the survey. The eight provinces included four from the "East" and four from the "Center" region. The western sparsely populated region of China was not represented in this survey. By simultaneously analyzing the associations of intrahousehold underweight and overweight of all three countries, it was possible to see which of the under/over household associations were cross-cultural and which were different for each country.

Brazil. The national survey from Brazil was based on data from PNSN undertaken from June to September 1989 (PNSN 1989). This survey was executed by the federal agency in charge of national statistics in Brazil, the Instituto Brasileiro de Geografia e Estatística (IBGE). The survey, like all other national surveys in Brazil, utilized an informed consent of subjects. Multistage stratified clustering sampling procedures were employed. The sample included 61,881 individuals from 14,431 households that were used in the prevalence data. Among these 1404 households were excluded from the logistic analysis because they were a single-person household or had >10 members, which was a household size greater than the 99th percentile.

China. The CHNS was a large national longitudinal survey. This analysis was based on data from the 1993 survey, which covered eight provinces, including four provinces from the eastern region (Guangxi, Jiangsu, Liaoning and Shangdong) and four provinces from the center (Guizhou, Henan, Hubei and Hunan) region. The provinces were selected to provide sufficient variability in geography, economic development and health indicators that they could be considered generally representative of the country. The sample included 13,814 individuals from 3440 households. Among these, 100 households were excluded from the logistic analysis because they were a single-person household or had >10 members, an extreme value (>99th percentile) for household size. The UNC-CH School of Public Health and the Chinese Academy of Preventive Medicine reviewed and approved procedures for the data collection for the CHNS.

Russia. We used data from the 1996 round seven survey of the RLMS. The individual and household level data were comparable to the CHNS. The sample included 10,703 individuals from 3750 households. Among these, 680 were excluded from the logistic analysis because they were a single-person household or had >10 members, an extreme value (>99th percentile) for household size. The University of North Carolina at Chapel Hill, School of Public Health and the Russian Institute of Sociology reviewed and approved the data collection procedures for the RLMS procedures.

Definitions of variables and categorizations

Classifications of overweight and underweight. Our approach focused on measures of current status of under- and overnutrition, hence we ignored stunting. The weight-for-height status of individuals within a household is the basis of the household classification.

Adults. Internationally accepted adult BMI cut-offs are well established and were used to define overweight as a BMI ≥ 25 kg/m^2 for adults ≥ 18 y and underweight or chronic energy deficiency as a BMI < 18.5 kg/m^2 (WHO Expert Committee 1995). Although the relationship between BMI and body fat or fat-free mass varies according to ethnicity, gender and age (Deurenberg et al. 1998), BMI is associated with increased morbidity and mortality in India (Campbell and Ulijaszek 1994) and also among children (Must et al. 1992). Furthermore, because this was an international comparison, it was necessary to use a single, internationally accepted, BMI cut-off.

Children and adolescents. Age and sex-specific BMI cut-points are recommended to define overweight and underweight in children because height and weight change with age. Centile curves have been used to establish BMI cut-offs equivalent to adult values, usually set as the 85th centile for overweight. Unfortunately, the reference data recommended by the WHO from the U.S. National Health and Nutrition Examination Survey (NHANES) I may not be appropriate as an international reference. However, BMI cut-offs equivalent to the adult values of overweight for children 6–18 y of age have been established by the International Obesity Task Force (IOTF) using an international sample (Cole et al. 2000). Additional, unpublished IOTF BMI references were developed for underweight children, and those 2–6 y of age using an international reference based on five large nationally representative surveys from Brazil, Britain, Hong Kong, the Netherlands and the United States (T. Cole, personal communication, Institute of Child Health, London, UK). The IOTF cutoffs provide centile equivalents to the adult BMI of 18.5 and 25 kg/m^2 for each of the six national surveys; these were averaged to obtain an appropriate centile cut-point for the entire international sample. The

reference population, obtained by averaging across a heterogeneous mix of surveys, provided a more appropriate international reference.

Comparisons of the IOTF definition of underweight to "wasting" (weight-for-height Z-score less than -2) defined using the NHANES I in children 2–5 (-2 weight-for-height Z-scores) showed high sensitivity (>93%) and specificity (>89%) for all three countries. Sensitivity/specificity comparisons were also made against the BMI cut-offs from NHANES I using the 5th percentile for underweight and the 85th percentile for overweight as suggested by the WHO. The results showed very high sensitivity and specificity for underweight, and high specificity for overweight. Sensitivity of the IOTF cut-point as a measure of overweight (75–83%) was not as precise.

Household types. An under/over household was classified as such if there was at least one overweight person and one underweight member of the household, excluding infants < 2 y old and pregnant women. The under/over household was compared with three other types, also categorized according to the weight status of individuals within the household. The four household types were as follows: *1*) under/over, households with at least one overweight and one underweight member and possibly normal weight members; *2*) under/normal, households with underweight members, no overweight members and possibly normal weight members; *3*) over/normal, households with overweight members, no underweight members and possibly normal weight members; 4) normal/normal, households with normal weight members only.

Household categorization was based on individuals in the household with available data. Individuals who were excluded from classification or those with missing data were ignored in the classification of the household, thus providing a conservative measure of the under/over household.

Income. Income was measured as a combination of all earned income plus the value of home production expressed in per capita terms. To control for differential purchasing power across the countries, we focused on relative income rankings by creating income per capita tertiles for each country.

Percentage of male subjects. The percentage of male household members was used as a household level variable to control for differences in gender demographics. Because male and female subjects differ in risk of underweight, overweight and obesity, it was necessary to control for differences in the gender composition at the household level. The percentage of male subjects variable was found to be an important confounder and was retained as a linear term in the models. Categorical variables representing tertiles, quartiles and quintiles were tested and did not change the other effect estimates.

Family size. Because a larger household is more likely to experience greater variability in body weight status, it was necessary to control for household size. However, a few households with a very large household size ($n > 10$), representing at least the 98th percentile of the national samples, were excluded from the logistic analysis. These households are more likely to have been under/over as a result of the larger n-value rather than because of environmental factors. After excluding these households, tertiles of household size were determined for each country.

Underweight child/overweight nonelderly adult. For one component of the analysis, the under/over households were further classified as those with an underweight child and overweight nonelderly adult because this was expected to be the most prevalent under/over household type. This analysis therefore included five household types: underweight child/overweight nonelderly adult, other under/over households, under/normal,[5] over/normal,[6] and normal weight only household. Of interest is whether the sociodemographic correlates of the underweight child/overweight nonelderly adult households were unique relative to the other under/over households.

Statistical methods. Households were categorized into the four types defined above using SAS statistical software (SAS Institute 1998). Multinomial logistic regression was used to identify the sociodemographic factors that significantly predicted the likelihood of one household type compared with each other household type using STATA statistical software (STATA 1999). All possible comparisons were made among the groups, but we present only the significant associations. The model examined, whether urban residence, household per capita (real) income in tertiles, tertile of total household size, or proportion of male household members as a continuous variable, was associated with the under/over household type. Single-person households and households with >10 members were excluded from the logistic model because they accounted for a very small percentage of households in the sample and could have disproportionately affected the results. This exclusion reduced the sample of households from 14,431 to 13,027 in Brazil, from 3440 to 3340 in China and from 3750 to 3070 in Russia. A separate logistic model further split the under/over household into those with the classic underweight child/overweight nonelderly adult pair type and those of other types. The purpose of this second analysis was to determine the factors associated with the underweight child/overweight nonelderly adult household. To avoid bias from comparing households with children to those without, this model included only households with at least one child (<18 y of age) and one adult (between 18 and 65 y).

Predicted probability of the under/over household type was determined by simulation, using the multivariate logistic regression coefficients. The predicted probability of household type for urban residence provided an estimate of the probability of being an under/over household, assuming that all households were urban, with income, household size and household gender demographics at their individual values. For comparative purposes, the predicted probability for rural residence was also calculated with income tertile, tertile of household size and percentage of male subjects set at their individual values. Probability of being an under/over household was similarly predicted for high and low income tertiles.

RESULTS

The total sample size, number of households by household type and mean values for the variables included in the logistic model are presented in **Table 1**. **Figure 1** shows the prevalence of overweight and underweight in Brazil, China, and Russia. **Figure 2** shows the percentage of each of the four household types. Coexisting under and overweight were a significant public health concern in all three countries. The proportion of under/over households ranged from 6% in Russia to 11% in Brazil. However, after excluding single-person households and households with >10 members, the prevalence of the under/over household in Russia increased from 6% to 8%, but the other results were unchanged. More important, from the public health perspective, is the proportion of under/over households relative to all households with an underweight member. **Figure 3** shows that 23, 45 and 58% of households with an underweight member also had an overweight member in China, Brazil and Russia, respectively.

Sociodemographic correlates

Household size and percentage of male household members were included as control variables. Larger households were significantly associated with the under/over vs. under/normal household type.

Urban residence. Urban residence was significantly associated with household type in all three countries. In China, urban residence was significantly associated with an increased odds of being an under/over household compared with under/normal [odds ratio (OR) = 1.9; 95% confidence interval (CI) = 1.4, 2.6] households and normal weight (OR = 2.1; CI = 1.6, 2.8) households. In Brazil, urban residence was significantly associated with being an under/over household compared with each of the other three household types; under/normal (OR = 1.8; CI = 1.5, 2.1), over/normal (OR = 1.4;

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[5] Under/normal households are households with underweight members, no overweight members and possibly normal weight members.

[6] Over/normal households are households with overweight members, no underweight members and possibly normal weight members.

TABLE 1

Demographic characteristics of the sample according to the four household (HH) types in Brazil, China and Russia

	All households	Household type			
		Under/Over[1]	Under/Normal[2]	Over/Normal[3]	Normal only[4]
Brazil, *n*	13,027	1415	1758	6458	3396
Urban, %	57.6	64.3	45.8	63.4	50.3
Mean income, *1989 US dollars per capita*	9842	8463	5081	12103	8533
Mean HH size, *n*	4.5	5.6	5.1	4.3	3.8
Male subjects, %	48.8	48.8	48.6	48.4	49.5
China, *n*	3340	276	924	882	1258
Urban, %	30.6	39.5	24.5	40.6	26.1
Mean income, *1992 yuan per capita*	746	783	683	825	729
Mean HH size, *n*	4.1	4.7	4.4	4.0	3.8
Male subjects, %	51.2	48.8	51.1	50.3	52.4
Russia, *n*	3070	239	172	2176	483
Urban, %	69.0	72.0	79.7	67.3	71.6
Mean income, *1992 rubles per capita*	2130	1753	2179	2184	2064
Mean HH size, *n*	3.3	4.0	3.5	3.2	2.9
Male subjects, %	46.6	43.3	43.1	47.1	47.6

[1] These households have at least one underweight coexisting with one overweight member. There may or may not be a normal weight individual.

[2] These households have at least one underweight member, cannot have any overweight members and may or may not include a normal weight individual.

[3] These households have at least one overweight member, cannot have any underweight members and may or may not include a normal weight individual.

[4] These households only have normal weight individuals and do not include any underweight or overweight members.

1.2, 1.6) and normal/normal (OR = 1.7; CI = 1.4, 2.0). However, in Russia, urban residence was statistically associated with being an under/over household only when compared with the over/normal household (OR = 1.6; CI = 1.2, 2.3). The predicted probability of being an over/under household was ~3–4 percentage points higher for urban households in all three countries (**Table 2**).

Income. There was no consistent pattern of association of household type with income across the three countries (**Table 3**). In China, the under/over household type was significantly associated with the highest income tertile only when compared with the under/normal (OR = 1.5; CI = 1.05, 2.12) and normal/normal (OR = 1.5; CI = 1.04, 2.05) households. The high income households had the highest predicted probability of under/over, but the difference was small (0.024).

In Brazil, high income increased the likelihood of the under/over household compared with the under/normal household (OR = 2.7; CI = 2.2, 3.3) and the normal/normal household (OR = 1.4; CI = 1.2, 1.7), but decreased the likelihood when compared with the over/normal group (OR = 0.6; CI = 0.5, 0.7). The net effect was that the predicted probability of the under/over household among high and low income households was virtually the same. However, the under/normal and normal/normal household types were more prevalent among low income households, and the over/normal households were more prevalent among high income households.

In Russia, the income relationship was significant only when comparing the under/over household with the over/normal household type (OR = 0.62; CI = 0.43,0.89). The predicted prevalence of the under/over household was higher in low income households; the difference in prevalence between low and high income households was 0.026.

Underweight child/overweight nonelderly adult. The classic condition of underweight child/overweight nonelderly adult is the predominant under/over pair type and existed in over half of the under/over households in Brazil (59%) and Russia (62%) and 39% of these households in China. The

pattern of differences in predicted probabilities of being an underweight child/overweight nonelderly adult household, related to income and urban residence, was similar to the results for all under/over households. However, in China, income was not significantly associated with the underweight child/overweight nonelderly adult household type regardless of the other household type used as a reference. Thus, the difference in predicted prevalence in low and high income households in China was not meaningful.

DISCUSSION

These analyses showed that an important proportion of households in these three large and diverse nations contained both overweight and underweight individuals. The prevalence of under/over households in Brazil, China and Russia may be explained by dramatic changes in diet and physical activity associated with the stage of nutrition transition for each country. The proportion of the under/over households in these three countries was consistent with the nutrition transition;
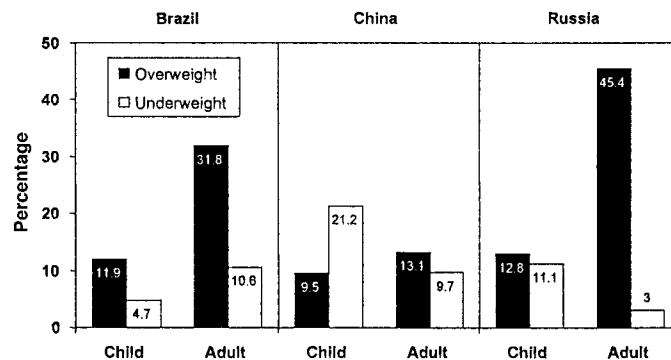

FIGURE 1 Prevalence of overweight and underweight in Brazil, China and Russia.
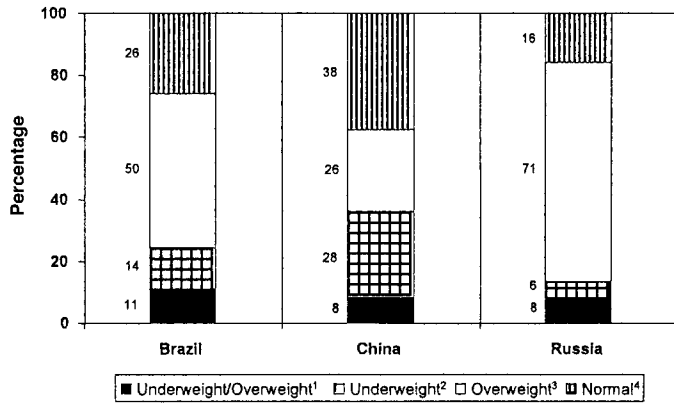
FIGURE 2 The four household types in Brazil, China and Russia are as follows: *1)* underweight/overweight: these households have at least one overweight coexisting with one underweight member, there may or may not be a normal weight individual; *2)* underweight: these households have at least one underweight member, cannot have any overweight members and may or may not include a normal weight individual; *3)* overweight; these households have at least one over-weight member, cannot have any underweight members and may or may not include a normal weight individual; *4)* normal: these households have only normal weight members and do not include any underweight or overweight members.

the proportion was highest in Brazil (11%), which is undergoing rapid transition.

Although the prevalence of households with both underweight and overweight individuals was large, it is useful to consider whether this is significantly different from what might be found randomly. Although, in fact, underweight and overweight vary according to age, gender and other individual characteristics, the assumption of randomness is necessary to determine the prevalence of under/over that would result by chance alone. Also, we assume the prevalence of under/over in the country would be equivalent to the probability of under/over for a household with the average household size for the country. This assumption ignores the actual distribution of household size within the country. To illustrate the best way of calculating the prevalence of under/over that would result from a random distribution of the underlying underweight and
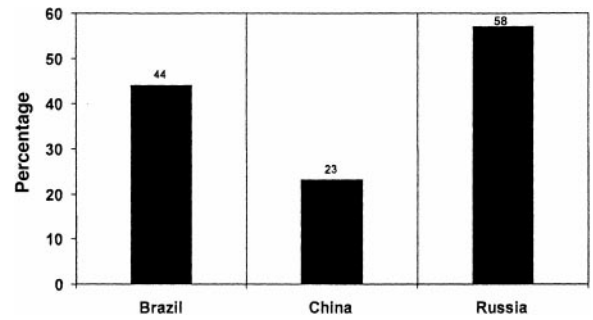

FIGURE 3 Prevalence of underweight/overweight coexistence. Among households with an underweight member, 23, 44 and 58% also have an overweight member in China, Brazil and Russia, respectively.

overweight, it is helpful to use the common example of a barrel full of balls (Moore and McCabe 1993). A barrel full of 34 red, 6 white and 60 black balls is useful as an example for the distribution of overweight, underweight and normal weight among household members when overweight prevalence is 34%, underweight is 6% and normal weight is 60%, as it is in Russia. The average household size in Russia is three; therefore, the probability of a household having underweight and overweight together is the probability of drawing both a red and a white ball when taking three balls from the barrel. It would be 0.0989 (9.89%) in Russia. The actual prevalence of under/over is 8%, which is a small difference.

The average household size for China and Brazil is four. Therefore, all calculations were repeated for household size of four. In Brazil, the prevalence of overweight is 22%, underweight 8% and normal weight 70%, resulting in a 0.150 probability of under/over; the same measure for China would be 0.154. The actual probabilities are 11% in Brazil and 8% in China for the household size of four. These indicate a larger difference between the actual and the predicted probabilities for China and Brazil compared with Russia.

The interesting implication, one often noted in discussions but not widely considered in research, is that when we are examining either under- or overnutrition and also their joint clustering, we are really trying to explain the patterns that lead to this lack of nonrandom clustering. We think that the

TABLE 2

Predicted probability of each household type associated with urban residence as an estimate of adjusted prevalence[1]

	Brazil[2]		China[3]		Russia[4]	
	Predicted probability		Predicted probability		Predicted probability	
	Urban	Rural	Urban	Rural	Urban	Rural
Under/over households	0.126	0.088	0.112	0.071	0.090	0.062
Under/normal households	0.125	0.143	0.242	0.290	0.067	0.035
Over/normal households	0.512	0.480	0.336	0.231	0.680	0.756
Normal/normal households	0.238	0.289	0.310	0.408	0.163	0.147
Underweight child/overweight adult among households with children[5]	0.088	0.061	0.070	0.034	0.085	0.060

[1] See Table 1 for explanation of the four household types.
[2] Based on Ó Pesquisa Nacional sobre Saúde e Nutrição (1989).
[3] Based on the China Health and Nutrition Survey (1993).
[4] Based on round seven survey of the Russian Longitudinal Monitoring Survey (1996).
[5] These households have an underweight child and an overweight nonelderly adult; the predicted probability is based only on households with at least one child and at least one nonelderly adult.

TABLE 3

Predicted probability of household type associated with high vs. low income as an estimate of adjusted prevalence[1]

	Brazil[2]		China[3]		Russia[4]	
	Predicted probability		Predicted probability		Predicted probability	
	High	Low	High	Low	High	Low
Under/over households	0.101	0.109	0.099	0.075	0.065	0.091
Under/normal households	0.066	0.190	0.249	0.279	0.042	0.063
Over/normal households	0.621	0.377	0.297	0.260	0.750	0.650
Normal/normal households	0.213	0.324	0.355	0.387	0.143	0.195
Underweight child/overweight adult among households with children[5]	0.068	0.078	0.049	0.043	0.062	0.085

[1] See Table 1 for explanation of the four household types.
[2] Based on Ó Pesquisa Nacional sobre Saúde e Nutrição (1989).
[3] Based on the China Health and Nutrition Survey (1993).
[4] Based on round seven survey of the Russian Longitudinal Monitoring Survey (1996).
[5] These households have an underweight child and an overweight nonelderly adult; the predicted probability is based only on households with at least one child and at least one nonelderly adult.

differences for China and Brazil, in particular, are large and important.

Earlier research in Brazil, China and Russia sheds some light on the phenomenon of the under/over households. In Brazil, the prevalence of adult overweight is rapidly increasing among low income families in which child underweight is still a relevant problem (Monteiro et al. 1995 and 2000). On the other hand, a study on the intrafamilial distribution of the occurrence of underweight indicated that even in low income families, only a small proportion of cases of undernutrition could be attributed to common household determinants (Monteiro et al. 1997). Changes in China have involved a shift from undernutrition as the principal concern, to a situation in which underweight and overweight are of equal importance. For example, in a 1982 survey, 9.7% of adults 20–45 y of age were underweight and 6% were overweight. By 1989, the prevalence of overweight had surpassed underweight, with 8.5% underweight and 8.9% overweight (Ge et al. 1994), and unpublished data show that between 1989 and 1997, the proportion of overweight adults more than doubled to 17.6%, whereas the proportion of underweight declined to 5.2% (Bell, University of North Carolina, unpublished data). Continual fluctuations in the economic conditions of Russia make the situation more difficult to characterize (Lokshin and Popkin 1999). However, a survey of households with children < 2 y of age, showed a high proportion with food insecurity (Welch et al. 1996). Other results from Mroz and Popkin (1995) show stunting in children as an emerging nutrition problem in Russia, resulting from both the decline in social services and changes in infant feeding practices.

As expected, urban residence and income were found to be important factors. Urban residence, linked with rapid increases in inactivity and an energy-dense diet, is consistently associated with under/over households in all three countries. High income was associated with increased prevalence of under/over in Brazil and China, but not in Russia. It is not surprising that under/over households were more likely than the under/normal and normal/normal to be high income in China and Brazil because such households are expected to occur under conditions of abundance. Similarly, the under/over household is expected to be lower income compared with the over/normal households. This is shown by the protective effect of high income on being under/over in Brazil and Russia, when the over/normal household is the reference. The income effect was attenuated when looking only at the classic under/over pair type, i.e., households with an underweight child and an overweight nonelderly adult. This is an important finding because it shows that factors other than income may be contributing to the under/over condition among these pairs.

Further exploration and in-depth analysis of food allocation and other related intrahousehold issues are required to understand these disparities. Although it is beyond the scope of this paper to resolve the question entirely, three possible explanations are plausible for overweight coexisting with underweight in households from nations as diverse as Brazil, Russia and China. First, changes in physical activity may not be uniform. Members of the household may differentially experience the changes in physical activity with the introduction of technologies and lifestyles that involve a shift from an active to a sedentary lifestyle. Second, in many countries, the nutrition transition is associated with a Western diet, marked by increased meat, fat and added sweeteners, and reduced vegetables and complex carbohydrates. All members of the household may not experience the changes in diet uniformly. Third, individuals within the household may eat differently both in terms of quantity and quality. This may occur as a result of intrahousehold food distribution or cohort differences in the acceptability and desirability of specific foods. Understanding the specific causal mechanisms warrants further study.

If large proportions of the households with an underweight member also contain an overweight member, programs targeting the reduction of underweight must be capable of addressing overweight as well. The fact that underweight and overweight do coexist to the extent shown in the three national surveys indicates that care must be taken to avoid increasing the likelihood of overweight among households with underweight individuals. For example, public health policies that aim to reverse undernutrition for one household member by improving either the energy density of the household food supply or household food insecurity may have the undesired consequence of contributing to overweight and obesity in another member of an "at risk" household. This has been shown in unpublished research from Chile, in which the programs that focused on undernutrition actually significantly enhanced the likelihood of overweight (Uauy, personal communication). By considering the factors that predict the under/over condition,

this may be avoided. Similarly, programs designed to address overweight may alter the household diet to the detriment of age groups vulnerable to underweight. To date, these issues, particularly the way in which promotion of an energy-dense diet might detrimentally affect a portion of the family, have not been addressed in program work.

The results presented here indicate the need to consider whether programs that focus on only one type of body weight outcome might actually exacerbate the other. Therefore, it is increasingly important for public health programs to focus on healthy diet and lifestyle patterns that will lead to optimal health outcomes at both ends of the spectrum. Several studies have shown that weight loss leads to improved health outcomes and reduced risks related to obesity (Bray 1999, deLeiva 1998). Furthermore, therapeutic diets have been effective in reducing mortality related to severe malnutrition (Golden et al. 2000). However, to develop programs that address both underweight and overweight, more research is required to determine the particular diet and activity patterns that may simultaneously be either protective against, or contribute to both underweight and overweight. If future programs for preventing (Oster et al. 1999) underweight as well as overweight were based on a single set of diet and activity recommendations, it could prevent both conditions simultaneously. Furthermore, it would help streamline public health messages and be a more efficient use of limited resources. Instead of addressing under- and overweight separately, developing countries may fight both conditions simultaneously with strong public health messages that would contribute to good health for all.

ACKNOWLEDGMENTS

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