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Examination of the Association between Socioeconomic Status and Overweight and Obesity In Bijapur, Karnataka, India

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Abstract

Examination of the Association between Socioeconomic Status and Overweight and Obesity among School-Going Adolescents in Bijapur, Karnataka, India

By Anh-Minh Alexander Tran

Background: India has been traditionally more affected by undernutrition but recently there has been a rise in rates of overweight and obesity. Rapid urbanization of rural and peri-urban areas as well as the increasing influence of globalization is facilitating the increased consumption of foods that are higher in calories and fat than traditional Indian diets. Rising overweight and obesity has mostly affected higher socioeconomic classes in India's large metropolitan cities.

Purpose: This research examines the association between socioeconomic status and overweight and obesity among school-going adolescents in a peri-urban environment such as Bijapur, Karnataka, India.

Methods: Analysis was conducted on cross-sectional survey data of 398 school-going adolescents. 4 different proxies were used to measure socioeconomic status (total household income, household education, possession wealth, and private school or public school attendance). The outcome was adolescent BMI classified using the International Obesity Task Force (IOTF) adolescent BMI cut points. Chi-square tests were used to determine statistically significant differences in BMI classifications and ordinal multivariate logistic regression modeling was used to estimate the association of socioeconomic status and adolescent BMI.

Results: Prevalence of overweight and obesity increased as socioeconomic status increased. Chi-Square tests showed statistically significant differences across various socioeconomic status indicators in regards to BMI. Ordinal multivariate logistic regression showed that as socioeconomic status increased so did the odds of being in a higher BMI category vs. a lower BMI category.

Conclusions: Our study suggests that there is a positive does-response relationship between socioeconomic status and increasing BMI among school-going adolescents in a peri-urban environment in India.

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CHAPTER I: BACKGROUND AND LITERATURE REVIEW

Malnutrition refers to both undernutrition and overnutrition. Undernutrition and occurs when someone is lacking the required levels of calories, proteins, and other nutrients required for proper growth and health and can manifest as wasting, stunting, and illness (1). Overnutrition on the other hand refers to the excess intake of nutrients that exceed the required levels for proper growth (1). Overweight and obesity are classified as overnutrition as caloric requirements are exceeded (1).

India has been highly affected by childhood undernutrition over the past several decades. According to UNICEF's State of the World report in 2011, India had a prevalence of severe acute malnutrition/undernutrition (severe wasting) of 20% (1). Undernutrition is widespread throughout the country as many regions in India had extremely high rates of childhood undernutrition (ranging from 20% to 80%), other areas have a high prevalence of adult undernutrition greater than 50% (2).

While undernutrition continues to affect the subcontinent and garner a large portion of the public health focus, rates of overweight, obesity and overnutrition have been rising throughout India (2). In 1989 the prevalence of overweight and obesity in India was 2%, while the prevalence had risen to upwards of 17% in 2006 (2). According to the 2007 National Family Health Survey, 12.1% of Males and 16% of females were either overweight or obese (3). This is a major concern because obesity and chronic overweight are associated with increased blood pressure, increased heart rate, poorer health outcomes, and increased morbidity and mortality (4). Childhood obesity may lead to negative lifelong health consequences including respiratory problems, diabetes, heart disease, as well as many other cardiovascular problems (5).

Problem of Childhood Overweight and Obesity in India

Childhood obesity (5-19 years of age) in India is a growing concern. One study from the Endocrine Review estimated the prevalence of childhood overweight and obesity in India to be 22% (5). According to a meta-analysis of 9 studies in India focusing on childhood obesity, the prevalence of childhood overweight and obesity in India was estimated to be 12.64% and childhood obesity to be 3.39% (6).

The large increase of overweight and obese individuals, especially children, in India is a threat to India's public health system. The public health system in India for many of the past decades has been focused on undernutrition and may not be able to adequately address overweight, obesity, and chronic diseases associated with it (2). This has led to India developing a double burden of disease, rising overweight and obesity rates in the setting of high rates of undernutrition (6).

Many non-communicable diseases related to overweight and obesity (diabetes, heart disease) are very much growing health problems in India. Currently India has an estimated 65 million people with diabetes—the second largest number of people with diabetes in the world—and obesity is a main contributor to the growing diabetes epidemic (7).

Globalization and Changing Socioeconomic Dynamics

As global communication and transportation have increased, people have been able to connect with one another in ways that were originally impossible. Unprecedented economic development and globalization has changed the socioeconomic landscape of India over the last several decades as millions of people have been pulled out of poverty (8, 9). In 1973, 55 percent of the population was impoverished; in 2004, poverty levels

had been reduced to 27 percent (10). For many in India globalization has increased access to health services, transportation, food access, income, job opportunities, and increased their livelihoods and health. In many respects India is in better position to battle against undernutrition that has long affected it due to the population's increased access to the global food supply chain.

But this creates a new challenge, as with globalization and economic development comes changing diets and lifestyles. As income level and employment increase in both urban and rural communities, there has been a correlation of increased demand for these new and less 'traditional' foods (11).

While this rapid economic development has benefited much of India, economic growth and opportunities have not been equal for everyone. A report by the Organization for Economic Co-Operation and Development (OECD) indicated that while poverty in India is decreasing, inequality is increasing especially when comparing the urban rich to the urban poor (9). Additionally a report by the United Nations Department of Economics and Social Affairs indicated that economic growth has been uneven, but overall has led to increased inequality between country regions, between rural areas and urban areas, and between the urban rich and urban poor (8).

This inequality has led to unequal access to adequate education, especially in urban vs. rural settings and across socioeconomic classes (12). Unequal access to education is causing inequality for employment opportunities, limiting social mobility, as well as limiting potential income (12). Additionally a family's background, especially in terms of religion and caste, is seen as a large predictor of a family's educational,

occupational, and income opportunities (12, 13) This growing socioeconomic class inequality is causing unequal access to new resources, including food.

In India, higher socioeconomic classes are associated with higher rates of overweight and obesity while those in lower socioeconomic classes have lower rates of obesity and overweight (2, 5, 13-19) Research suggests that high levels of overweight and obesity concurring with high levels of underweight is more likely to occur in areas with large socioeconomic inequality (13).

Furthermore the growing obesity epidemic in India at the moment is more concentrated in urban areas (Delhi, Calcutta, Chennai) than in rural areas (20). This may be because there is a higher level of resources, especially food resources that are accessible in urban areas that are not widely available in rural or peri-urban areas (20). These include fast/high caloric foods in urban areas of India that are widely popular among Indians living in urban areas (21).

Socioeconomic Status Differences in Food Consumption

India has seen a large increase in demand for foods that are high in calories, fat, sodium, and sugars as more of the population gains larger access to more food markets, including western fast foods (11). While the demand has increased across all income groups, some research shows that the consumption of these new and less traditional foods are more likely occur among those with larger disposable incomes and those in higher socioeconomic classes (5). In a study in Calcutta, adolescents classified as middle or high socioeconomic status were more likely to consume chocolate, processed food snacks, and eat out more at restaurants with their families which all contributed to higher levels of

overweight and obesity when compared to adolescents in lower socioeconomic classes (18).

Income inequality throughout India has caused unequal access and distribution of food resources, which has been characterized by the co-existence of overconsumption of food among higher-income groups and food insecurity among lower-income groups (13). A recent study (2014) showed that in areas with high inequality, households that were impoverished or near the poverty line were more likely to spend their scarce resources on status goods (televisions, furniture, other household goods) than on food in order to increase their community status. (22) This is becoming widespread throughout India in areas with growing inequality and is further contributing to unequal food consumption among different socioeconomic classes (22). Moreover, a meta-analysis of food consumption in India showed that the diets of higher-income groups contained 32% energy from fat while the diets of lower-income groups contained 17% energy from fat (21).

Sedentary Lifestyle and Lack of Physical Activity

In addition to high fat content and high caloric diets, increasingly sedentary lifestyles are also a driving factor in increasing rates of overweight and obesity (20). More children in India are spending less of their leisure time exercising or playing outdoors and are spending more of their leisure time doing sedentary activities such as watching television, playing video games, or spending time on computers (21). Additionally, some research suggests that children in India may be too focused on academics and schooling and are therefore less likely to participate in sports or outdoor activities (23). Moreover, sedentary lifestyles in some studies have shown to be different

across socioeconomic groups especially in the context of higher income leading to an increase in material assets and possessions (televisions, computers, etc.) leading to a more sedentary lifestyle (16).

Higher Socioeconomic Status and Overweight and Obesity

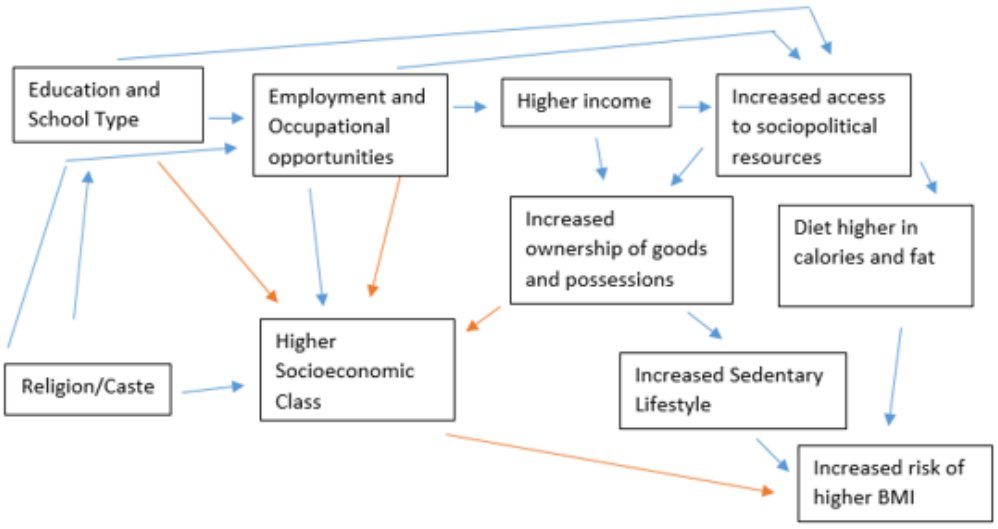
Given the unequal access to food and material resources across different socioeconomic groups, many studies support a framework of higher socioeconomic status being more strongly associated with higher BMI levels (2, 5, 15-19, 21, 23). A study in the central Indian state of Madhya Pradesh that used parents' education, income, and occupation as proxies for socioeconomic status found that the prevalence of adolescent obesity was over twice as high in high socioeconomic classes than in low and middle socioeconomic classes (17). A similar study in the western city of Ahmedabad that used parent's occupation and education as a measure of socioeconomic status found that 70% of obese adolescents were classified as high socioeconomic status (18). Another study in the southern city of Chennai found similar conclusions in that odds of being overweight or obese among high socioeconomic status adolescents was 3.4 times higher than low socioeconomic status adolescents (23).

The majority of the literature reviewed indicated that higher socioeconomic status had a stronger association with obesity than did middle or low socioeconomic status. Given the complexities of the causal association of socioeconomic status and overweight and obesity proposed in Figure 1 is a hypothesized conceptual framework helps give context to the issue.

Increased educational opportunities may lead to more occupational opportunities (12). Increased employment and occupational opportunities may lead to earning a higher

income (8, 9). This then leads to increased access to food resources (especially fast foods/globalized foods that have high fat and caloric content in urban areas) which can lead to higher levels of obesity (5, 11, 18). Additionally increased access to material resources can contribute to increasing sedentary lifestyles which can also lead to higher levels of obesity (16). It is assumed that those in lower socioeconomic status groups may not have the same opportunities, purchasing power, and access to sociopolitical resources thus are at lower risk of obesity in India (13). The conceptual framework for increased obesity in India can be hypothesized as follows:

Figure 1. Hypothesized Conceptual framework of SES and Obesity Based on the Established Literature



While there are many factors to consider, this paper is concerned with measuring the direct association of socioeconomic status and adolescent overweight/obesity. In Figure 1 the orange arrows indicate the components that will be directly tested. In the case of adolescent socioeconomic status, the caregiver's status is used as a proxy for the adolescent.

Changing Dynamics of socioeconomic status and adolescent obesity in India

While currently there is a strong association of overweight and obesity with high socioeconomic status, there are studies that suggest the opposite. The dynamics in India are quickly changing and seemingly the rates of overweight and obesity-related diseases are increasing at faster rates in low socioeconomic groups than in middle and high socioeconomic groups. Over the past several decades, rates of overweight and obesity have increased more rapidly in rural areas than in urban areas. In the past 10 years the prevalence of obesity in urban areas increased 1.7 fold. In the past 14 years the prevalence of obesity in rural areas saw a nearly 8.6 fold increase (24).

A study that used monthly household income as a proxy of socioeconomic status in the Chennai region followed 1,262 adult subjects over a 10 year period. (25) Initially there was a large gap in diabetes prevalence between low and middle income groups. The study found that the gap in diabetes prevalence between the two groups over that 10 year period had significantly decreased; low-income groups saw a change in prevalence from 6.5% to 15.3% while middle income groups saw a change in prevalence from 12.4% to 15.4% (25).

Additionally, a study recently published in 2012 where 6,198 participants were classified into the socioeconomic categories of occupation and formal education after adjusting for age actually showed that lower socioeconomic groups were at risk of higher obesity and cardiovascular risk factors. The authors noted that their study was the first study from India that showed a greater prevalence of multiple cardio metabolic risk factors including: high waist-hip ratio, low HDL cholesterol, and hypertriglyceridemia in

subjects with low education status and metabolic syndrome in subjects in a lower occupational class (25).

These studies and others like them are a possible indicator that the socioeconomic dynamics may be changing. The reversal in this trend may be a result of increased nutrition education and awareness of the health benefits of physical fitness especially among higher socioeconomic classes (25). Persons in higher socioeconomic classes are beginning to consume less calories, eat more fruits and vegetables, and are exercising more (15). Moreover the built environment may have an impact as high socioeconomic areas are developing more infrastructure that is conducive to walking and physical activity (25). While these studies may signal a new pattern, more studies will be needed in order to confirm these findings.

Methods of Measuring Overweight and Obesity

While there are many means of measuring overweight and obesity, Body Mass Index (BMI) is frequently used. BMI measures the ratio of weight to height. BMI is calculated as (mass [kg])/(height [m])^2. Based on BMI, persons may be classified into four main categories – underweight, normal weight, overweight, and obese. The WHO standard cut points for adult BMI as well as the International Obesity Task Force unofficial Asian adult BMI cut points are stated below (26, 27):

BMI Classification	**Standard Cut-Points**	**Asian Cut-Points**
Underweight	BMI below 18.5	BMI below 18.5
Normal Weight	BMI between 18.5 and 24.99	BMI between 18.5 and 22.99
Overweight	BMI between 25.0 and 29.99	BMI between 23.0 and 26.99
Obese	BMI greater than 30	BMI greater than 27

While BMI has been widely accepted in the classification of underweight, normal weight, overweight, and obese for adults, BMI is more complicated when applied to

children. Children are still growing and applying the adult scale of BMI to children will often lead to inaccurate BMI classifications.

When applying BMI to children, the use of standard growth-age charts from a standardized population has been developed to determine international standard growth curves for children. These growth charts have been used in the development of BMI-for age z-scores (26). The World Health Organization uses the number of standard deviations from the median in order to delineate BMI classifications. Classification groups are indicated as 2 standard deviations beneath the median as underweight and 2 standard deviations above the median as being overweight. Three standard deviations above the median would be classified as obese (1).

The International Obesity Task Force (IOTF) Extended International BMI Cut-points has developed age-specific BMI cut-points for children and adolescents that correspond with the standard and Asian adult cut-points. These cut-points are age-specific by month starting from age 2 to age 18 (27). The IOTF Extended International BMI cut-points were used to classify adolescent BMI in this study.

Methods of Measuring Socioeconomic Status in India

Socioeconomic status is a large spectrum that encompasses personal, societal, cultural, and economical aspects as well as material, human, and social capital (28). Depending on the combination of these different factors, many persons, families, households, and even geographic areas may cause a unequal access to resources which can affect their health and welfare (28).

Because of the multi-dimensional aspects of socioeconomic status, it is challenging to develop adequate measures that truly reflect socioeconomic status and its

relation to health. Socioeconomic status in the conceptual framework (Figure 1) is discussed in the context of increasing access to resources that may lead to behaviors that increase risk of overweight and obesity. This section will discuss different aspects of socioeconomic status and its relation to overweight and obesity. When measuring the socioeconomic status of a child or adolescent, the socioeconomic status of the parents or caregiver are primarily used (14).

Monthly Household Income

Many studies in India assessing the association of socioeconomic status and obesity used total monthly household income as a proxy of socioeconomic status (2, 5, 11, 13-19, 21-25). Household income is a measure of a household's direct cash-flow resources. As household income rises in developing countries there has been an association with increased demand and consumption for foods with higher fat and caloric content (11). Thus households with higher incomes have the ability to purchase more goods/food (especially foods with high fat content and calories) than households with less income (11).

One example classification of total household income in India is the use of the India Housing and Urban Development Corporation classification (25). In this classification, Low-Income Group is defined as a household monthly income between Rs. 2500–5500, Middle-Income Group is defined as a household monthly income between Rs. 5501–10,000, and High-Income Group was classified as a monthly household income of Rs. 10,001 and above (25).

While household income is a very important measure of socioeconomic status and is used in many studies in India it does not provide the full picture of socioeconomic

status. India still has an informal economy and wealth, affluence, and status can be measured in many different ways (9). Many Indians may have very decent wages and fairly good living standards but could also be considered a lower socioeconomic class because of other factors such as occupation and education (18).

Occupation

Occupation is also used as a proxy indicator for socioeconomic status in India (13, 15, 21-23, 25). For many in India this classification may be more important than household income (18). However the two are interrelated and it is seen that having a higher occupational status increases the potential of earning a higher income which can also help increase social status, increase household purchasing power, and increase access and consumption of goods (8, 9).

Many studies classify occupation into categories with 'white collar' jobs indicating a higher occupational class while 'blue collar' workers or laborers indicating a lower occupational class (18). A general break down of occupation and its perceived socioeconomic status can be as follows:

High Socioeconomic Status Occupations	Government officials, medical personnel, and professionals
Middle Socioeconomic Status Occupations	Store clerks/workers, trades/craft workers, skilled factory and agricultural workers
Lower Socioeconomic Status Occupations	Manual laborers, unskilled workers, beggars

While this study did not use occupation as a proxy for socioeconomic status, it is still important to understand given its potential relationship to other socioeconomic status indicators such as income and education.

Education

Education is also an important aspect of determining socioeconomic status in India. Many people in India put a very high premium on education and the attainment of educational degrees. Education is a measure of human capital and shows advancement in society and is seen as a potential gateway toward gaining a 'higher class' occupation which may lead to a higher income and thus increased status (29). A lack of an education can be seen as limiting a person's opportunities thus limiting their potential to gain access to a higher socioeconomic class. Additionally attendance to a private school is often seen as being part of a higher socioeconomic class and it has been found that those that attend private schools have higher levels of overweight and obesity than those that attend public schools (23).

Education is seen as a gateway to be able to obtain a higher level job or occupation as well as earning a higher income (29). This then increases access to resources that may increase the risk for overweight and obesity. These education levels can be split into the following general categories:

- Professional/Honors
- Graduate/Post Graduate
- Pre-University Course (PUC)
- High school/Intermediate/Diploma
- illiterate/primary school

Possession Wealth

The previous socioeconomic status classifications focused on human capital, social capital, and cash flow resources. Possession wealth instead measures wealth from material possessions and assets. As described in the hypothesized conceptual framework

(Figure 1) increased ownership of certain items, goods, and resources may increase sedentary activities which has a direct effect on overweight and obesity (16).

The previous indicators (education, income, occupation) were all related to the relative access to resources a household has while possession wealth measures a households current assets as indicative of its current resources rather than its potential to access more resources (30).

An example of possession wealth is the Standard Living Index (SLI). The SLI weights the items below and combines them into a composite score that classifies the socioeconomic status of the household. SLI measures the ownership and type of the following assets and possessions (30):

- Type and source of lighting
- Toilet facility
- Main fuel for cooking
- Source of drinking water
- Separate room for cooking
- House material
- Ownership of house
- Ownership of agricultural land, irrigated land, livestock
- Ownership of durable goods

The difference in socioeconomic status measurements between the SLI and the other indicators causes a potential problem of misclassification. The SLI showed that some persons that were classified as high socioeconomic status using the SLI were actually classified as middle or low socioeconomic status when using scales that incorporated occupation and education (30). The difference is that while the SLI measures current access to resources by measuring possession wealth, education and occupation measure potential access rather than current access to resources (30). Much of

the literature that was reviewed for this study did not use possession wealth indicators as a proxy for socioeconomic status instead using mostly income, education, and occupation as socioeconomic status proxies.

Socioeconomic Status Classification Summary

Household income potentially is the most appropriate for looking at body weight as it is directly connected to a household's ability to purchase food and other resources that contribute to increased risk of higher BMI (11). However education and occupation are potential precursors to earning a higher income and can be used if household income data were not available (29). Education also has an advantage in that human capital remains relatively stable while income and occupation can be lost almost immediately (29). Using possession wealth has an advantage in that it measures current resource level and can be used to assess socioeconomic status in rural areas where income and occupation may be difficult to measure (30). In the context of BMI, overweight, and obesity: Household income and possession wealth are indicators of a household's current access and level of resources while education and occupation are a measure of potential access to resources (11, 29, 30). Additionally the use of private school attendance and public school attendance is often used to classify socioeconomic status of adolescents as this can be directly measured for adolescents without the need for using the caregiver's socioeconomic status as a proxy (23)

Usefulness and Gaps in the Literature

The literature on socioeconomic status and its relation to childhood obesity has painted a picture of higher socioeconomic status being strongly associated with overweight and obesity. Much of the literature on the association of socioeconomic status

and obesity in India pertains to India's large urban metropolitan areas (i.e. Delhi, Chennai, Mumbai, and Bangalore). Persons in these large metropolitan areas have greater access to the global supply chain, global fast food chains, and different/fattier foods (21). Much of the past literature showed that urban areas had higher rates of overweight/obesity than rural areas (21). However new studies are showing that rates of overweight/obesity among those classified as low socioeconomic status are beginning to catch up to the rates of overweight and obesity in middle socioeconomic status groups.

Gaps Pertaining to Peri-Urban Areas (Bijapur, Karnataka, India)

There is a current gap in the literature regarding less developed cities that are surrounded by rural areas. This study addressed this gap by assessing if the association of high socioeconomic status and overweight and obesity is confirmed in a peri-urban city such as Bijapur. Bijapur has an estimated population of 350,000 people. While it is not the biggest city in Karnataka it is one of the most densely packed with the majority of its population living within a 10 square-km radius. Bijapur is considered to be a peri-urban city surrounded by mostly rural areas. According to the India Census, Bijapur is India's 133rd most populous city (31). While Bijapur remains mostly underdeveloped it is undergoing rapid urbanization and is becoming more affected by globalization. Additionally this study makes use of multiple socioeconomic status indicators (education, material wealth, household income, and school type) and measures their association with overweight and obesity. Specifically this study measures possession wealth while many other studies do not.

Thesis Focus and Research Questions

Much of the research on socioeconomic status in India has shown a positive association between high socioeconomic status and overweight and obesity. However several recent studies have shown that there is potentially a shift in the direction of the relationship of socioeconomic status and obesity and that lower socioeconomic status groups are becoming more at risk for being overweight or obese. This thesis will test the hypothesis that high socioeconomic status (using 4 different proxies – income, education, wealth, private school or public school attendance) is associated with higher BMI among school going adolescents in Bijapur, Karnataka, India.

Research Question: What is the strength and direction of association between different socioeconomic status indicators (education, household income, material wealth, school type) and being in a higher BMI category vs. a lower BMI category among school-going adolescents in a peri-urban environment (Bijapur, Karnatka, India)?

CHAPTER II: Methods

Study Setting

The study population of interest is school-going adolescents in Bijapur, Karnataka, India. This research was conducted as a partnership between Emory University Rollins School of Public Health in Atlanta, GA, USA and BLDE University Shri B.M. Patil Medical College in Bijapur, Karnataka, India. Bijapur is located in the Northern region of the state of Karnataka. The following project was funded by the National Institutes of Health (NIH) to support researchers of Emory University and BLDE University to understand the role of the family environment and social determinants in adolescent health in Bijapur, India. Emory University and BLDE University Institutional Review Board (IRB) have given approval for this study

Data Collection

The data were collected in the spring of 2012. The data that were collected included three survey instruments: an adolescent module (administered to adolescent participants), primary caregiver module (administered to the adolescents' primary caregiver), and opposite-sex sibling module (administered to the adolescents' opposite-sex sibling if applicable).

The surveys were developed first in English, translated into Kannada (language most widely spoken in Bijapur), and then translated by a different person back into English. The survey was validated for translational accuracy. All surveys were conducted in Kannada.

The study participants (caregiver, adolescent, and opposite-sex sibling) were surveyed at their home of residence. All study participants were administered a survey

consent form by a trained interviewer. All study participants had a right to refuse any questions as well as refuse to be interviewed.

All survey data have been stored safely and only research administrators have access to the research data. All electronic research data have been de-identified and stored on encrypted Emory University and BLDE University servers. All research data were kept confidential.

Study Participant Selection

3 private schools and 3 public schools were selected via simple random sample from the official school registry of schools in Bijapur provided by the Bijapur Department of Education. Each school had an equal chance of being randomly selected. The sampling of study participants was stratified by gender and school type (private school v public school). After stratification a total of 404 adolescent students were then selected via simple random sample from all 6 schools. There were an equal number of boys and girls as well as an equal number of adolescents from private and public schools selected for the study.

Weights

Data were weighted by gender (male or female) and by school type (private school or public school). Inverse probability weighting was used to calculate the sample weights. Study participants were assigned the following weights:

Adolescent Participant	Population	Sample	Selection probability	Inverse Probability of Selection	Final Weights
Private School Boys	2791	99	0.035471157	28.19191919	0.64
Private School Girls	2050	99	0.048292683	20.70707071	0.47
Public School Boys	6530	101	0.015467075	64.65346535	1.48

Public School Girls	6076	100	0.016458196	60.76	1.39

Given that each school had an equal chance of being randomly selected, the sample population after weighting was representative of school-going adolescents (age 12-17, grade standard 8 – 10) in Bijapur.

Main Exposures

The main overall exposure of the study was socioeconomic status as determined by a family's wealth, cash-flow resources, education attainment, and an adolescent's school type. The study had 4 separate candidate exposure variables. The first socioeconomic status classification exposure variable was monthly total household income, which was used in this study as a proxy for a household's cash-flow resources. The second socioeconomic status classification exposure variable was highest education attainment of any person in the household, which is used in this study as a proxy of human capital. The third socioeconomic status classification exposure variable was a custom wealth possession index, which is used in this study as a proxy for a family's wealth. The wealth possession index variables and weights will be discussed below. The fourth socioeconomic status classification exposure variable was school type (private school v public school) which is also commonly used in India as a proxy for socioeconomic status in studies of children and adolescents (23).

Only data pertaining to the adolescent and primary caregiver modules were used in this study. Data for the variables total household income, household education, and wealth possession index were derived from the primary caregiver module. Data for the school type variable was derived from the adolescent module.

Development of Wealth Possession Index Variable

The wealth possession index was created using a combination of eight variables. This is an exploratory index and has not been validated. It makes use of household material possessions as well as domestic assistance to determine household wealth. These variables were: household has a toilet facility inside the home, household has separate room for cooking, household's primary cooking fuel, family has domestic assistance, family ownership of a computer (laptop or desktop), household building material, family ownership of a television, and family ownership of satellite/Dish TV. The weights of each variable are stated in the following table.

Household Characteristics	**Possession Wealth Index Weight Score**
Household has a toilet facility inside the home	Yes = 1, No = 0
Separate Room For Cooking	Yes = 1, No = 0
Primary Cooking Fuel	Electricity=1, Gas/LPG=1, Wood = 0, Kerosene=0
Domestic Assistance	Yes = 1, No = 0
Ownership of a Computer	Yes = 1, No = 0
Household Building Material	Pucca=2, Semi-Pucca = 1, Kaccha = 0
Ownership of a TV	Yes = 1, No = 0
Ownership of Satellite/Dish TV	Yes = 1, No = 0

Possession Wealth Index Score Categories

Low Possession Wealth	Cumulative Score = 0-3
Medium-Low Possession Wealth	Cumulative Score = 4-5
Medium-High Possession Wealth	Cumulative Score = 6-7
High Possession Wealth	Cumulative Score = 8-9

Outcome

The outcome of this study is adolescent Body Mass Index (BMI). BMI was calculated using the formula: (mass [kg]) / (height (m))^2). Height (measured in meters) was measured with the study participants standing straight and against a wall. The height

was measured using a tape length measuring ruler. Study participants' height was measured twice and the average of the two height measurements was used to calculate BMI. Weight (measured in kg) was measured using a calibrated scale. Study participants' weight was measured twice and the average of the of the two weight measurements was used to calculate BMI.

Age and Gender specific adolescent BMI cut points were determined using the specific 2012 Extended International Obesity Task Force (IOTF) Asian adolescent BMI cut points (27). Based on these cut points, categories were created to classify adolescent study participants as underweight, normal weight, overweight, and obese:

IOTF Asian Adolescent Male Cut Points				
Age	Underweight	Normal Weight	Overweight	Obese
12	<15.59	15.59 - 19.67	19.67 – 23.47	23.74 <
13	<16.11	16.11 – 20.31	20.31 – 24.22	24.22 <
14	<16.68	16.68 – 20.99	20.99 – 24.94	24.94 <
15	<17.26	17.26 – 21.62	21.62 – 25.58	25,58 <
16	17.79	17.79 – 22.2	22.2 – 26.16	26.16 <
17	18.28	18.28 – 22.74	22.74 - 26.72	26.72 <

IOTF Asian Adolescent Female Cut Points				
Age	Underweight	Normal Weight	Overweight	Obese
12	<15.91	15.91 – 20.12	20.12 – 24.02	24.02 <
13	<16.55	16.55 – 20.91	20.91 – 24.92	24.92 <

14	<17.16	17.16 – 21.59	21.59 – 25.64	25.64 <
15	<17.68	17.68 – 22.13	22.13 – 26.15	26.15 <
16	18.08	18.08 – 22.54	22.54 – 26.53	26.53 <
17	18.38	18.38 – 22.86	22.86 - 26.85	26.85 <

Due to the coding and classification of the outcome, there is a potential for misclassification when compared to other methods. The IOTF uses age-specific BMI cut-points for children and adolescents that correspond with the adult BMI cut points. The IOTF Asian cut points use a lower threshold to determine overweight and obesity. The IOTF Asian adult threshold for overweight is BMI=23 while obesity=27 thus potentially overestimating overweight and obesity when compared to other methods (27).

Variables

Variable	Type	Description	Categories
Highest education level attainment of the household	Categorical	This is a primary exposure variable. Data for this variable was obtained from the primary caregiver module. This variable indicates the highest education attainment of any person living within the household. This variable is used as a proxy for socioeconomic status: human capital.	Primary, High School, PUC, Degree, Professional.
Collapsed highest education level attainment of household	Binary	Education variable collapsed into a binary variable separating those with or seeking higher education from those with a high school degree or below.	None/Primary/High School or PUC/Degree/Professional
Monthly household income	Categorical	This is a primary exposure variable. Data on this variable was obtained from the primary caregiver module. This indicates the monthly household income per month. This includes income from all members who contribute to the total household income. This variable is used as a proxy for socioeconomic status: cash-flow resources.	Less than 5,000 Rs/month, (Less than $83.33) 5,001-10,000 Rs/month, ($83.33-$166.67) 10001-20000 Rs/month, ($166.67 - $333.33)

			20001-30,000 Rs/month, ($333.33 - $500) More than 30,000 Rs/month, (More than $500) Refused, Don't know.
Collapsed monthly household income	Binary	Monthly household income variable collapsed into a binary variable separating households that earn less than 10,000 Rs/month from households that earn more than 10,000 Rs/month	Less than 10,000 Rs/month More than 10,000 Rs/month
School Type	Categorical	This is a primary exposure variable. Data on this variable was obtained from the adolescent module. This indicates the type of school the adolescent attends. This variable is used as a proxy for socioeconomic status: Status within the community.	Public School, Private School
Wealth Possession Index	Categorical	This is a primary exposure variable. Data on this variable was obtained from the primary caregiver module. This variable is used as a proxy for socioeconomic status: Possessions as a measure of wealth	Low possession wealth, medium-low possession wealth, medium-high possession wealth, high possession wealth
Possession Wealth	Continuous	The asset count of the wealth possession index. Data were not categorized	1-9
Toilet facility inside house	Categorical	This variable indicates if there is a toilet facility in the house. Data on this variable was obtained from the primary caregiver module. Many houses in poor communities have their toilet facilities outside the house; many in more affluent areas have their toilet facilities inside the house. This variable is part of the wealth possession index.	Yes, No, Refused.
Separate room for cooking	Categorical	This variable indicates if there is a separate room for cooking like a kitchen within the household. Data on this variable was obtained from the primary caregiver module. Further indicates the size of the house as well as the ability to designate different rooms for different tasks. This variable is part of the wealth possession index.	Yes, No, Refused
Type of fuel used for cooking	Categorical	This variable indicates the type of fuel that is used for cooking. Data on this variable was obtained from the primary caregiver module.	Electricity, Gas/LPG, Wood, Kerosene, Other Specify, Refused, Don't

		Types of fuel that are used are often associated with the amount of income and access to resources that a household has. This variable is part of the wealth possession index.	Know.
Household has domestic help	Categorical	This variable indicates if the household has anyone assisting them with domestic chores, housework, or other related tasks. Data on this variable was obtained from the primary caregiver module. This is taken into consideration because households that have domestic assistance often have more disposable income which is indicative of higher socioeconomic status. This variable is part of the wealth possession index.	Yes, No, Refused, Don't Know.
Ownership of TV	Categorical	This variable indicates whether the family owns a TV. Data on this variable was obtained from the primary caregiver module. Ownership of a TV is an indicator of socioeconomic status. This variable is part of the wealth possession index.	Yes, No, Refused
Ownership of Satellite/Dish TV	Categorical	This variable indicates whether the family has satellite TV or Dish TV. Data on this variable was obtained from the primary caregiver module. Ownership of satellite TV is an indicator of socioeconomic status. This variable is part of the wealth possession index.	Yes, No, Refused
Ownership of desktop/laptop computer	Categorical	This variable indicates whether the family owns a laptop or desktop computer. Data on this variable was obtained from the primary caregiver module. This is an additional ownership variable and the ownership of a computer may be indicative of socioeconomic status. This variable is part of the wealth possession index.	Yes, No, Refused.
Building material	Categorical	This variable indicates the material that the house was made of. Data on this variable was obtained from the primary caregiver module. Different building materials may be used by different families and households based on affordability, purchasing power, and are an indicator of socioeconomic status. This variable is part of the wealth possession index.	Pucca, Semi-Pucca, Kaccha.

Outcome Variables

Variable	Type	Description	Options
Height [cm]	continuous	This identifies the height of the adolescent in cm. This is an important outcome that is used to calculate BMI.	N/A
Weight [kg]	continuous	This identifies the weight of the adolescent in kg. This is an important outcome that is used to calculate BMI.	
Body Mass Index	categorical	Body Mass Index (BMI) is a measure of body adiposity and is a key outcome for determining overweight and obesity. This is calculated as (mass [kg])/(height (m))^2 BMI will be used as the main outcome for our study.	IOTF adolescent BMI Cut points used to determine underweight, normal weight, overweight, obese

Candidate Confounding Variables

Gender	Categorical	This variable identifies the adolescent study participant's gender.	Male, Female
Age	Continuous	This variable identifies the adolescent study participant's age.	N/A
Religion	Categorical	This indicates the religion of the caregiver. It is assumed that the religion of the main caregiver is the same for the adolescent.	Hindu, Muslim, Christian, Jain, Buddhist, None, Other Specify, Refused.
Caste	Categorical	This indicates if the caregiver/family is part of a caste (answered only if applicable). It is assumed that the caste of the main caregiver is the same as the adolescent.	General, Other Backward Classes, Scheduled Caste, Scheduled Tribe, Refused.
Ward location	Categorical	Ward location of study participants' home. It will indicate the ward location of each study participant within Bijapur.	Ward 1 – Ward 35

Data Cleaning and Statistical Analysis

A secondary data analysis was conducted for this study. Two primary datasets were used in this analysis: primary caregiver dataset and adolescent dataset. The two datasets were merged together so corresponding primary caregiver data matched the corresponding adolescent data. The data of the adolescent and his or her corresponding

primary caregiver were combined into 1 observation. 404 observations were eligible to be included into the analysis. Observations were eligible if data on the above variables were available. 4 observations were dropped because 4 primary caregivers were not surveyed. 2 additional observations were dropped due to substantial missing data within the observations. A total of 6 observations were dropped leaving a sample size of 398 eligible for analysis.

Data cleaning and statistical analysis was conducted using Statistical Analysis Software (SAS) version 9.3 (Cary, North Carolina).

Descriptive Statistics and Chi-Square Tests

Frequency counts were conducted on all the above variables of interest. Chi-square and Mantel-Haenszel Chi-Square statistical tests were conducted on all exposure variables and candidate covariates in relation to the outcome to assess statistically significant associations. The outcome was classified into its original categories: underweight, normal weight, overweight, and obese. Tables containing descriptive statistics and chi-square tables were first presented as unweighted and then with weights.

Logistic Regression Modeling

Ordinal multivariable logistic regression modeling was conducted to estimate the odds-ratios of the 4 main categorical exposure variables in regards to the outcome. The outcome, (adolescent BMI) was recategorized into underweight, normal weight, and combined overweight/obese in the ordinal logistic regression models. The 4 main categorical exposure variables are total household income, household educational attainment, household possession wealth, and school type. All data used in the logistic regression models were weighted using the previously calculated sampling weights.

Ordering the outcome has advantages in that it better measures the association of different BMI levels along the socioeconomic status continuum.

3 models were conducted for each of the 4 main categorical exposure variables. The first model is an unadjusted model (no covariates or exposures) that measures all exposures with the outcome independently of each other. The second model measures all exposures independently and adjusts for all candidate covariates (gender, age, religion, caste, ward id). The third model adjusting for all candidate covariates (gender, age, religion, caste, and ward id) but all exposures (household income, household education, possession wealth, school type) are run together within the same model.

3 additional models were conducted using the 2 collapsed exposure variables (household income and household education), linearized wealth possession index, and school type. The first model is an unadjusted model (no covariates or exposures) that measures all exposures with the outcome independently of each other. The second model measures all exposures independently and adjusts for all candidate covariates (gender, age, religion, caste, ward id). The third model adjusting for all candidate covariates (gender, age, religion, caste, and ward id) but all exposures (household income, household education, possession wealth, school type) are run together within the same model.

CHAPTER III: Results

Unweighted Descriptive Statistics of Exposure Variables and Covariates

Table 1 shows the characteristics of exposure variables and covariates of the study participants. The study contains the same number of males (n=198) and females (n=198) and nearly an identical number of participants attending private (n=197) or public school (n=201).

Most households have high educational attainment with 58.3% of households with at least one person that completed graduate or professional level education. A majority of study participants also score relatively high on the wealth possession index (67.8% with a medium-high wealth possession and above). In regards to education and material wealth, a majority of households would be considered middle or high socioeconomic status. However this is contrasted with the relatively low number of people with very high total household incomes (29.6% of households making over 20,000 Rupees per month).

Weighted Descriptive Statistics of Exposure Variables and Covariates

Table 2 contains descriptive statistics on exposures and covariates when study weights are taken into consideration. When weighted the sample is representative of school-going adolescents ages 12-17 and grades 8 – 10 in Bijapur. Nearly half of the households in Bijapur have high education attainment (47.2% with at least one person with a professional or graduate level education). A majority of households in Bijapur have middle to high wealth based on the results of the wealth index (57%). Half of the households in Bijapur were considered to be middle to high socioeconomic status based on household education and wealth. However a majority of the population would be

considered middle to low socioeconomic status based on income with 56.20% of households earning less than a total of 10,000 Rs per month.

Unweighted Descriptive statistics of Assets within the Wealth Possession Index

Table 3 shows the frequencies of ownership of items that constitute the wealth possession index among our study sample. A large majority of study participants had televisions in their home (90.2%), had an indoor toilet facility (81.9%), and had a separate room for cooking (87.4%). Additionally a large majority used electricity/gas/LPG as their primary cooking source (78.9%) as well as have their household built from pucca (78.6%).

Weighted Descriptive statistics of Assets within the Wealth Possession Index

Table 4 contains descriptive statistics of assets contained in the wealth possession index of the population. A majority of the population had indoor toilet facilities (74.7%), separate room for cooking (82.7%), used gas or electricity as their primary cooking fuel (71.1%), and owned a television (87.6%). Many households owned multiple assets surveyed, leading to high wealth possession index scores. However a large majority of the population did not own computers, have satellite TV, or have domestic assistance.

Descriptive Statistics of Adolescent BMI

Table 5 shows that overweight and obese adolescents make up a minority of the population (11.8%) and that most school-going adolescents in Bijapur were underweight (45.1%). Additionally the average BMI for female adolescents is generally higher than that of males throughout the younger and middle age groups (Table 6). However the mean BMI for males is higher than that of females in the highest age ranges.

Chi-Square and Mantel Haenszel Chi-Square Tests of Exposure and Covariates

Chi-Square Tests and Mantel Haenzsel Chi-Square Tests were conducted to test for significant differences among different exposure variables and covariates in regards to adolescent BMI. Each primary exposure variable, covariates, and variables that make up the wealth possession index underwent chi-square tests. Only weighted data were used for chi-square tests.

Table 7 shows weighted chi-square and Mantel-Haenszel chi-square tests of the socioeconomic status characteristics of the population in relation to Adolescent BMI. As total household income, educational achievement, and wealth increase the prevalence of overweight and obesity also increases. Private school adolescents also had a higher prevalence of overweight and obesity than adolescents that attended public schools. The Mantel-Haenszel chi-square tests were statistically significant for all exposure variables ($p<0.05$) indicating statistically significant differences across groups in regards to BMI categories. However the chi-square test for household education was not statistically significant ($p=0.1304$).

Table 8 shows weighted chi-square and Mantel-Haenszel chi-square tests of the demographic characteristics of the population in relation to adolescent BMI. The distribution of underweight, normal weight, overweight and obese adolescents is not statistically different ($p<0.05$) across different categories pertaining to gender, religion, or caste in Bijapur. Using the Mantel-Haenszel chi-square test for age groups, age is also not significantly associated with category of adolescent BMI ($p=0.1527$).

Table 9 shows weighted chi-square and Mantel-Haenszel chi-square tests of household assets that constitute the possession wealth index in relation to adolescent

BMI. The distribution of the variables in the table show a similar pattern. The prevalence of overweight and obese adolescents in Bijapur is higher in households that are in possession of the items in the following binary variables: toilet facility in house, separate room for cooking, family has domestic assistance, family owns a computer, and family has satellite TV. The Mantel-Haenszel Chi-Square tests for these variables are all statistically significant ($p<0.05$)

When comparing variables that have multiple responses the same pattern continues: the prevalence of overweight and obesity increases among adolescents in households that have access to better household building materials and better cooking fuel.

Multivariate Logistic Regression

All multiple ordinal logistic regression models fit the proportional odds assumption. Collinearity tests showed there was no collinearity among the multivariate logistic regression model variables.

Unadjusted Odds Ratios of Exposure Variables

Table 10 shows the weighted unadjusted ordinal odds-ratios of the primary socioeconomic status indicators and adolescent BMI. As household income, education, private school attendance, and wealth increase the odds of being in a higher BMI category vs. a lower BMI category increases among school-going adolescents in Bijapur.

Households that had a total household income less than 5,000 Rs per month was set as the referent group. Adolescents from households with a total income greater than 30,000 Rs per month have 6.75 (3.15, 14.45) times the odds of being in a higher BMI

category vs. a lower BMI category as compared with adolescents from households earning less than 5,000 Rs per month.

Highest household educational attainment of any person within the household showed statistically significant ORs at the highest levels of educational attainment when compared to those with primary education (referent group). Adolescents from households with at least one professional degree have 3.8 ([1.3, 11.6]) times the odds of being in a higher BMI category vs a lower BMI category as compared with adolescents from households that only have a primary education. The OR's comparing PUC, High School, and No Education to Primary Education were not statistically significant.

The comparison of private school vs. public school attendance was found to be statistically significant. Adolescents attending private school have 2.1 (1.5, 3.1) times the odds of being in a higher BMI category vs. a lower BMI category as compared to adolescents that attend public school.

Additionally the wealth possession index model showed a similar pattern as the rest of the socioeconomic status indicators in that as wealth increased so did the odds of being in a higher BMI category vs. a lower BMI category.

Adjusted Odds Ratios

Table 11 shows weighted ordinal multivariate logistic regression models for each of the 4 primary socioeconomic status indicators adjusting for the effects of gender, religion, caste, age, and the ward location that study participants live in. Models for each socioeconomic status indicator were run separately.

Table 11 shows that the household income, school type, and wealth remained statistically significant predictors of adolescent BMI categories after controlling for the

effects of age, gender, caste, religion, and ward location. The ordinal odds-ratios for household educational achievement was no longer statistically significant indicating that it is not an independent predictor of adolescent BMI when adjusting for the effects of age, gender, caste, religion, ward location. The adjusted models showed that there was a positive dose-dependent relationship between household income, possession wealth, and private school attendance and adolescent BMI categories. School-going adolescents from high wealth households have 4.6 (1.8, 11.8) times the odds of being in a high BMI category vs. low BMI category as compared to adolescents from low wealth households. Table 12 shows the results of an ordinal multivariate logistic regression model. The 4 socioeconomic status indicators were modeled together. The model also adjusted for the effects age, gender, caste, religion, and ward location. After controlling for the effects of the covariates and other socioeconomic status indicators household education, school type, and possession wealth were no longer statistically significant predictors of adolescent BMI. This may be indicative that the association of household education, school type, and wealth have been controlled for leaving total household income as the only socioeconomic status indicator with an association with adolescent BMI. Household income continues to show a positive does-dependent relationship between socioeconomic status and adolescent BMI after controlling for the effects of the covariates and other socioeconomic status indicators.

Collapsed Socioeconomic Status Indicators-Ordinal Multivariate Logistic Regression

Given the small sample size of the study each category was subject to wide confidence intervals and lack of precision. In order to achieve model parsimony the

exposure variables total household income and educational achievement were collapsed into binary variables and the possession wealth index was linearized.

Table 13 shows the unadjusted association of high vs. low socioeconomic status and adolescent BMI. Table 13 shows that the odds of being in a higher BMI category vs. a lower BMI category is higher among adolescents in a higher socioeconomic class when compared to adolescents in lower socioeconomic class. This association was found to be statistically significant for each socioeconomic status indicator.

Adolescents from households with a total income greater than 10,000 Rs per month have 3.5 (2.4, 5.2) times the odds of being in a higher BMI category vs a lower BMI category as compared to adolescents from Households earning less than 10,000 Rs per month. The linearized wealth index showed that the odds of being in a higher BMI category vs a lower BMI category increased by 23% for every unit increase in wealth.

Table 14 shows the association of high socioeconomic status vs. low socioeconomic status and adolescent BMI after adjusting for the effects of age, gender, religion, caste, and ward location. Table 14 shows the same pattern in that adolescents in higher socioeconomic status groups have a higher odds of being in a higher BMI category vs a lower BMI category than adolescents in low socioeconomic status groups. Adolescents in Bijapur who attended private school have 2.2 (1.4, 3.4) times the odds of being in a higher BMI category vs. a lower BMI category when compared to adolescents who attended public school.

Table 15 shows the association of high socioeconomic status vs. low socioeconomic status and adolescent BMI after adjusting for the effects of age, gender, caste, religion, ward location, and other socioeconomic status indicators. Once again

when the socioeconomic status indicators are controlled for the only socioeconomic status variable that remained an independently significant predictor of adolescent BMI was total household income. All other socioeconomic indicators (school type, household education, wealth) no longer had an association with adolescent BMI.

After adjusting for age, gender, caste, religion, ward location, and all other socioeconomic status indicators, the odds of being in a higher BMI category vs. a lower BMI category among adolescents from households earning more than 10,000 Rs per month is 3.3 (1.95, 5.6) times higher than adolescents from households earning less than 10,000 Rs per month.

CHAPTER IV: Discussion

The aim of the study was to assess the association and direction of different socioeconomic status indicators and BMI among school-going adolescents in a peri-urban environment in India (Bijapur, Karnatka, India). Our study used total household income, household education, material wealth, and private school vs. public school attendance as socioeconomic status proxies. Our study found that there was a positive dose-dependent relationship between all 4 socioeconomic status indicators and increasing adolescent BMI. This finding is consistent with findings in much of the literature regarding socioeconomic status and adolescent BMI in India (2, 5, 15-19, 21, 23).

Socioeconomic Status and Increasing Adolescent BMI

The prevalence of overweight and obesity among school-going adolescents in Bijapur was estimated to be 11.84% (using IOTF age-specific Asian adolescent BMI cut points) which is lower than what was found among a meta-analysis of adolescent BMI studies in India (16%) (This study however used the Centers for Disease Control and Prevention cut points: 85^{th} and 95^{th} percentile to determine adolescent overweight and obesity) (6). The burden of adolescent overweight and obesity in Bijapur lies mostly in high socioeconomic status households. Every socioeconomic indicator of our study (household income, household education, private school vs. public school attendance, and possession wealth) showed increasing prevalence of higher BMI categories as socioeconomic status increased. Mantel Haenszel chi-square tests for each socioeconomic status indicator was statistically significant ($p<0.05$) indicating differences in adolescent BMI across socioeconomic status categories.

Multivariate ordinal logistic regression showed that the odds of being in a higher BMI category vs. a lower BMI category increased as socioeconomic status increased. In

unadjusted models the increased odds of being in a higher BMI category vs. a lower BMI category occurred with every categorical increase in each socioeconomic status indicator.

A positive dose-dependent relationship between socioeconomic status and adolescent BMI was also found when socioeconomic status indicators were independently adjusted for the effects of age, gender, religion, caste, and ward location. The odds of being in a higher BMI category vs. a lower BMI category increased with every categorical increase in each socioeconomic indicator after adjusting for the selected covariates. However household education was not statistically significant after controlling for the effects of age, gender, religion, caste, and ward location indicating that it was no longer an independent predictor of adolescent BMI. The association of household education and adolescent BMI may be associated or explained by other variables in the model.

When all socioeconomic status indicators were added into a single ordinal logistic regression model and controlling for the effects of age, gender, religion, caste, and ward location, the only socioeconomic status indicator that remained statistically significant was total household income. Household education, private school vs. public school attendance, and possession wealth were no longer independent predictors of adolescent BMI possibly indicating that these indicators may be affected by other variables and societal factors.

Another reason may be because that the other socioeconomic status indicators may be related to household income or that household income is a better predictor of adolescent BMI than the other socioeconomic status indicators. Spearman's Correlation coefficients showed moderate correlation of household income to each of the other

socioeconomic status indicators (household education = 0.47, possession wealth = 0.61, school type = 0.53). This indicates that the multiple exposure model may not be the best predictor model for our study.

The conceptual framework (Figure 1) proposed that each of the socioeconomic status indicators were all connected on the pathway to obesity. Education (especially attendance at private schools) was portrayed as a potential gateway into gaining a higher income (12). Increased wealth was portrayed as result of higher income and greater access to resources (16). The relationship between these socioeconomic status indicators and the results of the study suggest that household income is a key factor in rising levels of overweight and obesity (11) especially in the context of increasing access to resources that increase food consumption and sedentary lifestyles (16, 18, 20-22).

While this study did not assess specific behaviors (diet or physical activity) it is possible that those in higher socioeconomic groups (especially higher-income groups) have higher access to resources that allow increased food consumption and increased sedentary activities. More research is needed to further understand the relationship between food consumption and sedentary activities with socioeconomic status in peri-urban areas.

Broader Societal Implications

The higher odds of being in a higher BMI category as socioeconomic status increases shows that Bijapur is undergoing similar changes that much larger urban areas are also experiencing. This study shows the same strength of association of socioeconomic status and obesity when compared to many studies that took place in much larger metropolitan cities (25).

Globalization, rapid urbanization, and increasing inequality may be changing the socioeconomic dynamics of India and could be causing both an increase and unequal access to food resources (22). There has been some evidence that levels of overweight and obesity in lower socioeconomic groups (especially in rural and peri-urban areas) are catching up to middle and high socioeconomic groups (24, 25). India is currently undergoing a nutrition transition (21) and it is not entirely clear where peri-urban areas like Bijapur currently are along that transition.

It is possible that peri-urban areas like Bijapur may continue to see an increase in the prevalence of higher levels of BMI, overweight, and obesity as socioeconomic status of the population increases. However, some recent literature indicates that higher levels of BMI, overweight, and obesity in rural areas and lower socioeconomic groups may be growing faster than urban areas and higher socioeconomic groups (24, 25). If the recent literature is correct then it is possible that peri-urban areas like Bijapur may see a rapid increase in higher levels of BMI among lower socioeconomic status groups and in time match levels of higher socioeconomic groups. This remains to be seen and more research and increased surveillance will be needed to further understand the changing dynamics of overweight and obesity especially in rural and peri-urban environments like Bijapur.

While the focus of this paper has been on higher BMI vs. lower BMI in terms of adolescent overweight and obesity in India, it should be noted that the adolescent population of Bijapur is largely underweight (45% are underweight when using the IOTF Extended International age-specific Asian adolescent BMI cut points). This is important as being underweight and undernourished has adverse health effects (acute malnutrition, wasting, stunting, and nutrition deficiencies) that may be more immediate than

overweight and obesity (chronic conditions, diabetes, heart disease, etc.) (1). In underweight groups increasing weight or BMI to a normal BMI category would be beneficial. The challenge however would be how to prevent normal weight adolescents from becoming overweight or obese while underweight adolescents are facilitated to normal weight.

Strengths

The study uses a stratified school-based sample to address the association of obesity in school going adolescents in India. The use of inverse probability sampling weights makes the sample representative of school-going adolescents in Bijapur ages 12-17 and grade 8-10. Additionally the study uses an ordered outcome in adolescent BMI categories (underweight, normal weight, and overweight/obese). Ordering the outcome (rather than overweight/obese vs. not overweight/obese) gives a better understanding of the risk of being in higher adolescent BMI categories vs. lower BMI categories along the socioeconomic status continuum and is effective in showing different levels of underweight, normal weight, and overweight or obese.

While other studies have examined the association of socioeconomic status and increasing BMI, most of those studies take place in larger metropolitan cities while this study focuses on a smaller peri-urban setting. Our study also contributes to the growing literature of adolescent BMI in more rural and less urban areas. Additionally this study makes use of several different socioeconomic indicators taking into account different aspects of a family/household in gaining access to resources that may increase risk of overweight or obesity.

Limitations

While this study adds to the growing literature of socioeconomic status and adolescent BMI there are several limitations. The survey that was administered for this study was not primarily designed to measure socioeconomic status as the strength of the survey was designed to measure family aspects and household behaviors in regards to overweight and obesity. The survey was still effective in classifying socioeconomic status using several different indicators.

While the study did use a wealth index, the index has not been validated but the findings using the wealth index have been consistent with the findings that increasing socioeconomic status increases risk of higher adolescent BMI. Additionally the study uses the IOTF Extended International age-specific Asian adolescent BMI cut points that may classify adolescent BMI differently from other competing measures (i.e. WHO BMI z-scores) and possibly makes direct comparisons to other studies using different classifications less straight forward.

Future Directions

To further address the issue of socioeconomic status and adolescent BMI it would be beneficial for studies in a peri-urban setting to assess the direct association of socioeconomic status and food consumption and sedentary activities. While it is seen that socioeconomic status is associated with adolescent obesity, further understanding the association of socioeconomic status and food consumption and sedentary activities in peri-urban areas like Bijapur would help provide more context to the hypothesized causal pathways. Currently there are several studies being produced that address these issues using the Bijapur dataset.

Currently data have been collected on food vendors in Bijapur and future studies will be produced in order to better understand the spatial association of adolescent BMI with access to food resources. Furthermore this was a cross-sectional study and a cohort study would be more effective to better understand the direction of BMI patterns over time in peri-urban areas like Bijapur. Following the same group of adolescents through a period of several years will help further add context to changing socioeconomic factors, family factors, environmental factors, as well as overweight and obesity.

The results will be presented to BLDE University, to the schools that participated in the study, as well as Bijapur city policy makers. The results of this research may be used to inform the development of more specific nutrition and exercise programs that target school-going adolescents that are at higher risk of being in a higher BMI category vs. a lower BMI category. This research highlights that there is increased risk of school-going adolescents being in a higher BMI category vs. a lower BMI category as socioeconomic status increases. The research also highlights that prevalence of underweight is high among school going adolescents in Bijapur (45%) and that the socioeconomic status continuum plays a role in the prevalence of different BMI levels across the socioeconomic strata. Programs will also be needed to address the high levels of adolescent underweight and more research on this issue will be beneficial in addressing rising levels of overweight and obesity in areas with high prevalence of underweight adolescents.

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Appendix

Bijapur Health and Transition Project

Data Use Agreement

Principal Investigators: Dr. Shailaja S. Patil and Dr. Solveig A. Cunningham

This is a project partially funded by the National Institutes of Health to examine adolescent health in the context of the home and social environment and globalization. The main survey and all auxiliary data collected in conjunction are part of the project and are guided by the following requirements:

__ Users must apply for and receive appropriate Human Subjects approval

__ Research topics must first be approved by Drs. Patil and Cunningham.

__All instruments and research proposals must be submitted to Drs. Patil and Cunningham for review and comment.

__ Drs. Patil and Cunnigham will collaborate as co-authors on all publications resulting from the use of the data

__ Authorship will be based on substantial contribution to the manuscript. Each collaborator will be first author on papers for which they developed the concept. Authors will discuss authorship order when they begin each paper and will discuss again before the paper is submitted to a journal and at the revise-and-resubmit stage to re-assess this order if needed.

__Users may not share the data with other researchers –inquiries about details of the dataset and data use must be directed to Drs. Patil and Cunningham

__ The data will be used in a secure IT environment, specifically those designated by IT at Emory University or BLDE.

__ Users of the main survey must acknowledge the NICHD funding in publications and oral and poster presentations as follows: "The project described was supported by Award Number 3D43HD065249-03S1 from the Eunice Kennedy Shriver National Institute of Child Health & Human Development. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Eunice Kennedy Shriver National Institute of Child Health & Human Development."

Name and affiliation of researcher: Anh-Minh Alexander Tran – Emory University Rollins School of Public Health

Project type, if applicable (eg. thesis, dissertation, rotation, practicum): Practicum, Thesis

Proposed paper title: Association of socioeconomic status and overweight and obesity

Signature of researcher:

Signature of PIs:

Institutional Review Board

December 20, 2011

Solveig Argeseanu, PhD
Rollins School of Public Health
1518 Clifton Road
Atlanta, GA 30322

RE: Determination: No IRB Review Required
IRB00053570 – ***Home environment and school going adolescents' weight status in rural India***
PI: Solveig Argeseanu

Dear Dr. Argeseanu:

Thank you for requesting a determination from our office about the above-referenced project. Based on our review of the materials you provided, we have determined that it does not require IRB review because it does not meet the definition of research involving "human subjects" as set forth in Emory policies and procedures and federal rules, if applicable. Specifically, in this project, you will be advising an Indian investigator (Shailaja Patil) in the development of a data collection project for the purpose of understanding the effects of secular changes in the home environment on food, activity, and weight in Bijapur, Karnataka, India. Additionally, your team will obtain pilot data from the investigator for the purpose of preliminary data analysis. Ms. Patil and her team will de-identify all data before sharing it with your team. With the data set you access, you will be unable to determine any individuals' identities. Accordingly, IRB review is not required.

45 CFR Section 46.102(f) defines "human subject" as follows:

> Human subject means a living individual about whom an investigator (whether professional or student) conducting research obtains (1) data through intervention or interaction with the individual, or (2) identifiable private information.

This determination could be affected by substantive changes in the study design, subject populations, or identifiability of data. If the project changes in any substantive way, please contact our office for clarification.

Thank you for consulting the IRB.

Sincerely,

Tom Penna, MTS
IRB Analyst Assistant
This letter has been digitally signed

Tables

Table 1. Unweighted Characteristics of Participants' Socioeconomic Status Indicators and Demographics

Exposure Variable Characteristics	n (%)	Confounding Variable Characteristics	n (%)
School Type		**Gender**	
Private	197 (49.5%)	Male	199 (50.0%)
Public	201 (50.5%)	Female	199 (50.0%)
Total Household Income		**Study Participant's Age**	
Less than 5000 Rs per month	56 (14.1%)	12	3 (0.8%)
5001-10,000 Rs per month	125 (31.4%)	13	44 (11.1%)
10,001 - 20,000 Rs per month	99 (24.9%)	14	154 (38.7%)
20,001 - 30,000 Rs per month	67 (16.8%)	15	132 (33.2%)
More than 30,001 Rs per month	51 (12.8%)	16	59 (14.8%)
		17	6 (1.5%)
Highest Household Education Achievement			
None	3 (0.8%)	**Religion**	
Primary	17 (4.3%)	Hindu	314 (78.9%)
High School	70 (17.6%)	Muslim	68 (17.1%)
PUC	76 (19.1%)	Christian	1 (0.3%)
Degree	190 (47.7%)	Jain	15 (3.8%)
Professional	42 (10.6%)		
		Caste	
		General	99 (24.9%)
Custom Wealth Possession Index		Other Backward Classes	219 (55.0%)
Low Wealth Possession	55 (13.8%)	Scheduled Caste	74 (18.6%)
Medium-Low Wealth Possession	73 (18.3%)	Scheduled Tribe	6 (1.5%)
Medium-High Wealth Possession	198 (49.8%)		
High Wealth Possession	72 (18.1%)		

Table 2. Weighted Characteristics of Participants' Socioeconomic Status Indicators and Demographics

Exposure Variable Characteristics	(%)	Confounding Variable Characteristics	(%)
School Type		**Gender**	
Private	27.5%	Male	53.4%
Public	72.5%	Female	46.7%
Total Household Income		**Study Participant's Age**	
Less than 5000 Rs per month	19.3%	12	0.7%
5001-10,000 Rs per month	36.9%	13	11.5%
10,001 - 20,000 Rs per month	22.7%	14	35.1%
20,001 - 30,000 Rs per month	13.6%	15	33.6%
More than 30,001 Rs per month	7.5%	16	17.3%
		17	1.9%
Highest Household Education Achievement			
None	1.1%	**Religion**	
Primary	6.1%	Hindu	74.3%
High School	23.3%	Muslim	23.2%
PUC	22.3%	Christian	0.4%
Degree	39.6%	Jain	2.1%
Professional	7.6%		
		Caste	
		General	18.7%
Custom Wealth Possession Index		Other Backward Classes	55.2%
Low Wealth Possession	19.7%	Scheduled Caste	24.1%
Medium-Low Wealth Possession	23.3%	Scheduled Tribe	1.9%
Medium-High Wealth Possession	45.9%		
High Wealth Possession	11.1%		

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

Table 3. Unweighted Characteristics of assets within the Wealth Possession Index

Wealth Possession Item	n (%)	Wealth Possession Item	n (%)
Toilet Facility Inside House		**Family owns a computer (Laptop or Desktop)**	
Yes	326 (81.9%)	Yes	98 (24.6%)
No	72 (18.1%)	No	300 (75.4%)
Separate Room for Cooking		**Family owns a TV**	
Yes	348 (87.4%)	Yes	359 (90.2%)
No	50 (12.6%)	No	39 (9.8%)
Family has domestic assistance		**Family has Satellite/Dish TV**	
Yes	100 (25.1%)	Yes	84 (21.1%)
No	298 (74.9%)	No	314 (78.9%)
Primary Cooking Fuel		**Building material of the home**	
Electricity	1 (0.3%)	Pucca	313 (78.6%)
Gas/LPG	313 (78.6%)	Semi-Pucca	64 (16.1%)
Wood	76 (19.1%)	Kaccha	21 (5.4%)
Kerosene	6 (1.5%)		

Table 4. Weighted Characteristics of assets within the Wealth Possession Index

Wealth Possession Item	(%)	Wealth Possession Item	(%)
Toilet Facility Inside House		**Family owns a computer (Laptop or Desktop)**	
Yes	74.7%	Yes	16.9%
No	25.4%	No	83.1%
Separate Room for Cooking		**Family owns a TV**	
Yes	82.7%	Yes	87.6%
No	17.3%	No	12.4%
Family has domestic assistance		**Family has Satellite/Dish TV**	
Yes	15.5%	Yes	17.2%
No	84.5%	No	82.8%
Primary Cooking Fuel		**Building material of the home**	
Electricity	0.2%	Pucca	71.3%
Gas/LPG	70.9%	Semi-Pucca	21.4%
Wood	26.8%	Kaccha	7.4%
Kerosene	2.2%		

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

Table 5. Distribution of Adolescent BMI Categories among Study Participants

Adolescent BMI Category	Unweighted n (%)	Weighted (%)
Underweight	165 (41.5%)	45.1%
Normal Weight	175 (44.0%)	43.1%
Overweight	43 (10.8%)	9.1%
Obese	15 (3.8%)	2.8%

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

Table 6. Mean BMI of Males and Females by Age

Age	Males		Females	
	Mean BMI	Std Dev	Mean BMI	Std Dev
12	15.4	2.6	16.4	N/A
13	16.3	2.6	17.8	3.2
14	18.0	3.5	18.5	3.2
15	17.5	2.7	18.9	3.6
16	19.7	3.6	18.6	3.2
17	22.2	5.1	19.9	3.5

Table 7. Distribution of Adolescent BMI Categories among Socioeconomic Status Indicators – Chi-Square and Mantel-Haenszel Chi-Square Tests

Exposure Variable	Underweight	Normal Weight	Overweight	Obese	Chi-Square Test (p-value)	M-H Chi Square
Total Household Income					p<0.0001	p<0.0001
Less than 5000 Rs per month	66.7%	31.5%	1.8%	0.0%		
5001-10,000 Rs per month	52.4%	41.0%	6.7%	0.0%		
10,001 - 20,000 Rs per month	32.3%	49.3%	11.4%	7.1%		
20,001 - 30,000 Rs per month	26.6%	50.4%	18.9%	4.1%		
More than 30,001 Rs per month	25.7%	51.4%	14.9%	8.0%		
Highest Household Education Achievement					p=0.1304	p<0.0001
None	68.1%	32.0%	0.0%	0.0%		
Primary	58.9%	35.0%	6.1%	0.0%		
High School	52.1%	44.9%	3.0%	0.0%		
PUC	49.6%	39.0%	9.8%	1.7%		
Degree	38.0%	44.9%	12.0%	5.2%		
Professional	32.6%	48.6%	14.2%	4.7%		
Custom Wealth Possession Index					p<0.0001	p<0.0001
Low Wealth Possession (0-3)	54.8%	43.4%	1.8%	0.0%		
Medium-Low Wealth Possession (4-5)	50.4%	46.6%	3.0%	0.0%		
Medium-High Wealth Possession (6-7)	43.3%	39.7%	12.8%	4.2%		
High Wealth Possession (8-9)	23.7%	49.2%	19.6%	7.5%		
School Type					p=0.0009	p<0.0001
Private	33.2%	45.9%	14.8%	6.1%		
Public	49.5%	42.1%	6.9%	1.5%		

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

*PUC – Pre-University Course

Table 8. Population Demographics and Adolescent BMI Categories –Chi-Square and MH Chi-Square

Covariate	Underweight	Normal Weight	Overweight	Obese	Chi-Square Test (p-value)	M-H Chi Square
Gender					p=0.0972	p=0.1087
Male	50.5%	38.3%	8.0%	3.2%		
Female	38.8%	48.6%	10.3%	2.3%		
Study Participant's Age					p=0.0167	p=0.1527
12	57.1%	42.9%	0.0%	0.0%		
13	47.2%	42.5%	6.2%	4.1%		
14	43.0%	45.9%	6.8%	4.4%		
15	49.8%	40.2%	8.9%	1.2%		
16	39.1%	47.7%	11.1%	2.2%		
17	37.3%	6.1%	56.6%	0.0%		
Religion					p=0.754	p=0.5226
Hindu	44.3%	44.3%	9.4%	2.1%		
Muslim	48.4%	39.4%	7.7%	4.5%		
Christian	100.0%	0.0%	0.0%	0.0%		
Jain	26.4%	50.8%	15.2%	7.6%		
Caste					p=0.4915	p=0.5985
General	49.2%	38.8%	9.3%	2.8%		
Other Backward Classes	43.9%	46.2%	6.7%	3.2%		
Scheduled Caste	44.5%	38.4%	15.1%	2.0%		
Scheduled Tribe	45.7%	54.3%	0.0%	0.0%		

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

Table 9. Household Possessions and Adolescent BMI Categories – Chi-Square and MH Chi-Square

Exposure Variable	Underweight	Normal Weight	Overweight	Obese	Chi-Square Test (p-value)	M-H Chi Square
Toilet Facility Inside House					p=0.0020	p=0.0001
Yes	41.2%	43.5%	11.7%	3.7%		
No	56.6%	42.1%	1.4%	0.0%		
Separate Room for Cooking					p=0.0607	p=0.0451
Yes	44.8%	41.3%	10.6%	3.4%		
No	46.2%	51.8%)	2.0%	0.0%		
Primary Cooking Fuel					p=0.0416	p=0.0013
Electricity	0.0%	100.0%	0.0%	0.0%		
Gas/LPG	29.5%	42.7%	11.8%	3.9%		
Wood	55.4%	43.3%	1.3%	0.0%		
Kerosene	34.4%	49.5%	16.1%	0.0%		
Family has domestic assistance					0.0003	p<0.0001
Yes	20.5%	57.6%	15.4%	6.4%		
No	49.6%	40.4%	7.9%	2.1%		
Family owns a computer (Laptop or Desktop)					p=0.0020	p=0.0002
Yes	34.3%	44.4%	13.5%	7.8%		
No	47.3%	42.8%	8.2%	1.7%		
Building material of the home					p=0.0249	p=0.0003
Pucca	41.6%	43.3%	11.3%	3.9%		
Semi-Pucca	51.1%	44.0%	4.9%	0.0%		
Kaccha	61.4%	38.6%	0.0%	0.0%		
Family owns a TV					p=0.1141	p=0.00188
Yes	43.9%	42.8%	10.2%	3.2%		
No	6.7%	5.6%	1.0%	0.0%		
Family has Satellite/Dish TV					p=0.0218	p=0.0066
Yes	45.4%	32.9%	15.6%	6.1%		
No	45.0%	45.2%	7.7%	2.1%		

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

Table 10. Unadjusted Multivariate Ordinal Logistic Regression of Socioeconomic Status Indicators and Adolescent BMI

Exposure Variable	OR	95% CI	P-Value
Household Income			
Less than 5,000 Rs per Month	(Ref)	(Ref)	(Ref)
5,001 – 10,000 Rs per Month	1.84	(0.97, 3.50)	p=0.0631
10,001 – 20,000 Rs per Month	4.47	(2.30. 8.70)	p<0.0001
20,001 – 30,000 Rs per Month	5.41	(2.63, 11.13)	p<0.0001
More than 30,000 Rs per Month	6.75	(3.15, 14.45)	p<0.0001
Highest Household Education Achievement			
None	0.68	(0.05, 8.52)	p=0.7632
Primary	(Ref)	(Ref)	(Ref)
High School	1.17	(0.41, 3.33)	p=0.7648
PUC	1.69	(0.60, 4.77)	p=0.3214
Degree	2.73	(1.02, 7.30)	p=0.0449
Professional	3.82	(1.25, 11.62)	p=0.0183
School Type			
Public	(Ref)	(Ref)	(Ref)
Private	2.21	(1.44, 3.38)	p=0.0001
Custom Wealth Possession Index			
Low Wealth (0-3)	(Ref)	(Ref)	(Ref)
Medium-Low Wealth (4-5)	1.10	(0.57, 2.15)	p=0.7728
Medium-High Wealth (6-7)	2.14	(1.20, 3.81)	p=0.010
High Wealth (8-9)	4.55	(2.31, 8.98)	p<0.0001

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

*The above models are unadjusted ordinal logistic regression models

*PUC – Pre-University Course

Table 11. Adjusted Multivariate Ordinal Logistic Regression Models - Association of Socioeconomic Status Indicators and Adolescent BMI

Exposure Variable	OR	95% CI	p-value
Household Income			
Less than 5,000 Rs per Month	(Referent)	(Referent)	(Referent)
5,001 - 10,000 Rs per Month	1.66	(0.89, 3.09)	p=0.1128
10,001 - 20,000 Rs per Month	4.18	(2.07, 8.45)	p<0.0001
20,001 - 30,000 Rs per Month	7.30	(3.12, 15.88)	p<0.0001
More than 30,000 Rs per Month	7.82	(2.66, 22.91)	p=0.0002
Highest Household Education Achievement			
None	0.86	(0.097, 7.69)	p=0.8940
Primary	(Referent)	(Referent)	(Referent)
High School	0.99	(0.37, 2.63)	p=0.9784
PUC	1.26	(0.47, 3.37)	p=0.6504
Degree	2.17	(0.83, 5.71)	p=0.1165
Professional	2.53	(0.80, 8.38)	p=0.1114
School Type			
Public School	(Referent)	(Referent)	
Private School	2.50	(1.02, 6.14)	p=0.0449
Custom Possession Wealth Index			
Low Wealth	(Referent)	(Referent)	
medium-low wealth	1.16	(0.60, 2.25)	p=0.6699
medium-high wealth	1.91	(1.02, 3.57)	p=0.0418
high wealth	4.60	(1.80, 11.75)	p=0.0014

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10

*The above models were adjusted for age, gender, caste, religion, ward location

*PUC = Pre-University Course

Table 12. All Exposure Combined Adjusted Multivariate Ordinal Logistic Regression model - Association of Socioeconomic Status Indicators and Adolescent BMI

Exposure Variable	OR	95% CI	P-Value
Household Income			
Less than 5,000 Rs per Month	(Referent)	(Referent)	
5,001 - 10,000 Rs per Month	1.71	(0.90, 3.22)	p=0.1004
10,001 - 20,000 Rs per Month	4.05	(1.91, 8.60)	p=0.0003
20,001 - 30,000 Rs per Month	7.00	(2.87, 17.07)	p<0.0001
More than 30,000 Rs per Month	7.27	(2.23, 23.73)	p=0.001
Highest Household Education Achievement			
None	1.13	(0.12, 10.39)	0.9306
Primary	(Referent)	(Referent)	
High School	0.75	(0.28, 2.07)	p=0.5846
PUC	0.80	(0.28, 2.25)	p=0.6706
Degree	1.26	(0.45, 3.56)	p=0.6574
Professional	1.06	(0.30, 3.77)	p=0.9306
School Type			
Public School	(Referent)	(Referent)	
Private School	0.92	(0.33, 2.58)	p=0.8782
Custom Possession Wealth Index			
Low Wealth	(Referent)	(Referent)	
medium-low wealth	0.83	(0.41, 1.68)	p=0.6088
medium-high wealth	0.90	(0.43, 1.86)	p=0.7664
high wealth	1.34	(0.45, 4.00)	p=0.6022

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10
*The above models were adjusted for age, gender, caste, religion, ward location, and other socioeconomic status indicators
*PUC = Pre-University Course

Table 13. Unadjusted Ordinal Odds-Ratios - Association of High SES vs. Low SES Indicators and Adolescent BMI

Exposure Variable	OR	95% CI	p-value
Household Income			
Less than 10,000 Rs per Month	(Referent)	(Referent)	(Referent)
More than 10,000 Rs per Month	3.52	(2.36, 5.24)	p<0.0001
Highest Household Education Achievement			
None, Primary, High School	(Referent)	(Referent)	(Referent)
PUC, Degree, Professional	2.02	(1.38, 2.95)	p=0.0003
School Type			
Public School	(Referent)	(Referent)	(Referent)
Private School	2.21	(1.44, 3.38)	p=0.0003
Custom Possession Wealth Index			
Linearized Possession wealth Index	1.23	(1.11, 1.35)	p<0.0001

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10
*The above models were unadjusted ordinal logistic regression models
*PUC = Pre-University Course

Table 14. Adjusted Multivariate Ordinal Logistic Regression – Association of High SES vs Low SES Indicators and Adolescent BMI

Exposure Variable	OR	95% CI	p-value	
Household Income				*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10
Less than 10,000 Rs per Month	(Referent)	(Referent)		
More than 10,000 Rs per Month	3.67	(2.30, 5.87)	p<0.0001	
Highest Household Education Achievement				
None, Primary, High School	(Referent)	(Referent)		
PUC, Degree, Professional	1.91	(1.22, 3.00)	p=0.0050	
School Type				
Public School	(Referent)	(Referent)		
Private School	2.43	(1.13, 5.22)	p=0.0237	
Custom Possession Wealth Index				
Linearized Possession wealth Index	1.30	(1.14,1.48)	p<0.0001	

*The above models were adjusted for age, gender, caste, religion, ward location
*Pre-University Course

Table 15. All Exposure Combined Adjusted Multivariate Logistic Regression - Association of High SES vs Low SES Indicators and Adolescent BMI

Exposure Variable	OR	95% CI	p-value
Household Income			
Less than 10,000 Rs per Month	(Referent)	(Referent)	
More than 10,000 Rs per Month	3.30	(1.95, 5.60)	p<0.0001
Highest Household Education Achievement			
None, Primary, High School	(Referent)	(Referent)	
PUC, Degree, Professional	0.75	(0.28, 2.07)	p<0.1366
School Type			
Public School	(Referent)	(Referent)	
Private School	0.92	(0.33, 2.58)	p<0.7957
Custom Possession Wealth Index			
Linearized Possession wealth Index	1.02	(0.88, 1.18)	p=0.9535

*Weighted data were representative of school-going adolescents in Bijapur ages 12-17 and grades 8-10
*The above models were adjusted for age, gender, caste, religion, ward location, and other socioeconomic status indicators
*Pre-University Course