THE PREVALENCE OF UNDERWEIGHT, OVERWEIGHT AND OBESITY IN TWO GROUPS OF CHILDREN (ST. KITT AND TRINIDAD), USING TWO METHODS OF CLASSIFICATION

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August 2014

A thesis submitted to McGill University in partial fulfilment of the requirements of the degree of Master of Science

Dedicated to my late grandfather, Samuel Payne, whose life epitomized hard work;

my parents Joan Payne and Lisle Griffith, and my brothers Julian and Gregg,

whose love made all life's adventures possible.

ABSTRACT

Background: This study compares prevalence estimates of underweight and excess weight among two groups of children from the Caribbean islands of St. Kitts and Trinidad, according to two Body Mass Index reference cut-points. The cut-points are based on growth references generated by the World Health Organization (WHO) and the International Obesity Task Force (IOTF).

Methods: Heights and weights were obtained from both cohorts of children from St. Kitts (n=189) and Trinidad (n=463) during the baseline assessment of the *'Improving the nutrition and health of CARICOM populations through sustainable agricultural technologies that increase food availability and diversity of food choices'* (2011). Prevalence of underweight, overweight and obesity was estimated using the WHO (2007) and IOTF growth cut-offs.

Results: Irrespective of classification method the prevalence of overweight and obesity were high: St. Kitts-12.3% and 8.0% (WHO); 7.0% and 3.7% (IOTF), Trinidad-14.4% and 12.7% (WHO) and 12.3% and 10.3% (IOTF), respectively. Underweight estimates also varied: St. Kitts-2.1% (WHO); 25.7% (IOTF), Trinidad-5.0% (WHO) and 13.6% (IOTF), respectively.

Conclusion: There is a lack of consistency between the two main international growth references in accessing weight status in children and adolescents. The IOTF growth reference produces higher estimates of underweight compared to the WHO and lower rates of overweight and obesity, which were all statistically significant. However there is virtually no stunting in the populations, with underweight children appearing to be as tall as children in other weight categories. Therefore the question of dual burden of underweight and excess weight in the groups from St. Kitts and Trinidad remains unclear. Therefore when interpreting the prevalence estimates of underweight, overweight and obesity for children it is paramount to consider the weight classification used.

RÉSUMÉ

Contexte: Cette étude compare les estimations de la prévalence de l'insuffisance pondérale poids et l'excès chez les deux groupes d'enfants se forment les îles des Caraïbes de Saint-Kitts-et Trinidad, selon deux références indice de masse corporelle les points de montage. Les seuils sont basés sur les références de croissance générées par l'Organisation mondiale de la Santé et le Groupe de travail international sur l'obésité.

Méthodes: Taille et le poids ont été obtenus à partir de deux cohortes d'enfants de Saint-Kitts (n = 189) et Trinidad (n = 463) lors de l'évaluation de base de la «Améliorer la nutrition et la santé des populations de la CARICOM à travers les technologies agricoles durables qui augmentent la nourriture la disponibilité et la diversité des choix alimentaires »(2011). Prévalence de l'insuffisance pondérale, surpoids et de l'obésité a été estimée à l'aide de l'Organisation mondiale de la santé (2007) et la croissance de l'International Obésité Task Force (IOTF) seuils.

Résultats: Peu importe la méthode de classification de la prévalence du surpoids et de l'obésité étaient élevés: Saint-Kitts-12,3% et 8,0% (OMS); 7,0% et 3,7% (IOTF), Trinité-et-14,4% et 12,7% (OMS) et de 12,3% et de 10,3% (IOTF), respectivement. Estimations insuffisance pondérale varie également: Saint-Kitts-2.1% (OMS); 25,7% (IOTF), Trinité-et-5,0% (OMS) et 13,6% (IOTF), respectivement.

Conclusion: Il y a un manque de cohérence entre les deux principales références de croissance internationale pour accéder statut pondéral chez les enfants et les adolescents. La référence de croissance IOTF produit estimation la plus élevée de l'insuffisance pondérale par rapport à l'OMS et des taux plus faibles de la surcharge pondérale et l'obésité, qui étaient toutes statistiquement significatives. Cependant, il n'existe pratiquement pas de retard de croissance chez les populations, avec des enfants souffrant d'insuffisance pondérale qui semblent être aussi grand que les enfants des autres catégories de poids. Par conséquent, la question de la double charge de poids insuffisant et l'excès dans les groupes de Saint-Kitts-et-Trinité, étant donné les taux de différentes références de prévalence, reste incertaine. Par conséquent, lorsque l'interprétation des estimations de la prévalence de l'insuffisance

pondérale, le surpoids et l'obésité chez les enfants, il est primordial de tenir compte de la classification du poids utilisé.

Acknowledgements

I would like to thank my brilliant and compassionate supervisor, Professor Katherine Gray-Donald, for her guidance and in-depth knowledge. She has given me the confidence and equipped me with the tools to grow as a researcher. Professor KGD is especially appreciated for her guidance through the research process and her helpful and reassuring words. I would like to acknowledge, Dr. Leroy Phillip, principle investigator of the CARICOM project and my committee, for first of all letting me contribute to the 'Improving *the nutrition and health of CARICOM populations through sustainable agricultural technologies that increase food availability and diversity of food choices'* project. I would also like to thank him for his insightful comments and editing my thesis proposal and thesis.

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, and with the financial support of the Government of Canada provided through Foreign Affairs, Trade and Development Canada (DFATD). Louise Johnson-Down deserves special thanks for her expert assistance guidance with data analysis. I am indebted to Dr. Maureen Rose for opening the door for me to pursue studies with in the department. Finally, I would also like to thank the members of the CARICOM Food Security Research and the Global Food Security research teams for the great sense of community I was afforded during my stay at McGill University.

Preface & Contribution of Authors

The study was a secondary analysis of data derived from the CARICOM project *'Improving the nutrition and health of CARICOM populations through sustainable agricultural technologies that increase food availability and diversity of food choices'*. Dr. Leroy Phillip was the principle investigator of the project and a professor at McGill University's Department of Animal Science. Dr. Phillip was a thesis committee member provided guidance and professional opinions throughout the study. Dr. Katherine Gray-Donald, candidate's supervisor and Associate Professor at McGill University, contributed to and supervised all aspects of the study, from conception to editing. Dr. Gray-Donald also contributed to the statistical analysis, and interpretation of the results.

List of Abbreviations

BMI	Body Mass Index
CARICOM	Caribbean Community
CDC	Centre for Disease Control
CFNI	Caribbean Food and Nutrition Institute
CVD	Cardiovascular Disease
DM	Diabetes Mellitus
FAO	Food and Agricultural Organization
GDP	Gross Domestic Product
GSHS	Global School-based Health Survey
HDI	Human Development Index
IOTF	International Obesity Task Force
NCD	Non-Communicable Diseases
NHANES	National Health and Nutrition Examination Survey
NHES	National Health and Examination Survey
OWO	Overweight and Obesity
PAHO	Pan-American Health Organization
SABE	Wellbeing and Aging in Latin America and The Caribbean

SAS	Statistical Analysis System
SES	Socio Economic Status
SPSS	Statistical Package for the Social Sciences
STEPS	STEPwise approach to Surveillance
USDA	United States Department of Agriculture
WHO	World Health Organization

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1. BACKGROUND

The Caribbean Common Market (CARICOM) is an economic grouping composed of 15 member states. The member countries are predominately small island states located in the Caribbean Sea, although some members are located on the mainland of Central (Belize) and South (Guyana) America. These countries, with a combined population of over 17 million inhabitants, have a long history of plantation based agriculture, such as sugar cane, bananas and spices, for economic development. This has resulted in the neglect of local food production, particularly fruits, vegetables and staple crops. A historic lack of food sovereignty has led to limited agricultural diversity (further exacerbated by a seasonal nature of crop production); inefficient land use; antiquated agricultural technologies; and an underdeveloped market structure (Rhiney, 2008). Moreover, changes in the global political economy, especially those relating to trade liberalization, have made many CARICOM states increasingly aware of the need to reform their agricultural sectors if they are to remain or become food secure nations (Rhiney, 2008). In addition, many CARICOM states are heavily dependent on the importation of highly processed energy dense foods, which have displaced the consumption of many traditional staple foods, such as sweet potatoes, yams and cassava.

The global obesity epidemic has been escalating over the past several decades, yet sustained prevention efforts have proven ineffective to stem its tide (Gortmaker et al., 2011). This phenomenon has not escaped CARICOM states. Overweight and obesity (OWO) once problems of the developed world, are having a dramatic impact on the public health landscape of these developing countries. Developing countries, such as those of CARICOM, are projected to have the highest increases in the prevalence of OWO. Forecasts suggest that high rates of obesity and non-communicable diseases (NCD) will have a debilitating effect on future populations' health and economics (Gortmaker et al., 2011). Recent data suggest that worldwide up to one third of children and adolescents are OWO (Benefice, Caius, & Garnier, 2004). With such a high prevalence, mapping of patterns and distributions of groups and individuals at risk of OWO is an important step to comprehending and reducing the problem. In addition some authors cite under-nutrition as a persistent and re-emerging public health threat within many developing nations (Gardner, Bird, Canning, Frizzell, & Smith, 2011).

2. RATIONALE

Children and other vulnerable groups in society are often the least able to adapt to changes in their environment. This is primarily related to an inability to understand and adapt to these changes. The adverse health implications of childhood OWO are well documented (Heinberg & Thompson, 2009; Must & Strauss, 1999). For these reason childhood is a critical period for monitoring the progression and understanding the influences of obesity. In order to understand the dynamics of childhood OWO; reduce the long-term public health foot-print; and begin stabilizing the increase in prevalence rates, it is also important to understand the influences of child obesity and how they differ among different communities and islands. This thesis focuses on St. Kitts and Nevis (here after called St. Kitts) and Trinidad and Tobago (here after called Trinidad).

Many studies have indicated that obesity rates in Caribbean children are increasing, in line with the global trend (Gardner et al., 2011; Gaskin & Walker, 2003; Rueda-Clausen, Silva, & López-Jaramillo, 2008; Xuereb, Johnson, Bocage, Trotter, & Henry, 2001). Under-nutrition also remains a persistent concern to public health and development. In a recent study in St. Lucia by Gardner and colleagues (Gardner et al., 2011) the estimated the prevalence of OWO to be 14.4% and 9.2% (WHO); 11.3% and 12.0% (CDC); and 9.9% and 7.1% (IOTF.), respectively. Estimates of underweight were calculated as high as 11.3% (CDC). They also cited that according to the WHO 2006 growth standard obesity was (15.2%) was more than 3 times the adjusted 1976 rate (4.3%). Gardener and colleagues reported no stunting in the study group. Other contemporary studies (Fernandez, 2012; Gaskin & Walker, 2003) have made similar findings, in relation to levels of underweight, overweight and obesity.

From an extensive literature search it is clear that OWO, in both adults and children, has not been documented in a systematic way on the islands of St. Kitts and Trinidad, and considerable knowledge gaps remain. Most recently analysis from the 2011 St. Kitts and Nevis Global School-based Student Health Survey (GSHS) highlighted that total prevalence of underweight overweight and obesity (students aged 13- 15 years) was 3.5%, 32.5% and 14.4%, respectively, using the WHO growth reference. Trinidad has one of the highest prevalence, morbidity and mortality rates for NCD in the Caribbean, with NCD accounting for over 60% of premature loss of life (death before 70 years). The WHO estimated that in 2005, 45% of women and 15% of men are obese (BMI ≥ 30). These rates are more than double what they were in the 1980s, and the rate of increase continues unabated. Existing evidence points to dramatic increases in OWO since the beginning of the global obesity epidemic during the 1980s and 1990s. Therefore it is essential to obtain a current measure of the prevalence rates for adults and children, using appropriate growth references; to begin to comprehend and address the potentially high OWO levels in St. Kitts, Trinidad and the wider CARICOM region.

Both extremes of childhood malnutrition create public health challenges, however understanding of the problem within the region remains limited. The islands of St. Kitts and Trinidad are no exception to this trend. The use of varying criteria to define childhood OWO within the scientific literature restricts the comparisons across research sudies and national surveys. Within this context this thesis attempts to estimate the prevalence of underweight, OWO in two groups of children and parents in St. Kitts and Trinidad, using two widely used international growth references.

3. STATEMENT OF PURPOSE

The primary objective of this thesis is to determine, using BMI, the prevalence of underweight, overweight and obesity of both groups of children 5-9 years old; and add to the literature on the state of childhood OWO in the CARICOM region. This assessment of weight status will be done using the WHO 2007 and the IOTF growth references. Secondary objectives include comparing the level of obesity of caregivers to their children; comparing and contrasting the current the prevalence rates of underweight, overweight and obesity, with historic data and other data available throughout the region. Also, this thesis examines the link between childhood and parental weight status and food security.

4. LITERATURE REVIEW

4.1 Obesity: The Size and Nature of the Problem

Until the latter part of the 21st century obesity was a rare phenomenon. Prior to that time an overwhelming majority of the population suffered from weight deficits and nutritional deficiencies. During that time increased body weight was associated with good health and elevated socio-economic status (SES). This paradigm has shifted over the past 30 years as the prevalence of obesity and its comorbidities, such as diabetes mellitus (DM) and cardiovascular diseases (CVD), increased exponentially. This increase has occurred consistently in high, medium and low income countries, and across all socioeconomic classes (Finucane et al., 2011).

In classical biological terms obesity can be characterized as a chronic energy imbalance, involving both an intake of excess energy and restricted energy expenditure. This conceptualization has an almost romantic simplicity; however within a public health context there are various physiological, behavioural and environmental factors which interact to promote or prevent the development of obesity. Evidence points to changes in the food system, which have resulted in the increased consumption of highly processed calorie dense foods and beverages. Moreover, our biology has also endowed us with a strong taste preference for high sugar and high sodium foods; coupled with effective marketing of these products an almost insatiable demand for these foods has developed (Chandon, 2012; Gortmaker et al., 2011).

The obesity epidemic seems to have begun concurrently in most developed countries in the 1970's and 1980's, with Japan being a notable exception, and subsequently spread to middle and low income countries (Finkelstein, 2005; Swinburn et al., 2011). The IOTF has estimated that 1 billion people can be classified as overweight (BMI 25-29.9kg/m^2) and 475 million can be classified as obese (BMI equal to and greater than 30kg/m^2). In 2010 the IOTF estimated that 200 million school aged children are overweight or obese, and of those 50 million can be classified as obese. By 2030 the global prevalence of overweight and obesity (OWO) is estimated to be 2.16 billion and 1.12 billion respectively (Popkin, Adair, & Ng, 2012).

Accurate analysis of the distribution of obesity had been limited due to the absence of representative data from many countries. However, the pattern which has emerged in middle income countries, such as such as Brazil, China, India and Mexico, is that groups of higher SES in urban centers tend to be first affected by a high prevalence of obesity; the burden of obesity then shifts to the lower SES groups, due to an increased accessibility of cheaper calories in the form of fats and sugars (Popkin & Doak, 1998; Swinburn et al., 2011). Conversely, in the world's poorest countries, where there are high levels of food insecurity the poor are 'protected' against obesity due to a simple lack of excess calories. Within this context, it appears that as a country's gross domestic product (GDP) increasing rates of OWO tend to follow, implying that economic development and prosperity facilitate higher levels of OWO (Swinburn et al., 2011). On the contrary, some low income counties, such as those Pacific Island Nations, have some of the highest rates of obesity worldwide (Waqanivalu, 2010). In at least 10 islands 50% (and in some up to 90%) of the population is overweight; rates of obesity range from 30% in Fiji to a shocking 80% among women in American Samoa (Waqanivalu, 2010). Although a reduction in a country's gross domestic product or a return to national poverty is not an ideal approach for reducing rates of obesity, it has been demonstrated to have that effect in countries, such as Nauru and Cuba (Swinburn et al., 2011).

4.2 A Downward Trend in the Prevalence of Overweight and Obesity?

A review published by Rokholm *et al.* (Rokholm, Baker & Sørensen, 2010) pointed to an apparent leveling off in the prevalence of adult obesity in England, USA and Sweden. However, their analyses also pointed to heterogeneity across groups of different SES, with the leveling off in obesity prevalence being less pronounced in lower SES groups and non-white ethnicities (Rokholm et al, 2010). No gender differences were identified in their study. This stability is also prevalent among children and adolescents in several parts of the world (Romon et al, 2009). Surprising, Rokolm *et al* also cited high quality studies which also demonstrated leveling off of the epidemic in children from Australia, Denmark, England, France, Greece, the Netherlands, Sweden, Japan and the USA (Rokholm et al, 2010; Romon et al, 2009; Salanave, 2009). However, Rokholm and colleagues (Rokholm et al, 2010) cautioned that major parts of the world populations were not covered in the analysis; and within countries where data were not available or not necessarily representative of all age groups. Therefore the apparent leveling off evident in many studies might not conclusively indicate a reversal in the obesity epidemic (Rokholm et al., 2010). The researchers also added, previous stable phases have been followed by further increases in the prevalence of obesity. Clearly the numbers of obese individuals in the world has never been greater than today, so the obesogenic environment continues to exert its effect.

4.3 Obesity in the CARICOM Region

Over the past three decades the Caribbean region has undergone unprecedented demographic and nutrition transitions (Rhiney, 2008; Sinha, 1995). During this time claorie intake significantly increased; primarily from increases in fat (mainly aninmal source foods) and processed carbohydrates (Sinha, 1995). On the other hand, Caribbean populations failed to meet the required intakes of fruits, vegetables, legumes (Table 2) and other high fibre foods. This is coupled with deminishing levels of physical activity as the society moved away from a labour intensive agrarian regime to a sedentary service based economy (Rueda-Clausen et al., 2008). With this new development the prevalence of malnutrition, infectious diseases and micronutrient defiencies have significantly declined (Sinha, 1995). Today the burden of NCD, which inculde CVD, hypertensive disorders, gastrointestinal cancers and Diabetes Mellitus (DM) are the leading causes of morbidity and mortality thorughout the region (Rueda-Clausen et al., 2008). A joint report by the World Health Organization (WHO) and Food and Agricultural Organization (FAO) concluded that by 2020 CVD and other NCD will be responsible for 57% of all deaths worldwide (Rueda-Clausen et al., 2008). The dramatic increase in the prevelance of these NCD is higher in low income groups in low and middle income countries, who have greater access to a Western lifestyle (characterized by calorie rich diets and increased levels of sedentary activity) (Rueda-Clausen et al., 2008).

Rueda-Clausen and colleagues (Rueda-Clausen et al., 2008) eluded to the fact that over the past 40 years there have been no reliable statistics to document the increasing prevelance in OWO within the Caribbean and to some extent the wider Latin America region, compared to systematic data available for the USA. Nonetheless, a central feature of the nutrition transition in the Caribbean is that the high levels of NCD have followed right on the heels of high levels of chronic undernutrition and infectious diseases. The alacrity of this epidemiological shift has caught regional governments by surprise, and few have been able to stem the increasing economic burden associated with the treatment of OWO and NCD (Francis, Nichols, & Dalrymple, 2010). This overall pattern of growing levels of NCD reflect deleterious physiological adaptations to the dramatic changes in the environment that have accompanied economic development (Health & Development, 2006). Moreover many CARICOM states are faced with mounting external debt, strucural adjustment policies and sweeping spending cuts across all sectors. In 2006 conservative estimates by Fraser (Fraser, 2006) suggested the economic cost of treating and managing obesity and its co-morbid conditions regionally amount to one billion US dollars per year.

Table 1 below highlights some of the key findings from a Panamerican Health Organization (PAHO) report (Pan American Sanitary, 2012) on the Latin American and Caribbean Region.

It illustrates that published prevalence data on obesity and NCD are not often available and when it is collected and published it is not done in a systematic or consistant manner. However available data reflect poor nutritional outcomes of much of the region. In Barbados 62.5% of the population is OWO, with almost 75% of females older than 25 years old having excess body weight. Alarmingly 95.4% of the population do not intake adequate levels of fruits and vegetables. On the islands of St. Kitts and Trinidad the outlook is equally disturbing, with NCD and obesity representing the primary impediments to optimal health. As a result these conditions are the primary causes of adult morbidity and mortality.

Table 1: Nutrition and Health challenges within selected CARICOM countries

Country	Nutition and Health Outcomes
Barbados	According to the BRFS 44% of the population is reported having at least 3 risk factors for NCD. The Ministry of Healh estimates by 2030, 86.3% of all deaths will be due to NCD. Within the Barbadian population 25 or older: • 65.2% - Overweight or obese • 54.6% - Males overweight or obese • 74.3% - Females overweight or obese • 95.4% - Eat fewer than 5 servings of fuits and vegetables daily
St. Kitts and Nevis	Secondary school students (11-16 years): • 32.5% - Overweight • 14.4% - Obese Prevalance of diabetes in 2010 was 20%. Combined prevelance of hypertension-34.5%; males- 38.2%; females- 31.9%
Trinidad and Tabago	• Prevalence of diabetes- 12% • Hypertension- 12% • NCD account for 60% of all adult deaths
Jamaica	Over the past 25 years NCD were the leading cause of death: • 60%- Men • 75%- Women In 2009 % of population aflicted with: • Diabetes- 7.9% • Hypertension- 35.3% • Obesity- 25% • Physical Inactivity- 30%
Dominica	NCD comprised 55% of all defined causes of mortality in 2009.
St. Lucia	NCD accounted for 71% of all deaths in 2008.

From the PAHO report it is clear that most CARICOM countries have made significant strides in adressing maternal and infant mortailty and communicable diseases. However, undernutriton remains a concern for governments and countries are dealing with the traditional maladies of early childhood undernutrition and emerging adult obesity simultaneously (Peña & Bacallao, 2000). In St. Lucia, Gardner and colleagues (Gardner et al., 2011), using the WHO 2007, CDC and IOTF growth references, estimated the combined (boys and girls at age 5) underweight prevelance to be 4.7%, 11.3% and 6.3% respectively. In a study in Barbados, using the WHO growth reference with a nationally representitive sample, Fernandez (Fernandez, 2012) estimated the prevelance of underweight at 3.3%. A study by de Onis *et al*. (de Onis, Blössner, Borghi, Frongillo, & Morris, 2004) which determined the prevalence of underweight in children 1990 and estimated the prevalence 2015. In 1990 the Caribbean region had a combined prevalence of 10.0% and it was estimated to decline to 2.8% in 2015. This is compared Europe, Japan, Australia, Canada, and United States which combined had an estimated prevalence rate of 1.6% in 1990 and a projected prevalence of 0.9% in 2015.

4.4 The Scarcity of Data In the CARICOM Region

Historically within Caribbean countries there has always been dearth of anthropometric research. This limits the accurate tacking and analysis of trends in underweight and OWO. Therefore it is difficult to make meaningful determinations and comparisons between contempory and historic trends. Comprehensive estimation of regional levels of OWO are often not possible, as many terrirories have not carried out national surverys to estimate prevalence rates. Moreover, it is not representitative to superimpose sparse data collected from the few terrorties to characterize the CARICOM region as a whole. Although inhabitants of many islands are predominantly of African origin, some islands are ethnically diverse consisting of large populaions of East and South Asian descent and indigenous populations. To paint an accurate portrait of the prevalence of underweight, OWO data have to be collected using identical growth references or standards throughout the Caribbean.

People of African ancestry living in the Caribbean share common genetic orgins, though they may live in different socioeconomic environments. A cross cultural study (The International Collaborative Study of Hypertension in Blacks) by Wilks *et al.* (Wilks, 1996) demonstrated that Barbadian participants had higher rates of obesity and hypertension, compared to Jamaica and St. Lucia counterparts; however they had lower rates for both obesity and hypertension than a black urban population in Chicago USA.

Table 2: Prevalence rates of obesity among adults (2007-2009)

	St. Kitts	BVI	Barbados	Dominica
Sample Size	1443	1105	1282	1059
Obesity in Men %	38	28	20	9
Obesity in Women %	52	44	35	33
Population consuming less than 5 servings of F&V a day %	97%	92%	95%	91%

BVI-British Virgin Islands; F&V- fruits and vegetables; Data adapted from the report of the Caribbean Commission for Health and Development (2006), Selected risk factors from STEP-wise approach to surveillance chronic non-communicable diseases risk factor surveys.

Although the prevalence of OWO has increased in all race and sex groups, secular trends among black women have increased more dramatically (Freedman et al, 2005). As with other regions, a central feature of OWO in the Caribbean is the disporptionate nature girls and women are affected (Ali, Rizzo, & Heiland, 2013). Table 2 presents a summary of data taken from a report published by Caribbean Commission for Health and Development (Health & Development, 2006). The prevalence of obesity in women was significantly greater compared to males, with the greatest disparity on the island of Dominica, where obesity in females is four times higher than that of males. Table 2 also highlights poor intake of fruits and vegetables within these countries. St. Kitts had the lowest intake, with only 3% of the population sampled having the required intake of 5 or more servings per day, as specified by the Canadian food guidelines. In a study from Jamaica by Ichinohe *et al*. (Ichinohe et al., 2005) the obesity prevalence of women was 23.9%, more than double that of Jamaican men. The study by Ichinohe and colleagues also demonstrated that their Jamaican study population also had low vegetable intake. They associated low vegetable intake with positive risk of obesity. Other lifestyle risk factors related to obesity were also investigated and Ichinohe *et al.* (Ichinohe et al., 2005) reported lower levels of exercise and lower education attainment in females to be associated with higher rates of OWO. Conversely, non-smoking and co-habitation were found to be protective against obesity in both men and women.

The Health, Well-Being and Aging in Latin America and the Caribbean (SABE) Study by Al Anih and colleagues (Al Snih et al., 2010) compared 6000 elderly subjects in six cities in

Latin American and the Caribbean. The study showed Barbados had the lowest rates of obesity and NCD compared to other Latin American cities. However Barbadians appear to be some of the unhealthiest in the Caribbean, based on a higher prevalence of obesity and NCD, though not as unhealthy as their South American counterparts (Al Snih et al., 2010). These findings are consistent with older data published by Popkin and Doak (Popkin & Doak, 1998) which highlighted Barbados and Cuba as having highest prevalence of obesity in the Caribbean.

4.5 The Effect of the Obesogenic Environment on Childhood and Adolescent Growth

Dietary interventions consistently fail to produce significant and sustained weight reduction in OWO adults (Bal, Finelli, Shope, & Koch, 2012). This limited success of adult obesity interventions has led to a renewed interest in prevention programs targeting children and adolescents. The burden childhood obesity places on the health care system is difficult to quantify because the related physical health problems are usually not evident until later in life (Shields, 2006) Therefore prevention and treatment of excess weight in children is paramount, especially since most children seldom outgrow this 'problem' and are at elevated risk of becoming OWO adults (Barlow & Committee, 2007; Whitlock, Williams, Gold, Smith, & Shipman, 2005). Studies which have examined the persistence of OWO from childhood through adulthood have consistently found OWO children are more likely to become obese adults. Conservative predictive estimates range from 40%-60% and higher estimates of 65%-84% have been observed (Freedman, et al., 2005; Serdula et al., 1993). These differences between studies may be a reflection of increasing adult obesity or differences in BMI cut-offs points that have been used to classify OWO by various researchers (Freedman, et al., 2005).

The burden of childhood OWO not only has significant physical health concerns (including elevated blood lipids, hypertension, sleep apnoea, premature death and DM), but can also result in significant psychological and social health concerns (Latzer et al., 2009; Sugerman et al., 2003). SES seems to be a key indicator of obesity risk, with increasing levels of poverty being associated with greater obesity prevalence in developed countries (Gordon-Larsen, Adair, & Popkin, 2003; Youfa Wang & Zhang, 2006), but not in low income countries (Hackett, Melgar-Quinonez, & Alvarez, 2009).

As with adults, obesity is increasingly affecting larger numbers of children and at younger ages. Based on national data, there has been a steady increase in OWO in the USA from the 1970s to the 1990s; this was followed by a steep rise from 2000 onward (Swinburn et al., 2011). Similar trends can be noted in the UK, Brazil and Australia, where the prevalence of OWO also increased at a rapid rate in the 1990s (Swinburn et al., 2011). The 2004 Canadian Community Health Survey (CCHS) estimated the prevalence of OWO in children between 2-17 years old to be 18% and 8% respectvely, using the IOTF growth reference (Shields, 2006). The report also cited that children and youth who ate at least 5 servings of fruit and vegetables a day were substantially less likely to be OWO. Moreover, the likelihood of being OWO rose dramatically as sedentary activity increased (watching TV, playing video games or using a computer). Shields (Shields, 2006) also reported that the combined prevalence of OWO has more than doubled among youth aged 12 to 17, while the prevalence of obesity alone has tripled. This was a significant increase compared to CCHS from 1978-1979 where the OWO prevalence was 12% and 3% respectively. Based on 2004 data the combined prevalence of OWO for each sex was about 70% higher than in 1978/79, and the prevalence of obesity alone was 2.5 times higher. Within First Nations communities combined rates of OWO were estimated at 41%, with 20% being obese. This was 2.5 times higher than the national average. By contrast a relatively low poportion of children of East Asian or South East Asian heritage were overweight or obese (18%). However, the relatively small populations of these groups did not significantly affect national Canadian estimates (Shields, 2006). Shields (Shields, 2006) also concluded that socioeconomic factors, such as higher education attainment as being associated with a lower risk of children being OWO.

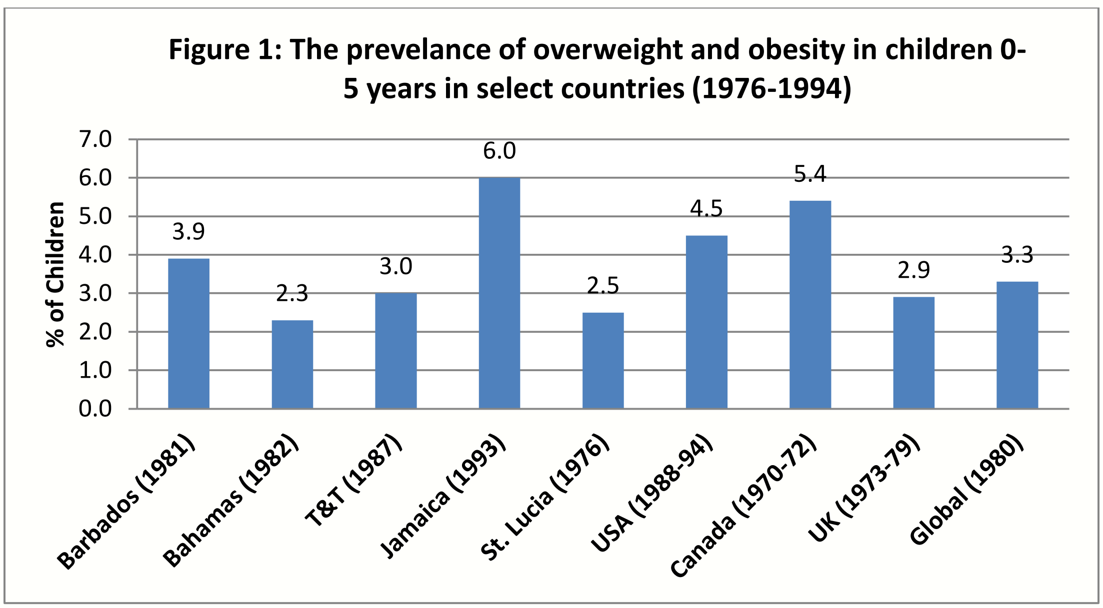
The results form the Nunavut Inuit Child Health Survey by Galloway *et al*. (Galloway, Young, & Egeland, 2010) with 388 children aged 3 to 5 years revealed the overall prevalence of overweight was 50.8%, with significantly more boys (57.1%) than girls (45.2%) in the overweight category. The study also revealed overweight prevalence is higher than that previously reported in Inuit children and may be occurring at an earlier age. Furthermore analysis of biological, dietary and socio-economic factors, including birth weight, breastfeeding, day care attendance, traditional food consumption and sugar sweetened beverage consumption revealed no significant associations that could explain the development of obesity risk in this population. Galloway and colleagues (Galloway et al., 2010) also posited the gender difference in child overweight prevalence runs counter to that reported in adults, leading to concern that contemporary growth patterns may result in significant increases in obesity related morbidity for young Inuit men. The overall rates of OWO in Inuit children were much greater than the national Canadian average but comparable to trends for children in the USA (Galloway et al., 2010).

NHANES data from 2007-2008 from the USA revealed an overall prevalence of childhood (2-19 years) OWO to be 31.7% and obesity at 16.9% (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). In the 6-11 age groups the overall prevalence was 35.5% and 19.6%, respectively, while for non-Hispanic black children OWO was slightly higher with a prevalence of 37.6% and obesity at 19.4%, respectively (Ogden et al., 2010). The trends for minority groups in the latest NHANES were similar to Latin America and the Caribbean, with childhood OWO more prevalent in Hispanic than Black children. Like the CARICOM region there is limited data on OWO in children from Saudi Arabia and the rest of the Middle East. El Mouzan *et al*. (El Mouzan Mi, 2010) conducted a recent study to establish the national prevalence of overweight and obesity in Saudi Arabian children and adolescents 5-18 years, using the WHO (2007) and the CDC growth reference. They found the overall prevalence of overweight, obesity and severe obesity was 23.1%, 9.3% and 2%, respectively, for the WHO reference. Although the CDC reference produced a significantly lower prevalence of overweight (20.4%), but not obesity (9.5%).

As with the apparent attenuation in adults obesity, recent studies have also revealed a similar trend in the prevalence of childhood OWO. Stamatakis and colleagues (Stamatakis, Wardle, & Cole, 2010) reported a stabalization in the prevelance of OWO, using a population of school-aged children (5-10 years old) living in England. However they also concluded that children from lower SES have not benefitted from the trend. A study by Yoshinaga and colleagues (Yoshinaga et al., 2010), using longitudinal and cross-sectional data from 1978-2007 with Japanese children ages 5-17 years, also demonstrated a gradual decrease in OWO since the early 2000s. The study also revealed the critical period for developing obesity was between 5-6 years old. Using an Australian population Olds *et al*. (Olds, Tomkinson, Ferrar, & Maher, 2010) concluded that although paediatric overweight remained high, the prevalence has flattened, not following the anticipated trajectory for the Australian peadiatric population. These studies are consistent with the review by Rokholm *et al*. (Rokholm et al., 2010) which also cited a leveling off of the obesity epidemic in some countries. However like Rokholm *et al.*, Kain and colleagues cautioned the data might not reflect an actual decline in the prevalence in childhood obesity, but might be a manifestation of various growth references used in different studies (Kain, Uauy, Vio, & Albala, 2002). Therefore one must proceed with caution when making comparisons among the IOTF, WHO (2007) and other growth references.

4.6 The Portrait Painted By Existing Data From CARICOM For Children

Data taken from a study by de Onis et al (de Onis & Blössner, 2000), where they estimated the combined prevalence of OWO in developing countries illustrated high rates of OWO among islands in the Caribbean (Figure 1). In some instances the obesity rates of some Caribbean exceeded those of developed countries, such as the United Kingodom and Canada. Figure 1 also shows prevalance rates form Jamaica and Barbados also exceeded the global estimate in 2000.



Adapted from Mercedes de Onis & Blössner, 2000

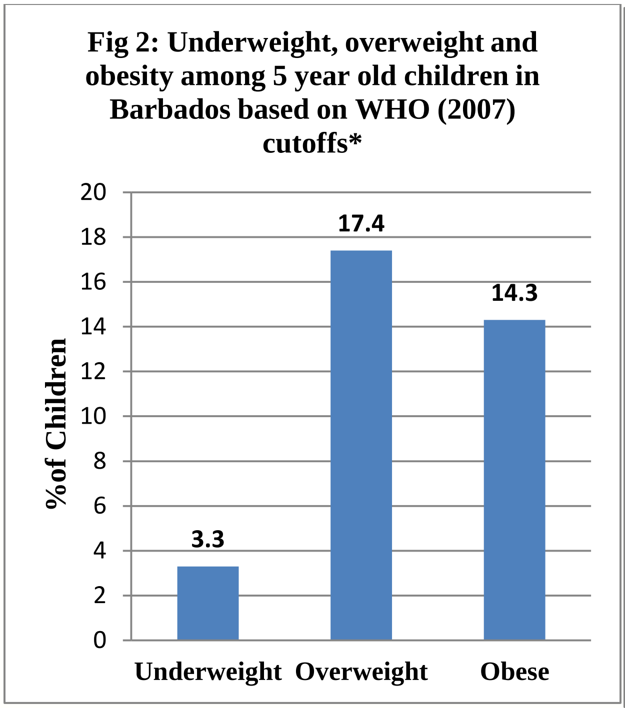
National survery data for different Caribbean countries found that for children under 15 years old between 7%-20% were classified as overweight, according to the NCHS/WHO growth reference (Sinha, 1995). However, data from Barbados for the period 1969-1981 (Table 2) overweight and obesity rates were as high as 38% in girls, with an average for boys and girls of 27%, in 1981. In the same study by Sinha (Sinha, 1995) it was observed that from 1969 to 1981 there was a 2.3 fold increase in OWO for males and an increase 1.2 fold for females. This suggests that high levels of OWO within the 0-15 years old population existed in Barbados from as early as 1969. No other data were found for any other CARICOM nation within that time frame. In a study published by the Caribbean Food and Nutrition Institute, Xreb and colleagues (Xuereb et al., 2001) concluded that combined OWO for children between 0-5 years old to have increased from 1990 to 1999 on the islands of Dominica, St. Kitts and St. Vincent (Table 3). The highest rates were seen on the island of St. Kitts, with an increase from 7.1% in 1990 to 10.7% in 1999.

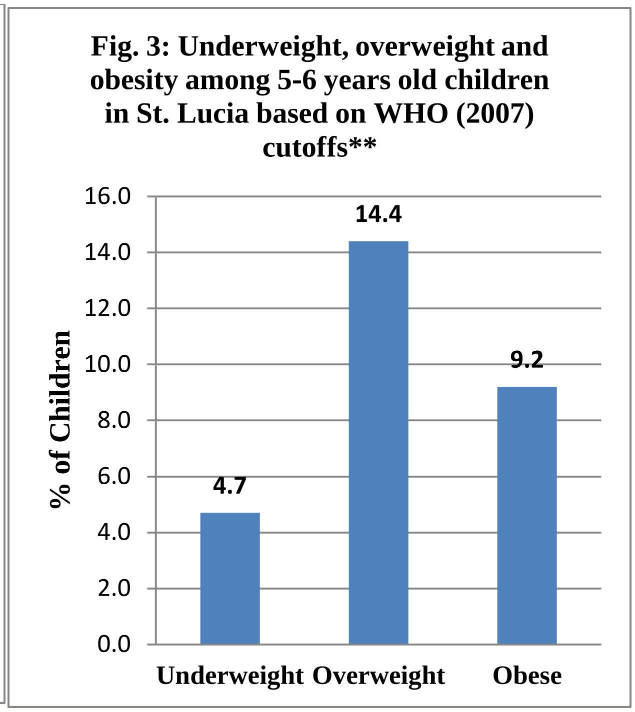
Table 3: Historical trends in the prevalence of overweight and obesity in the Caribbean region

				Overweight and Obese	
Study/Growth Reference	**Data Collection**	**Country**	**Age Range**	**Male**	**Female**
Sinha, 1995	1969	Barbados	0-15 yrs.	7.0%	33.0%
	1981			16.0%	38.0%
				Combined Overweight and Obese	
				1990	**1999**
Xuereb et al, 2001/ NCHS/WHO	1990 and 1999	Dominica	0-5 yrs.	6.0%	9.7%*
		St. Kitts		7.1%	10.6%*
	1990 and 1998	St. Vincent		6.9%	7.2%*

*- Rates of Overweight and obesity in 1999/1998; T&T-Trinidad and Tobago; UK-United Kingdom

In more recent studies by Fernandez *et al*. (Fernandez, 2012) and Gardener et al. (Gardner et al., 2011) rates of overweight and obesity were estimated using the WHO 2007 growth references, in Barbados and St. Lucia populations respectively. Figures 2 and 3 shows that groups from both islands have high rates of both OWO, with Barbados exceeding those of St. Lucia.





*Adapted from Fernandez et al. 20012; **Adapted from Gardener et al. 2011

Gardener and clleagues (Gardner et al., 2011) determined rates of underweight in a St. Lucian children ages 5-6, were estimated to be 4.7% and 6.6% using the WHO and IOTF cutoffs for children above 5 years old respectively. Rates of underweight in a Barbadian group of school aged children were estimated at 3.3% using the WHO 2007 growth reference (Fernandez, 2012). With this background one can safely conclude that underweight/undernutrition continues to persist in the Caribbean, though not as prevalent as in other developing regions (Table 4).

Table 4: Estimated prevalence of underweight children in 1990 and 2015

Region	1990 (%)	2015 (%)
Caribbean	10.0	2.8
Central America	12.4	5.8
South America	7.0	2.4
Africa	24.0	26.8
Asia	35. 1	18.5
Developed Countries	30.2	19.3
Developing Countries*	1.6	0.9
Global	26.5	17.6

* Europe, Japan, Canada and the United States   Data adapted from de Onis *et al*. 2004

4.7 Health Dynamics within Trinidad and St. Kitts

It is well established that consumption patterns among many of the region's children reflect high intakes of saturated fats, high glycaemic index carbohydrates and added sodium in the diet. In addition there is low consumption of traditional foods rich in complex carbohydrates, fruits, vegetables and food from plants (Francis et al., 2010; Luke, Cooper, Prewitt, Adeyemo, & Forrester, 2001).

Trinidad is considered one of the most prosperous inlands in CARICOM. Its economic growth is fuelled by its agricultural sector (primarily sugar and cocoa) and petroleum and natural gas exports. Unlike many regional islands Trinidad has a multi-ethnic population, consisting primarily of people of African descent, Indigenous Amerindians and South Asian ancestry. The WHO estimates for Trinidad & Tobago (2005) are that 45% of women and 15% of men are obese. The results of the STEPS survey indicated that more than half the country's adult population is OWO. Further, up to 60% of the population do not achieve the minimum recommended levels of physical activity daily. This translates into 55% of females and 47% of males being sedentary (urban), while 55% of urban and 45% of the rural population lead sedentary lifestyles. Also 90% of adults do not consume the daily recommended 5 servings-a-day of fruits and vegetables on a daily basis. These results underscore the reason for high levels of OWO and NCD. Using a population of 1139 adolescents (49% South Asian) aged 14 to 17 years old, children were classified as being thin (<5th percentile), normal (5th–85th percentile) or overweight and obese (>85th percentile). Simeon e*t al*. (Simeon et al., 2003) calculated 14% underweight and 13% overweight. Francis and colleagues (Francis et al., 2010) conducted a randomized, controlled, school-based intervention with school aged children in Trinidad. From the analysis of their sample approximately 23% of the 579 participants had BMI greater than the 85th percentile of the CDC growth reference, according to age- and gender-specific cut-off values (Francis et al., 2010).

The 2011 St. Kitts & Nevis GSHS was a nationally representative school-based survey of students in Forms 2-4. Table 5 highlights weight status, using the WHO 2007 growth reference cut-offs, for students 13-15 years old. The data imply there are alarmingly high levels of OWO in both girls and boys of that age range. The finding of the GSHS survey data showed that 61.6% of all students drank carbonated soft drinks one or more times per day during the past 30 days. Table 5 shows the percentage of students who were physically active at least 60 minutes per day on 5 or more days during the past seven days. Approximately 75% of students 13-15 years do not engage in adequate levels of physical activity. According to the data from Table 5 more than half of the students spent 3 or more hours per day doing sedentary activities, such as television watching or computer games. The data also showed that girls were more likely to be physically inactive.

Table 5: Weight status and participation in physical and sedentary activity of students aged 13-15 years old (WHO 2007 growth reference)

	Total (%)	Boys (%)	Girls (%)
Underweight	3.5	4.7	2.3
Overweight	32.5	32.6	32.5
Obese	14.4	16.6	12.1
Meeting Physical Activity Guidelines	25.6	29.3	21.9
Sedentary Life Style	58.4	52.4	64.2

Data adapted from the 2011 Saint Kitts & Nevis Global School-based Student Health Survey

4.8 Ethnicity, Sex and Their Effect on Body Weight Status

Although the prevalence of obesity has increased in all race and sex groups, secular trends among black women have increased more dramatically (Freedman et al., 2005). As with other regions, obesity appears to affect Caribbean women and girls in a disporptionate nature (Ali et al., 2013). As seen in Table 2, using adult data collected from the Commission for Health and Development (2006), obesity in women is significantly greater than of men. In Dominica the disparity is greatest, with the occurrence of obesity in females is four times higher than that of males. Furthemore, black race can be a predisposing factor for higher levels of OWO. In the study by Freedman *et al.* (Freedman et al., 2005), which involved tracking of childhood BMI through early adulthood, indicated differences between black and white girls exist. Sixty-five percent of white girls and 84% of black girls who were overweight children became obese adults (Freedman et al., 2005). Freedman *et al.* (Freedman et al., 2005) hypothesized that the difference in obesity predictions reflected contrasting patterns of BMI change, with black girls and boys, experiencing larger increases in BMI than their white counterparts.

4.9 Towards A Simplified Definition of Childhood Obesity

In adults cut-off points of 25 kgm^2 and 30 kgm^2 are good indicators of risk of adverse health outcomes. But unlike adults health risks associated with adiposity among children and adolescents are more difficult to quantify since related physical health problems are often not manifested until later in life (Krebs et al., 2007; Must & Strauss, 1999). However, contemporary evidence has indicated that the rapid increase in childhood obesity is linked to the early onset of risk factors for NCD (Must & Strauss, 1999). These risk factors may exert deleterious effects in childhood, which are further perpetuated into adulthood (Cole, Bellizzi, Flegal, & Dietz, 2000). Over the past decades childhood obesity has appeared as a serious public health problem that has been difficult to define. Because of its public health importance the trends in prevalence have to be accurately monitored. In an effort to standardize interpretations of body fatness of children and adolescents a few BMI-based classification systems have come into prominence. However, quantification and comparison of international trends remains a challenge due to the multiplicity of definitions and cut-offs of childhood obesity in use and the lack of a commonly accepted gold standard.

In the past childhood obesity has been defined by absolute weight, triceps skinfolds thickness, weight-for-height percentiles and percentage body fat. However these measures are often impractical away from a laboratory or clinical settings; and of limited use in epidemiological and public health contexts (Cole et al., 2000). BMI, although less sensitive than other adiposity measures, is widely accepted in the adult population and a cut-off of $30kg/m^2$ is recognized internationally as the definition for adult obesity. This cut-off point represents a point on the BMI distribution index where health risks of excess body weight start to rise steeply. On the contrary, such a cut-off point cannot be identified with great precision in childhood, as children experience less morbidity and mortality compared to adults (Cole et al., 2000).

To provide meaningful advice for the prevention of childhood OWO studies need to accurately estimate the prevalence and risk factors of obesity (Rolland-Cachera, 2012). Such research requires international consensus on the definition of childhood obesity, in order to form a global perspective on the epidemic. Significant progress has been made since researchers first started to investigate childhood OWO, based on corresponding definitions of underweight. Since then a variety of growth indices, cut-offs and weight for age and weight references have been proposed. The application of BMI to children and the publishing of the first reference curves, in the early 1980s (Rolland-Cachera et al., 1982), marked a step towards harmonization (Cole, 1979). The earliest BMI reference curves were constructed using national samples with statistically based centile cut-offs. BMI has since emerged as the most practical, widely available and inexpensive indicator for the classification of overweight and obesity in children (Rolland-Cachera, 2012).

4.10 The Case for BMI as a Surveillance Tool for Childhood and Adolescence

Obesity is by definition excess body fatness, therefore it should be ideally defined based on body fatness measure (Fu et al., 2003). Reference methods of measurement, such as dual-energy X-ray absorptiometry (DXA), bioelectrical impedance analysis and hydro-densitometry, can be used to access body composition directly. However these measures require the use of sophisticated apparatus and techniques. Also the associated cost and the cumbersome equipment restrict their use to a laboratory or clinical setting. Of the surrogate measures, BMI is the most practical, reproducible method for classifying OWO in adults and is increasingly being recommended for screening in children (Nichols & Cadogan, 2009; Y. Wang & Wang, 2002) . Furthermore this pattern of excess adiposity in children is similar to that seen in adults (Gaskin & Walker, 2003). BMI has been closely correlated with levels of adiposity measured in a more sophisticated manner (Fu et al., 2003; Gardner et al., 2011; Gaskin & Walker, 2003; Schroeder & Martorell, 1999) and long-term health risks in adults, children and adolescents(de Onis & Lobstein, 2010; Must & Strauss, 1999) . However, unlike in adults BMI varies with sex, age, sexual maturation and body composition (Freedman et al., 2005; Nichols & Cadogan, 2009). Therefore cut-offs for children and adolescents are sex and age specific. A further disadvantage of the use of BMI relates to its limitations as a means of monitoring changes in lean body and fat mass since BMI is not a proxy for both (Nichols & Cadogan, 2009; Reilly, Dorosty, & Emmett, 2000).

In adults BMI remains relatively constant unless there are fluctuations in body weight. Therefore when classifying adults it is possible to use the same thresholds for defining underweight and OWO, irrespective of the age and sex of the adult (Dinsdale, Ridler, & Ells, 2011). In children however, because of differences in the rates of maturation and its effect on body composition, assessment of adiposity by BMI is more challenging in children (Freedman, et al., 2005). Therefore the BMI of in children has to be defined based on age and sex specific parameters. The thresholds used to classify children are usually derived from a growth reference, which is calculated by weighing and measuring a large sample of children to illustrate how BMI varies in children of different age and sex. The data also provides a pattern of growth and distribution of measurements which allows individual children to be compared to the reference population and the degree of variation from the expected value can be calculated (Dinsdale et al., 2011). BMI cut-offs can be defined in terms of specific Z Scores, centiles or on a child growth reference. The recommended thresholds for growth references are usually defined based on statistical convention as:

- Whole number of standard deviations from the mean
- Whole number of centiles (85^{th} or 95^{th})
- Whole numbers which line up with adult BMI cut-offs for obesity and overweight at age 18 years.

Many researchers using their own data and their own choices of cut-offs, sought to develop a national definition of childhood OWO. This effort resulted in a plethora of definitions of childhood OWO and prevalence rates based on them. In essence it was not possible to make meaning international comparisons and form a wider global perspective on childhood OWO. Many countries, such as the USA and UK, have their own population specific thresholds for assessing BMI in children. Table 6 below summarizes some of the more frequently used international growth references.

Table 6: Examples of growth references used in international studies

Reference	Reference Population/Use	Age Range	BMI Cut-off
IOTF	Cross-sectional surveys from: Brazil (1989), Great Britain (1978-93), Hong Kong (1993), Netherlands (1980), Singapore (1993), and the United States (1963-1980). **International Use**	2-18	Age and sex specific cut-off points extrapolated from adult BMI cut-offs: **Overweight:** 25kg/m^2 **Obesity:** 30kg/m^2 – **Thinness:** <18.5kg/m^2
WHO (2006)	An international sample from Brazil, Ghana, India, Norway, Oman and the United States. **International Use**	0-5	**Overweight**: Between +1SD and +2SD **Obese**: Greater than +2SD
WHO (2007)	Three multi-ethnic USA datasets (NHES II and III and NHANES I) consisting of 30,000 observations. **International Use**	5-18	**Thinness:** Less than <-2SD **Overweight**: Between +1SD and +2SD **Obese**: Greater than +2SD
CDC 2000	5 NHANES for girls and boys **US only**	2-20	**Risk of overweight** Greater than 85th Percentile **Risk of obesity** Greater than 95th
UK90	12 distinct surveys, collected between 1978 and 1994. **UK only**	0-23	**Underweight**: 2nd centile **Overweight**: 85th percentile (pop) 91st centile (clinical) assessment **Obese**: 95th percentile (pop) 98th centile (clinical)

4.11 International Obesity Task Force Growth Reference

In 2000 the IOTF, using data from 6 countries, proposed age- and gender-specific BMI cut-offs values for childhood OWO (Cole et al, 2000). In total the reference population consisted of 192,727 children 0-25 years old, with each of the 6 national data sets consisting of over 10,000 subjects. These cut-offs were specifically developed for international comparisons of OWO prevalence and are not recommended for clinical use when assessing an individual child's growth. (de Onis & Lobstein, 2010). This reference population was obtained by averaging across a heterogeneous combination of surveys, with differing prevalence rates for OWO (Cole et al., 2000). Moreover, the appropriate cut off points for OWO were defined in BMI units in young adulthood and extrapolated to childhood, conserving the corresponding centile in each dataset (Cole et al., 2000) . BMI centile curves were plotted so they intersected the points of 25 kg/m^2 and 30 kg/m^2 at age 18 using data collected between 1963 and 1993, prior to the beginning of the obesity epidemic in the mid-1990s. Again although these values correspond to adult cut-off points, the health consequences for children above the cut off points may differ from those for adults.

A study by Fu et al. (Fu et al., 2003), to determine the appropriateness of the IOTF growth reference in a population of 623 Chinese children aged 6–11 years old, suggested that the IOTF-BMI cut-offs may be associated with low sensitivity. This can result in failure to identify obese childen. Fu et al. also noted that percentage weight for height (PWH) and IOTF BMI cut-off values gave significantly different prevalence rates. The prevalence rates of obesity using IOTF BMI cut-off values were much lower at 6.9% than that for PWH at 16.4% (Fu et al., 2003). The IOTF cut-offs are also not without limitations. The most glaring limitation is the restriction in age range from 2-18 years, rather than throughout childhood, 0-19 as with the WHO 2006 growth standard and 2007 reference. However, according to Chinn and Rona (Chinn & Rona, 2002) normalizing the cut-offs to 19 or 20 years would have reduced the sex difference in the cut-offs. The original mandate of the IOTF growth reference was to provide universal definition of childhood OWO to replace the replace the numerous definitions that emerged thorough out the 1990s.

4.12 The WHO 2007 Growth Reference

The reference previously recommended by WHO for children above 5 years of age, was the NCHS/WHO international growth reference. However this methodology had some drawbacks, in particular it starts at 9 years of age, groups data annually and covers a limited percentile range (de Onis et al., 2007). Many countries cited the need to have BMI curves that start at 5 years and permit unrestricted calculation of percentile and Z-score curves on a continuous age scale from 5 to 19 years (de Onis et al., 2007). An expert panel commissioned by the WHO concluded that a multicentre study, similar to the one that led to the development of the WHO Child Growth Standards for 0 to 5 years, would not be feasible for older children as it would not be possible to control the dynamics of their environments. As a result, the experts suggested that a growth reference be constructed for this age group using existing historical data (de Onis et al., 2007). The WHO 2007 growth reference was constructed from 3 multi-ethnic USA datasets reference population and was chosen after review of a large number of studies demonstrated unacceptable heterogeneity in both methods and socio-economic composition of the study samples (Duggan, 2010). Hence the WHO reconstructed the 1977 NCHS/WHO growth reference using the original sample (a non-obese sample with expected heights), supplemented with data from the WHO 2006 growth standard (to facilitate a smooth transition at 5 years) (de Onis et al., 2007). In the development of the growth reference it was important to avoid upward skewing of the curves by over-representation of populations exhibiting trends towards OWO. The reference was based on existing historical data, with 'data cleaning' to avoid bias owing to (over) representation of overweight subjects (Duggan, 2010).

4.13 Characteristics of the Ideal Screening Tool for Overweight and Obesity

A population based screening tool for the detection of childhood obesity should show both high sensitivity and specificity. A tool with high sensitivity is necessary to avoid failure of identifying obese children. Alternatively, high specificity of the screening tool ensures that non-obese children are not misclassified as obese. While the latter concerns are not trivial, failure to identify the obese child may have more serious consequences than misclassification since it results in an increase in adult morbidity and mortality. The high public health burden and social cost associated with the treatment of childhood OWO and its associated diseases support the need for early intervention and treatment. Therefore, a tool with high sensitivity may be a more important consideration when choosing an appropriate screening tool for childhood obesity (Fu et al., 2003).

Reilly *et al.* (Reilly et al., 2000) have demonstrated that the IOTF growth reference had high specificity but low sensitivity in a population of UK children and the sensitivity differed between boys and girls. Findings from Gaskin and Walker (Gaskin & Walker, 2003) reflected a similar pattern of low sensitivity and high specificity of the IOTF BMI cut-off points for overweight in children at 7-8 years old. They also noted the strength of the relationships between BMI and other adiposity measures (triceps and subscapular skinfolds) increased with age that is from 7 – 8 years to 11–12 years. This close relationship between IOTF BMI reference and other body composition measures suggests that BMI reflects adiposity in these age groups. However, Gaskin and Walker cautioned that BMI cut-off points may not identify some children with high body fatness. In the study by Gardner *et al*. (Gardner et al., 2011), comparing the IOTF and CDC growth references and the WHO 2006 growth standard, the IOTF consistently demonstrated lowest sensitivity of identifying OWO.

A study by Nichols and Cadogan (Nichols & Cadogan, 2009), using a population of Afro-Caribbean decent adolescents (12-14 years old) from Tobago, concluded that the CDC cut-offs had a higher sensitivity than the IOTF cut-offs in screening for excess adiposity. On the contrary, Nichols and Cadogan (Nichols & Cadogan, 2009) concluded, based on the results of a positive likelihood ratio test, the IOTF reference has superior ability to classify persons as having excess adiposity when that is indeed the case (i.e. higher specificity). In a further comparison of the two growth references Nichols and Cadogan pointed out the choice of which system should be used is based on context and includes issues related to ease of use, universal interpretation of the results, and ability of the growth reference to predict future health risk (Nichols & Cadogan, 2009). The fact that cut-off values for childhood, adolescence and adulthood are extrapolated from adult cut-off points for OWO provides a distinct advantage over other growth references (Nichols & Cadogan, 2009).

4.14 Body mass Index Tools to Define Underweight/Thinness in Children

Obesity and underweight represent opposite ends of the adiposity continuum and are both quantified in terms of weight and height relative to the age of the child. In 1983 the WHO recognized the NCHS classification as the international reference and used it to classify children as underweight, wasted or stunted, each based on a cut-off of -2 Z scores. In 1995 the WHO expert committee (FerroLuzzi et al., 1995) endorsed the use of BMI for accessing thinness in adolescents, based on data published by Must et al (Must, Dallal, & Dietz, 1991) and the WHO 2006 growth standard. However these had limited international use as the Must et al data only represented a USA population.

The international cut-offs for OWO are based on the widely accepted adult value of 25 and 30 $kg/m^{2.}$ These thresholds represent cut points on the BMI spectrum where health related risk increase significantly. Underweight or thinness can be described as low BMI for age. Health related cut points for underweight or thinness in adults are also available, but their use is less consistent. The WHO defines underweight or thinness as body mass indices below 18.5, 17 and 16, which correspond to thinness grades 1, 2 and 3 respectively. In the children and adolescents the WHO recommends a BMI cut-off of 17 kg/m^2 as the most appropriate to estimate the adult target for thinness or underweight in children because it is closer to -2 SD and it is also the definition of thinness grade 2 in adults (Cole, Flegal, Nicholls, & Jackson, 2007). Similarly the IOTF also adopted the BMI cut-offs of 16, 17 and 18.5 as the basis of their classification of thinness in children and adolescents (Ferro-Luzzi et al., 1995). The term "thinness" was used by the IOTF to refer to low BMI in children and to avoid potential confusion between the terms wasting and stunting. Thinness is also used by the WHO to refer to low BMI adolescents and adults. It is important to recognise that thinness is not the opposite of fatness, and a low BMI is more closely correlated with lean mass than fat mass (Cole et al., 2007). However, BMI is a surrogate measure of adiposity as it does not differentiate between lean mass and fat mass; therefore it is an imperfect measure of lean mass or adiposity.

The age of 18 was chosen as the crossover age between childhood and adulthood is not ideal for a number of reasons. Firstly, BMI increases after this age faster in males than females (Cole et al., 2007). According to Cole et al (Cole et al., 2007) age 20 would have been a more suitable age, but some of the country data sets lack data for that age, so researchers were unable to extend the crossover age beyond 18. Cole and colleagues also cited the lack of adjustment for puberty is another limitation to the cut-offs. BMI is known to be higher in more sexually mature individuals of the same age and delayed puberty is associated with thinness (Sandhu, Ben-Shlomo, Cole, Holly, & Smith, 2006). An adjustment of pubertal stage, though statistically complex, could have been considered in the development of the cut-off. However, Cole and colleagues reiterated that none of those limitations invalidates the underlying principle of the cut-offs, which is to provide a rigorous enough tool to compare prevalence rates across heterogeneous populations. In addition Cole and colleagues also cited the central feature of the cut-offs, for both thinness and OWO, was their ability to compare prevalence rates across countries, ethnicities and time. Unlike the WHO 2007 growth reference, which uses an American population, the IOTF cut-off is able to include data from several disparate populations increasing its generalizability.

4.15 Socioeconomic Status, Obesity and Overweight

The possibility that SES might be related to body weight was first raised more than a century ago by Veblen in his 1889 publication "The Theory of The Leisure Class". In this publication he postulated that thinness became an ideal of feminine beauty in when it served as a status symbol of an emerging leisure class. Sobal and Stunkard (Sobal & Stunkard, 1989) published a seminal review of the literature on the relation between SES and obesity. The review was based on an exhaustive literature review from the 1960s through the mid-1980s on the impact of SES on obesity, in adults and children in developed and developing countries. With respect to women in developed countries their analysis found a strong inverse relationship among women, with obesity being six times more prevalent among women of lower SES (Sobal & Stunkard, 1989). The relationship for men was less consistent. The relationship between SES and obesity in girls in developed societies was also weaker and less consistent than that in women and among boys the results were similar (Sobal & Stunkard, 1989). However, in developing countries a strong direct relation was observed for men, women and children, with a higher prevalence of obesity among persons in higher SES (Sobal & Stunkard, 1989). Sobal and Stunkard further concluded that in developing countries the associations of lower SES and higher prevalences of obesity were not limited to one geographical area but were present in studies in Africa, Asia, North and South America, Australia, and the Pacific Islands (Sobal & Stunkard, 1989).

Although the findings of the review by Sobal and Stunkard continue to be relevant for research on SES and obesity, it is becoming less useful by its dated content. In a more recent systematic review of the literature McLaren (McLaren, 2007) reported consistent findings to those reported in 1989. That is for women in low and medium Human Development Index (HDI) countries a positive association between SES and obesity was most common. McLaren also observed that the medium HDI countries indicators of SES, namely education, occupation, and area-level indicators, were inversely related to obesity. An earlier review by Monteiro *et al*. (Monteiro, Moura, Conde, & Popkin, 2004) of the socioeconomic patterning of obesity in developing countries highlighted the propensity of obesity towards lower SES groups. This shift seems to occur with an increase in the gross national product of the country (Monteiro et al., 2004). Therefore although obesity continues to increase worldwide, there are contributing forces which are acting to shift the burden of obesity onto the poor in developing countries (McLaren, 2007; Monteiro et al., 2004). Contributing factors include societal and nutrition transitions, which result from economic growth, modernization, and globalization of food markets (Hawkes, 2005; Monteiro et al., 2004). Extremely high levels of excess weight among residents of Kosrae, Micronesia, where nearly 90% of the adult population is OWO, this has been attributed to factors related to foreign dependence and influence, the global food trade and massive associated social changes characterized by the popularity and prestige of imported processed foods (Hawkes, 2005). As Monterio *et al*. (Monteiro et al., 2004) pointed out, the burden of obesity and ill health affects persons in lower socioeconomic classes within middle and low income countries. Hawkes points out key processes related to globalization and the nutrition transition (including production and trade of agricultural goods, foreign direct investment in food processing and retailing, and global food advertising and promotion) exacerbates nutritional inequalities between the rich and the poor. Conversely, high-income groups (especially in developing countries) tend to benefit from an expanding marketplace (Monteiro et al., 2004). Whereas groups of lower SES suffer most from the economic and cultural convergence towards low quality diets (Monteiro et al., 2004).

4.16 Food Insecurity and Obesity and Overweight

Obesity and its co-occurrence with household food insecurity, among low income families is a public health concern, because both are associated with adverse health consequences. Food security is a condition related to the ongoing availability of food. One can imagine that throughout human history concerns over food security have always existed. As a concept food security has undergone significant evolution since its formal conception at the 1974 World Food Conference, held under the auspices of the United Nations Food and Agriculture Organization (FAO). Today the definition of food security encompasses the four primary pillars: food availability, access to nutritious food, utilization and stability (the ability to obtain food over time). According to the FAO food security is said to exist "when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life". On the other hand a state of food insecurity can be described as, limited or intermittent access to nutritionally adequate, safe, and acceptable foods accessed in socially acceptable ways (Anderson, 1990). Food insecurity may or may not be accompanied by hunger, defined as “an uneasy painful sensation caused by a lack of food” (Anderson, 1990). The most severe forms of food insecurity occur when children in a household are children are experiencing reduced food intake and hunger (Anderson, 1990). Adverse health outcomes have been linked with food insecurity in children and adults. These include substandard educational attainment, inadequate intake of essential nutrients, poor health, increased risk for and development of NCD, poor disease management, and reduced psychological and cognitive functioning (Hamelin, Habicht, & Beaudry, 1999). In addition to this chronic maternal food insecurity has been shown to be highly correlated to certain birth defects (Carmichael, Shaw, Yang, Abrams, & Lammer, 2007; Carmichael, Yang, Herring, Abrams, & Shaw, 2007). During the past decades the food insecurity and obesity have risen, and in developed countries an association has emerged between the seemingly paradoxical states (Dinour, Bergen, & Yeh, 2007).

Several studies have established a relationship between household food insecurity and obesity in adults (Adams, Grummer-Strawn, & Chavez, 2003; Olson & Strawderman, 2008). Moreover research has consistently shown that women who consistently experience food insecurity are at higer risk of OWO than women who live in food secure households (Olson, 2005; Wilde & Peterman, 2006). However, findings can vary depending on the tool used to assess food security (Kaiser, Townsend, Melgar-Quiñonez, Fujii, & Crawford, 2004). William Dietz (Dietz, 1995) was one of the first researchers to suggest that food insecurity might also be an underlying contributer to childhood obesity. He attributed this to the incorperation of more nutrient poor and high calorie foods of dubious nutritional quality in diets of children in food insecure households; or binge eating as an adaptive mechanism to acute food shortages. Since his early insight, both crossectional (Casey et al., 2006; Metallinos-Katsaras, Sherry, & Kallio, 2009) and longditudinal (Jyoti, Frongillo, & Jones, 2005) studies in school age children and preschoolers, examining the relationship between pediatric obesity and food insecurity, have yeilded conflicting results. Although this relationship has been inconsistent, yielding positive, negative, or no relationship in children (Dinour, Bergen, & Yeh, 2007), studies differ based on age, race, household income and sex. While in adults, research continues to support that food insecurity is associated with OWO, especially among women from households experiencing marginal food security (Dinour et al., 2007; Wilde & Peterman, 2006).

4.17 Proposed Hypotheses Surrounding the Food Insecurity–Obesity Paradox

Several hypotheses have been postulated to explain the correlation between food insecurity and obesity. Firstly, children who grow up in poverty are at increased risk of becoming obese adults and, thus, childhood food insecurity as a result of poverty may increase the effect of poverty on adult obesity (Parker, 2005). Secondly, the low cost of energy-dense foods may promote overconsumption of energy, leading to weight gain. Overeating when food is available and consumption of low-quality diets high in fats and sugars (Drewnowski, 2009; Holben, 2010). On the other hand the frequency of fruit and vegetable consumption declines significantly as food insecurity status worsens (Drewnowski, 2009).

4.18 Factors Affecting Food Security in the Caribbean

According to Beckford and Campbell (Beckford & Campbell, 2013) food security in the Caribbean is affected by a number of factors including: declines in productivity of land and labour in the sector, resulting in a diminished capacity to supply food competitively; declining revenues from traditional export crops; loss of preferential trade agreements; a high dependence on imported food; the increasing poverty which affects people's access to food; and the linkage between the high use of imported foods, associated with a North American lifestyles, and growing incidence of NCD. Assessed within this context the dimension of food security in the Caribbean becomes apparent. With the exception of Haiti, the famine and chronic hunger which characterizes much of Sub-Saharan Africa and some Asian countries is not associated with the Caribbean. However, considering the declining food production, greater reliance on imported food and ever-increasing levels of poverty, the region's status may be described as vulnerable (Beckford, Bailey, McGregor, Dodman, & Barker, 2009).

In high income countries obesity is generally associated with lower SES, whereas in low income countries obesity is linked to affluence. This observation may indicate that in more food abundant environments socioeconomic factors, such as income level and education attainment, may modify the relationship between food security and obesity (Beckford, 2002). However in middle income countries the relationship is less consistent. Food insecurity among children can lead to hunger and under-nutrition increasing vulnerability to diseases associated to malnutrition (Struble & Aomari, 2003). In different areas of the world it has also been found to be associated with poverty (Gulliford, Nunes, & Rocke, 2006), stunted growth (Baig-Ansari, Rahbar, Bhutta, & Badruddin, 2006), iron-deficiency anemia (Skalicky, Meyers, Adams, Yang, & Frank, 2006), poor learning among preschool and school-aged children, poor social skills and poor physical health status (Jyoti et al., 2005). It is clear that the relationship between food security and obesity is a dynamic one. As a result obesity may be associated with affluence in some situations but with poverty in others. Under some circumstances underweight and OWO may occur in the same household or neighbourhood (Oldewage-Theron, Dicks, & Napier, 2006). A study by Racine and colleagues (Racine, Jemison, Huber, & Arif, 2009) exploring the levels of household food insecurity, on the islands of Barbados, St. Lucia and St. Vincent and the Grenadines, concluded that 33% of all households were considered food insecure. Their results also indicated that food insecurity within households was linked to families burdened with disability, family system disruption (illness or divorce) or child health care needs.

A study in Trinidad by Gulliford *et al*. (Gulliford, Nunes, & Rocke, 2006) using the 18 Household Food Security Survey (HFSS) of the USDA items survey concluded that 19% of the adult respondents were food insecure without hunger, 10% food insecure with moderate hunger and 6% food insecure with severe hunger. In children the classification showed 23% of children were food insecure without hunger and 9% food insecure with hunger. Moreover Gulliford and colleagues noted food insecurity was positively correlated with low income and disability; and food insecure subjects were less likely to consume a balanced diet, rich in fruits and vegetables. Gulliford and colleagues (Gulliford et al, 2006) also noted the prevalence of OWO was high in all socioeconomic classes in their group, but there were no clear associations between their food insecurity, or household income, and obesity. In an earlier study by Gulliford et al. (Gulliford, et al, 2003) food insecurity was reported to be frequent at all levels of BMI and was also associated with lower fruit and vegetable consumption.

4.19 Conclusion

In developing countries such as St. Kitts and Trinidad, with rapidly evolving lifestyles, monitoring the prevalence and trends of OWO is critical to effectively address nutrition related health concerns in children and adults. However, in the case of St. Kitts, no recent comprehensive study has been conducted with school aged children, resulting in wide knowledge gap about childhood OWO. Although more contemporary data are available for Trinidad, knowledge gaps still exist. Rates of OWO estimated in Trinidad and St. Kitts are estimated to be less than that of Canada and the USA and similar to some of the neighbouring islands such as Jamaica and St. Lucia. Data available throughout the region points to an alarming increase in obesity over the last few decades. The long term health consequences of childhood OWO can result in a significantly reduction in an individual’s quality of life. Inhabitants of the Caribbean islands suffer from some of the highest rates of NCD in the world. To begin to address that problem steps to monitor and mitigate childhood OWO need to be implemented.

5. METHODOLOGY

5.1 Ethical Approval

Ethical approval for the wider project was obtained by the McGill Research Ethics Board. In addition, permission to gain entry into the schools was obtained from the Trinidad and St. Kitts Ministries of Education. Consent for data collection from the children was granted by caregivers and informed consent from children was obtained prior to data collection.

5.2 Project Overview

Improving the nutrition and health of CARICOM populations through sustainable agricultural technologies that increase food availability and diversity of food choices is a multidisciplinary research project conceptualized to link linking agriculture to health. The project is regional in nature and was piloted in Guyana, Trinidad, St. Lucia and St. Kitts. The overall goals of the project is to improve nutrition and health outcomes of CARICOM populations through an integrated, gender equal, environmentally sustainable systems approach to food availability, safety and quality. These goals are facilitated by a combination of socio-economic and community surveys, field research and nutrition interventions in schools. The project also addresses the problems of land and water degradation, inefficient pre- and post-harvest practices that underlie food and nutrition security and the rising prevalence of NCD.

5.3 Study Populations and Design

The present study is a cross-sectional investigation embedded within the wider CARICOM study. The St. Kitts study population consisted of 189 students and caregivers, from the rural communities of Stapleton and Mansion. The site locations have a total of 4 schools, all of which were part of the study. It was originally estimated the sample size would be 300 individuals and their households, however complete data sets were collected from 189 students and their households. In the Trinidad study complete data sets were collected from 462 children from 8 schools in a deprived urban area of Port of Spain. Data for the study was collected at baseline (September 2011) and will be at the end of the project (September 2013). There were no rigid inclusion criteria and all students with parental consent participated in the study. Though not representative of their national population, both groups provided robust samples to make meaningful and important comparisons.

The research comprised two major nutrition interventions at the school level conducted intensively in Trinidad and St. Kitts in collaboration with the National Schools Dietary Services, and the Ministries of Health and Education. Due to large differences in population sizes and number of primary schools in each country, the design differed marginally. In all cases, the study will target school children aged 5-9 years old and their households.

5.4 Anthropometric Measurements

All adults and children who had signed consent forms, indicating their willingness to participate in the study, were included in the study. Data for the study was collected at baseline (September 2011). Standing height was measured using a stadiometer, a platform with a vertical, graduated rod extending at a ninety-degree angle. The investigator asked children to remove their shoes and stand on the base of the stadiometer. Heights were measured (nearest 0.25 inches) without shoes or hair ornaments. Weight was recorded using a professional scale and its accuracy was tested with standardized weights. Baseline data collection records indicate participants were weighed (nearest 0.1 lb) wearing light clothing, on a mechanical or electronic step scale. Height and weight data was collected for the parents in a manner consistent to that used for the children.

5.5 Body Mass Index Classification

Body composition of adults was accessed using the WHO BMI cut-offs as a screening tool. Adults were classified as underweight (below 18.5 kg/m^2), healthy weight (between 18.5-24.9 kg/m^2), overweight 25.0-29.9 kg/m^2) and obese (above 30 kg/m^2). Since there is no uniformly accepted classification system for children and different cut off methods can yield different prevalence estimated of underweight, OWO, prevalence rates were generated using two prominent international methods, thus permitting wider comparisons with other studies. Children were classified by BMI as underweight, healthy weight, overweight and obese according to the age and sex specific cut-off of the IOTF (Cole, Bellizzi, Flegal, & Dietz, 2000; Cole, Nicholls, & Jackson., 2007) and the WHO 2007 (Onis et al., 2007).

Using the SAS program (version 9.4) software syntax statements were written to classify children according to WHO 2007 growth reference tables. SAS syntaxes were also created to classify children according to the IOTF cut-offs to generate height-for-age, BMI-for-age and weight-for-age Z Scores. For children over 5 years old the WHO defines underweight (thinness) as less than -2SD of the reference median; normal/healthy weight as the range between -2SD and +1SD; overweight as a BMI greater than +1SD but less than or equal to +2SD, obesity is greater than +2SD.

5.6 Assessment of Food Security Status

The tool used to estimate the level of food insecurity in both groups was the six-item version of the Household Food Security Scale (HFSS) of the United States Department of Agriculture (USDA). This vision was developed by Blumberg et al (Blumberg, Bialostosky, Hamilton, & Briefel, 1999) by using a subset of items from the 18- item full scale. Selection of a potential subset of items was based on a few guiding principles. The first was to ensure that the tool worked equally well with households with and without children, therefore the items that were applicable only to households with children were excluded. Secondly the short form does not distinguish between the 2 most severe categories of food insecurity. Subsequently the results of Blumberg et al (Blumberg et al., 1999), using this abbreviated for, correctly classified 97.7% of households. They then concluded that short form, although brief, is a potentially useful tool for surveys to assess food security.

Questionnaires were administered by trained interviewers to subjects participating in the study. The questionnaire included items on food choices, food security and socioeconomic variables. Relevant information pertaining to socio-economic status (such as household roster, age, education, income and occupation), consumption and expenditure patterns and nutrition knowledge were also collected. Each item in the household food security scale was reduced to the categories of affirmative or not as described by Blumberg et al (Blumberg et al., 1999) Based on their overall score, responses were coded into the following 2 categories food secure or food insecure.

5.7 Consent and Assent

Consent for the children to participate in the study was obtained through consent forms sent to their guardians. Both children and caregivers were given an oral description of the study and the use of the results and were asked to sign an informed assent for the child to ensure their willingness to participate in the study prior to measurements being taken.

6. STATISTICAL ANALYSES

6.1 Caregivers

Descriptive statistics were carried out on both groups (St. Kitts and Trinidad) of care givers independently to describe population characteristics. Caregiver BMI was determined and each subject was assigned to one of 6 BMI categories corresponding to the WHO definitions of underweight, normal weight, overweight, class I obesity, class II obesity and class III obesity.

6.2 Children

There is no uniformly accepted classification system for children, and different methodologies yield varying estimates. In an effort to facilitate comparison with other studies, prevalence rates were generated using two growth cut-offs, the WHO 2007 and the IOTF. Children were classified by BMI as underweight, normal weight, overweight and obese according to age-specific and sex-specific cut-offs proposed by the WHO (de Onis et al., 2007) and Cole *et al*. (Cole et al., 2000; Cole et al., 2007). In 2000 Cole and colleagues (Cole et al., 2000) published BMI cut-offs, which were adopted by the IOTF, to classify children as overweight and obese; in 2007 (Cole et al., 2007) cut-offs were also published to define thinness/underweight, this was the cut-off equivalent to the adult BMI of 17. For children over 5 years old or above 60 months the WHO defines thinness/underweight as a BMI less than -2SD of the reference median, overweight as BMI greater than +1SD, but less than or equal to +2SD of the 2007 reference median and obese as greater than +2SD. Using the SAS program and the WHO Anthro Plus software syntax was created to classify children according to the WHO 2007 standards. Similarly SAS syntax was developed to classify children according to the IOTF cut-offs.

6.3 Food Security and Body Mass Index

To exmine the relationships between food security status and caregiver BMI T-tests were used to compare the differences between food secure and ood insecure groups. Also Chi Square analyses were done to compare the ratio of each BMI category between food secure and food insecure groups. Also to determine the potential effect caregiver weight on on child weight status Person's correlatons were used, using caregiver BMI, child BMI for age Z-scores.

7. RESULTS

7.1 Descriptive Statistics for Caregivers

The final sample for St. Kitts included 178 caregivers and 188 children. This was a sample taken from two rural areas of St. Kitts and the majority of the respondents (90.4%) were women. The average age of the caregivers was 35.2 years, and the average BMI was 30.0 kg/m^2. The Trinidad sample consisted of 257 caregivers and 462 children. The average age was 35.6 years and the average BMI was 28.9 kg/m2. The sample was drawn form a low-income area of Port of Spain and as with St. Kitts the majority of the caregivers (97.4%) were women. Other demographic characteristics are shown in Table 7

Table 7: Mean (standard deviation) of weight, height, BMI and age for St. Kitts and Trinidad caregivers

	St. Kitts			Trinidad		
	Males (n=18)	**Females (n=170)**	**Total (n=188)**	**Males (n=12)**	**Females (n=254)**	**Total (n=266)**
Weight (kg)	73.7 (5.2)	77.8 (1.8)	80.1 (17.8)	85.7 (26.0)	75.6 (18.6)	76.7 (19.0)
Height (m)	1.63 (0.0)	1.63 (0.1)	1.6 (0.8)	1.75 (0.1)	1.62 (0.1)	1.62 (0.1)
BMI (kg/m^2)	28.1 (2.0)	30.2 (6.8)	30.0 (6.6)	34.4 (9.8)	28.6 (7.8)	28.9 (7.9)
Age (years)	38.7 (2.7)	34.7 (0.7)	35.2 (9.1)	31.3 (7.5)	35.7 (9.3)	35.6 (9.3)

*No significant differcence observed between sexes for weight, height and BMI.

7.2 Body Mass Index Classification for Caregivers

Table 8 display the BMI classification of caregivers from St. Kitts and Trinidad. Within both groups the prevalence of overweight and obesity was high, accounting for approximately 79% of St. Kitts caregivers and 66% in the Trinidad group. Although males accounted for a small proportion of both groups (St. Kitts - 9.6% and Trinidad – 2.2%), in the Trinidad group 83.3% were OWO and in St. Kitts 82.4% were OWO. Of the females in Trinidad 64.4% were OWO and 78.8% were OWO in St. Kitts. Compared to overweight, obesity is more strongly associated with increased risk of cardiovascular and other non-communicable diseases, reduced life expectancy and greater all-cause mortality (Whitlock et al., 2009). A meta-analysis, published in the Lancet by Whitlock and colleagues (Whitlock et al., 2009) concluded that a BMI of 30–35 kg/m^2 reduced median survival by 2–4 years and between 40–45 kg/m^2 was theorized to reduce life expectancy by 8–10 years; which is comparable with the effects of smoking.

Table 9: BMI classifications of caregivers from St. Kitts and Trinidad.

	St. Kitts			Trinidad		
	Males %	**Females %**	**Total %**	**Males %**	**Females %**	**Total %**
Underweight	0.0	1.9	1.7	0.0	5.7	5.5
Healthy Weight	17.6	19.3	19.1	16.7	28.7	28.1
Overweight	35.3	34.8	34.8	25.0	28.7	28.5
Class I Obesity	41.2	23.6	25.3	0.0	20.9	19.9
Class II Obesity	0.0	13.0	11.8	33.0	10.2	11.3
Class III Obesity	5.9	7.5	7.3	25.0	5.7	6.6

Several studies have identified parental obesity as a key risk factor which increases the risk of children becoming OWO. Parental obesity more than doubles the risk of adult obesity in children under 10 years of age (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). Although not all OWO children become OWO adults there seems to be a greater probability that obesity beginning in early childhood will persist throughout the life span (Huffman, Kanikireddy, & Patel, 2010).

For the St. Kitts group, when caregiver BMI was assessed with childhood BMI Z-Score it was not significant. For the Trinidad group a small positive correlation was observed for the comparison between caregiver BMI and child BMI Z-score for age (0.14, p value 0.001).

7.3 Level of Household Food Security

For the St. Kitts sample 100% caregivers completed the food security questionnaire, whereas 62.6% of food security questionnaires were completed by caregivers in Trinidad. The remaining caregivers could not be reached to complete the questionnaire. Based on the finding form the six-item HFSS a high proportion of households can be said to experience food security. In the St. Kitts group 43.0% of caregivers reported household food insecurity and in the Trinidad group 51.6% reported their household as being food insecure.

7.4 Descriptive Statistics for Children

The average age for the St. Kitts children was 7.1 years, with an average BMI of 15.3 kg/m^2 , which is within the healthy weight range. Table 10 below presents a description of the other characteristics of the sample. The average age (7.8 years) and BMI (16.8 kg/m2) for the Trinidad group was slightly higher than that of the St. Kitts sample. There were no significant sex differences in height, weight, BMI or age.

Table 10: Mean (standard deviation) of weight, height and age of children from St. Kitts and Trinidad.

	St. Kitts			Trinidad		
	Boys (94)	**Girls (93)**	**Total (187)**	**Boys (232)**	**Girls (230)**	**Total(462)**
Weight (kg)	26.2 (5.2)	26.0 (5.5)	26.1(5.3)	29.2 (0.6)	29.5 (0.6)	29.4(9.0)
Height (m)	1.27 (0.1)	1.27 (0.1)	1.27 (0.1)	1.31 (0.0)	1.30 (0.0)	1.30 (0.1)
BMI (kg/m^2)	15.3 (0.2)	15.3 (0.3)	15.3 0.2)	16.8 (0.3)	17.1 (0.2)	16.8(0.7)
Age (years)	7.1 (0.8)	7.1 (0.8)	7.1 (0.8)	8.2 (0.1)	8.7 (0.1)	7.8 (1.2)

*No significant differences between boys and girls

The average age (7.8 years) and BMI (16.8 kg/m^2) for the Trinidad group was slightly higher than that of the St. Kitts sample. Table 10 presents a description of the other characteristics of the sample. There were no significant sex differences in height, weight, BMI or age.

7.5 The Prevalence Estimates of Overweight and Obesity

Prevalence estimates of underweight, OWO, by two methods, are displayed in Tables 11 and 12. Firstly, there is an overall significant difference between the prevalence rates that were generated using the WHO (2007) and the IOTF growth references cut-offs for both St. Kitts and Trinidad. For both groups the IOTF cut-points consistently produced higher estimates for underweight, in both boys and girls. For the St. Kitts group the overall prevalence was approximately 12 times higher. For the Trinidad group, the disparity in prevalence of underweight, between the WHO and IOTF, was less pronounced. The difference in both sexes was approximately 3 times higher.

Conversely, the WHO produced higher estimates for healthy weight, overweight and obese, though the differences for these cut-offs were less marked, compared to underweight. All weight categories were significant when tested based on weight category and sex, using chi-square analysis, the sex specific differences were all significant except those between healthy weight boys and overweight boys. For the Trinidad group, the difference between all weight categories and sexes were significant, except for healthy weight boys, at the 0.05 level for the WHO and IOTF cutoffs.

Table 11: Prevalence (95% confidence intervals) of underweight, healthy weight, overweight and obesity by two classification methods, for the St. Kitts children.

	Methodology WHO (2007) (CI)	IOTF (CI)
	Underweight	
All; n= 187	2.1 (-0.02-4.2)	25.7 (19.4-32.0)
Boys; n= 94	4.3 (0.2-8.3)	26.6 (17.4-35.2)
Girls;n= 93	0.0	24.7 (15.9-33.5)
	Healthy weight	
All	77.5 (71.4-83.6)	63.6 (49.2-77.9)
Boys	74.5 (65.3-83.7)	64.9 (55.4-74.7)
Girls	80.6 (71.6-89.6)	62.4 (52.6-72.2)
	Overweight	
All	12.3 (7.6-17.0)	7.0 (3.3-10.7)
Boys	14.9 (6.2-23.6)	6.4 (1.5-11.3)
Girls	9.7 (3.7-15.7)	7.5 (2.1-12.9)
	Obese	
All	8.0 (4.0-11.9)	3.7 (1.0-6.4)
Boys	6.4 (1.4-11.3)	2.1 (0.8-5.0)
Girls	9.7 (3.7-15.7)	5.4 (0.8-10.0)

*Difference between WHO(2007) and IOTF prevalence rates.

Table 12: Prevalence (%) of underweight, healthy weight, overweight and obesity (95% confidence interval) by two Classification methods, for the Trinidad Children.

	Methodology WHO (2007)	IOTF
Underweight		
All; n= 462	5.0 (3.0-7.0)	13.6 (10.5-16.7)
Boys;n=232	7.0 (3.7-10.3)	12.4 (8.2-16.8)
Girls;n= 230	3.1 (0.8-5.2)	14.4 (9.8-18.8)
Healthy weight		
All	67.8 (63.3-72.1)	63.9 (59.5-68.2)
Boys	68.1 (65.5-69.3)	69.3 (63.5-75.3)
Girls	67.5 (69.3-65.5)	58.6 (52.7-65.3)
Overweight		
All	14.4 (12.8-17.6)	12.3 (9.8-15.8)
Boys	11.8 (7.6-16.0)	8.3 (4.7-11.7)
Girls	17.1 (6.8-16.6)	16.2 (11.4-20.9)
Obese		
All	12.7 (9.7-15.4)	10.3 (7.6-13.2)
Boys	13.3 (8.9-17.7)	10.1 (6.2-14.0)
Girls	12.3 (8.1-16.5)	10.8 (6.8-14.8)

*Difference between WHO(2007) and IOTF prevalence rates.

Although the prevalence of underweight was significantly higher using the IOTF cut offs, the prevalence of stunting, as determined by a height for age Z-score of less than or equal to -2 standard deviations, in both groups was very low (St. Kitts- 1.07%, Trinidad- 0.44%). When the average height of underweight children, according to the IOTF cut-offs, were compared to other BMI categories (Table 13) there was no significant difference in mean height for either country.

Table 13: Comparison of mean height of underweight and other combined BMI for age categories (IOTF) of children.

	Mean Height (SD) m
St. Kitts	
Underweight	1.29 (0.1)
Healthy weight, Overweight and Obese	1.30 (0.1)
Trinidad	
Underweight	1.29 (0.1)
Healthy weight, Overweight and Obese	1.26 (0.1)

7.6 Relationship Between Food Security and Weight Status

There was no significant difference in the weight of the caregiver or children from food secure and food insecure households, in the Trinidad and St. Kitts groups.

Table 14: Mean weight of caregivers and children in food secure and food insecure homes.

	Food Insecure (SD)	Food Secure (SD)
	St. Kitts	
Caregiver Wt. (kg)	79.8 (16.0)	80.32(19.6)
Caregiver BMI (kg/m^2)	29.8 (6.3)	30.3 (7.0)
Child Wt. (kg)	25.6 (4.9)	26.6 (5.7)
	Trinidad	
Caregiver Wt. (kg)	78.9 (20.6)	75.1 (17.5)
Caregiver BMI (kg/m^2)	28.4 (7.0)	30.1 (9.8)
Child Wt. (kg)	27.9 (8.1)	29.3 (9.0)
	St. Kitts and Trinidad	
Caregiver Wt. (kg)	79.4 (18.1)	77.4 (18.6)
Caregiver BMI (kg/m^2)	29.9 (8.0)	29.3 (7.0)
Child Wt. (kg)	27.0 (7.0)	28.2 (8.1)

No significant relationship was observed when food security status was assessed with BMI and average caregiver weight, for both St. Kitts and Trinidad. The data in Table 15 below was derived using Chi Square to compare the ratio of each BMI category for adults. The analyses shows that there was no significant difference between food secure and food insecure groups from each BMI category for groups from St. Kitts, Trinidad and both groups combined.

Table 15: Comparison of adult BMI categories between food secure and food insecure groups

	Underweight	N. Weight	Overweight	Obese	P-value
St. Kitts					
F.S (%)	2.4	15.3	31.8	50.6	0.35
F.I (%)	1.1	20.4	39.8	38.7	
Trinidad					
F.S (%)	5.2	27.8	29.9	37.1	0.33
F.I (%)	5.7	15.7	34.3	44.3	
St. Kitts and Trinidad					
F.S (%)	3.8	22.0	30.8	43.3	0.59
F.I (%)	3.1	18.4	37.4	41.1	

F.S- Food Secure; F.I-Food Insecure; N. Weight-Normal Weight

Using Chi Square analyses to assess the relationship for BMI category and food security status, for both the WHO and IOTF cut-offs, no significant relationship was detected (Table 16 and 17). As with adults there was no significant relationship between food secure and food insecure groups for each BMI category when the islands were assessed individually and combined.

Table 16: Comparison of children's BMI categories between food secure and food insecure groups using the IOTF cut-offs.

	Underweight	N. Weight	Overweight	Obese	P-value
St. Kitts					
F.S (%)	26.4	67.8	4.6	1.1	0.20
F.I (%)	25.0	60.0	9.0	6.0	
Trinidad					
F.S (%)	12.2	63.4	15.1	9.3	0.83
F.I (%)	13.9	64.8	11.5	9.8	
St. Kitts and Trinidad					
F.S (%)	9.3	69.9	13.5	7.3	0.59
F.I (%)	8.1	68.5	12.6	10.8	

F.S- Food Secure; F.I-Food Insecure; N. Weight-Normal Weight

Table 17: Comparison of children's BMI categories between food secure and food insecure groups using the WHO (2007) cut-offs

	Underweight	N. Weight	Overweight	Obese	P-value
St. Kitts					
F.S (%)	3.4	82.8	10.3	3.4	0.09
F.I (%)	1.0	73.0	14.0	12.0	
Trinidad					
F.S (%)	5.8	68.6	11.6	14.0	0.57
F.I (%)	7.4	65.6	16.4	10.7	
St. Kitts and Trinidad					
F.S (%)	12.7	68.3	9.3	9.7	0.43
F.I (%)	15.3	63.1	13.1	8.6	

F.S- Food Secure; F.I-Food Insecure; N. Weight-Normal Weight

8. DISCUSSION

Body mass index, calculated from auxological indices such as weight and height, represents a simple and accurate indicator for monitoring the body composition and weight status of adults and children. However, interpretation of BMI measurements requires an appropriate set of reference values to which they will be compared and contrasted. To this end a number of country specific and international growth references and standards have been developed. The aim of this study was to estimate the prevalence of underweight and OWO, in two groups of school aged children from communities from St. Kitts and Trinidad, using the two most commonly used international growth references (WHO 2007 and IOTF). Secondarily, the study attempted to describe any relationship between household food insecurity and weight status of the caregivers of the two groups.

The study revealed that the prevalence estimates for underweight and OWO in St. Kitts and Trinidadian children differed significantly when using different BMI growth references. This difference in the findings is consistent with similar studies, that reported the WHO (2007) reference generally yields higher prevalence estimates for OWO, while the IOTF reference yields a higher prevalence of underweight (Christoforidis et al., 2011; Fernandez, 2012; Fu et al., 2003; Gardner et al., 2011; Gonzalez-Casanova et al., 2013; Monasta, 2011; Shields & Tremblay, 2010). The magnitude of this difference varied most substantially for the underweight population of St. Kitts, where the prevalence of 2.1% (WHO) and 25.7% (IOTF) were very different and lead to very different interpretations of the nutritional problems in the country. Therefore it is critical to consider the choice of growth reference when comparing surveillance data from different settings or studies describing secular trends of underweight, overweight and obesity.

The WHO and the IOTF growth references were conceptualized with different objectives. The WHO growth reference was developed to ensure a smooth transition from the WHO (2006) growth standard. The WHO (2007) growth reference utilized the NCHS 1977 reference population (NHES II and III and NHANES I) to represent a non-obese, healthy population, whose BMI profile had not shifted to the right due to the obesity epidemic of the 1980s and 1990s. Another mandate for the growth reference was to obtain an equivalent of a healthy population used to develop the WHO 2006 growth standard for children 0-60 months (Gonzalez-

Casanova et al., 2013). On the other hand, the IOTF reference was developed with the goal of obtaining an international reference. Age and sex specific BMI centile curves were forced to intersect with cut-points for adults of 25 kg/m^2 and 30 kg/m^2 at age 18 years old. These cut-offs are based on the principle that health consequences in adulthood, can be tracked back to younger ages. The reference populations used by the IOTF, though larger and more ethnically diverse, were derived from more recent data, in which the BMI distribution for the reference populations had shifted towards obesity (Gonzalez-Casanova et al., 2013; Shields & Tremblay, 2010). The differing objectives for curve construction and reference population selection can partly explain the differences in prevalence estimation. The very strong discrepancy, particularly in terms of the prevalence of underweight begs the question which is the most appropriate standard. Given the lack of underweight in the adult population, the caregivers of these children and their comparable height to healthy and overweight children, and the lack of stunting in this population, it may be that the children classified by IOTF as underweight, but not by WHO reference, may be a thin but healthy group of children.

8.1 Comparisons of OWO to Historical Data

The prevalence rate of overweight in the St. Kitts children ranged from 12.3% (WHO) to 7.0% (IOTF) and obesity was 8.0% (WHO) and 3.7% (IOTF). The available historic data for comparison were prevalence rates published by the CFNI (Xuereb et al., 2001), using data from children 0-5 years old. The prevalence was estimated at 9.7% OWO, generated using the 1977 NCHS growth reference, which is now replaced by the WHO (2006) growth standard. These data indicated a general increase in OWO from 1990 to 1999. Because the CFNI study and the findings of this thesis used different growth references to define OWO and participants were of different age ranges, comparisons between studies are problematic. However, the crude numbers would imply a doubling of OWO (20.3%) using the WHO estimates, or a similar prevalence when comparing the Xuereb et al estimate of 9.7% to the prevalence estimated using the using the IOTF (10.6%) cut-offs. The 2011 Saint Kitts and Nevis Global School-based Student Health Survey (children 13-15 years old), using the WHO 2007 growth reference, found the combined prevalence of OWO to be 49.2% and 44.6% in males and females respectively. In 2012 the report, published by the PAHO using the WHO 2007 growth reference, also highlighted the very high prevalence of OWO in St. Kitts adolescents. The report pointed to an overall prevalence of 46.9% OWO in children 11-16 years old. These data, though from different studies and using different growth references in some cases (WHO 2007, NCHS and IOTF), highlight a general progression of OWO as individuals go from childhood into adolescence.

Similar to the St. Kitts group, the IOTF growth reference produced more conservative estimates for OWO, in the Trinidadian group. Recent prevalence estimates determined using a similar growth references were not found in the literature. Data published by Francis et al (Francis et al., 2010), using the CDC growth reference, reported that approximately 23% of participants were OWO, that is a BMI above the 85th percentile. In an older study by Gulliford et al (Gulliford et al, 2001), using the NCHS growth reference, the prevelance of overweight was estimated at 8.5% and obesity at 2.4%. Based on the prevalence rates determined in this study, a combined prevelance of OWO, 27.1% (WHO) and 22.6% (IOTF) one can assume an increasing trend of excess body weight. However, these trends have to be interperted with a measure of caution when making inferences about national trends in OWO over time. This is because neither study sample was nationally representitive and the growth references used were not consistent across the studies. This lack of current nationally representitive data and inconsistent use of growth references are the primary challenge to making firm conclusions about the incidence of underweight, OWO and establishing secular trends throughout the Caribbean region.

The present data reported a greater concordance between prevalence estimates for obesity, compared to underweight, for both the WHO and IOTF growth references. This was similar to results reported by Gonzalez-Casanova and colleagues (Gonzalez-Casanova et al., 2013) and a similar study by Gardener et al (Gardner et al., 2011) , though in younger populations (0-60 months). The greater agreement between the estimates generated for obesity alone, rather than overweight and underweight, is encouraging because childhood obesity is more strongly linked with adverse health outcomes. Using a population of Canadian children 6-11 years old Shields and Tremblay (Shields & Tremblay, 2010) reported the combined prevalence of OWO to be 36.5% and 25.8%, for the WHO and IOTF respectively. The prevalence rates reported in St. Kitts and Trinidad, though less than those for Canada remain high. Although considered as developing countries, individual CARIOCM states are at differing stages of development, with more developed islands, such as Trinidad and Barbados have higher prevalence of OWO compared to less developed islands such as St Kitts and St. Lucia. Again caution is needed when interpreting the prevalence estimates for St. Kitts and Trinidad as these samples are not nationally representative. Moreover, in the case of Trinidad, the group was chosen from 8 schools in deprived areas of Port of Spain and with the St. Kitts group, from rural areas of Mansion and Stapleton.

8.2 The Existence of Over Nutrition and Undernutrition

Researchers caution that although the prevalence of OWO are increasing worldwide, underweight and under nutrition remain a significant public health concern in many developed and developing countries (Cole et al., 2007; Onis & Blössner, 2000). Moreover, many developing nations are faced with a double burden of malnutrition, which relates to the challenge of both obesity and underweight, sometimes coexisting in the same household. In this study and other studies done in the Caribbean and internationally, using multiple growth references, conflicting results are found. According to the analysis from using the IOTF cut-offs, St. Kitts and Trinidad appear to be no exception to this trend of high prevalence of excess weight and underweight. While WHO figures show no evidence of a double burden of malnutrition.

Within a public health context underweight, thinness and other manifestations of under nutrition have been linked to growth faltering and are associated with increased morbidity and mortality (Freedman et al., 2005). Therefore monitoring all aspects of growth and nutrition status is of primary importance. Underweight or thinness can be used as a marker of malnutrition, although thin children may not be necessarily undernourished (Freedman et al., 2005). This manifestation of malnutrition in school aged children and adolescents are largely under studied, compared to the vast amount of literature on obesity in children and adolescents.

With the St. Kitts group, depending on the classification method, as many as 25.5% (IOTF) of the population was classified as thin or underweight. The WHO cut-off, of less than -2 standard deviations yielded a significantly smaller proportion, 2.1% for underweight children. Unlike the IOTF which estimated the prevalence in females to be 24.7%, the WHO cut-off estimated the female underweight population to be 0%. For the Trinidad group, depending on the classification method as little as 5.0% (WHO) and up to 13.6% (IOTF) were classified as underweight. As with OWO, the IOTF and WHO produce significantly different prevalence rates for underweight.

Also this difference is consistent with contemporary literature from the region (Fernandez, 2012; Gardner et al., 2011) and internationally (Christoforidis et al., 2011; Gonzalez-Casanova et al., 2013; Monasta, 2011). There was greater consistency between the prevalence estimates generated for underweight for the Trinidad group, compared to the St. Kitts group, though the difference in both was significant. This difference could be attributed to the fact the Trinidad group consisted of a larger sample size.

The IOTF growth reference could potentially misclassify the taller and thinner individuals from the rural population as underweight. Whereas the WHO growth reference, which is less sensitive to the detection of underweight, could potentially classify these children in higher BMI cut-off range. The potential misclassification of tall thin children by the IOTF growth reference, as underweight, can potentially be corroborated by the very low prevalence of stunting in both groups of children. When the subgroup of children classified as underweight, according to the IOTF cut-offs in terms of height for age Z scores, were compared to other BMI categories (Table 13), there was no significant difference in height across the categories. This would imply the children were not stunted, but possibly tall and thin. Hence one can assume the majority of children classified as underweight according to the IOTF are in no danger of negative health effects, but this needs to be explored further. The big discrepancy, according to the prevalence rates determined by the WHO and IOTF, raises the question as to whether there is really a double burden of malnutrition within the groups from St. Kitts and Trinidad. Moreover, statistics from the WHO not only indicate nominal levels of underweight but also that there is virtually no stunting within the two groups. While this needs to be confirmed by representative samples, it puts into question the concern about a double burden of malnutrition. This needs to be explored as interventions to address obesity and underweight can be very different and public health interventions need to understand clearly where the nutritional problems exist.

Unlike elevated BMI, which is linked with a variety of maladies (Freedman et al., 2005; A. Must & Strauss, 1999), clinical findings linking underweight or thinness to ill health in children and adolescents are still scarce (Duggan, 2010; Freedman et al., 2005) . In the Seychelles, using the IOTF growth reference cut-offs, Bovet et al demonstrated a substantially lower level of physical fitness among both overweight and thin children, as compared to “healthy” weight children

(Bovet, Auguste, & Burdette, 2007). Like OWO, determining the clinical cut-off for underweight is complicated by several factors, including changes in body composition with growth, variations in body frame and sexual maturation. Moreover, as with OWO, there is an absence of a gold standard growth reference to define underweight. Reference population data should not be based on populations that are not burdened with excessive overweight or underweight problems (Cole et al., 2007; Cole & Lobstein., 2012). The "true" prevalence of underweight would be underestimated if the base population from which the indicator is derived was undernourished and overestimated if there was no under-nutrition problem in that reference population (Bovet et al., 2011). The WHO cut-offs take this factor into consideration, as its reference population is based on data collected prior to the start of the obesity epidemic. Conversely the IOTF data, though derived from a larger international sample, contains data which were collected after the upswing of the obesity epidemic. The inclusion of this more recent data, which potentially reflects the upward shift in population's mean BMI, reduces the specificity of the IOTF to determine underweight status in children.

Ideally, growth reference cut-offs should have both high sensitivity and specificity (Fu et al., 2003). High sensitivity is necessary to avoid failure of identifying obese children and high specificity of the screening tool ensures that non-obese children are not misclassified as failure to identify obese children may have more serious consequences than misclassification since obesity results in an increase in adult morbidity and mortality. Therefore, high sensitivity may be a more important consideration than specificity in choosing an appropriate screening tool for childhood obesity. The resilience on the of the WHO growth standard also extends to their use to assess underweight and stunting in children and adolescences. Like the IOTF, the WHO growth reference provides a classification for different grades of underweight or thinness. Moreover the WHO cut-off was developed for clinical and epidemiological use. Within that context the WHO growth reference appears to be the more ideal choice for assessment of childhood overweight and underweight.

8.3 Food Security Status and Obesity

Early research has shown that in high income countries, such as USA and Canada, obesity is more often associated with lower socio-economic status. Conversely, in low income countries obesity is associated with affluence (Sobal, 1989). This observation implies that in more food-abundant environment, socioeconomic factors such as income level, education attainment and marital status may modify the relationship between food availability and obesity. However, middle income counties, such as Trinidad and other CARICOM states, the relationship between food security and obesity appears to be less consistent (Gulliford et al., 2003). This suggests that obesity might be associated with affluence in some situations, but poverty in others. Previous studies in the region have used both the 18 and 6 items HFSS items to classify food security status of adults and children. In Trinidad, Gulliford et al (Gulliford, et al., 2006) demonstrated that the questionnaire performed in a very similar manner to results obtained from the US. Based on their finding they were able to conclude the problems associated with food insecurity were considerably more frequent in Trinidad than the USA. Previous work by Gulliford (Gulliford, Mahabir, Nunes, & Rocke, 2005; Gulliford, Mahabir, & Rocke, 2004), using the six-item version of the HFSS also provided accurate results in Trinidadian populations.

In the present study the prevalence of food insecurity within households was high, with St. Kitts having a total of 43.0% and Trinidad 51.6% of households characterized as food insecure. For both St. Kitts and Trinidad there was no significant difference in BMI for food insecure and food secure households, within caregiver populations, with the average BMI in the overweight to obese range for both countries. Furthermore, Chi Square analyses showed that there were no significant differences in BMI categories between food secure and food insecure households for St. Kitts, Trinidad and both countries combined (Table 15). Similar results were observed with children when food secure and food insecure households were accessed using BMI cut-offs from WHO and IOTF (Tables 16 and 17). Therefore children living in food insecure households might not need additional calories for optimal growth.

So within that context food insecurity does not appear to be associated with a deficiency of calories. Some other lifestyle component, such as physical inactivity, could be also contributing to the high prevalence of obesity. The findings were similar to other studies done in other developing countries which did not establish a significant relationship between food security and obesity or underweight. To further elucidate the relationship between food security and obesity assessment of socioeconomic status and a more detailed assessment of diet quality to determine if diets are of poor quality (high in fats and sugars and low in fruits and vegetables).

8.4 Strength and Lmitations of Study

It can be advanced that the data used for this study is more accurate, that is having less measurement error, because it was collected specifically for research. The data were collected by trained personnel and not based on self-report or derived from an existing database. The overall response rate to the food security questionnaire for St. Kitts was 100% was exceptional for studies of this type; and for Trinidad the response rate was 64% which was comparable to similar surveys.

As with other studies assessing body composition using BMI as a proxy for body composition, there are some limitations to be expected. Firstly, with the caregiver population no additional information on health outcomes, such as elevated blood pressure, diabetes and cardiovascular disease, was collected that could be used to determine correlations between disease prevalence and obesity. Although studies have shown that increasing levels of BMI are associated with higher levels of disease risk, BMI only represents a surrogate measure of adiposity. Alternatively, the use of a more direct measure or multiple measures to determine body fatness, which are more highly associated with negative health outcomes, could have provided greater insight. Though not the mandate of the present study, the use of biochemical markers (such as serum triglycerides and low density lipoprotein cholesterol) could have been used to provide essential information to elucidate any potential relationship between higher estimated body fatness and an increased risk for CVD and other conditions in boys and girls. Because no additional information on health outcomes was collected for the children that could be used to determine which classification system performs better as a screening tool. Only differences in prevalence can be described. In the caregiver population, no additional information was collected on health outcomes, such as diabetes, CVD and other NCD. This would have allowed researchers the opportunity to establish the prevalence of NCD and establish prevalence rates within the two caregiver populations.

Due to the cross-sectional nature of the data, one cannot attribute cause or effect, that is if food insecurity as the casual factor of obesity or underweight. Hence only differences in prevalence can be described. Although no significant relationship was found it cannot be conclusively said that the food security is not linked to obesity in the caregiver groups. As with similar studies assessing food insecurity and weight status, casual relationships between weight status and food security could not be discerned. The cross sectional nature of the study does not facilitate the assessment of incidence of underweight and OWO or follow the sample to assess BMI over time.

To assess household food security the Six-Item HFSS from the USDA was used was chosen as a reliable substitute to the longer 18 and 10 item varieties. This was primarily due to its lower respondent burden and its widespread use in estimating food security. The six-item questionnaire does not facilitate the measurement of the most severe levels of food insecurity, such as moderate hunger and severe hunger. Additionally, this food security assessment tool does not assess children in the household. Therefore household food security status reflected that of the caregiver, rather than the children's status. However, previous studies have suggested that adults might buffer the effects of household food insecurity on their children by depriving themselves at meal times (Coleman-Jensen, Nord, Andrews, & Carlson, 2011; Metallinos-Katsaras et al., 2009).

Although both the St. Kitts and Trinidad study samples are not nationally representative (with the St. Kitts group representing a rural population and Trinidad group representing an urban population living in deprived conditions), they provided large enough samples to make robust comparisons. Nonetheless, it is difficult to make strong conclusions about national trends in obesity prevalence and food insecurity. On the other hand, because the study participants were recruited from rural and economically deprived areas, particularly in the Trinidad group, household food insecurity would be more relevant among these low-income groups, given that is much more pervasive in these populations. This recruitment strategy therefore reflects the knowledge that there are inherent socioeconomic differences between food insecure and food secure groups, given the virtually non-existence of food insecurity in high income groups. The rationale behind this was to ensure that socioecomicially deprived participants, utilizing the school lunch program, would more likely utilize the school lunches from the modified school menus. Therefore participants would be more likely to benefit from the intervention and improve nutritional outcomes.

9. Conclusions and Implications for Intervention

The approach of this study made it possible to demonstrate the differences in the estimates of the prevalence of underweight, overweight and obesity using the two most frequently used international growth references. The findings of the present study are consistent with other reports of increasing levels of obesity in Caribbean children. The study also highlights the need to further investigate the occurrence of underweight and thinness and the methodologies used to assess them. Moreover the study also provides impetus for future co-ordinated surveillance and interventions to address the growing concerns around childhood underweight and OWO.

Some of the primary goals of identifying childhood malnutrition at a population level are to identify prevalence rates, secular trends, to identify potential determinants of malnutrition and to identify populations at risk of suffering the health consequences of underweight and obesity. Therefore to advance childhood obesity research and prevention, it is paramount to establish the potential of BMI classification systems to predict adverse health consequences associated with underweight and obesity and accurately reflect body fat. The IOTF was the first growth reference specifically designed to reflect the risk of obesity related health outcomes. However it has lower sensitivity, compared to the WHO (2007) reference, for diagnosing childhood OWO. The WHO 2007 growth reference was designed using data, which predates the obesity epidemic of the 1980's. Considering the above caveats the WHO 2007 growth reference is likely better suited for developing countries, such as St. Kitts and Trinidad, where the obesity prevalence is relatively low, compared to the USA or Canada.

Although BMI appears to be a convenient and feasible screening tool for accessing OWO in children, further detailed studies are needed to improve interpretation of this measure and to recommend a single and unique international reference, which adequately reflects percentage fat and risk of adverse health outcomes. In the absence of this gold standard the use of multiple references facilitates wider comparison of findings across studies. The present approach, of using two internationally recommended growth references, made it possible to demonstrate the differences in estimates of prevalence. Additional research, using nationally representative samples, is needed to determine the prevalence of underweight and OWO in St. Kitts, Trinidad and throughout the region; research aimed at understanding how low income families manage food insecurity; and data on physical activity can also help further elucidate the relationship between food insecurity and obesity. The use of the 18-item form of the HFSS questionnaire in future studies would provide more information rich data. That instrument would permit the categorization of food insecurity into moderate and severe hunger. Moreover it will allow the estimation of food security status of children and adults to done separately.

There are different risk factors for obesity for adults and children living in the same household and environment. Therefore different preventative strategies may be needed to prevent and manage obesity in children and adults. Strategies and interventions that only increase nutrition awareness are not enough to alleviate malnutrition (underweight and obesity) and food insecurity, considering that healthier foods (whole grains, fruits vegetable, low fat foods and lean meats) cost more than cheaper calorie dense processed foods. However, food insecurity and poverty alone seem not a risk factor for obesity. Tracking individuals into adulthood, while measuring changes in BMI and food security status, could help elucidate when food security becomes a risk factor for underweight and obesity. Longitudinal studies of this nature could potentially help reveal the dynamics of this relationship between obesity and food insecurity in families and identify when interventions can be most effective. The wider CARICOM project, consisting of nutrition education and modification of school feeding menus, soil and water conservation, agricultural diversification and production, seeks to address these challenges through an integrated, gender equal, environmentally sustainable systems approach to food availability, access, food safety and quality.

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