

**Urbanization, Fast-food Restaurants, and Individual Agency:
An Ecological and Life Course Analysis of Body Weight Changes in Chinese Youth***

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Abstract

The conventional trickle-down model of community effects on body weight status is theoretically flawed. A better understanding of the association between community contextual effects and youth's body weight status is needed to improve the existing theory and inform public health policy. We propose to integrate an ecological approach with a life course perspective and introduce human agency and its dynamic interactions with contextual factors into our model. Drawing upon longitudinal and multilevel data, we study body weight changes captured by both general and central obesity measures in Chinese youth. We employ a difference-in-difference model to adjust for "pretreatment heterogeneity bias." We examine three dimensions of individual agency, including family resources, health knowledge, and self-perceived body shape, and their interactions with two important community factors, urbanization and fast-food restaurants, thereby adjusting for "treatment effect heterogeneity bias." Our preliminary results highlight complex patterns of body weight change as Chinese youth transitioned from early childhood to late adolescence.

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Introduction

The Chinese population has been rapidly gaining weight in the recent decades (Popkin et al. 1995; Wang 2005). This trend has not bypassed children. Consequently, the prevalence of overweight and obesity among children between the ages of 7 and 17 in China reached 12 million in 2009 (Ma 2009), and overweight and obesity is now considered a serious public health threat for the young generation in China (Wang, Monteiro and Popkin 2002).

Reasons for rapid weight gain in China are multifaceted and the subject of considerable debate among scholars. Nonetheless, consensus suggests that it is likely that rising incomes, higher fat diets, reduced physical activity, and cultural ideals regarding desirable weight, all play a role. Many of these changes are thought to stem from urbanization processes, and recent research has implicated changing community contexts, including changing food environments (e.g., Monda et al. 2008; Monda et al. 2007; Xu, Short and Liu 2012).

An emphasis on the role of community characteristics in studies of overweight and obesity is not uncommon. Indeed, across settings, community context has been associated with individual body weight status, including birth weight (Cerdá, Buka and Rich-Edwards 2008; Morenoff 2003; Schempf, Strobino and O'Campo 2009), being overweight or obese among children (Richards and Smith 2007), among adults (Chang 2006; Frank et al. 2007), and abnormal weight gain (Kahn et al. 1998). However, despite the consistency of these findings, this literature is hindered by what might be called a “trickle-down theory,” an approach that effectively treats communities as exogenous and pre-determined, and individuals as the passive recipients of their effects without having any human agency (Entwisle 2007; Glass and McAtee 2006).

This paper will integrate an ecological approach with a life course perspective to examine the association between two key contextual factors – urbanization and fast-food restaurants – and body weight changes among Chinese youth. Drawing upon longitudinal and multilevel data, we study body weight changes captured by both general and central obesity measures. We employ a difference-in-difference model to adjust for “pretreatment heterogeneity bias.” We examine three dimensions of individual agency, including family resources, health knowledge, and self-perceived body shape, and their cross-level interactions with contextual factors, thereby adjusting for “treatment effect heterogeneity bias.” Our preliminary results highlight complex demographic patterns of body weight changes as Chinese youth transitioned from early childhood to late adolescence.

Background

Previous multilevel analyses often implicitly assume homogeneous effects of community contexts on individual weight status, an assumption that may not hold in reality for at least two reasons: (1) pretreatment heterogeneity, and (2) treatment effect heterogeneity, as described in the literature on causal inference (Xie, Brand and Jann 2012). Pretreatment heterogeneity refers to the fact that in an observational study, subjects who receive treatment (e.g. exposed to a high level of urbanization) are systematically different from those in the control group (e.g. exposed to a low level of urbanization). For example, Chinese children who live in cities are likely to be well-nourished compared to those who live in remote villages and may remain at risk of under-

nutrition. Without appropriately adjusting for such differentials at the precondition, regression estimates of the effect of urbanization on youth's weight change can be biased. Treatment effect heterogeneity, on the other hand, refers to the situation in which subjects in the treatment group, for some reason, respond differently to the treatment, resulting treatment effects that vary across subjects. Following the example above, among children who live in an urban community with a McDonald's or Kentucky Fried Chicken nearby, those who are from wealthy families may be more likely to eat out there than those from relatively poor families because of the affordability of western style fast food which is expensive and considered as a faddish diet that signifies modernity and novelty (Zhou and Hui 2003). Again, ignoring the potential issue of treatment effect heterogeneity can lead to misleading results.

In contrast, an ecological model of health behavior emphasizes that not only do multiple levels of factors influence health behavior, but these influences also interact across levels (Sallis, Owen and Fisher 2008; van Sluijs, McMinn and Griffin 2007). It predicts that individual health behavior and outcome results from complex interactions at multiple levels, from individual health knowledge to family background to community environment. Therefore, an ecological model recognizes that (Sallis et al., 2008, p. 470) "single-level interventions are unlikely to have powerful or sustained population-wide effects." An education campaign that advocates physical activity is unlikely to be effective in a community that lacks of physical activity facilities and walkability. Likewise, building a grocery store that sells expensive organic foods in an ordinary neighborhood may only benefit affluent families, but not those too poor to afford such foods. An ecological model allows us to embed individual- and household-level heterogeneity into a conventional trickle-down multilevel framework so as to capture cross-level interaction effects.

At the same time, we need to recognize that these processes are not static. A life course approach highlights the important roles of the timing, sequencing, and duration of life events in shaping behavior outcomes (Elder 1994, 1998). This principle predicts a cumulative process of health advantage or disadvantage as people age as well as the long-term influences of earlier life conditions on later life health outcomes (Gillman 2004; Perry and Lumey 2004; Smith and Lynch 2004). Life course theory also emphasizes the broad social and historical contexts within which an individual's health trajectory unfolds over his or her lifespan. This principle coincides with the conventional multilevel framework that focuses on contextual effects on individual behavior and outcomes. Furthermore, the human agency principle of life course theory states that (Elder 1998: 4), "individuals construct their own life course through the choices and actions they take within the opportunities and constraints of history and social circumstances." This implies that individuals are not passively exposed to community environment, but instead actively shape outcomes by responding in different ways, as individual resources allow and preferences dictate.

Taken together, a richer understanding of the association between community contextual effects and youth's body weight status needs to account for individual agency, which in this study, will be captured by family socioeconomic status (SES), individual health knowledge, and self-perceived body shape. We will focus on two contextual factors, level of urbanization and presence of western style fast-food restaurants. Urbanization is one of the most dramatically changing features of communities in contemporary China. It is expected to have a strong impact on changing individual physical activity patterns which in turn may lead to the emergence of

overweight/obesity epidemic in China (Monda et al. 2008; Monda et al. 2007). Fast-food restaurants are widely considered an important contextual contributor to the so-called “obesogenic environments”, environments that promote obesity by encouraging physical inactivity and excessive energy intake (Mehta and Chang 2008; Swinburn, Egger and Raza 1999), although conflicting findings have been reported on the association between fast-food restaurants and body weight status especially in studies outside of the U.S. (for a brief review, see Xu et al. 2012). We hypothesize interaction effects of urbanization and fast-food restaurant with family SES. Specifically, we anticipate that higher levels of urbanization and easier access to western fast-food restaurants will be associated with an increase body weight to a greater extent for youth from affluent families than for those from less wealthy families. We also hypothesize that these two community-level factors interact with individual health knowledge such that those who are more knowledgeable about health- and nutrition-related risky factors and behaviors are less affected by a higher level of urbanization or greater exposure to fast-food restaurants.

Our approach assumes a temporally dynamic relationship between community and individual level factors and weight change. Our prior research (Xu et al. 2012) indicated that exposure to western fast-food restaurants in the community has a temporally lagged effect on weight gain in Chinese adults. Nonetheless, it might be categorized under the conventional trickle-down multilevel framework in that the contextual effects were assumed to be homogeneous; little attention was paid to the potential cross-level interactions – or how individual differences mattered across contexts – making the results subject to the treatment effect heterogeneity bias. Furthermore, our previous study did not directly measure individuals’ eating out at fast-food restaurants, limiting interpretation of our findings.

Combining the ecological model and life course theory, the current study aims to make several contributions to the literature by addressing the conceptual and methodological challenges discussed above. First, using longitudinal and multilevel data from the 2000-2009 China Health and Nutrition Survey, we expand upon previous trickle-down multilevel research by incorporating individual agency and examining the multilevel interaction effects of urbanization with family SES, individual health knowledge, and perception of current and ideal body shapes on body weight changes during transition from childhood to adolescence. Our analysis will contribute new insights into the issue of treatment effect heterogeneity as it affects understandings of obesogenic environments and weight gain. Second, employing a change score or difference-in-difference (DID) modeling approach (Allison 1990; Xu et al. 2012), we alleviate the pretreatment heterogeneity bias that is rarely addressed in the prior research. Third, we estimate temporally lagged contextual effects, and explore cross-level interactions, to achieve a better understanding of the life course trajectory of overweight/obesity (Gillman 2004). Finally, our analysis of weight change relies on both general adiposity and central adiposity with physically measured anthropometric data, minimizing erroneous inference that can result from sole reliance on body weight measures (Xu et al. 2012).

Data and Measures

Subjects for this study were children and adolescents of age 6-17 in the China Health and Nutrition Survey (CHNS), a panel survey that includes more than 4000 households across 9 provinces in contemporary China. The CHNS data are not nationally representative. However,

households were randomly selected from a diverse set of nine provinces in northeast, central, and south China. Together, these nine provinces are home to more than 40% of China's population, or 548.56 million people. Thus, while not generalizable to all of China, the results should be informative regarding the associations under study in the Chinese context.

Households were selected through a multistage, random cluster sampling process. The response rate at the individual level is 88 percent. Details on the design and sampling of CHNS are available elsewhere (Popkin et al. 2010). In addition to individual-level data, the CHNS collected background characteristics of the communities where respondents resided from local officials. An urban community is an administratively defined community known as 'street committee' (*ju-wei-hui*), with an average population about 3,000, while a rural community refers to a natural village, with an average population about 3,800 (Chen and Meltzer 2008).

This study draws on data from the most recent four waves of the survey, 2000, 2004, 2006, and 2009. The dependent variable, body weight status, is captured in two different ways: (1) body mass index (BMI), calculated from body weight (in kilograms) and height (in centimeters), and triceps skinfold (TSF), averaged over three measurements, both of which tap general obesity; and (2) waist circumferences (WC), waist-to-height ratio (WHtR), and waist-to-hip ratio (WHpR) that tap central obesity. All the anthropometric measures were physically taken by experienced health care workers. Even though widely used as an indicator for measuring whole body obesity, BMI does not suit to measure abdominal fat accumulation, an indicator of central obesity. In several populations, measures of central obesity, such as WC, WHtR, and WHpR, were found to be superior predictors of cardiovascular disease risk and more useful for obesity screening when compared to BMI (Knowles et al. 2011; Li et al. 2006; Yusuf et al. 2004). Solely relying on BMI may not accurately capture increased body weight status associated with obesogenic environments.

The first key community-level predictor is an urbanicity index that is designed to capture multiple dimensions of urbanization, ranging from communication to economics, and from transportation to environmental sanitation, standardized so that higher values indicate greater urbanization. Detailed information on this measure is available elsewhere (Monda et al. 2007). The second one is constructed as the number of western style fast-food restaurants such as McDonald's and Kentucky Fried Chicken (KFC) in the community or within 1 kilometer if outside the community. This measure does not include Chinese style fast-food restaurants, as information about these was not collected in the CHNS.

Family SES is captured by household per capita income inflated to its 2009 value and the highest educational attainment among all the household members. Educational level is categorized into primary schooling or less, some or complete junior high school, and some senior high school or beyond. Youth's self-perceived body shape is captured by his/her selection from nine silhouette figures of different body shapes ranging from skinniest to heaviest (as illustrated for boys in Figure 1) which he or she considered resembling him/herself the most. Youth's ideal body shape is captured by collected by his/her selection from the same set of silhouette figures. The difference between the two ratings provides a measure of self-satisfaction with one's own body shape. The heavier the ideal body shape is than one's self-perception, the stronger the motivation or desire is to increase body weight; whereas the thinner the ideal body shape is, the stronger the desire is to lose weight. Finally, youth's health knowledge will be constructed from

responses to a battery of questions that ask about what kinds of diet and physical activity are healthy or unhealthy.

We will control for other important socioeconomic and demographic variables as informed by the literature, including but not limited to age, gender, birth cohort, rural/urban residence, and region.

Preliminary Descriptive Results

In exploratory analysis, we plotted different measures of body weight status across age groups, stratified by gender and rural/urban residence as shown in Figures 2-5. We ignore waist-to-height ratio for the moment to preserve space. There are some interesting patterns, although we must be cautious in interpretation as these results do not yet take into account birth cohort or period effects.

In terms of general obesity measures, urban boys had on average a higher BMI than the other groups at early childhood. Such difference gradually disappeared as all the groups converged as they transitioned into adolescence. In contrast, the average triceps skinfold rapidly diverged between boys and girls as they grew with a persistent female advantage, whereas within each sex, rural-urban differentials fluctuated over time with a stable urban advantage.

Turning to measures of central obesity, there was no substantial gender or rural-urban difference in the average waist circumference, as all the groups experienced steady increases as they aged. In contrast, the average waist-to-hip ratio declined across all the groups, and the gender gap diverged over time. In addition, rural-urban gap was reduced for boys but not girls.

Together, these preliminary results highlight the complex demographic patterns of body weight changes as Chinese youth transitioned from early childhood to late adolescence. They also illustrate the importance of examining multiple body weight measures to avoid drawing partial and even misleading conclusions based on any single measure.

Analytical Plan

We plan to adopt a difference-in-difference (DID) approach with additional control for baseline outcome measures. We will use hierarchical regressions to model differences in within-individual weight changes for a given period of time between individuals exposed to different policy and community environments, while adjusting for intra-group correlations due to repeated measures and clustering. Two sets of models will be estimated and described below. Let y_{ij}^t be an outcome measure for individual i living in community j at time t , X_{ij}^t be a set of individual-level key predictors and control variables, and Z_j^t be a vector of community-level urbanization and fast-food restaurant. The first model examines the associations between exposure to multilevel factors at time t and changes in the outcome between t and $t+1$. It can be written as follows:

$$y_{ij}^{t+1} - y_{ij}^t = \alpha_0 + \beta X_{ij}^t + \gamma Z_j^t + \delta y_{ij}^t + \tau_i + \varphi_j + \varepsilon_{ij}$$

where τ_i represents individual-level random effects following $N(0, \sigma_\tau^2)$, φ_j represents community-level random effects following $N(0, \sigma_\varphi^2)$, and ε_{ij} is the regular residual term. Using change score, $y_{ij}^{t+1} - y_{ij}^t$, as the dependent variable, alleviates two types of problems: (1) falsely concluding a treatment effect when a straightforward examination of means indicates none, and (2) falsely concluding that regression to the mean within groups implies regression to the mean between groups (Allison 1990). This is essentially a difference-in-difference model where individuals serve as their own control to estimate within-individual change between two time points and between individuals exposed to different contextual effects. Together with including y_{ij}^t on the right-hand side of the equation as a control variable, this model adjusts for differences at the baseline (i.e. pretreatment heterogeneity bias). Test of cross-level effects can be easily accomplished by adding interaction terms, $\beta * Z$, to the right-hand side of the equation.

To explore the potential long-term effects, we can simply modify the model above by lagging key predictors from time t to $t-1$ as the following:

$$y_{ij}^{t+1} - y_{ij}^t = \alpha_0 + \beta X_{ij}^t + \gamma Z_j^t + \beta' X_{ij}^{t-1} + \gamma' Z_j^{t-1} + \delta y_{ij}^t + \tau_i + \varphi_j + \varepsilon_{ij}$$

where β' denotes a different vector of coefficients than β instead of the transpose of β , and so does γ' .

Finally, we will not exclude cases with missing data to avoid erroneous inferences that can stem from discarding data that are missing-at-random (Landale and Oropesa 2001). Instead, we will perform multiple imputations to handle missing data provided that no strong evidence of non-ignorable missing mechanism is discovered in exploratory analyses (Schafer 1999).

Figure 1. Silhouette figures of different body shapes for boys.

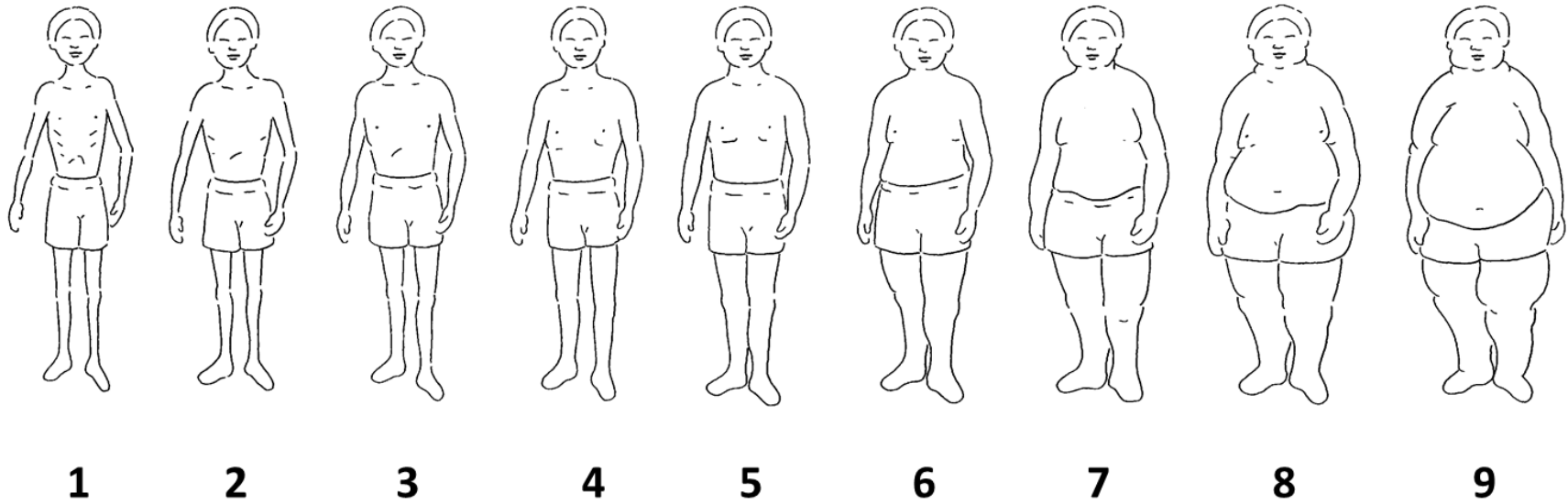


Figure 2. Body mass index across age groups, stratified by gender and rural/urban residence

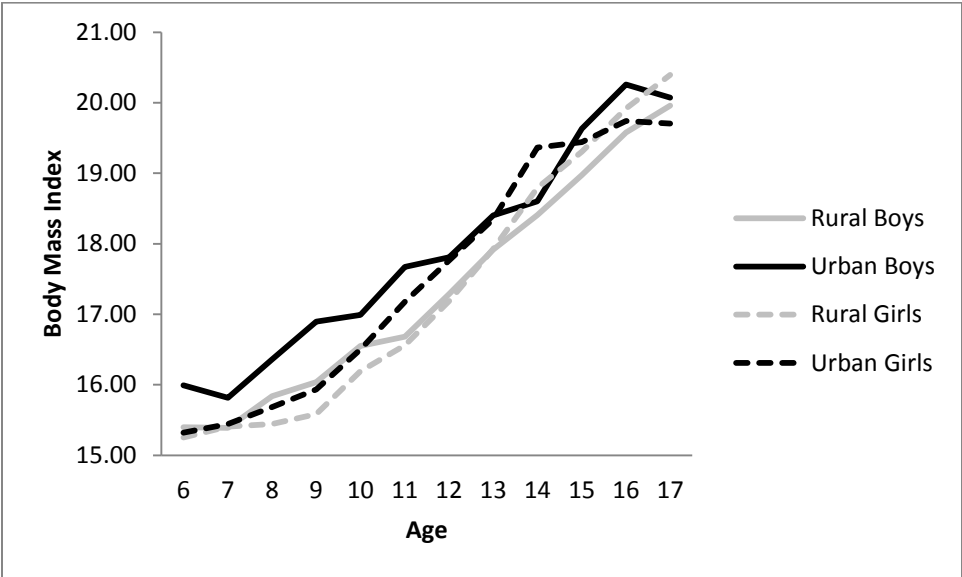


Figure 3. Triceps skinfold (mm) across age groups, stratified by gender and rural/urban residence

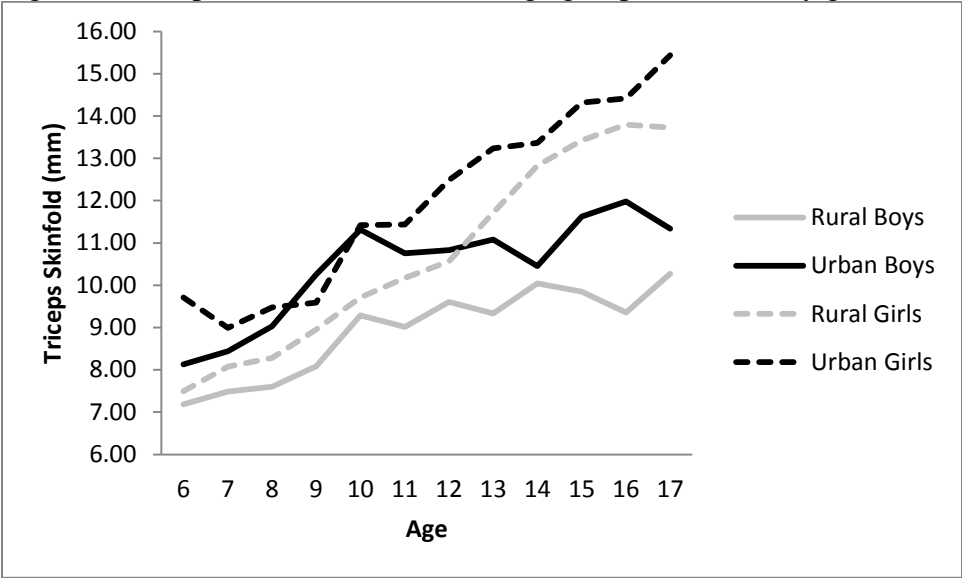


Figure 4. Waist circumference (cm) across age groups, stratified by gender and rural/urban residence

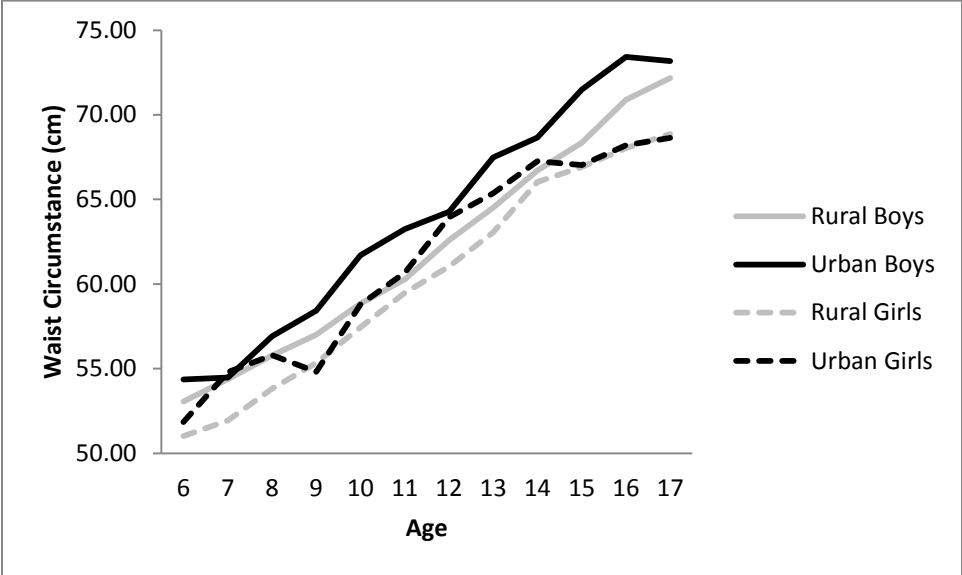
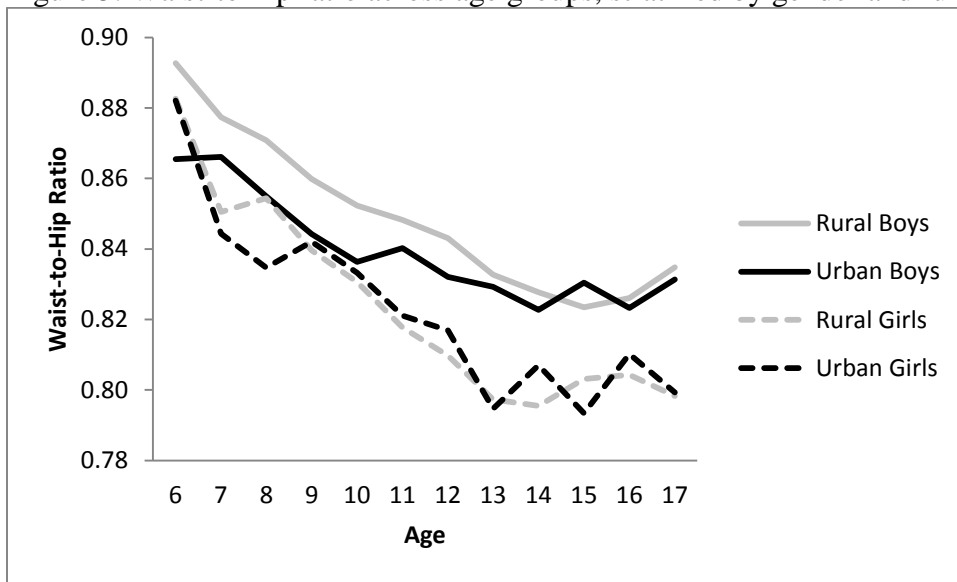


Figure 5. Waist-to-hip ratio across age groups, stratified by gender and rural/urban residence



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