SALLI E. CHISM
The Prevalence of Overweight and Obesity in Trinidadian Adolescents.
(Under Direction of RICHARD D. LEWIS)

The prevalences of overweight and obesity among male (n=126) and female (n=170) adolescents, ages 12-18, in urban and rural areas of Trinidad was determined. Demographics, height, weight, skinfolds, dietary intake, physical activity, and sexual maturity were assessed. The overall prevalence of overweight and obesity among Trinidadian adolescents was 13.2% and 4.4%, respectively. African females had the highest rates of overweight (18.8%) and obesity (15.6%). Urban African (70.2 ± 32.7) and mixed (66.7 ± 24.0) girls had higher skinfolds than rural African (49.1 ± 16.5) and mixed (45.0 ± 12.4) girls ($p<0.05$). In boys, inactivity correlated with BMI ($r = 0.309$; $p<0.01$) and skinfolds ($r = 0.222$; $p<0.05$), while in girls, skinfolds were inversely correlated with accelerometer counts/minute ($r = -0.389$; $p<0.05$). Overweight and obesity rates indicate a public health concern, particularly for African females.

INDEX WORDS: Trinidad, Adolescent, Overweight, Obesity, Dietary intake, Physical activity

THE PREVALENCE OF OVERWEIGHT AND OBESITY IN TRINIDADIAN ADOLESCENTS

by

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THE PREVALENCE OF OVERWEIGHT AND OBESITY IN TRINIDADIAN

ADOLESCENTS

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DEDICATION

This thesis is dedicated to Bernadine Cowie and her family, Carlos, Lance, Chris Beth, Joelle, and Jessi. Bernadine is a wonderful nutrition instructor, graduate student, wife, mother, and friend. She and her family live life honestly and fully. They welcomed me with hugs, smiles, laughter, and even songs. And they continue to remind me what joy, love, and friendship are all about—in Trinidad or anywhere.

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Thank you all.

TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Purpose

The prevalence of obesity in the U.S. has escalated at an alarming rate in recent years, and as a result, experts now consider it a serious public health epidemic (1). Approximately 61% of American adults age 20 and older are overweight (body mass index, BMI >25) or obese (BMI>30). In early 2001, 22.4% of American adults were reported to be obese (2). Many serious health risks are associated with obesity including heart disease, cancer, stroke, and Type 2 diabetes mellitus (1, 3). Obesity is also economically expensive, costing billions of dollars each year. It is estimated that 7% of total U.S. health care costs are directly linked to obesity, and additional money is lost due to indirect costs, such as sick leave or disability pensions associated with obesity and related disorders (4).

The problem is not limited to adulthood; more and more children are suffering from obesity. Between 1963-1965 and 1988-1994, childhood and adolescent obesity in the U.S. nearly doubled. NHANES III data showed that 30.9% and 29.4% of 12-14 year old girls and boys, respectively, were overweight; and 23.0% and 23.2% of 15-17 year old girls and boys, respectively, were overweight (5). Not only does childhood obesity often lead to adult obesity but it has been associated with chronic disease during adulthood independent of adult BMI (6-9). Moreover, obesity can result in childhood health problems including hyperlipidemia, glucose intolerance, hypertension, sleep apnea, orthopedic complications, and psychological and social problems (7). Because treatment of childhood obesity is more successful than adult obesity treatment, public health interventions should focus on the childhood and adolescent years (9).

Many hypotheses have been developed to try to explain the recent surge in obesity among the U.S. population. While genetic factors do play an important role in obesity development, it is unlikely that a change in the gene pool has caused the recent obesity surge (10). It is more probable that lifestyle factors, such as a decrease in physical activity along with the consumption of excess calories, has had a major influence on escalating BMI's (11).

It has been hypothesized that these lifestyle behaviors characteristic of the U.S. and other developed countries are passed to less developed countries, leading to more obesity. Popkin suggests that developing countries throughout the world are experiencing nutrition transitions, characterized by a decrease in undernutrition and an increase in obesity (12, 13). In Columbia, Chile, Mexico, Costa Rica, Ghana, and Zimbabwe 45%, 42%, 36%, 32%, 18% and 8% of adults, respectively, have been reported to be overweight (14, 15). In Sao Paulo, Brazil, 21.9% of adults were overweight and 14.6% were obese; 21% and 8.8% of adolescent females and males, respectively, were reported to be obese (16).

The prevalence rates vary depending on ethnicity (2, 17), location (17, 18), and socioeconomic status (18, 19). For example, racial differences sometimes result in inherent differences of nutritional status. African Americans have higher prevalences of obesity than European Americans (20). Blacks in South Africa are two times more likely to be obese than whites in South Africa (17). Studies conducted in developing countries show higher prevalences of obesity in urban areas than in rural areas (12, 18). In Morocco, 14.6% of urban women and 10.3% of rural women were reported obese; while in Tunisia, 28.3% of urban women and 12.3% of rural women were obese. Though no longitudinal data exist to clearly demonstrate the reason for this urban/rural difference, it has been suggested that as a nation industrializes and develops, urban areas advance before rural areas, and thus experience dietary and physical activity shifts earlier (17). In several developing countries, obesity rates are higher among higher socioeconomic status groups (12, 18).

As fats and refined sugars become cheaper and more available to developing societies, traditional diets that are rich in complex carbohydrates are being replaced with diets high in fats and sugars (13). For example, in China between 1978 and 1987, mean energy intake increased from approximately 2200 kcals/day to 2800 kcals/day. A significant increase was seen in the consumption of meat, edible oils, sugar, eggs, and fish resulting in a shift from a diet with a mean fat intake of 14% to a diet of 19% fat (19). In Brazil between 1962 and 1988, there was a decrease in relative percentage of food consumed for grains, pasta, roots and tubers, and fruit. Margarine and oil consumption, on the other hand, went from a relative percentage of 8.1% to 16% of the average dietary intake over the 26-year period (21).

A decrease in physical activity is likely to occur when developing countries Westernize, and televisions, computers, and automobiles become more common while physical labor becomes less of a necessity (22). When one group of Guatamalan, male agricultural workers joined the army, they gained an average of 6.4 kg, mainly as fat mass, after 16 months. The men reported that after basic training, their physical activity in the army was substantially less than what their agricultural work required. It has been suggested that as physical activity decreases as a result of technological advances it is not completely replaced with vigorous exercise in developing countries (22). In San Miguelito, Panama, 50% of men and 72% of women reported doing very little or no regular exercise (22).

Trinidad and Tobago is an example of a developing country that may be experiencing a nutrition transition. Trinidad and Tobago is a two-island nation located in the Caribbean, just off the coast of Venezuela. The World Bank considers it an upper-middle income nation with a Gross National Product per capita between U.S. $2,996-9,265 (23). Of the 1.26 million people, 40% are of African descent, 40% are of East Indian descent, and 18% are mixed (24).

Observation and anecdotal evidence, along with limited research, suggests that obesity could be developing into a major public health concern in Trinidad (25). Chronic disease is on the rise, accounting for only 40% of deaths in Trinidad and Tobago in 1963 and up to 60% by 1986. A study conducted in 1979-1981 estimated that about 30% of women in Trinidad were obese (26). A recent study by the Ministry of Health examined school children ages 5-6 and 8-9 and showed that 8.5% of the children were overweight and 2.4% where obese (27). African children were taller and had slightly higher BMI's (27).

According to natives, Trinidad looks more westernized than it did a decade ago. When visiting, one notices that the streets are crowded with cars, American fast food restaurants are becoming Trini favorites, and cable television is commonly watched.

These changes have the potential to result in increased energy intakes and decreased physical activity, both of which may contribute to obesity (13, 22).

To date there are no published data on the prevalence of obesity in adolescents in Trinidad. Furthermore, dietary and physical activity variables that could contribute to obesity have not been assessed in Trinidadian adolescents. Therefore, this project was developed to evaluate the prevalence of obesity among Trinidadian adolescents particularly in different genders, ethnic groups, and urban versus rural areas. In addition, this project was designed to examine the potential roles of diet and physical activity on obesity and to test the feasibility of using specific dietary and physical activity data collection methods in this population.

Hypotheses

1. The prevalence of adolescent obesity is highest among African Trinidadian adolescents.
2. The prevalence of adolescent obesity is higher in urban areas than in rural areas of Trinidad.
3. BMI is positively correlated with total energy intake, total fat intake, and inactivity levels, but negatively correlated with physical activity levels in Trinidadian adolescents.
4. The prevalence of adolescent undernutrition is higher in rural areas than in urban areas of Trinidad.

Goals and Objectives

The overall goal of this investigation was to determine the prevalence of overweight and obesity among Trinidadian adolescents as a whole and stratified by ethnicity and school location. Secondary objectives included: 1) assess energy and macronutrient intakes using three-day diet records; 2) assess physical activity levels and activity counts by questionnaires and CSA accelerometers, respectively, and 3) determine the feasibility of using various methods in Trinidadian secondary schools, including diet diaries, physical activity questionnaires, and CSA accelerometers.

CHAPTER 2

LITERATURE REVIEW

This review explores the various aspects of the nutrition transition that is occurring throughout the world. In addition, it contains a discussion on the assessment of underweight, overweight, and obesity, focusing on assessment among adolescents, and an explanation of normal adolescent development. The current nutrition situation in Trinidad is reviewed using what little data exists on this matter. Finally, dietary intake and physical activity are discussed with a description of assessment methods.

Nutrition Transition

A nutrition transition is occurring in developing countries throughout the world. Traditional diets, rich in whole grains, are being replaced with diets high in fat and refined sugars (28). This transition is characterized by a decrease in infectious diseases and undernutrition along with an increase in chronic disease and a notable prevalence of obesity (17). Undernutrition and deficiency diseases have not been eradicated, but instead they have been joined by chronic diseases associated with overnutrition (12, 17).

Undernutrition. Undernutrition occurs in virtually all nations, but Asia, Africa, and Latin America suffer from the highest prevalences of childhood undernutrition (29). Of the approximate 12.2 million deaths per year among children under the age of five, the World Health Organization (WHO) estimates that 6.6 million are associated with malnutrition (30). In addition, malnutrition affects growth and causes both stunting (low height for age) and wasting (low weight for age) in millions of children worldwide (31). Poverty is the major cause for malnutrition (30).

Obesity. Obesity, on the other hand, was once considered a disease of developed countries. This thought is somewhat justified since obesity is actually epidemic in many industrialized countries. In the United States, approximately 61% of adults age 20 and older are overweight (body mass index, BMI >25) or obese (BMI>30). In 2001, 22.4% of American adults were reported to be obese (2). Certain subpopulations have an even higher prevalence. Forty percent of African American women, for instance, were reported to be obese in the mid-nineties (20). Many related chronic diseases and health risks are associated with obesity including heart disease, cancer, stroke, Type II diabetes mellitus, and gallbladder disease (1). Obesity is also economically expensive. It is estimated that 7% of total U.S. health care costs are directly linked to obesity, and additional money is lost due to indirect costs, such as sick leave or disability pensions, associated with obesity (4, 32). The condition results in billions of dollars of expenditure each year. One study showed increased annual medical costs of 8% for individuals with "high risk" body mass indexes, or BMI >27.8 for men and >27.3 for women (33).

Childhood obesity. Childhood and adolescent obesity are of particular concern. Between 1963-1965 and 1988-1994, childhood and adolescent obesity more than doubled in U.S. boys and girls (34). Using BMI > 95th percentile to define overweight, 13% of children in the U.S. ages 6-11 are considered overweight and 14% of children ages 12-19 are overweight; this is up from 11% in both 6-11 year olds and 12-19 year olds in 1988-94 (35). Moreover, NHANES III data showed that when using BMI >85th percentile to define overweight, 30.9% and 29.4% of 12-14 year old girls and boys, respectively, were categorized as overweight, and 23.0% and 23.2% of 15-17 year old girls and boys, respectively, were overweight (5).

Complications of childhood obesity are numerous and include hyperlipidemia, glucose intolerance, hypertension, sleep apnea, orthopedic complications, and psychological and social problems (7). Research has demonstrated that adolescent obesity, independent of adult BMI, actually increases the risks of adult chronic disease (Must et al., 1992). Furthermore, childhood and adolescent obesity are strong predictors of adult obesity and its associated health risks (7-9). One promising aspect is that the treatment efforts to reduce obesity in children are more successful than treatment efforts in adults (9). This suggests that public health efforts concerning obesity should focus on prevention and treatment during the childhood years.

Nutrition transition in developing countries. Under- and overnutrition, and the associated diseases, were once believed to occur in distinct, separate areas and populations, but they now coexist in developing countries (12, 36). This phonomenon has been termed a "nutrition transition" (12). One such example is the nutrition situation found in Brazil, a country that traditionally battled malnutrition. Researchers documented both childhood obesity (6.4% of boys and 8.7% of girls) and malnutrition (30% of children) in a shantytown population of Sao Paulo, Brazil (16). Not only was obesity and malnutrition found co-existing among individuals living in the same area, but even among individuals living in the same household (16). In Peru, between the years 1992 and 1996, obesity defined as BMI ≥ 30 increased form 8.8% to 9.4% (12). In the Dominican Republic, obesity in women increased form 7.3% in 1991 to 12.1% in 1996 (14).

Table 2.1 shows documented prevalences of obesity in various underdeveloped and developing areas. While this table is not all-inclusive, it does present a good picture of what is happening throughout the world. It is important to note that most nutrition related research in developing areas have looked at pre-school children or adults, especially women of childbearing years (14). Future studies should give more attention to school-age children.

Racial differences could result in inherent differences in body size. Africans have higher rates of obesity in various cultures around the world. In the U.S., for example, 35.8% of African American women are obese, while 19.3% of non-Hispanic white women are obese; and blacks in South Africa are two times more likely to be obese than whites in South Africa (2, 17). Some races may be genetically shorter than others. For instance, well-nourished boys living in Calcutta, India appear to be shorter than European reference populations.

It has been suggested that obesity is more prevalent in urban than in rural areas in developing countries (12, 18). Urban women in Morocco were more obese than rural women (14.6% vs 10.3%). Similarly in Tunisia 28.3% of urban women and 12.3% of rural women were obese (37). Martorell et al. showed that among women in Latin America and the Caribbean, obesity rates tended to be higher in urban areas (14). While no longitudinal data exists to clearly demonstrate the reason for this urban/rural difference, it has been suggested that as a nation industrializes and develops, urban areas advance before rural areas and thus experience dietary and physical activity shifts earlier (17, 22).

In the U.S. and other developed countries, populations of lower socioeconomic status tend to exhibit higher rates of obesity, but this does not hold true in developing countries (38). In Brazil, prevalences of overweight and obesity increased with income in men, where approximately 35% of the men from the highest income bracket and 12% of the men from the lowest income bracket were overweight (18). The China Health and Nutrition Surveys in 1989 and 1991 looked at men and women from low, middle, and high income brackets (19). Underweight was defined as BMI < 18.5 and overweight was defined as BMI > 25. A decrease in underweight was seen in the middle and high income bracket, but an increase in underweight was seen in the low-income bracket. There was an increase in obesity in all groups except low-income women. Percentage of overweight adults went from 5.4% to 4.3% in the low-income bracket, 6.6 to 9.3 in the middle-income bracken, and 6.5% to 8.9% in the high-income bracket (19). In some Latin American countries childhood overweight increased with higher maternal education, but in some countries obesity in women decreased with education (14).

Early stunting and later obesity. One interesting and unfortunate twist is that undernutrition and stunting earlier in life seem to be associated with obesity and chronic disease later (16-18, 39). Children in developing countries often do not receive adequate nutrition early in life and suffer from stunting, which predisposes them to obesity (40). While the cause of this predisposition is not clear, it is suggested that the early undernutrition that causes stunting also causes long-term changes in insulin and growth hormone (41). Then, as these children grow older, they have access to more westernized, high fat foods, and/or they become less physically active (17). This effect seems to be greatest when stunted individuals from developing countries actually immigrate to the U.S. or other developed nations (17).

TABLE 2.1

Prevalence of obesity and overweight in underdeveloped or developing nations and areas

Country or Area	Specific population	Assessment standards used	% over-weight	% obese	Reference
Brazil	female adolescents (>10-18) in Sao Paulo	Modified NCHS charts - wt. for ht.	21		Sawaya et al., 1995 (16)
Brazil	male adolescents (>10-18) in Sao Paulo	Modified NCHS charts - wt. for ht.	8.8		Sawaya et al., 1995 (16)
Brazil	adults in Sao Paulo	overwt: BMI >25-27.5 obese: BMI >27.5	21.9	14.6	Sawaya et al., 1995 (16)
Bolivia	pre-school children	overwt: Z-score>1 SD above WHO/NCHS mean wt. for ht. obese: Z-score> 2 SD	13.1	2.1	Martorell et al., 1998 (14)
Bolivia	adult women	overwt: BMI >27.3 obese:BMI>30	16.8	7.6	Martorell et al., 1998 (14)
Chile	adults	BMI≥25	42		deOnis and Habicht, 1996 (15)
China	adults	BMI≥30		7.2	WHO, 1996 (20)

Country or Area	**Specific population**	**Assessment standards used**	**% over-weight**	**% obese**	**Reference**
Columbia	pre-school children	overwt: Z-score>1 SD above WHO/NCHS mean wt. for ht. obese: Z-score> 2 SD	21.6	9.2	Martorell et al., 1998 (14)
Columbia	adults	BMI≥25	45		deOnis and Habicht, 1996 (15)
Costa Rica	adults	BMI≥25	32		deOnis and Habicht, 1996 (15)
Cuba	adults	BMI≥30		26.9	WHO, 1996 (20)
Dominican Republic	pre-school children	overwt: Z-score>1 SD above WHO/NCHS mean wt. for ht. obese: Z-score> 2 SD	23.3	12.1	Martorell et al., 1998 (14)
Dominican Republic	adult women	overwt: BMI >27.3 obese:BMI>30	15.3	4.6	Martorell et al., 1998 (14)
Ghana	adults	BMI≥25	18		deOnis and Habicht, 1996 (20)
Haiti	adults	BMI≥25	5		deOnis and Habicht, 1996 (20)

Country or Area	Specific population	Assessment standards used	% over-weight	% obese	Reference
Honduras	pre-school children	overwt: Z-score>1 SD above WHO/NCHS mean wt. for ht. obese: Z-score> 2 SD	18.7	7.8	Martorell et al., 1998 (14)
Hondurus	adult women	overwt: BMI >27.3 obese:BMI>30	3.7	1.4	Martorell et al., 1998 (14)
India	adults	BMI≥30		3	WHO, 1996 (20)
Peru	pre-school children	overwt: Z-score>1 SD above WHO/NCHS mean wt. for ht. obese: Z-score> 2 SD	22.8	9.4	Martorell et al., 1998 (14)
Peru	adults	BMI≥30		24.8	WHO, 1996 (17)
Mexico	adults	BMI≥25	36		deOnis and Habicht, 1996 (20)
Micronesia	adult women on island of Nauru	BMI≥30		70	WHO, 1996 (17)
Micronesia	adult men on island of Nauru	BMI≥30		65	WHO, 1996 (17)
Morocco	adult women	overwt: BMI≥25 obese: BMI≥30	33.0	18.3	Mokhtar 2001 (37)
Morocco	adult men	overwt: BMI≥25 obese: BMI≥30	28.0	5.7	Mokhtar 2001 (37)
Thailand	urban area; children (6-12)	≥120% of Bangkok ref.		12.7	Mo-Suwan et al., 1993
Thailand	urban adult men	BMI≥25	25.5		Popkin, 1994 (20)
Thailand	urban adult women	BMI≥25	21.4		Popkin, 1994 (20)

Country or Area	Specific population	Assessment standards used	% over-weight	% obese	Reference
Togo	adults	BMI≥25	18		deOnis and Habicht, 1996
Tunisia	adult women	overwt: BMI≥25 obese: BMI≥30	22.7	28.2	Mokhtar 2001 (37)
Tunisia	adult men	overwt: BMI≥25 obese: BMI≥30	23.3	6.7	Mokhtar 2001 (37)
Zimbabwe	adults	BMI≥25	8.0		deOnis and Habicht, 1996
South Asia	adult women	overwt: BMI≥25 obese: BMI≥30	2.2	0.1	Martorell et al., 2000 (42)
Sub-Saharan Africa	adult women	overwt: BMI≥25 obese: BMI≥30	9.9	2.5	Martorell et al., 2000 (42)
Latin America & Caribbean	adult women	overwt: BMI≥25 obese: BMI≥30	25.7	9.6	Martorell et al., 2000 (42)
Central Eastern Europe	adult women	overwt: BMI≥25 obese: BMI≥30	26.7	15.4	Martorell et al., 2000 (42)
Middle East and North Africa	adult women	overwt: BMI≥25 obese: BMI≥30	28.8	17.2	Martorell et al., 2000 (42)

While similar trends are occuring world-wide, every nation undergoing a nutrition transition is dealing with issues unique to that nation (13). Malnutrition and infectious disease have not been eradicated in developing countries and should not be ignored (13). The complete picture, one that includes both under and overnutrition and also takes a look at specific cultural concerns, must be considered when public health measures are taken.

Assessment of Underweight, Overweight, and Obesity

Body mass index (BMI) and growth charts. Assessment of underweight, overweight, and obesity in any population is challenging. Assessing adolescents, especially adolescents in developing countries, adds even more factors to the challenge. Currently, Body Mass Index (BMI) is the most accepted measurement technique for assessing obesity in large population studies, partly because of the ease at which it can be obtained (43). In adult populations a BMI $\geq$25 is typically considered overweight and $\geq$30 is obese. For children and adolescents, the NCHS and the CDC recently released new growth charts that incorporate BMI for age. These charts, based on NHANES data, are very useful in identifying underweight, overweight, and obese adolescents in the U.S. both clinically and epidemiologically. These growth charts, however, are not necessarily appropriate for assessments in populations outside the U.S. Must et. al. developed standards that included BMI and triceps skinfold values for 85^{th} and 95^{th} percentiles for children and adolescents using NHANES I data (44). For lack of a more appropriate reference, WHO once recommended the Must charts for international work (45).

As obesity prevalence research skyrocketed worldwide in recent years, the need for a standard definition for childhood and adolescent overweight and obesity was acknowledged. In 2000, the International Obesity Task Force released new BMI charts with defined BMI for age cutoff points for overweight and obesity (46). The international standards are based on centile curves that pass through BMI's 25 and 30 for overweight and obesity respectively, using data from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the U.S. (46). All data came from surveys with over 10,000 subjects ranging in age from 6 to 18. While these cutoff points are undoubtedly the best standards to date, Cole et. al. acknowledged the fact that more research should be done in different populations, especially Asian and African ones, for the development of standards that are truly representative of the world's children and adolescents (46).

The standards created by Cole, Must, and the CDC all yield similar results. Compared to the CDC-U.S. growth charts, Cole's values give lower estimates of overweight for younger children, but higher estimates of overweight for older adolescents (5). Must's standards show a slightly higher prevalence of overweight in all children compared to the CDC-U.S. growth charts (5). **Table 2.2** shows the prevalence of overweight among U.S. adolescents using NHANES III data (1988-1994) when assessed by the CDC-U.S. growth charts, Cole's standards, and Must's standards.

TABLE 2.2

Prevalence of overweight among U.S. adolescents when assessed by the CDC-U.S. growth charts, Cole's standards, and Must's standards[1]

Age Group and Reference Values	Girls NHANES III (1988-1994) % overweight	Boys NHANES III (1988-1994) % overweight
12-14 years		
CDC-US growth charts	30.9	29.4
Cole et al	31.2	29.1
Must et al	29.7	30.0
15-17 years		
CDC-US growth charts	23.0	23.2
Cole et al	25.0	27.1
Must et al	24.0	23.5
17-19 years		
CDC-US growth charts	18.5	16.0
Cole et al	23.8	23.6
Must et al	21.1	16.2

[1]Adapted from Flegal et al., 2001 (5).

Some studies suggest that adolescent BMI is related to height (47, 48). Freeman et al. suggests that if you have a tall adolescent and a short adolescent who are the same age, the tall one is more likely to have a high BMI (48).

Body composition measurements. Although studies show BMI correlates with body fatness, it is not a precise indicator of body fat (49). Techniques used to assess body fatness or body composition include skinfold thickness measurements, underwater weighing, Dual X-ray Absorptiometry (DXA), and bioelectrical impedence. While DXA and underwater weighing reign superior in assessing body composition accurately, they are expensive and too cumbersome for large population studies (50, 51).

Skinfold measurements are used to assess body fatness by measuring the thickness of the subcutaneous fat layer found just below the skin (52). Skinfolds are relatively inexpensive and easily used in the field but have several limitations. For instance, skinfold measurements are highly variable. This variabilty can be minimized within a study by using a single researcher trained in standardized techniques to take all measurements. However, this does not solve the problem of comparing skinfold measurements of different study groups. Furthermore, as Ellis pointed out, there are over 100 published skinfold prediction equations (equations that use skinfold measurements to determine percent body fat), which use many different sites on the body (49). There is no consensus on the most appropriate equation to use or the best sites on the body to measure for achieving standardization in research (49).

Assessment of undernutrition. Currently, there are no international standards to assess undernourishment in children and adolescents. U.S. National Center for Health Statistics charts are often used (53). BMI's < 3^{rd} percentile for age or <5^{th} percentile for age are commonly used standards to describe underweight in international settings.

Adolescent Development

Adolescence is a time of rapid growth characterized by significant changes in height, weight, body composition, skeletal maturation, and sexual maturation. An adolescent will experience growth spurts, changes in body shape, the onset of secondary sexual characteristics, the completion of physical maturation; but each individual's experience may be different due to variations in age, order, and duration of each development. However, average ages and durations of each maturation stage have been determined and will be discussed in this section to demonstrate the basic story of adolescence.

Height changes. Children increase in height at a rate of approximately 5-7cm/year until the age of 9-10, when rate of growth increases (54, 55). Peak height velocity occurs at age 10-14 in girls and 12-16 in boys with the onset of the pubertal growth spurt (56). Adult stature is usually reached by ages 13-17 in females and 15-19 in males (56).

Body composition changes. Changes also occur in fat and lean tissues that lead to overall body composition changes. The level of maturation of an adolescent will affect his BMI and body composition (57). During childhood prior to puberty, girls are about 19% fat and boys are 15% body fat. During the later stages of puberty, fat increases in girls while lean tissue decreases. In boys, however, lean tissue increases. By the end of maturation, girls will have about twice as much fat as boys, with girls being approximately 27% body fat and boys being around 16% (58).

Sexual maturation. Many of the physiological changes that occur in adolescence, including changes in BMI, have been linked to sexual maturity rather than chronological age (57). Determining the sexual maturation stage of adolescence proves difficult due to the variation in the order that certain changes or developments occur and the varied duration of each stage among individuals. The most accepted standard used to assess sexual maturation to date is Tanner Stages, which describes the changes in five stages (59). Stage I describes the state when no sexual maturation has yet occurred, and Stage V describes the state of complete maturation or physical adulthood. The stages include pubic hair development in both sexes, genitalia in males, and breast development in females (59). The onset of menarche usually occurs about 2 years after initial breast development between Tanner Stages IV and V (58). Average age of menarche for U.S. girls is 12.8, with a normal range of 10.5-16.5 years (56, 58). The development of axillary hair is highly variable, but usually occurs in Tanner Stage IV in both boys and girls. Facial hair in males tends to develop in Stage IV or V (58).

While Tanner Stage assessment by a trained medical professional is preferred, adolescents, ages 11-17, are able to accurately assess their own Tanner stages using pictures and written descriptions (60-62). Ideally, we could use sexual maturation ratings instead of chronological ages to assess nutritional status (63). However, no standards exist that correlate BMI with sexual maturation level.

Adolescent development world-wide. It is important to note that most of the descriptive adolescent data come from U.S. or British studies (64). The world-wide picture could be very different. For instance, the average age of menarche in the highlands of New Guinea was documented to be 18.0 years as opposed to 12.8 in the U.S. (65). Height is influenced by ethnic origin as well. Research has shown that growth curves for Indian boys from Calcutta lay about 5 centimeters below U.S. NCHS references (66). The Indian population used for the study consisted of mostly middle class boys who belonged to upper castes and who exhibited appropriate peak height velocities. This suggests a true difference in normal height for the Indian population compared to the reference population rather than a high prevalence of stunting among the Indian boys (66). Further studies in more populations are needed.

Developing Countries

Since the terms "developing country" and "third world country" are somewhat ambiguous terms, some explanation and clarification will be beneficial for putting this project into perspective. "Developing country" and "third world" are often used interchangeably. The term "third world" was initially used as a political term in the 1950s. Democratic nations were considered first world, socialist nations were second world and all other nations were labeled third world countries. The countries labeled "third world" were poorer, and the term eventually evolved into a description of economic status (67). Typically third world, or developing, countries have low GNP per capita, high illiteracy rates, and high prevalences of malnutrition and infectious diseases.

Still, the terms are quite broad and group countries together such as South Korea, a newly industrialized country that is becoming richer, and Somalia, a nation with stagnant or even falling income (68). The World Bank has classified countries into 4 categories based on gross national product (GNP) per capita. The groups are: 1)low income, ≤$755; 2) lower middle income, $756-$2,995; 3) upper middle income, $2,996-$9,265; and 4) high income, ≥$9,266. The first three categories (low, lower middle, and upper middle income) describe developing countries, and developed nations are in the fourth (high income) category. Trinidad and Tobago, a developing country, falls into the upper middle income category (23).

Trinidad

Trinidad and Tobago is a two island nation, populated mainly by people of African and East Indian descent, located in the Caribbean just off the Venezuelan coast (see **Figures 2.1** and **2.2**).

Nutrition situation. Trinidad appears to be in the middle of a nutrition transition. Though undernutrition is still a major concern, it appears to be decreasing (25). On the other hand, overnutrition and chronic disease are on the rise (25). In 1963, chronic diseases accounted for only 40% of deaths in Trinidad and Tobago; by 1986, chronic diseases accounted for almost 60% of deaths (69). Adult obesity is not uncommon. In fact, 20% of women and 19% of men ages 35-69 are estimated to be obese (Caribbean Food and Nutrition Institute, unpublished data). WHO predicts the prevalence of obesity in some parts of the Caribbean may be close to that of European countries (1). An influx in fast food and other westernized, high fat foods as well as an increase in television watching, which leads to inactivity, could help explain the nutritional changes taking place in Trinidad (22, 70).

In 1989-1990, of school age children in their first year of primary school, 7.1% were wasted, 2.7% were stunted, and only 2% were overweight (Caribbean Food and Nutrition Institute, unpublished data). A recent study of school children ages 5-6 and 8-9 showed 8.5% of children are overweight and 2.9% are obese (27). The prevalences of both overweight and obesity were higher among the older group and higher among children of African descent than among children of East Indian descent. There were no significant gender differences in obesity prevalence. The children of East Indian descent were shorter and thinner than the children of African or mixed descent (27). The overall sample has smaller BMI's than British reference groups. The study also showed that Trinidadian children had high values for subscalpular skinfold but low values for triceps skinfold. This could indicate a more central distribution of fat, which is associated with higher LDL cholesterol, triacyl glycerol, and insulin concentrations (71).

Simeon et. al. looked at the desired body size in high school students (72). Not surprisingly, females reported that movie stars (44%), fashion models (43%) and sports personalities (31%) were their main influences when it came to desired body size. Males reported that sports personalities (55%) and movie stars (31%) were their biggest influences. Each participant was shown four silhouettes that corresponded to underweight, normal weight, overweight, and obesity. Eighty-three percent of the females reported that they wanted to be normal size, and only 13% reported wanting to be underweight. Sixty-six percent of boys wanted to be normal weight, 31% overweight, and 2% underweight. Simeon et al concluded that, unlike other cultures, most Trinidadadian adolescents do not desire very slim body sizes (72).

Cultural diversity. Trinidad's cultural diversity should be considered. Of the 1.26 million people in Trinidad and Tobago 39.5% are of African descent, 40.3% are of East Indian descent, 18.4% are mixed, 0.6% are European, and 1% are Chinese or other. Differences in ethnic origins could result in inherent differences of nutritional status. This disparity is seen in other countries as well. African Americans commonly have higher prevalences of obesity than European Americans (20). Blacks in South Africa are two times more likely to be obese than whites in South Africa (17). Whether or not similar findings exist in Trinidad is unknown. A 1985 study, showed that there was no significant difference in the prevalence of obesity between African and Indian

Trinidadians (26). However, disparities in adult obesity could have emerged in the last fifteen years. Furthermore, since East Indians appear to be shorter than reference populations, which suggest Indo-Trinidadians may be shorter and lighter than Afro-Trinidadians due to genetic factors (66).

Future of Trinidad. If ignored, Trinidad could head down the same road the U.S. has traveled, the road that leads to an obesity epidemic. Adolescents need to be assessed in order to determine this group's particular nutritional situation and to form a more complete assessment of the nutritional status of the people of Trinidad.

Dietary Intake

Dietary intake is one major factor that affects obesity (73). Therefore, dietary intake assessment can provide valuable insight into an individual's or a population's nutritional status.

Adolescent intakes. Data from NHANES III showed that U.S. male adolescents ages 12-15 had an average energy intake of 2,568 kcals, and male adolescents ages 16-19 had an average intake of 3,085 kcals (74). Females 12-15 and 16-19 had average intakes of 1,832 kcals and 1,950 kcals respectively (74). Among U.S. children ages 2 months to 19 years, 53% of total kilocalories came from carbohydrates, 34% from fat, and 14% from protein (75). U.S. adolescents had macronutrient distributions very similar to the average distribution for all children (52%, 33% and 13% for 12-15 year olds; 51%, 35%, and 14% for 16-19 year olds) (75). Costa Rican adolescent males and females has mean energy intakes of 2342 ± 751 and 1930 ± 589 kcals/day, with 30% of calories coming from fat. It is a common perception that teenagers like junk food. It was shown that even adolescents in Brazil tend to choose low nutrient dense snacks regardless of whether or not affordable high nutrient dense snacks were available (76).

Dietary intake assessment. In any study, it is important to use the most appropriate method. Metabolic measurements, while accurate, are tedious, expensive, and impractical for large population studies. Observation and food weighing methods, which yield considerably accurate results, are also time consuming and tedious (77). Self-reports, such as food frequency questionnaires, 24-hour recalls, and diet diaries are used extensively in population studies.

Self-report methods are relatively quick and inexpensive, but each type has specific advantages and drawbacks. Food frequency questionnaires (FFQ) may be simple or extensive, but all are based on retrospective information. While FFQ can be useful in adolescent populations, they are less accurate than food diaries (77-80). Furthermore, FFQ's must be culturally specific and accurate in order to get a true look at a population's diet (81, 82). Since FFQ's have not yet been developed for most third world countries, other assessment methods should be used in these populations.

Twenty-four hour recalls are more accurate than FFQ's, but offer only one day's worth of information (78, 83). Multiple 24-hour recalls are more for use in children and adolescents (79).

Diet diaries are considered the most accurate of the self-report measures but are intensive and require the participant to be motivated enough to actually record all of the food eaten in a specified time (77, 78). While children have been shown to significantly underestimate food intake as much as 17-33% when keeping records of their diets, people as young as 10 years old are able to complete interviewer reviewed diet diaries satisfactorily (78, 79, 84). This underreporting tends to increase with age (85). One study showed that, unlike American women, Egyptian women did not underreport their intake (86). This suggests that underreporting may be cultural, and should be further investigated in developing countries. Diet diary accuracy can be improved when an interviewer reviews the diary with the participant to ensure completeness and accuracy (78).

Physical Activity

Since physical activity, or lack thereof, is associated with obesity, assessment of physical activity can provide valuable information (73). But like dietary assessment, the advantages and drawbacks of the assessment method chosen must be weighed carefully (87, 88). The doubly labeled water technique is considered the "golden standard" in energy expenditure assessment due to its high accuracy and objectivity (89). However, doubly labeled water is too expensive for most large-scale studies. It is extremely useful for validation of more practical methods of assessing physical activity in large field studies (89). Numerous observation methods have been validated, but are often avoided due to the expense and time involved (90). Heart rate monitors can be used to assess energy expenditure, but difficulties arise since heart rate is affected by many confounding variables (91). Measuring heart rate is most useful for estimating very intense activity, but less intense activity is probably beneficial to health and should be taken into consideration as well (92). Motion sensors, such as pedometers, assess total distance covered. This method is limited because it does not evaluate intensity at all and does not give consistent values between instruments (91).

CSA accelerometer. Accelerometers made by Computer Science and Applications (CSA) give accurate physical activity measures of children that have been validated using doubly labeled water (93). These accelorometers are small (2.2 x1.5 x0.6 inch), lightweight (1.5 oz), and made of rugged polycarbonate, which makes them ideal for field studies involving children. They can be worn or the waist, hip, or ankle and count movement, or acceleration, per minute.

Dale et al. reported CSA acceleromter counts per minute on children ages 7-15 for days when the children had physical education class and recess and for days when physical education and recess were restricted (94). **Table 2.3** shows mean counts per minute reported for times throughout the day on both active and restrictive days. On active days the mean accelerometer count per minute for the total day was 445 ± 284 ct/min. On the restricted days, the mean was 187 ± 121 ct/min (94).

TABLE 2.3

Activity levels of children (average counts per minute) on active and restricted days[1]

Time Period	Active day	Restricted Day
In school 9:00 a.m.-3:00 p.m.	366 ± 165	129 ± 85
Recess 20 min (a.m.)	1,050 ± 882	136 ± 119
Lunch recess 20 min	918 ± 855	81 ± 76
Physical education 30 min	1,050 ± 555	129 ± 85
After school 3:00 - 7:30 p.m.	525 ± 306	246 ± 177
Total day 9:00 a.m. - 7:30 p.m.	445 ± 284	187 ± 121

[1]Mean and standard deviation given. (94)

Physical activity questionnaires. Self-reports emerge as the method of choice for many population studies due to low cost and ease of administration (95-97). Sallis created interviewer and self-administered physical activity checklists for fifth grade students, which have been validated using heart rate monitors (98). The checklists obtain information regarding physical activity the subject participated in during the previous day and takes into account type of activity, time involved, and intensity. For analysis, each type of activity is assigned a certain MET value, a multiple of resting metabolism used to reflect the energy cost of the activity. The Bogalusa Heart Study used Sallis' Self-Administered Physical Activity Checklist to assess physical activity in children grades 5-8 (99). The study found that males reported an average of 153 minutes of physical activity per day, while females reported an average of 110 minutes of activity per day (99).

It has been suggested that measuring physical inactivity may be just as important as measuring activity (100). Television viewing, a major form of inactivity, increased significantly from 1986 to 1990 and is believed to be linked to 60% of childhood obesity cases in the U.S. (73). Sallis' physical activity checklists provide some measurements of inactivity by asking about hours spent watching television and playing video games (98). Any questionnaire must be culturally sensitive to provide meaningful results.

Although accelerometers and self-reports are significantly correlated, self-reports have been shown to demonstrate 41.2% higher physical activity estimates than accelerometers (101). Both methods can be useful in large-scale studies, but can not be compared to one another.

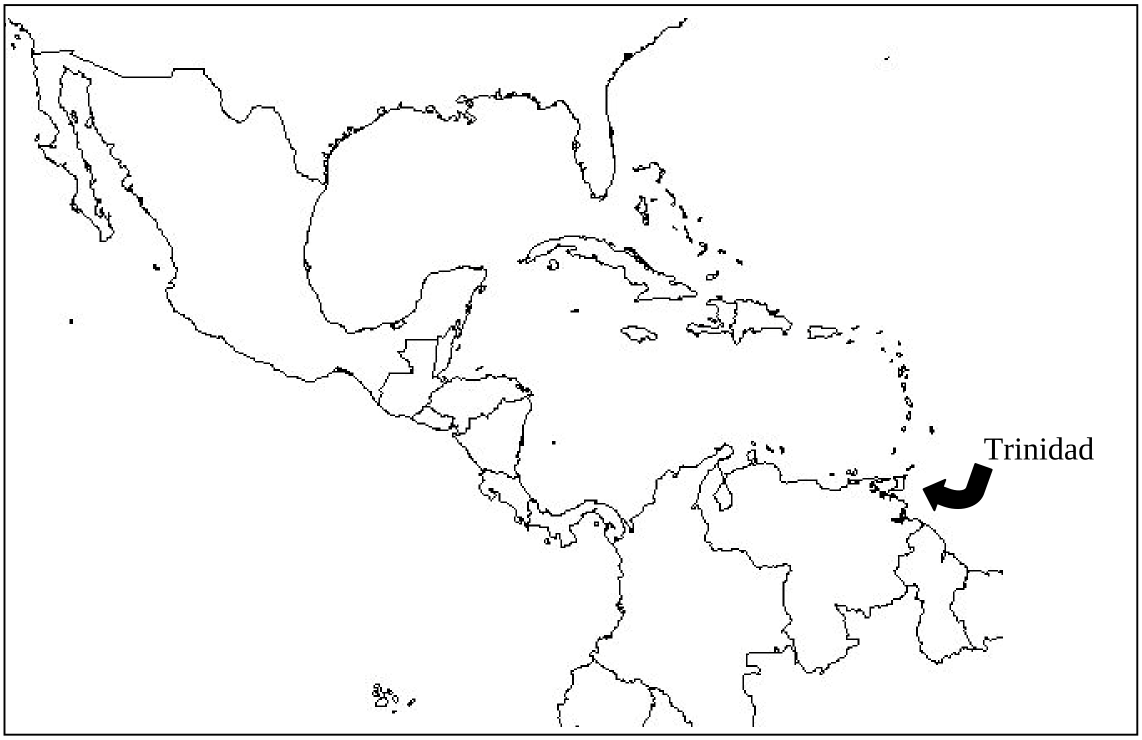

Figure 2.1 Central America and the Caribbean. http://geography.about.com

Figure 2.2 Trinidad and Tobago;

Adapted from the CIA World Fact Book

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CHAPTER 3

THE PREVALENCE OF OVERWEIGHT AND OBESITY IN TRINIDADIAN ADOLESCENTS[1]

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ABSTRACT The prevalence of overweight and obesity was determined in a random sample of 296 adolescents, 12-18 years of age, from rural and urban areas in Trinidad. Demographics, height, weight, three-site skinfold thickness, dietary intake using three-day food records, physical activity using questionnaires, and sexual maturity were assessed in males (n=126) and females (n=170) attending secondary schools. CSA accelerometers were used to assess activity in a subsample of the population (n=55). The overall prevalence of overweight and obesity was 13.2% and 4.4%, respectively. Females exhibited higher prevalences than males for both overweight (15.9% vs. 9.5%) and obesity (7.1% vs. 0.8%). African females had the highest rates of overweight (18.8%) and obesity (15.6%). Africans tended to have higher mean values for height, weight, and BMI than East Indians. Although urban adolescents did not exhibit higher obesity rates than rural adolescents, urban African (70.2 ± 32.7) and mixed (66.7 ± 24.0) girls had higher skinfolds than rural African (49.1 ± 16.5) and mixed (45.0 ± 12.4) girls ($p<0.05$). In boys, inactivity correlated with BMI ($r = 0.309$; $p<0.01$) and skinfolds ($r = 0.222$; $p<0.05$), while in girls, skinfolds were inversely correlated with accelerometer counts/minute ($r = -0.389$; $p<0.05$). Overweight and obesity rates in Trinidadian adolescents indicate a public health concern, especially for African females.

KEYWORDS • Trinidad • Adolescent nutrition • Obesity • Overweight • Caribbean

INTRODUCTION

Adult and childhood obesity has risen to epidemic proportions in developed countries (1, 2). In the United States, approximately 61% of adults age 20 and older are overweight (body mass index, BMI >25) or obese (BMI>30). In 2001, 22.4% of

American adults were reported to be obese (3). Moreover, NHANES III data showed that 30.9% and 29.4% of 12-14 year old girls and boys, respectively, were categorized as overweight, and 23.0% and 23.2% of 15-17 year old girls and boys, respectively, were overweight (4). These childhood prevalences are of particular concern because of the increased risk for developing health complications during childhood, and because an obese child is likely to become an obese adult (5-7).

While obesity has not been considered a priority health issue in developing countries, some countries are experiencing a nutrition transition characterized by a rise in obesity and related chronic diseases (8, 9). In Columbia, Chile, Mexico, Costa Rica, Ghana, and Zimbabwe 45%, 42%, 36%, 32%, 18% and 8% of adults, respectively, have been reported to be overweight (10, 11). In Sao Paulo, Brazil, 21.9% of adults were overweight and 14.6% were obese; 21% and 8.8% of adolescent females and males, respectively, were reported to be obese (12).

Similar to the health disparities observed in the U.S., the prevalence of obesity may be greater in specific ethnic groups, locations, and socioeconomic status groups (3, 13-15). For example, African Americans have higher prevalences of obesity than European Americans (16). Likewise, South African blacks are two times more likely to be obese than South African whites (13). Furthermore, it has been suggested that obesity is more prevalent in urban than in rural areas in developing countries (8, 14). Urban women in Morocco were more obese than rural women (14.6% vs 10.3%) (17). Similarly in Tunisia 28.3% of urban women and 12.3% of rural women were obese (17). While no longitudinal data exists to clearly demonstrate the reason for this urban/rural difference, it has been suggested that as a nation industrializes and develops, urban areas advance before rural areas, and thus experience dietary and physical activity shifts earlier (13). In several developing countries, obesity rates are higher among higher socioeconomic status groups (8, 14).

As fats and refined sugars become cheaper and more available to developing societies, traditional diets that are rich in complex carbohydrates are being replaced with diets high in fats and sugars (9). For example, in China between 1978 and 1987, mean energy intakes increased from approximately 2200 kcals/day to 2800 kcals/day. Increased consumption of meat, edible oils, sugar, eggs, and fish resulted in a shift from 14% to 19% of the calories from fat (15). Similarly, in Brazil between 1962 and 1988, the relative percentage of foods consumed for grains, pasta, roots and tubers, and fruit decreased, and margarine and oil consumption increased resulting in an increase in the relative fat intake from 8.1% to 16% (18).

Decreased energy expenditure may also contribute to the obesity problem in developing countries, although little supporting data exist. As developing countries Westernize and incorporate more technology such as televisions, computers, and automobiles, physical labor becomes less of a necessity (19). When male Guatamalans left their agricultural work and joined the army, they gained an average of 6.4 kg, mainly as fat mass, after 16 months. Physical activity reported by the men was substantially less in the army following basic training than in their agricultural work (19). In San Miguelito, Panama, 50% of men and 72% of women reported doing very little or no regular exercise (19).

Like other developing countries, Trinidad and Tobago, a culturally diverse two-island nation located in the Caribbean, may be experiencing a nutrition transition. Deaths in Trinidad and Tobago associated with chronic disease increased from 40% in 1963 to 60% in 1986, which implies a concomitant rise in obesity (20). The one report of obesity prevalence of adults in Trinidad conducted twenty years ago, suggested that 30% of women were obese, with no significant differences among racial groups (21). To date, there is only one published report on the prevalence of childhood obesity in Trinidad(22). Gulliford et. al. (22) assessed primary school children, ages 5-6 and 8-9, and found that overall, 8.5% of the children were overweight and 2.4% were obese. No gender differences were seen, but Africans did have slightly higher prevalences of overweight and obesity than East Indians. Furthermore, higher rates of overweight were reported in the older children (22). Whether or not the trend for older Trinidadian children to display higher rates of obesity continues into adolescence is unknown. The overall objective of this study was to assess the prevalence of overweight and obesity among adolescents, ages 12-18, from urban and rural areas of Trinidad and to examine the influences of diet and physical activity. We hypothesized that the prevalence of obesity in the overall population would be high, but lower than rates seen among U.S. adolescents. Furthermore, it was hypothesized that obesity rates would be higher among African than East Indian or mixed adolescents and higher in those attending schools in urban areas rather than rural areas.

MATERIALS AND METHODS

Research design and subjects. Four hundred Trinidadian secondary school students, ages 12-18, were randomly selected to participate in the study by the Central Statistical Office in Trinidad and Tobago. There were 97 eligible secondary schools in Trinidad, 57 urban and 40 rural. Approximately 58,760 students attend schools in urban areas and 45,240 attend schools in rural areas. Twenty schools, 11 urban and 9 rural, were randomly selected, and 20 students from each of the schools were randomly selected to participate (400 total students). Furthermore, three students per school were selected as alternates to participate in case any of the students from the original random sample elected not to participate. A total of 302 students participated in the study. Only children of African, East Indian or mixed descent were included in statistical analyses (n=296).

General Procedures. All measurements were conducted within a one-month time frame in January and February of 2001. All data were collected in secondary schools by a team of trained researchers consisting of a nurse, four food demonstrators, a graduate assistant from the University of the West Indies, and a graduate assistant from The University of Georgia. Demographic, dietary, and physical activity questionnaires were given to participants to take home and complete. Once completed, the forms were returned to a designated school official, and later collected by the research team. All procedures were approved by the Institutional Review Board for Human Subjects at the University of Georgia, the Ministry of Health Ethics Committee in Trinidad and Tobago, and the Ministry of Education in Trinidad and Tobago. Prior to testing, a signed parental consent form and student agreement were obtained from each participant.

Anthropometric assessment. One trained investigator performed height and weight measurements on all prticipants as described by Tanner et. al. (23). A second investigator recorded all height and weight results. Height was measured to the nearest 0.1 centimeter using a Holtain stadiometer. Two height measurements were taken on each participant, and the results were averaged. Participants were weighed on an electronic digital scale two times, wearing school uniforms with no shoes and emptied pockets. Weight was recorded to the nearest 0.1 kilogram, and the recorded weights were averaged. Body mass indexes were calculated as weight in kilograms divided by height in meters squared.

Three-site skinfold measurements were performed using a Lange caliper (Cambridge, Maryland). Chest, abdomen, and thigh skinfold measurements were assessed in males, and triceps, suprailium, and thigh skinfolds were assessed in females. Three repeat measures were taken at each site, rounded to the nearest millimeter, and averaged (24). One trained investigator performed measurements on all participants, and a second investigator recorded the results.

Dietary intake. A trained researcher instructed students on how to accurately record three-day food diaries. While three day diet records have been shown to underestimate total dietary intake in children, they are still considered the most accurate dietary self-report measure (25, 26). Participants were requested to complete the diet records in as much detail as possible using brand names, preparation methods, and portion sizes. Diets were analyzed by a Trinidadian nutritionist using FoodProcessor II Nutrition and Dietary Analysis System, Version 7.11 (ESHA Research, Salem, OR). Common Trinidadian foods were added to the FoodProcessor Database using the *Food Composition Tables for use in the English Speaking Caribbean* and a popular Trinidadian cookbook (27). Three-day averages for total energy intake (kcals), protein intake (g), carbohydrate intake (g), fat intake (g), and % fat were reported in mean ± SD of the total sample population; 92% of female and 75% of male participants returned completed dietary records.

Physical Activity Questionnaires. A modified version of Sallis's Interview-Administered Physical Activity Checklist, which has been validated using heart rate monitors, was used to assess physical activity and inactivity (28). Activities found on the checklist that are specific to the U.S., such as American football and baseball, were replaced with common Trinidadian activities, including football (soccer) and cricket. Inactivity included watching television and playing computer games. Each student answered the questions on the checklist during an interview with a trained investigator.

CSA Accelerometers. Activity counts were assessed in a subsample of the population (n=55) from urban (n=28) and rural (n=27) areas using CSA accelerometers (Computer Science Applications, Inc., Model 7164). CSA accelerometers give accurate physical activity meaures of children, having been validated using doubly labeled water (29, 30). Participants selected to wear the accelerometers were chosen solely by the availability of the accelerometers, beginning with the first school that participated in testing. The participants were instructed to wear the accelerometers for three days, including two weekdays and one weekend day, at all times except when sleeping or involved in a water activity, such as bathing or swimming. The students were given a sheet to record the dates and times the accelerometers were worn. Accelerometers and time sheets were returned to a designated school official. Accelerometer counts per minute were averaged for the three day period.

Sexual maturation. A modified version of a sexual maturation questionnaire was completed by participants (31). Attainment of pubic hair, axillary hair, facial hair, and the onset of menstruation were determined and used to estimate Tanner Stages as follows: attainment of pubic hair, Tanner Stage 2-3; attainment of axillary hair, Tanner Stage 3-4; attainment of facial hair or menstrual cycle, Tanner Stage 4-5 (31, 32).

Statistical analysis. Data were analyzed using the Statistical Package for the Social Sciences (SPSS/PC version 9, SPSS Inc., Chicago, IL). Data were screened for missing data, invalid data, and outliers. All outliers were adjusted before statistical tests were run. Descriptive statistics (mean ± SD) were summarized. To compare means of variables of interest, 2 x 3 analysis of variances (ANOVA's) were conducted with location (urban, rural) and ethnic origin (African, East Indian, and mixed) as independent variables. All main effects and interactions were assessed.

Pearson correlations were run to examine the relationships between 1) BMI and variables associated with obesity; and 2) skinfold measurements and variables associated with obesity. Linear regression analyses were performed using age, accelerometer average counts/min., and total energy intake to predict skinfold measurements. An alpha level of 0.05 was chosen to identify any significant differences.

RESULTS

Descriptive characteristics of the subjects are presented in **Tables 3.1, 3.2,** and **3.3**. The overall prevalence of overweight and obesity among Trinidadian adolescents, defined by BMI cutoffs recommended by the International Obesity Task Force (IOTF), was 13.2% and 4.4% respectively. Females exhibited higher prevalences than males for both overweight (15.9% vs. 9.5%) and obesity (7.1% vs. 0.8). **Figure 3.1** shows the prevalences of overweight and obesity among urban and rural adolescents, and **Figure 3.2** shows the prevalences of overweight and obesity among different ethnic groups. Findings showed 6.4% of urban males, 14.1% of rural males, 24.7% of urban females, and 20.3% of rural females were either overweight or obese. The African females exhibited the highest prevalence of overweight (18.8%) and obesity (15.6%) of any subgroup. Approximately 18% and 22.6% of East Indian and mixed females, respectively, were either overweight or obese. Of African, East Indian, and mixed male participants, 9.5%, 12.0%, and 8.8% were classified as either overweight or obese, respectively.

In males, there was an ethnicity effect for height, weight, and BMI. African males had higher mean values for height ($p < 0.01$), weight ($p < 0.01$), and BMI ($p < 0.05$) than East Indian males. A location x ethnicity interaction for energy intake, protein intake, and fat intake was seen in males. Total energy intake was significantly higher in urban East Indian boys than in urban mixed boys ($p < 0.05$). Urban East Indian boys had higher protein intakes than rural East Indian boys ($p < 0.05$). Urban East Indian boys also reported higher fat intakes than African and mixed boys in urban areas ($p < 0.05$). There were no significant location, ethnicity, or location x ethnicity effects for skinfold measurements or physical activity/inactivity measures.

Among females, a group effect for ethnicity was seen for height, with Africans significantly taller than East Indians ($p < 0.01$). A location x ethnicity interaction was observed in females for weight, BMI, sum skinfold measurement, and protein intake. Among urban females, weight and BMI values were significantly higher in African females than in East Indian females ($p < 0.05$). Among mixed females, mean weight, BMI, and skinfold measures were higher in urban areas than in rural areas ($p < 0.05$). Summed skinfold measurements were also higher in urban African females than in urban East Indians and rural Africans ($p < 0.05$). In East Indian females, protein intake was higher in urban areas than in rural ($p < 0.05$). A location effect was seen for minutes of physical activity reported in a day, with rural girls reporting higher values than urban girls on the physical activity checklist ($p < 0.05$). In females, there were no location, ethnicity, or location x ethnicity effects for age, energy intake, minutes of inactivity (minutes of television watched and computer games played), or accelerometer counts/minute.

No differences in BMI skinfolds, dietary intake, or physical activity levels were observed between participants with parental education levels at or below secondary school and those with parental education levels above secondary school in either males or females.

Table 3.4 shows the prevalence of overweight in U.S. adolescents using data from NHANES III compared to Trinidadian adolescents (4). Both the U.S. CDC growth charts >85th percentile BMI for age and the IOTF BMI cutoffs were used to define overweight (33, 34). The prevalences of overweight among Trinidadian boys and girls were less than that seen in boys and girls from the NHANES III using both the CDC growth charts and the IOTF BMI cutoff points. Use of the IOTF cutoffs increased the prevalences of overweight in Trinidadian girls, ages 12-14 and 15-17 and in boys, ages 15-17.

The prevalence of underweight, defined using the U.S. CDC growth chart < 3rd percentile BMI for age, was higher among males (9.5%) than females (7.6%) (34). The highest rates for underweight were seen in the East Indian groups. African, Indian, and mixed males had underweight prevalences of 2.4%, 16.0%, and 8.8% respectively, while

African, East Indian, and mixed females had underweight prevalences of 3.1%, 14.5%, and 1.6% respectively.

Selected Pearson correlations are presented in **Tables 3.5** and **3.6**. As expected, BMI was strongly correlated with summed skinfold thickness in boys and girls ($p < 0.05$). BMI was also positively correlated with maturation in both genders ($p < 0.05$), whereas summed skinfold thickness was positively correlated with maturation only in girls ($p < 0.01$). In boys, energy intake was negatively correlated with average accelerometer counts/minute. Average accelerometer counts were inversely correlated with summed skinfolds in females ($p < 0.05$). Minutes of inactivity (time watching television and/or playing computer games) in a day and skinfold measurements were correlated in both males ($p < 0.05$) and females ($p < 0.01$), and inactivity and BMI were correlated in males ($p < 0.01$). The inverse relationship between sum of skinfolds measurements and accelerometer counts in females was further supported using linear regression. When controlled for age and energy intake, a significant relationship still existed (R^2=0.233, $p < 0.05$).

TABLE 3.1

Subject characteristics[1]

	Males (n=126)		Females (n=170)	
Variable	*n*	*Percent (%) of subjects*	*n*	*Percent (%) of subjects*
Location of school attended[2]				
Urban	62	49.2	101	59.4
Rural	64	50.8	69	40.6
Ethnic origin				
African	42	33.3	32	18.8
East Indian	50	39.7	76	44.7
Mixed	35	27.8	62	36.5
Parental education level[3]				
≤ Secondary school	48	50.5	87	58.0
> Secondary school	47	49.5	63	42.0
Estimated Tanner Stage[4]				
Tanner stage I	7	7.3	2	1.3
Tanner stage II-III	13	13.5	3	1.9
Tanner stage III-IV	33	34.4	22	13.8
Tanner stage IV-V	43	44.8	133	83.1

[1]Data presented as percentages.
[2]Schools determined to be in urban or rural settings by Central Statistical Office in Trinidad and Tobago.
[3]Level of parent with the highest education level as reported on returned demographic questionnaires (n=250).
[4]Tanner stages estimated as follows for participants who returned the sexual maturation questionnaire: attainment of pubic hair, Tanner stage II-III; attainment of axillary hair, Tanner stage III-IV; attainment of facial hair or menstrual cycle, Tanner stage IV-V (n = 250).

TABLE 3.2

Descriptive characteristics for male participants[1]

	Urban Males			Rural Males			Effect[6]
	African	Indian	Mixed	African	Indian	Mixed	
	(n=28)	*(n=9)*	*(n=25)*	*(n=14)*	*(n=41)*	*(n=9)*	
Age (years)	14.6 ± 1.6	14.7 ± 2.1	14.9 ± 1.9	15.4 ± 1.8	14.7 ± 1.7	14.7 ± 2.0	--
Weight (kg)	57.5 ± 11.6	49.5 ± 9.7	54.1 ± 12.6	62.7 ± 11.3	50.3 ±12.4	51.1 ± 13.4	ethnicity[7]
Height (cm)	169.2 ± 13.6	163.9 ± 9.4	166.0 ± 9.8	173.6 ± 10.2	164.2 ± 9.9	165.6 ± 11.8	ethnicity[7]
BMI (kg/m^2)	20.0 ± 2.8	18.3 ± 2.4	19.4 ± 3.3	20.0 ± 2.5	18.5 ± 3.5	18.3 ± 3.3	ethnicity[7]
Sum of skinfolds[2] (mm)	27.3 ± 2.4	29.3 ± 4.2	25.2 ± 2.5	22.6 ± 13.0	28.8 ± 14.7	20.2 ± 9.5	--
	(n=17)	*(n=8)*	(n=18)	*(n=10)*	*(n=33)*	*(n=8)*	
Energy (kcals)	1797 ± 903	2598 ± 839	1646 ± 710	1923 ± 392	1848 ± 614	1982 ± 591	loc x eth[8]
Protein (g)	63.7 ± 31.3	93.8 ± 40.1	61.8 ± 26.6	74.2 ± 21.1	62.5 ± 27.1	67.1 ± 21.7	loc x eth[9]
Carbohydrates (g)	238± 148	310 ± 108	202 ± 95.2	239± 69.9	248 ± 94.6	275 ± 89.6	--
Fat (g)	68.2 ± 38.0	110± 38.4	66.9 ± 30.5	76.2 ± 29.1	73.5 ± 32.8	70.0 ± 22.3	loc x eth[10]
Percent fat (%)	34.1 ± 11.5	37.6 ± 5.6	36.6 ± 7.4	35.0 ± 8.2	34.5 ± 7.7	31.4 ± 4.4	--
	(n=28)	*(n=9)*	*(n=25)*	*(n=14)*	*(n=41)*	*(n=9)*	
Min. of activity[3]	203 ± 161	207 ± 220	169 ± 132	161 ± 133	152 ± 126	231 ± 149	--
Min.of inactivity[4]	124 ± 94	119 ± 69	117 ± 87	164 ± 153	100 ± 104	97.5 ± 83.0	--
	(n=11)	(n=9)	--	(n=1)	(n=7)	(n=1)	
Accel. count/min[5]	503 ± 248	796 ± 393	--	633	562 ± 119	319	--

[1]Data presented as mean ± SD.
[2]Thigh, abdomen and chest skinfolds.
[3]Minutes of activity as reported on 24-hour physical activity checklist.
[4]Minutes of inactivity (watching television and playing computer games) as reported on the 24-hour physical activity checklist.
[5]Three-day average accelerometer counts/minute.

[6]$p < 0.05$
[7]African > Indian
[8]Urban Indian > urban mixed
[9]Urban Indian > rural Indian
[10]Urban Indian > urban African and urban mixed

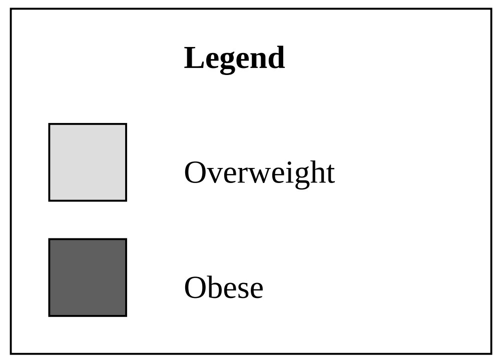
TABLE 3.3

Descriptive characteristics for female participants[1]

	Urban			Rural			Effect[6]
	African *(n=20)*	Indian *(n=45)*	Mixed *(n=36)*	African *(n=12)*	Indian *(n=31)*	Mixed *(n=26)*	
Age (years)	13.8 ± 0.9	14.5 ± 1.9	14.7 ± 1.6	15.6 ± 1.8	14.5 ± 1.9	14.8 ± 1.8	--
Weight (kg)	61.5 ± 20.7	46.8 ± 9.2	57.5 ± 13.7	56.3 ± 10.9	49.6 ± 10.6	49.9 ± 8.4	loc x eth[7]
Height (cm)	161.3 ± 5.7	157.8 ± 6.0	161.9 ± 6.3	160.9 ± 6.9	156.2 ± 6.0	16.0 ± 7.5	ethnicity[8]
BMI (kg/m^2)	23.5 ± 7.4	18.8 ± 3.5	22.0 ± 4.6	21.8 ± 4.6	20.4 ± 4.2	19.3 ± 3.1	loc x eth[7]
Sum of skinfolds (mm)[2]	70.2 ± 32.7	53.9 ± 16.6	66.7 ± 24.0	49.1 ± 16.5	56.6 ± 18.3	45.0 ± 12.4	loc x eth[9]
Dietary intake	*(n=17)*	*(n=41)*	*(n=31)*	*(n=12)*	*(n=31)*	*(n=21)*	
Energy (kcals)	1805 ± 566	2111 ± 533	2070 ± 686	2017 ± 680	1724 ± 634	2051 ± 587	--
Protein (g)	60.6 ± 16.8	69.3 ± 20.8	68.7 ± 25.9	71.6 ± 23.1	55.6 ± 18.1	64.8 ± 18.6	loc x eth[10]
Carbohydrates (g)	228 ± 73.4	272± 76.3	258 ± 80.2	247 ± 94.7	227 ± 95.6	261 ± 75.7	--
Fat (g)	75.0 ± 30.1	85.0 ± 26.5	83.8 ± 30.8	80.5 ± 32.8	68.0 ± 26.5	85.6 ± 29.7	--
Percent fat (%)	36.1 ± 6.0	36.0 ± 5.0	36.2 ± 7.0	35.4 ± 8.3	35.2 ± 4.5	36.8 ± 4.9	--
Activity patterns	*(n=20)*	*(n=45)*	*(n=36)*	*(n=12)*	*(n=31)*	*(n=26)*	
Min. of activity[3]	81.3 ± 57.3	94.6 ± 86.0	98.1 ± 92.0	153 ± 143	108 ± 93.7	121 ± 96.6	location[11]
Min.of inactivity[4]	94.9 ± 122	119 ± 104	111 ± 103	117 ± 118	94.0 ± 86.2	147 ± 114	--
	(n=4)	*(n=9)*	*(n=1)*	*(n=4)*	*(n=8)*	*(n=6)*	
Accel. count/min[5]	418 ± 181	393 ± 146	291	420 ± 23.4	309 ± 80.2	327 ± 32.2	--

[1]Data presented as mean ± SD.
[2]Thigh, triceps and suprailium skinfolds.
[3]Minutes of activity as reported on 24-hour physical activity checklist.
[4]Minutes of inactivity (watching television and playing computer games)as reported on the 24-hour physical activity checklist.
[5]Three-day average accelerometer counts/minute.
[6]$p < 0.05$
[7]Urban African > urban Indian
[8]African > Indian
[9]Urb. Af. > rural Af. and urb. Ind.; urb. mixed > rur. mixed
[10]urban Indian > urban African
[11]Rural > urban

Figure 3.1 The prevalence rates of overweight and obesity among urban and rural participants. For urban males, n=62; rural males, n=64; total males, n=126; urban females n=101; rural females, n=69; and total females, n=170. Overweight and obesity were defined using the BMI for age cutoff points recommended by the International Obesity Task Force.



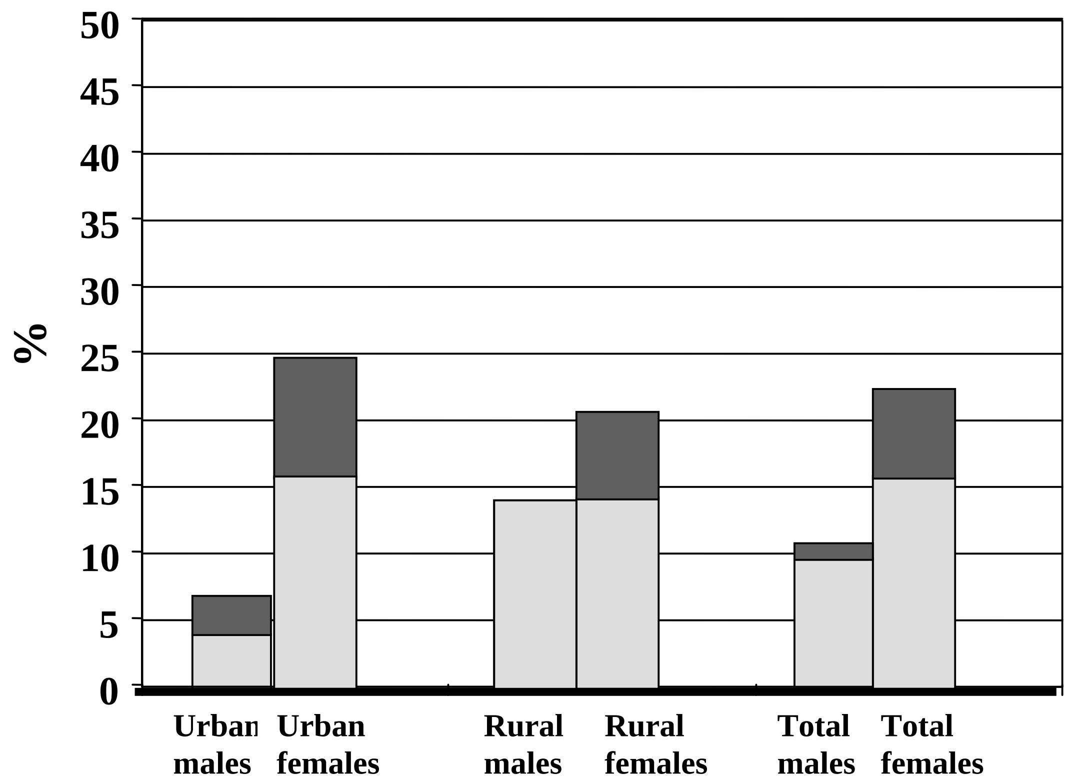
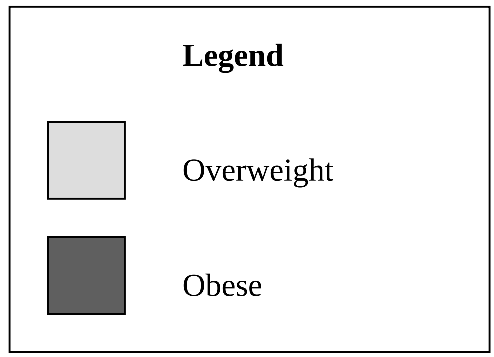
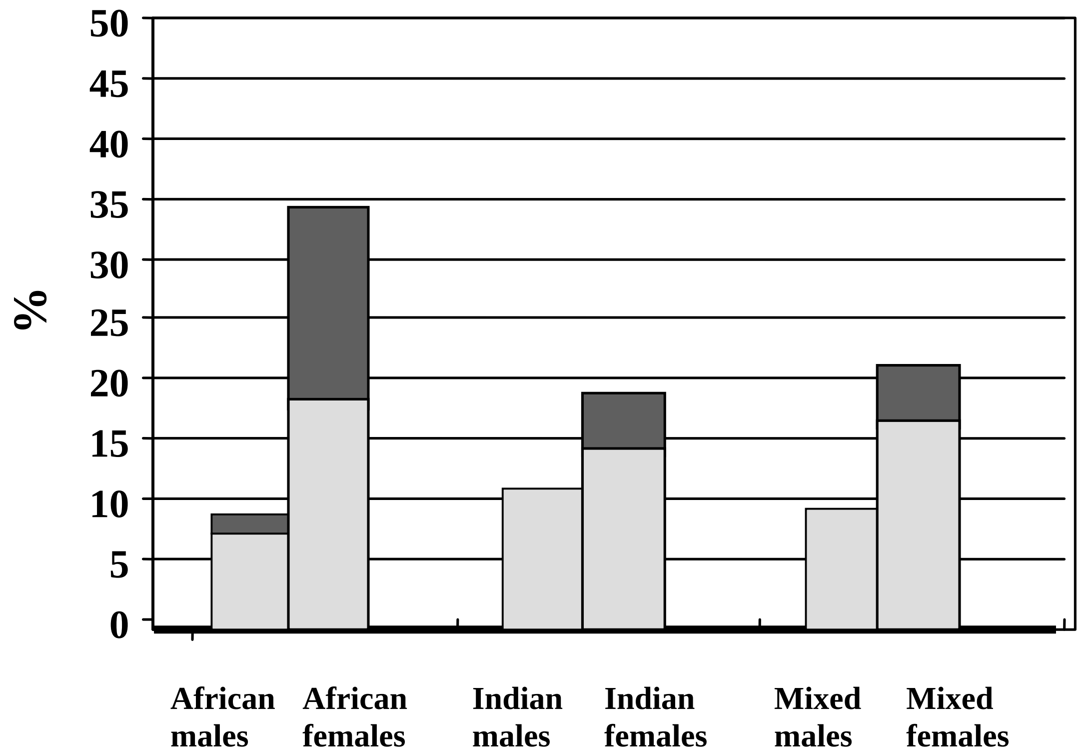

50
45
40
35
30
25
20
15
10
5
0
%
Urban males
Urban females
Rural males
Rural females
Total males
Total females

Figure 3.2 The prevalence rates of overweight and obesity among African, East Indian, and mixed participants. For African males, n=42; East Indian males, n=50; mixed males, n=35; African females, n=32; East Indian females, n=76; and mixed females, n=62. Overweight and obesity were defined using the BMI for age cutoff points recommended by the International Obesity Task Force.





50
45
40
35
30
25
20
15
10
5
0
%
African males
African females
Indian males
Indian females
Mixed males
Mixed females

TABLE 3.4

The prevalence of overweight among U.S. and Trinidadian adolescents using two reference standards to define overweight (4).

Age Group and Reference Values	Girls NHANES III (1988-1994) % overweight	Boys NHANES III (1988-1994) % overweight	Girls[3] Trinidad (2001) % overweight	Boys[4] Trinidad (2001) % overweight
12-14 years				
CDC-US growth charts[1]	30.9	29.4	19.4	17.4
Cole et al[2]	31.2	29.1	26.5	17.4
15-17 years				
CDC-US growth charts	23.0	23.2	17.9	3.7
Cole et al	25.0	27.1	19.4	6.3

[1]U.S. CDC growth charts BMI for age >85th percentile (34).
[2]BMI for age cutoff points as recommended by the International Obesity Task Force (33).
[3]n=170
[4]n=126

TABLE 3.5

Correlation matrix of relations between selected variables for boys

	BMI	Sum of Skinfolds	Energy Intake	Minutes of Activity	Minutes of Inactivity	Accel. (ct/min)	Sexual Maturity
BMI	1.000						
Sum of Skinfolds	.620**	1.000					
Energy Intake	.032	-.137	1.000				
Minutes of Activity	-.023	-.137	-.031	1.000			
Minutes of Inactivity	.309**	.222*	.003	.003	1.000		
Accel. ct/min	-.260	-.090	-.501*	-.048	-.202	1.000	
Sexual Maturity	.253*	-.102	.170	.059	.115	-.296	1.000

*Significant at $p < 0.05$
**Significant at $p < 0.01$

TABLE 3.6

Correlation matrix of relations between selected variables for girls

	BMI	Sum of Skinfolds	Energy Intake	Minutes of Activity	Minutes of Inactivity	Accel. (ct/min)	Sexual Maturity
BMI	1.000						
Sum of Skinfolds	.824**	1.000					
Energy Intake	-.132	-.127	1.000				
Minutes of Activity	.009	-.012	-.082	1.000			
Minutes of Inactivity	.087	.056	.015	.121	1.000		
Accel. ct/min	-.085	-.389*	.013	-.040	-.167	1.000	
Sexual Maturity	.252**	.255**	-.053	-.002	.043	-.357*	1.000

*Significant at $p < 0.05$
**Significant at $p < 0.01$

DISCUSSION

In recent years, there has been an alarming increase in the prevalence of childhood and adolescent obesity in the United States (2). It has been suggested that in developing countries, where undernutrition has been the primary concern, a nutrition transition is occurring and obesity and related disorders are becoming more evident (8). Little data exist, however, that document the extent to which overweight and obesity exist in certain underdeveloped countries, especially in adolescents.

The purpose of the present investigation was to determine the prevalence of overweight and obesity in adolescents from urban and rural areas of Trinidad. It was hypothesized that the prevalence of overweight and obesity would be highest among African adolescents and higher in adolescents attending schools in urban areas. The findings of the current study support the notion that overweight is becoming a public health issue in Trinidadian adolescents. Trinidadian adolescents showed higher rates of overweight and obesity than Trinidadian primary school children (who were found to have overall prevalence rates of 8.5% overweight and 2.4% obese), suggesting that overweight and obesity may increase with age in Trinidad (22).

In the U.S. 30.9% and 29.4% of 12-14 year old girls and boys, respectively, and 23.0% and 23.2% of 15-17 year old girls and boys, respectively, are overweight (4). Similarly, 21% of females, 10-18 years of age, in Sao Paulo, Brazil, were found to be overweight (12). The 23.0% overweight prevalence in Trinidadian females in the current study is similar to values reported for US females, 15-17 years of age and for females 10-18 years of age from Sao Paulo, Brazil. The 10.3% prevalence of overweight in Trinidadian adolescent males was considerably lower than US males, but comparable to the values reported for males from Sao Paulo, 10-18 years of age (8.8%). It appears as though the problem of overweight and obesity emerging in Trinidad is not unlike the US, with female adolescents being a high risk population group.

Part of the explanation for the high rate of overweight in Trinidadian females is related to ethnicity. The African females in the current study exhibited the highest prevalence of overweight (15.6%) and obesity (15.6%) of any subgroup. Recently, Gulliford et al. (22) reported that 17% of female Africans from Trinidad and Tobago, eight to nine years of age, were considered overweight compared to 7.5% and 14% for Indian and mixed girls, respectively. The health disparity documented in Trinidad is not unlike that observed in the U.S or in other cultures around the world. In the U.S., for example, 35.8% of African American women are obese compared to 19.3% of non-Hispanic, white women (3). In South Africa, blacks are two times more likely than whites to be obese (3, 13).

Urban African females had a higher mean weight and BMI than urban Indian females, similar to the ethnic differences described in Trinidad and Tobago primary school students (22). Also, African males had a higher mean height, weight, and BMI than Indian males. While both male and female Africans tended to be larger than Indians, only the females showed higher overweight and obesity rates.

Previous studies have shown that the prevalence of obesity tends to be higher in urban areas than in rural areas of developing countries, but no differences in obesity rates were identified in the present study (11, 14). The lack of difference may be related to the methodology used to randomly select subjects for participation in the study. Adolescents were selected to participate by the schools they attended. The island of Trinidad is only about 3,000 km^2 in size and for some schools, the delineation between rural and urban is not clearly evident. It is quite possible that students living in rural areas of Trinidad attended urban schools and vice versa. Classification of students into rural and urban groups by their place of residence, rather than by the location of the school, may have provided better evidence of urban versus rural differences in obesity. The other possibility is that the rural and urban areas are not different with respect to lifestyle patterns that potentially influence the development of overweight.

While mean BMI values did not differ based on location, urban African and mixed girls did have significantly higher skinfold measurements than rural African and mixed girls, indicating greater adiposity in the urban girls than the rural girls. The difference in the sum of skinfold measures does not appear to be related to diet. There were no differences in energy intake between the groups. However, females attending rural schools did report more minutes of activity on the previous school day than females attending urban schools ($p < 0.05$). It has been suggested that in developing countries, physical activity is higher in rural areas since there are usually less technological advances, such as automobiles, television, and other labor-saving devices, and more needs for physical labor in rural areas (19). Moreover, a significant inverse correlation was observed between accelerometer counts and skinfold measurements in females suggesting that activity plays a key role with respect to body composition. It is interesting to note that Trinidadian African (62.3 ± 29.3 mm), East Indian (55.0 ± 17.3 mm), and mixed (57.6 ± 22.6 mm) females had 3-site skinfold measurements slightly higher than 3-site skinfold measurements observed in U.S. white (46.3 ± 21.5 mm) and

African (53.3 ± 23.9 mm) females, ages 9-17 (35). Unlike the females, no difference in activity was observed between rural and urban males.

Trinidadian adolescents do appear to be relatively active. Both the boys and girls reported slightly higher minutes of activity on the prior school day than U.S. children and adolescents reported on the same physical activity checklist in the Bogalusa Heart Study (36). However, the impressive difference between data from the present study and the Bogalusa Heart Study is seen in minutes of inactivity defined as time spent watching television and/or playing computer games. Trinidadians reported about half as many minutes of inactivity compared to U.S. adolescents (36). In Trinidadian boys, the minutes of inactivity reported was a better predictor of BMI and skinfold thickness than minutes of activity. Data from NHANES III suggests that time spent being inactive may be a better predictor of childhood overweight than reported activity (37). This may be because it is easier for people to accurately estimate the amount of time spent watching television or playing video games compared to estimating total time spent in physical activity.

In girls, the correlation between activity measured by accelerometer counts and skinfolds suggests greater activity in girls may result in less fatness. Accelerometer average counts per minute in boys (557 ± 240) and in girls (359 ± 101) were comparable to those seen in U.S. children ages 7-15, on days with physical education (PE) classes and recess (445 ± 284) (38). However, many U.S. adolescents do not participate in regular physical education classes and accelorometer counts in U.S. children ages 7-15, was significantly lower on days when the children did not attend PE in school. (187 ± 121), which suggests Trinidadian children, on average, are probably more active than U.S. adolescents (38).

The prevalence of overweight and obesity in Trinidadian males and females did not appear to be related to energy intake, with no correlations between kilocalories and BMI or skinfold measures. Furthermore, no differences in enegy intakes were observed among African, East Indian and mixed participants that could explain the difference seen in obesity prevalences. Total energy intake in the Trinidadian boys (1896 ± 744) was less than average U.S. male adolescent intakes, but the girls had higher intakes (1977 ± 618) than that reported for U.S. female adolescents. In this age group, males typically have higher intakes than females, but Trinidadian females reported a slightly higher mean energy intake (39). This is the first study to evaluate energy intake in this population, and unfortunately, there are no validation studies using 3-day food records in Trinidadian adolescents. It is possible that the males were not as comprehensive as the females in recording their intakes and underreported energy consumption. Both males and females had relative dietary fat intakes similar to U.S. adolescents (33-35%) (40).

In conclusion, the current project is the first to evaluate the prevalence of overweight and obesity, diet, and physical activity in Trinidadian adolescents. Adolescent overweight does appear to be a public health concern in Trinidad, especially among African females. Studies with increased sample sizes will help to clarify the current findings. In addition, by comparing the current study with Gulliford et al.'s primary school data, it appears that childhood overweight and obesity increase with age, but only longitudinal research can accurately determine this information (22). While no differences in BMI, skinfolds, dietary intake, or physical activity levels were observed between participants with parental education levels at or below secondary school and those with parental education levels above secondary school, comparison of these variables using other measures of socioeconomic status, including income, would be useful. This study should serve as the preliminary step for initiating on-going monitoring of overweight and obesity in Trinidadian adolescents.

ACKNOWLEDGEMENTS

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CHAPTER 4

SUMMARY AND CONCLUSIONS

A nutrition transition is occurring throughout the world, and developing countries are experiencing an increase in obesity and related chronic diseases. No published data from the Caribbean country of Trinidad and Tobago exist on the prevalences of obesity in children and adolescents. The primary purpose of this study was to determine the prevalence of overweight and obesity among Trinidadian adolescents in urban and rural areas. Secondary purposes were to assess dietary intake and physical activity levels in this population. Demographics, height, weight, body mass index (BMI), three site skinfold thickness, three-day dietary intake, physical activity, and sexual maturity were assessed in males (n=126) and females (n=170), ages 12-18, attending secondary schools throughout Trinidad.

Findings support the notion that obesity is becoming a public health issue in Trinidadian adolescents. Twenty three percent of females and 10.3% of males were either overweight or obese. This gender difference is typical for obesity patterns. The African females exhibited the highest prevalence of overweight and obesity (34.4%) of any subgroup. Approximately 18% and 22.6% of East Indian and mixed females, respectively, were either overweight or obese. African females were taller than East Indians, and urban African females had higher mean weight and BMI values than urban East Indian females. Of the African, East Indian, and mixed males, 10%, 12%, and 9%, respectively, were classified as either overweight or obese. Although African males had higher height, weight, and BMI values than East Indian males, the prevalence of overweight and obesity was actually lower in African than in Indian males. While both male and female Africans tended to be larger than Indians, only the females showed higher overweight and obesity rates. The racial differences observed could not be explained by dietary or physical activity differences, which suggests there may be genetic factors influencing the height, weight, and BMI values of Trinidadian adolescents of varying ethnic origins.

We hypothesized that urban adolescents would have higher obesity rates. However, no clear differences in obesity rates were seen in the present study between urban and rural areas. This could be due to an unclear distinction between urban and rural areas or because we categorized students according to their schools instead of their residence. Skinfold measures, however, were significantly higher in urban African and mixed girls than in rural African and mixed girls. This indicates more fatness in the urban girls, even though no BMI differences were observed between areas.

While no relationships were seen between dietary intake and BMI or skinfold measurements, there were indicators that physical activity plays a key role in determining BMI and fatness. Females attending rural schools did report more minutes of activity than females attending urban schools (127 ± 12 versus 91 ± 10; $p<0.05$). In addition an inverse relationship was seen between skinfolds and accelerometer counts/minute in females ($r = -0.389$; $p < 0.05$). In boys, BMI and skinfolds were correlated with minutes of inactivity (watching television and playing computer games), while in girls, skinfolds were inversely correlated with activity measured by accelerometer counts/minute. Mean energy intake values were less than what is reported in U.S. adolescents, and Trinidadian adolescents also reported more minutes of activity and less minutes of inactivity than U.S. adolescents.

The present study was the first to assess overweight and obesity prevalence, diet, and physical activity in adolescents from urban and rural Trinidad. In conclusion, based on a small sample population, adolescent obesity appears to be a public health concern in Trinidad, particularly among African females. Data from this study can be used as preliminary data for larger scale studies of overweight and obesity and serve as a baseline when evaluating obesity rate changes over time among Trinidadian adolescents. If no preventative steps are taken, Trinidad could experience an obesity epidemic much like the one seen in the U.S. and other developed countries. Based on the results of this study, efforts should be focused on increasing activity in girls and decreasing inactivity (television and computer games) in boys. Trinidad has a chance to act now, before obesity reaches levels seen in the U.S.

APPENDIX A

Parental Consent Form

Nutrition and Metabolism Division
119, Eastern Main Road
Laventille.

November 13th 2000.

Dear ……………………………………

The Nutrition Unit of the Ministry of Health is about to embark on an assessment of the Nutritional Status of Secondary School Students in Trinidad. Such Surveys are done from time to time in most countries to give us an idea of certain aspects of the health of our population in the age group 12 – 18. The information that is obtained will then be used to determine what needs to be done at a National level to ensure that the health of this important group is what it should be. In many countries there are problems relating to eating patterns and exercise, for instance, among adolescents which can lead in later life to an increased risk of a number of health-related problems such as heart disease, diabetes and hypertension.

The Study is being conducted with the help of the University of Georgia, USA, and permission has been obtained from the Ministry of Education. We hope to do the following:

1 Measurements of height, weight and skin-fold thickness;
2 Obtain a record of all foods eaten over a period of three days;
3 Assess the types of physical activity in which adolescents participate;
4 Take a sample of blood for blood sugar, fats and other basic nutrients.

Trained health workers with extensive experience shall do all measurements. The sample of blood will be taken by an experienced Nurse under strictly sterile conditions and will be relatively painless. **This carries no risk whatever to the students.** A Teacher from each school in which the Survey is being done will be present throughout the exercise that would be done in **privacy**. All information collected will be **confidential** and will be used for no other purpose than as outlined above.

Your child has been chosen by the Central Statistical Office through a process of random selection to be a participant in this Survey. His/her participation in this Survey shall be of great importance to the Ministry of Health in understanding certain aspects of adolescent health. Eventually, the information obtained will be utilized to improve the health of our young people. The Survey is a continuation of a similar one that was done successfully in 66 Primary Schools throughout Trinidad and Tobago in which 7000 students were involved.

I write to seek your consent for your child to participate in this Survey. If you need further clarification you may speak to the Principal or call the Nutrition Division at 625-2296/2582.

The Technical Staff wishes to thank you for kindly considering this request.

I remain
Yours respectfully

Deepak Mahabir

Deepak Mahabir MB FRCP(Lond) FRCP(Edin) FCCP
Consultant Physician

NUTRITION AND METABOLISM DIVISION

MINISTRY OF HEALTH

....................2000

To the Parent

I hereby agree/disagree to allow my child ______________________ to participate in the Survey entitled: 'The Nutritional Status of Secondary School Children in Trinidad' which is being conducted by the Nutrition and Metabolism Division of the Ministry of Health in collaboration with the University of Georgia, U.S.A.

____

Parent's Signature

APPENDIX B

Testing Checklist

__________ID #

Participant Checklist

Initials	*Date Completed*	
________	____________	Consent Form collected
________	____________	Demographics Questionnaire collected
________	____________	Skinfold measurements
________	____________	Anthropometric measurements
________	____________	Blood draw
________	____________	Given food **(AFTER BLOOD DRAW)**
________	____________	Physical activity questionnaire
________	____________	3-day diet record explained and given
________	____________	Activity monitor explained and given
________	____________	Parent Behavior Questionnaire collected
________	____________	Teacher Behavior Questionnaire collected

APPENDIX C

Day 1 of Three Day Diet Diary

ID Number ___________

DAY 1 OF THE DIET DIARY

ID: ___________________________ Checked by: ____________________

Date: _________________________ Day of Week: ___________________

Did you drink a calcium-fortified beverage today (e.g. Calcium-fortified orange juice) or eat a calcium-fortified food (e.g. Total breakfast cereal?) Yes No

If yes, list all the calcium-fortified beverages/foods, with the BRAND name, and how much : ____

____

Write down everything you eat, beginning with the first thing you have for breakfast. Be sure to include very detailed information such as how the food was prepared, how much you ate, and the brand names.

Time Eaten	**Foods Eaten**	**Preparation Methods**	**Amount (cup, 1/2 cup, piece, etc.)**

APPENDIX D

Physical Activity Questionnaire and MET Equivalents

Physical Activity Data Form

Activity	Before School	None, Some, Most	During School	None, Some, Most	After School	None, Some, Most
Bicycling						
Swimming Laps						
Water Play (swimming pool, ocean, lake, river)						
Gymnastics (bars, beam, tumbling, trampoline)						
Exercise (push-ups, sit-ups, jumping jacks)						
Basketball						
Baseball/softball/rounders						
Football						
Volleyball						
Racket sports (badminton, tennis, lawn tennis)						
Table tennis						
Netball						
Games: tag, hopscotch						
Outdoor Play (climbing trees, hide and go seek)						
Jump rope/skip						
Dance						
Outdoor Chores (mowing, raking, gardening, cutlassing)						
Indoor Chores (mopping, vacuuming, sweeping)						
Mixed walking/running						
Walking						
Running/Jogging						
Cricket						
Golf						
Kite Flying						
Other (physical activity classes, lessons, or teams)						

	Before School	**After School**
T.V./Video	______hours _______minutes	______hours _______minutes
Video Games / Computer	______hours _______minutes	______hours _______minutes

List of MET Values for Physical Activities

Activity	METs
Bicycling	4.0
Swimming laps	8.0
Gymnastics: bars, beam, tumbling, trampoline	4.0
Exercise: push-ups, sit-ups, jumping jacks	8.0
Basketball	6.0
Baseball/Softball/Rounders	5.0
Soccer	7.0
Volleyball/Netball	3.0
Racket sports	5.7
Ball playing: four square, dodge ball, kickball, catch	5.0
Games: chase, tag, hopscotch	5.0
Outdoor play: climbing trees, hide and seek	5.0
Water play: swimming pool, ocean, or lake	6.0
Jump rope	10.0
Dance	4.5
Outdoor chores: mowing, raking, gardening	4.8
Indoor chores	3.5
Mixed walking/running	6.0
Walking	3.5
Running	8.0

APPENDIX E

Activity Monitor Form

________ID #

☆ **Please Return to School By: ______________________**

<u>Activity Monitor Instructions</u>

1. Attach monitor to your waist
5. Wear for **THREE (3)** days**: 2 weekdays and 1 weekend day**
6. Monitor should be worn at all times, from wake-up time, until bedtime

   EXCEPT: during baths and/or swimming

- ✓ Please complete the 3-day period before the date at the top of the page
- ✓ Record days, dates, and time the monitor was worn in the spaces below

☆ AND RETURN THIS SHEET WITH THE MONITOR ☆

DAY ONE:	day:	date:	time:
DAY TWO	day:	date:	time:
DAY THREE	day:	date:	time:

<u>CAUTIONS</u>

- ✓ ***Never get the monitor wet***

1. ***Please check clothing before washing to avoid laundering***

If you have any questions about the monitor, please call Dr. Deepak Mahabir at : 868-625-2296.

THANK YOU FOR YOUR PARTICIPATION IN OUR STUDY!

APPENDIX F

Demographic Questionnaire

Study #___________
(To be completed
by investigator)

CONFIDENTIAL
TRINIDAD AND TOBAGO ADOLESCENT HEALTH SURVEY 2001

1. **School ___________________________________**

Your answers will help to provide information on the health of children in Trinidad and Tobago. It will be a great help if you answer all questions. Answers will be treated as strictly confidential.

If possible the questionnaire should be completed by the participant with the help of a parent or guardian.

Please tick (√) your answers where appropriate.

2. When were you born?

Month___________ Day________ Year_________

3. How much did you weigh at birth?
If you do not know, do not guess but state "don't know"

____________lb and ___________oz

OR _____________grams OR don't know ______

4. **How many children are in your family?___________**
Include yourself

ADOLESCENT'S FOOD AND DIET

During the school term do you usually:

5. Have breakfast at school? Yes____ No_____

6. If yes, is this meal free of charge? Yes_____ No_____

7. Have lunch at school? Yes_____ No_______

8. If yes, is this meal free of charge? Yes_____ No_____

9. Have other food at school? Yes_____ No______

10. If yes, is this food free of charge? Yes_____ No_____

11. Are you a vegetarian? Yes_____ No______

ADOLESCENT'S PARENTS AND HOME

12. **How much does your NATURAL mother weigh?**

________stones OR ________lbs

OR ___________kg OR Not known_____

13. **How tall is your NATURAL mother?**

________ft _________inches

OR _______metres ________cm

OR Not known______

14. **How much does your NATURAL father weigh?**

________stones ________lbs

OR ____________kg

OR Not known_____

15. **How tall is your NATURAL father?**

________ft ________inches

OR _______metres _______cm

OR Not known______

16. **How many people live in your household?_________**

Please include babies and any person who usually shares food bought or prepared for your household.

1. **How many rooms are used by your household? _____**

Not including bathroom and toilet.
Exclude kitchen if it is only used for cooking and Washing.

18. **Does your mother or female guardian work outside the home?**

Yes_______ No___________

19**. What was the highest level of education your MOTHER or FEMALE GUARDIAN received?**

none____ primary_____ secondary_____

commercial or technical______ university_____

20. **What was the highest level of education your FATHER or MALE GUARDIAN received?**

none____ primary_____ secondary_____

commercial or technical______ university_____

21. **Does your MOTHER or FEMALE GUARDIAN live in the home?**

Yes______ No_______

22. **Does tour FATHER or MALE GUARDIAN live in the home?**

Yes______ No_______

Which of your grandparents live in the same home as you?

23. Grandmother on mother's side ______

24. Grandmother on father's side ______

25. Grandfather on mother's side ______

26. Grandfather on father's side ______

27. **Is your FATHER or MALE GUARDIAN employed at present?**

Yes______ No_______

28. **If NO has he been unemployed for more than 12 months?**

Yes______ No_______

29. **Is your MOTHER or FEMALE GUARDIAN:**

a housewife?______

in paid employment at present?_______

not in paid employment at present? ________

30. **How would you describe your ethnic group?**

African _____
Indian _____
White _____
Chinese _____
Mixed _____
Other _____
Not Known _____

31. **What is the drinking water supply that you use at home?**

piped supply in house ______
piped supply in yard ______
private catchment not piped ______
public stand pipe ______
public tank ______
other ______
not known ______

FEMALES

32. **Have you started your menstrual cycles?**

Yes_____ No_____

If yes, how long have you had your period?

_____years _______months

Thank you for completing the questionnaire. Please write any comments here:

____

____

____

____

____

APPENDIX G

Sexual Maturation Rating

ID Number ___________

CONFIDENTIAL
Your information will be kept private. It will not be shared with anyone.

TRINIDAD AND TOBAGO ADOLESCENT HEALTH SURVEY 2001

MATURATION

2. School ___________________

3. Stated age (years) ________________

4. Date of birth ________________

5. Gender ______________

6. a. Do you have pubic hair? _____yes   ______no

   b. If yes, at what age did you develop pubic hair? _____

6. a. Do you have underarm hair? _____yes   _____no

   b. If yes, at what age did you develop underarm hair? ______

7. (MALES ONLY)

   a. Do you have facial hair? _____yes   _____no

   b. If yes, at what age did you develop facial hair?

8. (FEMALES ONLY)

   a. Have you started your menstrual cycles? _____yes   _____no

   b. If yes, at what age did you start your menstrual cycles? _______

APPENDIX H

International Obesity Task Force International Cutoff Points

International cutoff points for body mass index for overweight and obesity by sex between 11 and 18 years, defined to pass through body mass index of 25 and 30 kg/m^2 at age 18, obtained from data from Brazil, Great Britain, Hong Kong, Netherlands, Singapore, and United States.

	Body mass index 25 kg/m^2		Body mass index 30 kg/m^2	
Age (years)	Males	Females	Males	Females
11	20.6	20.7	25.1	25.4
11.5	20.9	21.2	25.6	26.1
12	21.2	21.7	26.0	26.7
12.5	21.6	22.1	26.4	27.2
13	21.9	22.6	26.8	27.8
13.5	22.3	23.0	27.2	28.2
14	22.6	23.3	27.6	28.6
14.5	23.0	23.7	28.0	28.9
15	23.0	23.9	28.3	29.1
15.5	23.6	24.2	28.6	29.3
16	23.9	24.4	28.9	29.4
16.5	24.2	24.5	29.1	29.6
17	24.5	24.7	29.4	29.7
17.5	24.7	24.8	29.7	29.8
18	25	25	30	30