

A SNAP-SHOT OF CHILD OBESITY IN BARBADOS;
PREVALENCE OF OVERWEIGHT AND OBESITY, DEMOGRAPHIC VARIABLES,
FAMILY CHARACTERISTICS, EATING HABITS AND ACTIVITIES OF GRADE FIVE
CHILDREN

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April 2012

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

Dedicated to my parents,
who have supported me through all my adventures
and Isaël, for all the small stuff

Abstract

Few data on the nutritional status of children have been collected in Barbados over the last 30 years and little is known about this topic in present day. The aim of this study was to update the literature on the current nutritional status of children by surveying a cross section of grade five students. A total of 255 boys and 325 girls were weighed and measured. From this group, subsamples of 494 students and 229 parents were interviewed. The prevalence of overweight and obesity (OWOB) was 32% for boys and 37% for girls. OWOB has increased by over 20 percentage points since 1981, much more rapidly than in similarly developed nations. Higher parental education and access to sedentary entertainment were related to OWOB in all children. Having married parents and infrequent snacking while watching television were related to OWOB in boys only. Maternal BMI and maternal OB were directly related to weight status in girls. Conversely, active transport and family meals were protective factors for OWOB. This study was not able to determine any links between OWOB and sedentary activities or involvement in sports. Children from very low income families were at greater risk for both obesity and malnutrition. The results suggest that it is important to implement a child obesity monitoring program in Barbados in order to better assess the progression and understand trends in OWOB. Immediate interventions to protect vulnerable low income children are warranted.

Résumé

Au cours des 30 dernières années, très peu de recherches scientifiques ont étudié le bilan nutritionnel des enfants à la Barbade. Le but de cette recherche était de dresser un portrait sur l'état actuel de la nutrition chez les enfants à l'aide d'une étude transversale sur des élèves de 5e année du primaire de la Barbade. Au total, 255 garçons et 325 filles ont été pesés et mesurés. Auprès de ce groupe, un sous-groupe de 494 élèves ainsi qu'un autre sous-groupe de 229 de parents d'élèves ont été questionnés à l'aide de sondage. La prévalence d'embonpoint et d'obésité est de 32 % chez les garçons et 37 % chez les filles. La prévalence d'embonpoint a augmenté d'au moins 20 points de pourcentage depuis 1981, un taux beaucoup plus rapide, et ce comparativement à des pays semblables en voie de développement. Deux facteurs contribuant au risque d'embonpoint et d'obésité ont été identifiés, soit le niveau élevé d'éducation scolaire reçu par les parents et l'accès au média. Par ailleurs, les enfants de parents mariés et avec des habitudes irrégulières de grignoter en regardant la télévision étaient associés à des risques d'embonpoint et d'obésité chez les garçons. L'indice de masse corporelle et l'obésité maternels étaient tous les deux des facteurs associés au poids des filles. Les enfants de familles à faible revenu étaient plus à risque pour de l'embonpoint et malnutrition. Le transport actif et les soupers en famille ont été identifiés comme étant des facteurs qui réduisaient le risque d'embonpoint et d'obésité chez les enfants. Par contre, l'étude menée n'a pas permis d'établir si les activités sédentaires et l'implication dans des activités sportives avaient un lien avec l'embonpoint et l'obésité. Les résultats de cette étude suggèrent qu'un système de monitoring est requis pour mieux comprendre les tendances et risques d'embonpoint et obésité. De plus, il est suggéré que des interventions pour protéger la vulnérabilité des enfants provenant de familles à faible revenu méritent une considération immédiate.

Acknowledgements

I would like to thank my supervisor, Dr. Stan Kubow, for opening the doors to this project by putting me in contact with Dr. Pamela Gaskin at the University of the West Indies. He has given me the confidence to grow and mature as a researcher. Thanks to his enduring support in pursuance of over a dozen awards applications, I was able to secure the financial resources to accomplish my research project. I thank the principal investigator, Dr. Gaskin, for first of all letting me contribute to the Barbados Children's Health and Nutrition Study. She has led me through this project and showed patience and support through every step of our research. I am very grateful to Dr. Katherine Gray-Donald for the time she spent discussing methodology and results with me. I would like to thank my committee members Dr. Danielle Donnelly and Dr. Maureen Rose for commenting on and editing my thesis proposal.

I would also like to thank my colleague JaDon Knight for his friendship and partnership throughout all 22 school visits. A special thanks to the research team (Andrea Low, Elaine Chiu, Gabriela Bernales, and Rachel Malcangi) from McGill University who assisted with Antropometric measurements.

I would like acknowledge the Ministère d'éducation loisir et sport (MELS), l'office de Québec-Amérique pour la jeunesse (OQAJ), the International Union for Nutritional Sciences (IUNS), the Canadian Federation of Independent Grocers (CFIG) and the Canadian Association of Foodservice Professionals (CAFP), for their financial support through travel grants and awards that allowed me to finance my studies, conduct my field work, and attend the Obesity Society Annual Meeting in 2011.

Research manuscripts in preparation for publication

Manuscript I: Changes in childhood overweight and obesity between 1981 and 2010; results from the Barbados Children's Health and Nutrition Study

Contribution of authors: the candidate designed the study questionnaires, recruited participants, measured and weighed subjects, as well as recorded, entered, cleaned, analysed and interpreted the data, and wrote the article. Dr. Gaskin, the principal investigator and a lecturer at the University of the West Indies (UWI) in Barbados, designed the studies as well as contributed to and supervised all aspects of the study from conception to editing. Dr. Kubow, the candidate's supervisor and an associate professor at McGill University, contributed to the study design, data interpretation, and edited the article. Dr. Kubow also provided guidance and professional opinions throughout the study. Dr. Gray-Donald, the candidate's committee member and an Associate Professor at McGill University, contributed to the statistical analysis, and interpretation of the results. JaDon Knight, a graduate student at UWI, assisted in school sampling methodology, subject recruitment and contributed to editing the article.

Manuscript II: High parental education, low income, access to sedentary entertainment, infrequent family dinners, and inactive transport are associated with overweight and obesity in Barbados

Contributions of authors: the candidate designed the study questionnaires, interviewed all participants, as well as recorded, entered, cleaned, analysed and interpreted the data, and wrote the article. Dr. Gaskin designed the studies as well as contributed to and supervised all aspects of the study from conception to editing. Dr. Kubow contributed to the study design, data interpretation, and edited the article. Dr. Kubow also provided guidance and professional opinions throughout the study. Dr. Gray-Donald contributed to the conception of the study questionnaires, the statistical analysis, and interpretation of the results. JaDon Knight assisted with subject recruitment and contributed to editing the article.

List of abbreviations

AAP	American Academy of Pediatrics
BAZ	Body mass index for age z-score
BD	Barbados dollar
BMI	Body mass index
CBC	Caribbean Broadcasting Corporation
CDC	U.S. Centers for Disease Control and Prevention
CFNI	Caribbean Food and Nutrition Institute
CHNS	Children's Health and Nutrition Study
CI	Confidence interval
CL	Confident limit
CV	Coefficient of variation
DMT2	Diabetes mellitus type two
FAO	Food and Agriculture Organization
HDI	Human development index
ht	Height
IASO	International Association for the Study of Obesity
IMF	International Monetary Fund
IOTF	International Obesity Task Force
kcal	Kilocalories
kg	Kilogram
NCD	Non-communicable diseases
NHANES	National Health and Nutrition Examination Study
NHS	National Health Service of England
NNC	National Nutrition Center
OMS	Organisation mondiale de la santé (WHO)
OR	Odds ratio
OWOB	Overweight and obesity
PAHO	Pan American Health Organization
PHAC	Public Health Organization of Canada

r	Rho
RR	Relative risk
SD	Standard deviation
SES	Socioeconomic status
TV	Television
UNICEF	United Nations Children Fund
USA	United States of America
UWI	University of the West Indies
WHO	World Health Organization
wt	Weight
χ^2	Chi-Squared

Table of contents

Abstract	ii
Résumé	iii
Acknowledgements	iv
Research manuscripts in preparation for publication	v
List of abbreviations	vi
Table of contents	viii
List of tables	xi
List of figures	xii
I. Introduction	
1.1 Background	1
1.2 Rationale	1
1.3 Statement of purpose	3
II. Literature review	
2.1 Obesity: the global epidemic	3
2.1.1 Obesity in the Americas and the Caribbean	5
2.1.2 Prevalence of overweight and obesity in Barbados	6
2.1.3 Child obesity prevalence	10
2.1.3.1 Children in Canada and the U.S.A	11
2.1.3.2 Children in Barbados	14
2.2 Origins of obesity	17
2.2.1 The nutrition transition	17
2.2.2 Socioeconomic status and demographic variables	19
2.2.3 Diet	20
2.2.4 Activity	22
2.2.4.1 Sedentary and physical activities	23
2.2.4.2 Activity recommendations	24
2.3 Consequences of obesity	25
2.3.1 Economic	25
2.3.2 Non-communicable diseases	26
2.3.3 Maternal obesity and child health outcomes	27
2.4 Conclusions	28
III. Linking statement I	29
IV. Manuscript I	31
4.1 Abstract	32
4.2 Introduction	32
4.3 Methods	34
4.3.1 Sample size and selection	34
4.3.2 Recruitment	35

4.3.3 Ethics approval	36
4.3.4 Measurements	36
4.3.5 Prevalence of overweight and obesity calculations	36
4.3.6 Statistical Analysis	37
4.4 Results	37
4.4.1 Sample characteristics	37
4.4.2 WHO BMI for age growth references	37
4.4.3 CDC BMI for age percentiles	38
4.4.4 IOTF cut-offs	39
4.4.5 Harvard weight/height for age standards and the change in prevalence of overweight and underweight since 1981	39
4.5 Discussion	41
4.5.1 Prevalence of child overweight and obesity in Barbados	41
4.5.2 Differences between overweight and obesity prevalence between genders and cut-offs	41
4.5.3 Comparisons to reference populations in the U.S.A	43
4.5.4 Increases in overweight and obesity and decreases in underweight since 1981	43
4.6 Limitations	44
4.7 Conclusion	45
4.8 Disclosure	45
V. Linking statement II	46
VI. Manuscript II	47
6.1 Abstract	48
6.2 Introduction	48
6.3 Methods	51
6.3.1 Interviews	51
6.3.2 Ethics approval	51
6.3.3 Statistical Analysis	52
6.4 Results	53
6.4.1 Guardian interviews	53
6.4.1.1 Characteristics	53
6.4.1.2 Demographic variables	54
6.4.1.3 Household income	54
6.4.1.4 Maternal weight status	56
6.4.2 School interviews	58
6.4.2.1 Family setting, eating habits, and sleep	58

6.4.2.2 Active transportation	61
6.4.2.3 Sedentary activities and sports	61
6.4.2.4 Media and sedentary entertainment access	61
6.4.3 Bias	63
6.5 Discussion	63
6.5.1 Demographic variables	64
6.5.2 Maternal BMI	67
6.5.3 Protective effects of family dinners on overweight and obesity	68
6.5.4 TV snacking and sedentary entertainment usage	68
6.5.5 Active transportation	70
6.6 Limitations	71
6.7 Conclusions	72
6.8 Disclosure	72
VII. Additional Methodology	
7.1 Study Population	73
7.2 Sample size	73
7.3 Recruitment	74
7.4 Anthropometric Measurements	75
7.4.1 Height	75
7.4.2 Weight	75
7.4.3 Inter-investigator reliability	76
7.5 Questionnaires	76
7.5.1 School interview	76
7.5.2 Guardian telephone interview	76
7.6 Consent and assent	76
VIII. Overall summary and conclusions	
8.1 Conclusions	77
8.2 Summary of contributions	78
8.3 Future research	78
IX. References	81
X. Appendices	94

List of tables

Table	Title	Page
1	Nutrition surveys and obesity prevalence studies in Barbados	8
2	The prevalence of child overweight and obesity in selected countries	11
3	Means of descriptive characteristics	37
4	Prevalence of overweight and obesity in grade five Barbadian children using WHO BMI for age Z-scores	38
5	The prevalence of overweight and obesity in grade five Barbadian children using various growth references and differences between boys and girls	38
6	Comparison of overweight and obesity prevalence between Barbadian 8-11 year old and American 6-11 year old children using CDC BMI percentiles (≥ 85 th)	39
7	Gender differences and relative risk of overweight and obesity in boys compared to girls based on different measurement criteria	39
8	Change in underweight and overweight from 1981-2010 based on Harvard weight/height for age standards	40
9	Percent increment in child overweight and obesity in selected countries over last 30-40 years	40
10	Unadjusted relative risk (RR) of selected demographic variables from guardian interviews for overweight and obesity in grade five children	55
11	Logistic regression analyses examining demographic variables associated with overweight and obesity	56
12	Student t-test showing differences in BMI between groups of demographic variables from guardian telephone interviews	57
13	Unadjusted relative risk (RR) of selected variables from school interviews for overweight and obesity in grade five children	59
14	Student t-tests showing differences in BMI between groups of variables from school interviews	60

List of figures

Figure	Title	Page
1	Age adjusted prevalence of obesity in Barbados	7
2	Age adjusted prevalence of OWOB in Barbados	7
3	Prevalence of underweight (< 80% wt/ht for age) and overweight (> 120% wt/ht for age) in children 0-14 years in Barbados in 1981	15
4	The stages of the nutrition transition	19

I. INTRODUCTION

1.1 Background

Obesity has been a growing global child health concern over the last several decades (Gortmaker, Swinburn et al. 2011). It is estimated that as much as 20% of the world's children aged 5-14 years are overweight and 10% of children may also be obese (The Lancet 2006). Obesity is no longer a health problem limited to the developed world (WHO 2010). Small nations and emerging economies such as Barbados are likely to be at high risk for elevated prevalence obesity. Significant economic and lifestyle changes over the last 30 to 40 years in Barbados have resulted in a nutrition transition. These changes have created an environment which has potentially put Barbadian children at risk for overweight and obesity (OWOB). The present thesis will examine child OWOB in relation to the nutrition transition in Barbados and address the complexity of common obesity influences. Furthermore, the change in child OWOB in Barbados over the last three decades will be estimated and the current state of OWOB will be reviewed by surveying a cross section of children in grade five using international comparisons.

1.2 Rationale

The global increase in obesity has recently been described by as “a normal response by normal people to an abnormal environment” (The Lancet 2011, p. 741). Children are the most vulnerable members of society to obesity because of their inability to change or understand how to adapt to their environments. It is well documented that child obesity may have serious health impacts that are carried into adulthood (Heinberg and Thompson 2009). For these reasons, childhood would be a critical period for both monitoring the progression and understanding the influences of obesity.

The last global estimate in 2010 cited 200 million overweight school children, 20-25% of whom were also obese (IASO [unknown date]). Several developed nations have strong national health and nutrition monitoring programs

which include the analysis of OWOB at various periods over the last several decades (HC 2010; CDC 2011). Many studies and surveys have been conducted that have thoroughly examined factors that influence child obesity (Han, Lawler et al. 2010); however, the data collected are most often situational and may only be relevant to a unique nation or part of the world. Even though these statistics provide very valuable data, the conclusions are not easily transferable to other nations or cultures. It is important to note the influences of child obesity and how they differ between communities and nations in order to begin to affect change in stabilizing the increase in prevalence rates, particularly in high risk countries such as Barbados and in vulnerable populations such as children.

Barbados is a developed nation and according to the human development index (HDI) is ranked as the 3rd most developed nation in the Americas (The World Bank 2010). Nevertheless, UNICEF has recognized a problem with poverty in Barbados, which could have negative impacts on both health and education of Barbadians (Loudon 2006). The Gini Coefficient, an indicator of wealth inequality (UNDP 2010), was very high in Barbados (Thomas and Wint 2002) giving an idea of the potential income inequities Barbadians face. These inequities in combination with rapid economic change over the last several decades, an epidemiological transition from infectious to non-communicable diseases (NCD), and the current phase of nutrition transition have created an environment making Barbadians vulnerable to high obesity prevalence. These are all likely causes that, in part, are at the root of the high obesity rates in Barbados and which are projected at over 50% for adult women in 2010 (Ono, Guthold et al. 2005).

The state of OWOB and its increase in Barbadian adults has been documented through various studies as well as national surveys over the last three to four decades (Table 1). The most recent national nutrition survey conducted in 2000 revealed an obesity prevalence of approximately 20% in men and 29% in women (NNC 2002). The obesity rates are considered to be high in adults; however, very little is known about the nutrition status of children. There has not been any nationally representative information collected on the weight status of

primary school children in Barbados in almost 30 years (Ramsey, Demas et al. 1986). The extraordinary economic, health, and societal changes that have occurred since the 1980's have created an environment, whereby a very real possibility exists that the rates of OWOB in children have dramatically increased since the last nutrition survey. It is essential to obtain a current measure of the prevalence of OWOB in a nationally representative sample of children in order to proceed with the impending steps to ameliorate the likely precarious nutrition status of children in Barbados.

1.3 Statement of purpose

The primary objective of this thesis is to determine the prevalence of OWOB of a cohort of grade five children to update the literature on the state of childhood OWOB in Barbados. The change in nutrition status from 1981 to 2010 is estimated in addition to comparisons using various recognized growth standards for the purpose of international comparisons.

The secondary objective is to determine whether known obesity influences in other parts of the world are also applicable to the Barbadian context and whether they act as risk factors or protective agents for OWOB so as to better inform future research. This thesis examines the obesity influences that are commonly seen in other nations and suspected of impacting the weight status of Barbadians, and includes demographic variables, family life, children's activities, transportation, and sedentary activities.

II. LITERATURE REVIEW

2.1 Obesity: the global epidemic

Over a decade ago the World Health Organization (WHO) formally labeled obesity as an epidemic (OMS 2003), a silent cause of death that has grown over the last 30 years. More recently, obesity has been described as a pandemic (Swinburn, Sacks et al. 2011), affecting developing and developed

nations alike (Egger and Swinburn 1997; Prentice 2006). Worldwide, there are an estimated 400 million obese adults (WHF 2010). Illustrations of the global prevalence of obesity shown on the International Obesity Task Force (IOTF) website demonstrate a high concentration of obesity in the Americas. Obesity prevalence over the last few years ranged between 0.6% to 34.2% in the African region and 6.3% to 37.4% in the Americas region (IASO [unknown date]).

The global prevalence of OWOB is expected to double the prevalence of under-nutrition by the year 2025 (Macdiarmid and Rigby 2002). Obesity rates are likely to increase at a more dramatic pace in developing nations, thus worsening the pandemic. The United States of America (USA) is often used as a marker of obesity expansion. Obesity maps such as those drawn by the Center for Disease Control (CDC) have been commonly used to illustrate the expansion of obesity in the USA over the last several decades (CDC 2009).

A classic perception of obesity is that it affects the wealthy and wealthier nations. While this may have been true in the past, there are increasing levels of obesity in poor countries and in lower socioeconomic circles (Pena and Bacallau 2000). Nevertheless, obesity is still perceived as a “wealthy disease”. The highest levels of obesity in the world were once thought to be in the USA, a country that has been blamed as the originator of the epidemic (Prentice 2006). However, this is no longer the case as the incidence of obesity in developing countries is on the rise. In Latin American countries such as Panama, where obesity rates appear to have overshot those of the U.S. (IASO 2010), this is particularly true. Also, Nauru and American Samoa are now among the countries with the highest rates of obesity in the world (WHO 2006). Caballero (2005) points out that the world’s poorest countries are protected against obesity due to the simple lack of food resources, whereas the middle-income countries and emerging economies are at greatest risk for obesity due to the abundance of cheap vegetable oils and sugar (Caballero 2005). The annual increase in obesity prevalence in developed European countries and America was between 0.3-0.5 percentage points while in developing countries the increase was as much as four times greater (Popkin 2004).

2.1.1 Obesity in Latin America and the Caribbean

Obesity rates all over the Caribbean have been consistently increasing with the same gender disparities seen in Barbados. It appears that obesity affects women at younger ages in the Caribbean (Sinha 1995). Barbados is arguably one of the countries in the Caribbean with the highest rates of obesity and possibly the highest rates of morbidity and mortality (Sinha 1995). Chronic diseases have largely replaced infectious diseases as the major cause of death in the Caribbean. The death rate in Barbados attributed to diabetes was double that of Canadians in the late 1980's (Sinha 1995). Additionally, rates of diabetes mellitus type 2 (DMT2) and other NCD were thought to be increasing more rapidly in Barbados and the Caribbean than in developed countries.

Findings from the International Collaborative Study of Hypertension in Blacks (ICSHIB) showed that Barbados had a consistently larger percentage of participants of both sexes with higher rates of obesity and hypertension than St. Lucia and Jamaica. Barbadians, however, had lower rates than an urban sample of African-Americans from Chicago (Wilks, McFarlane et al. 1996). Barbados also had higher rates than the Bahamas for obesity, hypertension, elevated blood glucose, low HDL and high cholesterol (Sinha 1995). Jamaica is similar to Barbados in culture and racial make-up and certain health and disease trends are likely to be similar. The wealth disparity between the two countries is clear and may partially explain why obesity is less frequently seen in Jamaican, which is a less affluent nation than Barbados. Nevertheless, obesity prevalence of Jamaican women was estimated to be 23.9%, more than double that of Jamaican men (Ichinohe, Mata et al. 2005), a similar gender trend to Barbadians. Lifestyle risk factors related to obesity were studied in Jamaica, by Ichinohe, Mata et al. (1995), and were found to be similar to those in other developed countries. They included lower exercise levels, low amounts of vegetable consumption and lower education in females. Non-smoking and co-habitation were found to be protective factors, and were associated with lower levels of obesity in both men and women (Ichinohe, Mata et al. 2005).

From Caribbean countries for which information is available, Barbados and Cuba had the highest prevalence of obesity (Popkin and Doak 1998). The SABE (Salud, Bienestar, y Envejecimiento en America Latina y el Caribe) study published in May of 2010 compared over 6000 elderly subjects in six cities in Latin America and the Caribbean and showed that Bridgetown, Barbados, had lower rates of obesity and NCD than the Latin American cities in the study (Al Snih, Graham et al. 2010). While the inhabitants of Barbados are likely to be some of the unhealthiest in the Caribbean, it appears that they have not yet surpassed their Latin American counterparts. Although, statistics have shown that Barbadian women had the third highest prevalence of combined overweight and obesity in the Americas, behind Mexico and Panama, and were ranked as the 13th most overweight women in the world (WHO 2006).

2.1.2 Prevalence of overweight and obesity in Barbados

In Barbados, the WHO projected an increase in obesity of over 1% per year between 2002 and 2015 (Ono, Guthold et al. 2005). World comparable age-adjusted estimates of obesity and OWOB in Barbados are seen in Figure 1 and Figure 2. These graphs paint a shocking portrait of obesity prevalence in women, who were ranked as the having the highest estimated rates in the Americas region at over 50% in 2002 and projected to over 60% in 2010 (WHO 2008). These projections are considerably higher than those for males, although the increase in prevalence for male OWOB is expected to rise at a quicker pace. The 2000 Barbados National Food Consumption and Anthropometric Survey shows the same gender disparities, but is more optimistic citing the overall prevalence of female obesity to be 29.3% (NNC, Ministry of Health et al. 2005). The 1981 National Health Survey in Barbados published the prevalence of OWOB (defined as $>120\%$ weight (wt)/height (ht) using Harvard standards) at 38% for women and 16.2% for men (Ramsey, Demas et al. 1986). An unpublished survey of urban adults over 25-years-of-age revealed that female obesity had already reached 30% in 1991, three times greater than male obesity during the same period (CFNI, Frazer et al 2003).

Figure 1*. Age adjusted prevalence of obesity in Barbados

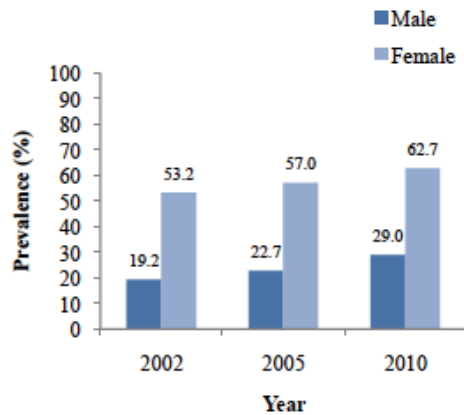
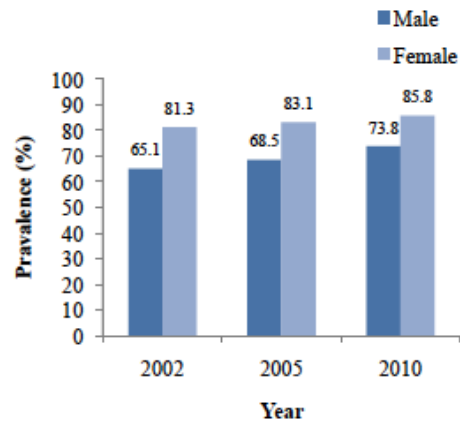


Figure 2*. Age adjusted prevalence of OWOB in Barbados



* Adapted from (Ono, Guthold et al. 2005)

Table 1 shows a summary of the findings of national nutrition studies conducted in Barbados over the last century. The statistics in these studies vary widely because of sampling differences as well as the use of different cut-offs and age groups. In the 1990s, the National Institute of Health consensus values from the NHANES II survey for overweight and obesity cut-offs were commonly accepted and utilized in Barbados (Forrester, Wilks et al. 1996). The overweight and obesity cut-offs for men were 27.8 kg/m² and 31.1 kg/m² and for women were 27.2 kg/m² and 32.3 kg/m². Due to differences between the now commonly used IOTF and WHO cut-offs of 25 kg/m² for overweight and 30 kg/m² for obesity, determining the progression of OWOB over the last few decades has been difficult. In addition, overweight and obesity were used interchangeably prior to the 1990's and obesity was often defined as 120% of standard weight for height. Recent combined overweight and obesity rates ranged from 60.4% in a nationally representative group of adults 18-99 years (NNC, Ministry of Health et al. 2005) to as high as 84.1% in a large sample of 40+ year olds (Nemesure, Wu et al. 2008).

Table 1. Nutrition surveys and obesity prevalence studies in Barbados

Source	Date	Sample	Indicator	Male	Female
(Ramsey, Demas et al. 1986)	1941	1831 children 0-59 months	Sub-optimal to poor	22.8%	27.6%
(Platt 1946)	1945	N/A School aged children	Micro deficiencies (iron, vitamin A, B vitamins) prompting initiation of school lunch program	N/A	
(Standard 1964)	1961	977 Children 4-7 years	Health status	> 50% low haemoglobin 55% dental carries 34.6% parasite infestations 25.8% Trichuriasis 13.6% Ascariasis	
(Standard, Lovell et al. 1966)	1965	9232 Children 5-14 years	Heights and weights (improved nutrition status)	N/A	N/A
(CFNI and FAO 1972)	1969	693 households	Children malnourished 0-59 months	16.5%	
		579	Female Obesity (>130% wt/ht Harvard standards)	N/A	32%
(NNC 1975)	1975	3763 children	Malnutrition children 0-59 months (<80% wt/length Harvard standards)	10.2%	
(Ramsey, Demas et al. 1986)	1981	408 0-59 months	Underweight (<80% wt/length Harvard standards)	3.4%	
			Overweight (>120% wt/length Harvard standards)	3.8%	
		352 5-14 yrs	Underweight (<80% wt/ht Harvard standards)	10%	11%
			Overweight/Obese (>120% wt/ht Harvard standards)	5.3%	11.5%
		1367 15+ yrs	Underweight (<80% wt/ht Harvard standards)	5%	5.8%
			Overweight (120-139% wt/ht Harvard standards)	11.4%	21.7%

			Obese (>140% wt/ht Harvard standards)	4.8%	16.2%
(Hennis, Wu et al. 2002)	1988-1992	4314 Adults 40-84 yrs	Overweight (BMI > 25)	61.2%	
			Obese (BMI > 30.8)	20.5%	
(Wilks, Bennett et al. 1998)	1991	N/A Urban adults 25+	Overweight (BMI 25-30)	15%	28%
			Obesity (BMI > 30)	10%	31%
(Foster, Rotimi et al. 1993)	1993	190 men 274 women 40-79 yrs	Overweight (BMI > 25)	63.2%	72%
			Obese (BMI > 30)	10%	30%
(Forrester, Wilks et al. 1996)	N/A	810	Overweight (BMI > 27.8 men and 27.5 women)	30.8%	69.2%
			Obese (BMI > 31.1 men and 32.3 women)	11%	34.6%
(Wilks, McFarlane et al. 1996)	N/A	330 men 483 women Age 25+	Mean BMI kg/m ²	25.9 +/- 4.3	29.4 +/- 6.4
			>85 th percentile of BMI (countries across Diaspora)	~30%	~36%
			Obesity (BMI > 31.2 men and BMI >32.3 women)	~5-23% (depending on age group)	~20-36% (depending on age group)
(Cooper, Rotimi et al. 1997)	1994	329 men 482 women Bridgetown urban adults 25-100 yrs	Obese (BMI > 30)	14.3%	40.2%
(Tull, Butler et al. 2001)	1997	268 women 20-55 yrs	Overweight (BMI > 27.3)	N/A	40.8%
(NNC 2005)	2000	1653 adults 18-99 yrs	Pre-obese (BMI 25-30)	40.4%	34.2%
			Obese I (BMI 30.1-35)	12.8%	19.3%
			Obese II-III (BMI >35)	2.6%	10.3%
(Nemesure, Wu et al. 2008)	2002	4631 adults Men and women 40+	Overweight (BMI 25-30)	60.5%	

			Obese (BMI >30)	23.6%	
(Gaskin, Broome et al. 2008)	2006	236 girls 164 boys 11-16 yrs	Overweight	15%	17%
			Obese	7%	12%
(Carter, Levesque et al. 2009)	2009	97 children 7-12 yrs	Overweight IOTF BMI 25.1-30	16.5%	
			Obese IOTF BMI 30	14.5%	
(Lai, Guy et al. 2009)	2009	29 boys 33 girls 9-11 yrs	Overweight IOTF BMI 25.1-29.9	44.8%	30.3%

2.1.3 Child obesity prevalence

Obesity has become a global issue, affecting increasingly larger numbers of individuals worldwide at younger ages. Approximately 45 million children under the age of five in the world are overweight, with 83% of these children living in developing nations (WHO 2010). It is estimated that 1-2% of children between the ages of 5-17 are obese (IASO [unknown date]). According to the WHO, childhood obesity is a serious public health issue and nations should make prevention a priority.

A dramatic increase in child OWOB in various countries across the globe has been noted, especially over the last two decades. A steady increase in OWOB in the USA from the 1970s to the 1990s, followed by a steeper rise in rates into 2000 can be tracked from national data (Swinburn, Sacks et al. 2011). Similar trends can be noted in the United Kingdom (U.K), Brazil and Australia, where the prevalence of OWOB increased at a more rapid rate sometime in the 1990s (Swinburn, Sacks et al. 2011). The most recent trend studies for childhood OWOB prevalence have revealed the attenuation of rates in the United Kingdom (Stamatakis, Wardle et al. 2010), Japan (Yoshinaga, Ichiki et al. 2010), Australia (Olds, Tomkinson et al. 2010) and amongst American girls (Ogden, Carroll et al. 2010). However, Kain, Uauy et al. (2002) cautioned that drops in prevalence may appear if changes in cut-offs and methods are used. For example, the use of IOTF cut-offs for children (BMI 25-30 kg/m² overweight, BMI > 30 kg/m² = obese)

show lower rates than methods used in the past, such as the WHO weight for height standard deviations (1-2 SD = overweight, >3SD = obese) and the CDC/NCHS 2000 growth charts (85-95 percentile = overweight, > 95 percentile = obese) (Kain, Uauy et al. 2002).

In the Middle East, Saudi Arabia recently conducted a large survey of the childhood prevalence of OWOB showing a population with moderately high rates of OWOB. The study analyzed the 2005 data with the WHO 2007 standards and CDC 2000 percentiles, noting that the WHO method indicated higher rates of OWOB (El Mouzan, Foster et al. 2010). It is important to note which methods are used to estimate prevalence when comparing nations as well as analyzing trends over the years. The relatively new WHO growth charts are good universal tools that will help standardize future tracking of OWOB prevalence.

In the Caribbean, Costa Rican school children have similar rates of OWOB as Hispanic children in the USA (Nunez-Rivas, Monge-Rojas et al. 2003). Overall rates of OWOB among Indian children are much lower than in the developed world at 12.9% and 8.2% for boys and girls, respectively (IASO 2009), but the rates among children of upper socioeconomic status (SES) in India are substantially higher (Thakar and Viswanathan 2009). In contrast, in the Brazilian city of Maceo, OWOB in school children 7-17 years old was 9.3% and 4.5% respectively, with increasing likelihood in public school children (Mendonca, da Silva et al. 2010), much lower than the national average estimated with IOTF cut-offs of 23% and 21.1% for 7-10 year olds (IASO 2009). Table 2 gives a brief comparison of childhood OWOB rates in various countries.

2.1.3.1 Children in Canada and the USA

In Canada, the prevalence of OWOB in children 2-17 years old from the 2004 Canadian Community Health Survey (CCHS) was 18% and 8%, respectively. A significant increase was noted from the 1978-1979 CCHS prevalence of 12% and 3%. Among minority groups, such as First Nations and South East Asian children, the combined overweight and obesity prevalence varied significantly from the overall Canadian rates and estimated at 41% and

Table 2. The prevalence of child overweight and obesity in selected countries

Country	Source	Sample	Indicator	Male	Female
Canada	CCHS, 2004 (Shields 2005)	NA 2-17 yrs	IOTF overweight	27%	25%
			IOTF Obese	9%	7%
United States	NHANES 2007-2008 (Ogden, Carroll et al. 2010)	3281 2-19 yrs	Overweight CDC > 85 percentile	32.1%	31.3%
			Obese CDC > 95 percentile	17.8%	15.9%
			CDC > 97 percentile	13%	10.6%
Saudi Arabia	(El Mouzan, Foster et al. 2010)	19 317 5-18 yrs	WHO 2007 Overweight > +1 SD	22.4%	23.8%
			WHO 2007 Obese > +2 SD	10.1%	8.4%
			WHO 2007 Severe obesity > +3 SD	2.3%	8.6%
Costa Rica	(Nunez-Rivas, Monge-Rojas et al. 2003)	1718 7-12 yrs	Overweight CDC > 85 percentile	36.8%	32.3%
			Obese CDC >85 percentile + tricept and subscapular skinfolds > 85 percentile	30%	22.5%
Mexico	IASO 2006 (IASO 2009)	NA 5-17 yrs	Overweight and obese IOTF	30.5%	31.5%
India	IASO 2002 (IASO 2009)	NA 5-17 yrs	Overweight and obese IOTF	12.9%	8.2%
United Kingdom	Government Statistical Service, 2005 (NHS 2006)	NA 2-15 yrs	U.K national percentiles Obese > 95	18%	18.1%
Norway	Bergen growth study 2003-2006 (Juliussen, Eide et al. 2010)	6386	IOTF overweight + obesity	13.2%	14.5%
Algeria	National Survey 2006 (Oulamara, Agli et al. 2009)	19 263	IOTF overweight	7.8%	7.8%
			IOTF overweight	2.5%	0.9%
Chile	School Entry Census Data, 2000 (Kain, Uauy et al. 2002)	102 316 boys 97 128 girls 6 yrs	Overweight	18.8%	19.6%
			Overweight CDC 85P-95P	19.2%	18.5%
			Obese IOTF	7.2%	15.8%
			Obese CDC > 95P	14.7%	17.5%
U.K	Health Survey of England 2007 (Stamatakis, Wardle et al. 2010)	2210 boys 2149 girls 5-10 yrs	Overweight IOTF	17.9%	21.8%
			Obese IOTF	5.7%	6.1%

18%, respectively for these minorities in 2004 (Shields [date unknown]). These groups, however, represent a small percentage of the overall population and have minimal influence on the national average, unlike minorities in the U.S that make up significant fractions of the population. Canadian children who spent > 2 hours watching television (TV) or playing video games per day were twice as likely to be overweight or obese as children who watched <1 hour daily (Shields [date unknown]). In addition, children from middle-income families were more likely to be overweight or obese than children from low or high income families. Moreover, children with parents who have higher levels of education were less likely to be overweight or obese (Shields [date unknown]). The overall prevalence of OWOB was a little lower for Canadian children compared to Americans; however, the obesity rates in children were significantly higher in Americans. Among the Inuit of Canada the prevalence of OWOB in preschool children was 50.8%, with boys having higher rates than girls, contrary to the trend seen in adults (Galloway, Young et al. 2010). The overall rates were much greater than the national Canadian average but comparable to trends in the USA (Galloway, Young et al. 2010). Extreme obesity ($BMI > 35 \text{ kg/m}^2$) in southern California was highest among minority groups reaching prevalence as high as 11.2% in Hispanic boys and 11.9% in African-American girls (Koebnick, Smith et al. 2010).

The overall prevalence of OWOB children in Barbados is likely to be similar to that of children in the USA. Contrary to the gender trend in the USA, it is expected that obesity will be more frequent among Barbadian girls than boys. Researchers believe that the current rates of OWOB of Barbadian children will be lower than Non-Hispanic Black American children (35.9%), but similar to White American children (29.3%) (Ogden, Carroll et al. 2010). The latest NHANES data (NHANES 2007-2008) in the USA revealed an overall prevalence of childhood (2-19 years) OWOB at 31.7% and obesity at 16.9% (Ogden, Carroll et al. 2010). In the 6-11 age groups the overall prevalence was 35.5% and 19.6%, respectively, while for non-Hispanic black children OWOB was slightly higher with a prevalence of 37.6% and obesity slightly lower at 19.4%, respectively (Ogden, Carroll et al. 2010). The trends for minority groups in the latest NHANES were

similar to Latin America and the Caribbean, with childhood OWOB more frequently seen in Hispanic than black children. In contrast, obesity was more commonly seen in boys than in girls in the USA.

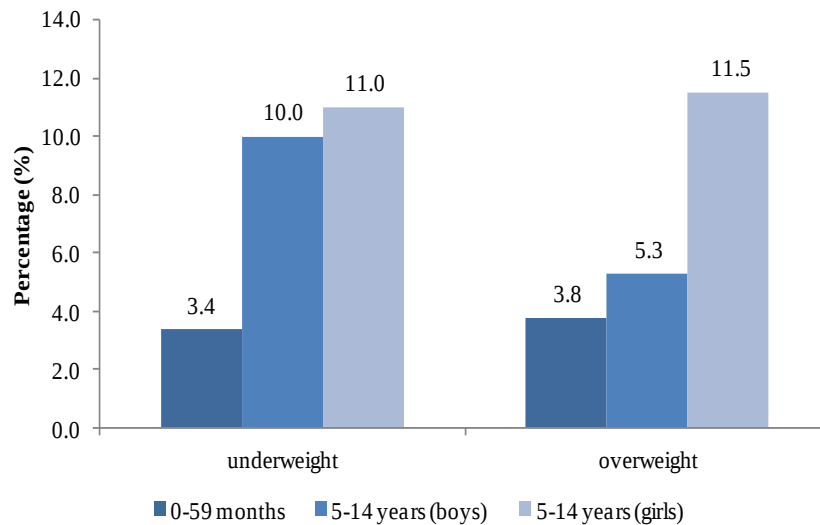
2.1.3.2 Children in Barbados

A large anthropometric study conducted in Barbados by Standard, Lovell et al. (1966), measured the heights and weights of a representative sample of children aged 4-12, but did not look at BMI or weight classifications. The numerical data published showed a normal distribution for weight and heights at all ages for both sexes. The study concluded that Barbadian children were slightly larger than children from other Islands in the Caribbean, but smaller than those in London, England (Standard, Lovell et al. 1966). However, this study did not look at BMI or malnutrition.

The rate of child OWOB in Barbados is largely unknown. Few surveys on this topic have been conducted in the past. The last anthropometric data collected for primary school children is shown in Figure 3 and dates from 1981. The National Nutrition and Health Survey in 1981 found that the prevalence of malnourishment exceeded OWOB in most children, except for girls aged 5-14, where the opposite was true (Ramsey, Demas et al. 1986). Using Harvard standard growth tables combined obesity and overweight was defined as greater than 120% wt/ht for age. Obesity in preschool children in 1981 was estimated to be 3.8%, which was greater than the global prevalence of 3.3% for this age group (Fitzroy 2004). However, the Harvard tables were thought to produce error especially in preschool children (Sykes 1977). Overweight prevalence for girls aged 5-9 was estimated at 5.6% and then jumped to 20% for girls aged 10-14 (Ramsey, Demas et al. 1986). The prevalence for boys in the same age groups was 3.2% and 7.8%, respectively. Both malnutrition and overweight were more prevalent among girls than boys in Barbados (CFNI, Frazer et al. 2003), which might have been an indication of a double burden of obesity having a greater impact on girls than boys. At the time of this survey, undernourishment was shown to have improved greatly since the 1960's and 1970's, nevertheless it was

still a greater concern than overweight, particularly in children ≤ 5 years old. By the late 1980s and early 1990s, Barbados was considered to have a negligible prevalence of malnutrition (Sinha 1995).

Figure 3*. Prevalence of underweight ($< 80\%$ wt/ht for age) and overweight ($> 120\%$ wt/ht for age) in children 0-14 years in Barbados in 1981



* Adapted from (Ramsey, Demas et al. 1986)

With the exception of a study conducted by Gaskin and Broome (2008), which looked at the prevalence of OWOB in relation to physical activity in secondary school children aged 11-16, there has been no recent research on weight status in youth. There have been no updates since the 1981 survey about the progression of overweight, obesity or even further decreases in underweight. Nevertheless, a report published in 2002-2003 by the Chief Medical Officer in Barbados indicated growing anxiety over increasing childhood obesity (CFNI, Frazer et al. 2003). Barbadian authors are in agreement that child OWOB are growing national health issues; however, no statistics or studies have been cited (Wilks, McFarlane, Anderson et al. 1996; PAHO 2007). Table 1 shows results from two pilot studies that estimate the prevalence of OWOB in 2009 (Carter,

Levesque et al. 2009; Lai, Guy et al. 2009), however underweight was not studied.

The lack of updated literature about the prevalence of OWOB in Barbadian children has made it difficult to encourage decision-makers to appreciate the need for programs targeted at youth to decrease the incidence of obesity. The problem of child OWOB in Barbados has remained anecdotal due to the lack of confirming data. The existing documentation about childhood health in Barbados is almost three decades old and does not contain comprehensive data about nutrition or weight status (CFNI, Frazer et al. 2003). Only assumptions based on pilot studies conducted by investigators at the University of the West Indies (UWI) and McGill University in 2009 can provide a gross estimate about the state of OWOB in Barbadian children (Carter, Levesque et al. 2009; Lai, Guy et al. 2009). A pilot study conducted in June 2009 revealed that the prevalence of OWOB in children was between 15.5 -16.5% and 14.4-16.5%, respectively (Carter, Levesque et al. 2009). A second pilot study carried out with a larger sample of students found the combined prevalence of OWOB to be 44.8% and 30.3% in boys and girls (Lai, Guy et al. 2009). Both pilot studies, however, had relatively small sample sizes resulting in very low statistical power and cannot be used to generalize OWOB in the entire childhood population. In addition, the higher prevalence of OWOB found in boys than in girls is contrary to previous studies in adults and children, and could be an indication of sampling bias.

According to UNICEF, the primary concern of Barbadian parents was education, while health was a secondary concern, but only for younger children (Loudon 2006). Targeting nutrition and overnutrition as health concerns for parents of younger children may be a goal for future prevention programs, but other approaches may need to be developed for older children. Data about child and family characteristics would be extremely useful to steer the direction of these programs.

2.2 Origins of obesity

Barbados is considered a high-income country by the World Bank (2010) and is ranked very high on the Human Development Index (UNDP 2010). Nevertheless, it is still thought to be a developing country with an emerging economy (IMF 2009). With this in mind, it can be assumed that the nutrition transition theories proposed by Drenowski and Popkin (1997) and Caballero (2005) hold true for Barbados and may explain, to a limited extent, the rapidly increasing obesity rates in adults. Other factors that contribute to the rapid increase in Barbados are likely similar to those in developed countries and may include increased sedentary activity as well as greater consumption of energy dense foods. According to a review, modifiable risk factors for childhood obesity for which there is relatively strong evidence, include energy expenditure, intrauterine exposure to gestational diabetes, TV viewing, diet, socioeconomic status, and possibly sleep (Han, Lawlor et al. 2010).

2.2.1 The nutrition transition

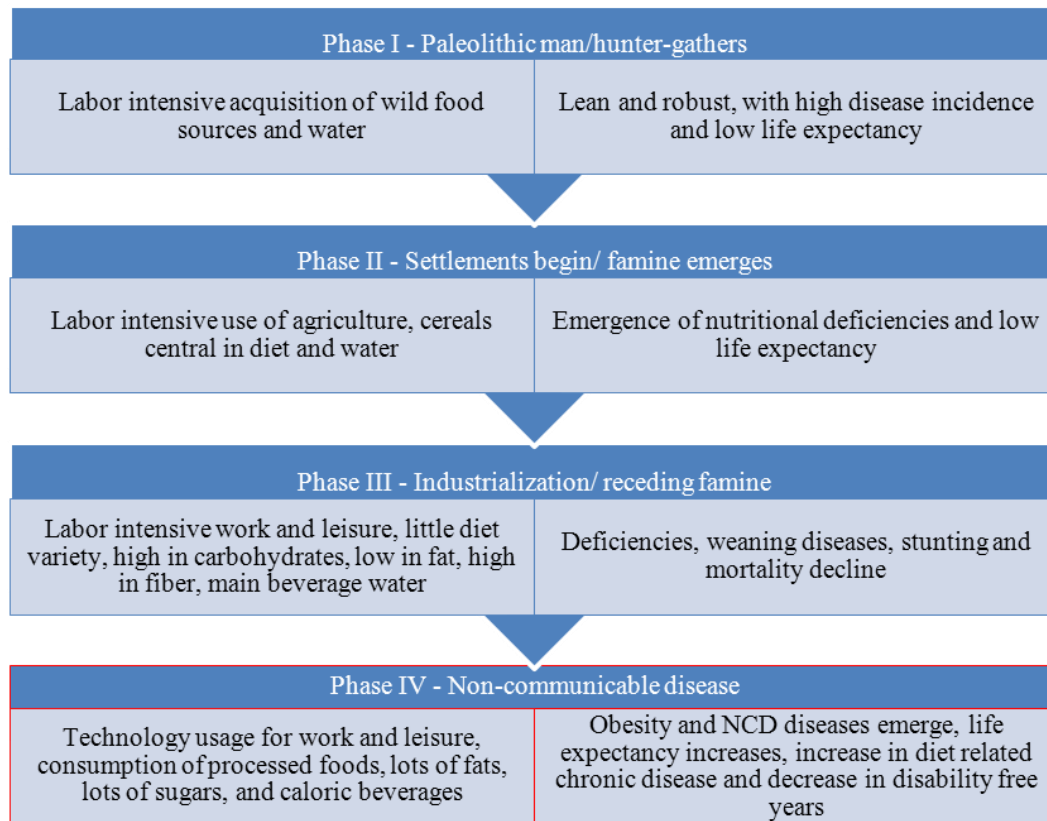
Enormous industrialization took place during the 20th century, which resulted in dramatic changes in agriculture, economy and health in nations across the globe (Gardner and Halweil 2000). Many countries faced an unprecedented situation in which obesity and undernutrition co-existed and where obesity had exceeded the latter (Gardner and Halweil 2000). In countries where undernutrition had been rampant in previous decades, obesity had almost become the norm. The paradox of undernourished children living in the same households as obese adults, became known as the double burden of malnutrition (Caballero 2007). This phenomenon was suspected to have occurred during the 1981 Barbados Health and Nutrition Survey since maternal obesity was already very high and malnutrition was still notable in children 0-59 months and girls 5-14 years (Ramsey, Demas et al. 1986). This paradox is more apparent in countries such as Barbados that have experienced rapid shifts in economic prosperity, agriculture technology, and urbanization (Downes 2002). Some of the driving forces behind the changes in nutrition status from undernourishment to obesity can be attributed

to globalization (Popkin 2004). To varying extents urbanization, advanced communications, and rapid technological advancement have altered personal and national lifestyles, which have changed the types of foods available, purchased, and consumed including ready prepared, high fat, and high sugar foods (Prentice 2006). Changes in food consumption patterns have led to energy dense diets that result in greater accumulation of body mass (Popkin and Doak 1998). Moreover, the increased usage of mechanized and automated technologies have ultimately created a shift from traditional jobs with physically demanding labor to contemporary lifestyles requiring less physical exertion (Popkin 2004; Caballero 2007). Rural workers who expended countless calories during employment or acquisition of basic necessities, transitioned to urban centers where everything from employment to leisure activities demanded little physical effort (Caballero 2006). Urbanization occurred in concert with dietary changes involving greater availability of energy dense foods, thus augmenting the shift in positive energy balance (Caballero 2006).

The effects of globalization, urbanization, and technological changes on health that have taken place since the middle of the 20th century can be summarized by the theory of nutrition transition (Caballero 2006). Barbados and much of the developed world have reached the fourth phase of the transition proposed by Popkin (2010). Phase 4 stems from the shift from infectious diseases to an increase in NCD, a phenomenon known as the epidemiological transition (Omran 1971). The changes from the 1960's to the 1980's in health, nutrition and disease have been reported by the Caribbean Food and Nutrition Institute (CFNI) and were illustrated by Sinha (1995) for various countries in the Caribbean region. Sexually-transmitted diseases and HIV aside, infectious diseases are no longer a significant health threat in Barbados (CFNI, Frazer et al. 2003). Similarly, childhood nutrient deficiencies are no longer a primary health concern, affecting less than 5% of children under 5 years of age (Sinha 1995). Consistent with the nutrition transition, increasing amounts of sugars and vegetable fats became available in the Barbadian food supply (CFNI, Frazer et al. 2003). A known component of the nutrition transition is an increase in childhood obesity

(Drewnowski and Popkin 1997), which is strongly suspected but has yet to be documented in Barbados. In addition, NCDs have replaced infectious diseases as the primary cause of adult mortality in the Caribbean (CFNI 2004).

Figure 4*. The stages of the nutrition transition



*Adapted from <http://www.cpc.unc.edu/projects/nutrans>

2.2.2 Socioeconomic status and demographic variables

Changes in obesity incidence and prevalence have demonstrated different trends across the globe. Obesity was once thought to be a disease that affected wealthy nations, but has now commonly become associated with poverty. The relationships between obesity and SES are inconsistent between developing and developed nations (Pena and Bacallau 2000). In the USA poverty is one of the factors linked to overall obesity (Menifield, Doty et al. 2008). In other countries such as Chile, obesity is only linked to poverty in women of low socioeconomic

standing (Pena and Bacallau 2000). Thakar and Viswanathan (2009) showed that affluent children in urban India were at greatest risk for OWOB compared to non-affluent children (Thakar and Viswanathan 2009), indicating that obesity was a disease of the wealthy and middle class. In Canada, obesity is directly associated with income for men but there is no direct relationship for women. However, there is an indirect negative relationship between income and obesity for women (Ward, Tarasuk et al. 2007). Obesity in English speaking Caribbean countries is thought to be more prominent in the relatively wealthier nations (Forrester, Wilks et al. 1996), like Barbados. In countries like China, obesity is associated with urbanization (Macdiarmid and Rigby 2002), whereas in the USA there is a greater prevalence in rural areas (Patterson, Moore et al. 2004). Obesity in Barbados has also been linked to larger family sizes, households headed by women, low education, and families living below the poverty line (NNC, Ministry of Health et al. 2005). The only underlying trends across the globe are that the rates are increasing and obesity is occurring at younger ages (OMS 2003).

2.2.3 Diet

The National Nutrition Centre (NNC) in Barbados published a National Food Guide in Collaboration with the Queen Elizabeth Hospital and the Food and Agriculture Organization (FAO) in 2009. The Barbados food guide contains six food groups: staples, legumes, vegetables, fruits, foods from animals, and fats and oils (Broome, Callender-Medford et al. 2009). Prior to this guide there were no consistent recommendations about numbers of servings and portion sizes. The current guide could be an excellent learning tool to educate Barbadians about healthy eating and exercise. It is a new tool and it is likely that this guide has not been widely circulated and national health care practitioners might not be consistently using it. A major difference between this guide and the Canadian Food Guide or the American Food Pyramid is that there is no dairy group. Instead, milk and cheese are included with animal foods. The guide uses culturally relevant objects to illustrate serving sizes such as a golf ball, a pot

spoon, or a cricket bat. The guide has also included some physical activity recommendations.

Diets in Barbados and across the globe have changed dramatically over the last several decades to include greater amounts of refined sugars and vegetable fats as well as prepared and processed foods. In Barbados, the food supply may have been altered even more dramatically due to the dependence upon imported food goods and decrease in domestically grown crops (Sinha 1995). The majority of calories available in the food supply came from foreign markets and the increase in imported food goods was drastic from 62% in 1966 to 78.8% in 1986-1988 (Sinha 1995). The tourism industry has also likely shaped the types of foods that are imported into Barbados.

A review of food supplies available in the country revealed that the products with the greatest increase in availability over the last several decades were vegetable fats, sugars and fruits (CFNI, Frazer et al. 2003). The increase in the fruit supply should be interpreted with caution as it may not directly translate to population wide increases in consumption. According to the FAO, only 4.4% of dietary energy supply comes from fruit and vegetables (CFNI, Frazer et al. 2003). Past dietary studies have cited low fruit and vegetable consumption in Barbados (CFNI and FAO 1972) and the Caribbean (Sinha 1995). In the Caribbean, there is concern about the trend towards increased animal food consumption and fats as well as decreased amounts of complex carbohydrates. The change in fat kilocalories (kcal) was most drastic with an increase of fat from 20% of daily kcal in 1961-1963 to 29% in 1985 (Sinha 1995). The English-speaking Caribbean population goals for nutrient intakes outlined in Sinha (1995) are equivalent to the acceptable macronutrient distributions in other countries. High quality animal foods such as fish are not distinguished from lower quality animal foods such as fried chicken. Individual countries across the Caribbean have also developed food guides similar to the Barbados food guide representing an important step towards nutrition education.

A study analyzing dietary patterns in Barbados reported that sugar was the most frequently consumed food and sweetened fruit juices and drinks were the

largest contributor to daily sugar intakes (Sharma, Cao et al. 2008). According to dietary data collected from food frequency questionnaires in two pilot studies, Barbadian school children's diets contain an excessive amount of sweetened beverages that provide few nutrients and are high in calories (Carter, Levesque et al. 2009; Lai, Guy et al. 2009). In addition, the diets are relatively high in fat with close to 30% of total daily energy coming from fat (Carter, Levesque et al. 2009; Lai, Guy et al. 2009). This is consistent with amounts of fat found in adult Barbadian diets (CFNI, Frazer et al. 2003). This amount is at the higher range recommended for children by Health Canada (HC 2007) and the sugar intake was 2.5 fold higher than the recommended amount by the WHO for 10% or less of daily energy (WHO [unknown date]). Low fiber, fruit and vegetable intake were also reported in children (Carter, Levesque et al. 2009; Lai, Guy et al. 2009). Diets of children and adults are relatively high in fat and sugar as well as low in fiber, calcium, and fruit (Sharma, Cao et al. 2008). The diet described above is known to encourage chronic diseases. According to Epstein et al. (2001) fruit and vegetable promotion might be more effective than cutting back on sugar and fat in order to combat childhood OWOB at the family level (Epstein, Gordy et al. 2001). The high cost of fresh produce in Barbados may make fruit and vegetable promotion problematic.

2.2.4 Activity

In an editorial in 2004, Fitzroy criticized the Caribbean community for building communities that were unsafe, that did not encourage physical activity and recreation, and school policies that have reduced physical education (Fitzroy 2004). Depending on the country studied, between 35-60% of Caribbean adults participated in only sedentary activities. The high level of sedentary behaviors is augmented by the fact that physically strenuous jobs have decreased while the usage of mechanical aids, including mechanized transportation, has increased (Fitzroy 2004). In one pilot study, activity recalls cited the top three sedentary activities for children to be watching television, playing video games or computer games and doing homework (Lai, Guy et al. 2009). A more comprehensive

activity survey conducted on a sample of 1579 children aged 8-18 in Barbados concluded that activity levels were relatively high with 69% of subjects having spent at least one hour doing physical activity in the previous day. Children, however, spent an average of twice as much time engaged in sedentary activities compared to physical activities (Prochaska, Sallis et al. 2002). Although there were no differences in the time spent engaged in sedentary activities between boys and girls, the study did note that there were substantial gender differences in the types of physical activities practiced. Outcomes from this study were in contrast to earlier research conducted in 2000 where 15% of students aged 10-18 were completely sedentary and the boys participated in physical activity more than girls (Alert, Holland et al. 2000). The latter study also remarked that television and computer games were competitors for physical activity.

2.2.4.1 Sedentary and physical activities

Activity is a major modifiable component of the energy balance equation and both physical and sedentary types play a role. Sedentary activity can be defined as activities that require none to very little physical effort such as TV viewing or playing video games. Physical and sedentary activities were thought to have an inverse relationship, but there is increasing evidence that they are independent of each other. Ekelund, Sardinha et al. (2004) ascertained from the European Youth Heart Study that physical activity and sedentary behaviors are likely separate independent metabolic risk factors (Kaunitz, Hughes et al. 1985). Similarly, sedentary activity such as television viewing was strongly associated with fatness without decreased energy expenditure (Jackson, Djafarian et al. 2009). These results indicates that children who spend lengthy amounts of time watching TV may be equally active as children who watch little TV (Jackson, Djafarian et al. 2009).

Positive associations have been found between sedentary activity and obesity (Robinson 2001) as well as negative relationships between physical activity and obesity (Kim and Lee 2009). A recent study conducted by Steele, van Sluijs et al. (2009) on over 1800 9-10 year-old English children illustrated these

findings using various intensities of physical activity. It was noted that vigorous intensity physical activity had a more powerful association to fatness than sedentary activities (Steele, van Sluijs et al. 2009), indicating that high intensity physical activity may be a more important part of the energy balance equation. TV viewing or screen time can be considered as major sedentary behaviors seen in children. Despite the relative weak association between TV viewing, the considerable exposure this sedentary behavior makes it an important modifiable obesogenic factor. In addition, TV viewing has been linked to increased blood pressure in children (Martinez-Gomez, Tucker et al. 2009), metabolic syndrome in adolescents (Mark and Janssen 2008) and even blood glucose control in type 1 diabetic children (Margeirsdottir, Larsen et al. 2007).

The American Academy of Pediatrics (AAP) has long recognized the role of sedentary activity in adverse health outcomes, particularly TV viewing. In 2001 the AAP published a list of recommendations which include limiting TV use to no more than 1-2 hours per day for children and discouraging TV viewing for infants less than two years of age (Committee on Public Education 2001; Zwiauer 2000; American Academy of Pediatrics 2001). Some researchers believe that these recommendations are premature, indicating that sedentary behaviors have little clinical relevance when compared to physical activity (Marshall, Biddle et al. 2004). The literature is split with regards to whether increased physical activity as opposed to decreased sedentary behavior is more important for health maintenance, particularly obesity prevention. Therefore, to conduct a comprehensive study involving obesogenic factors, it is necessary to examine both components of activity.

2.2.4.2 Activity recommendations

The WHO recommendations for physical activity for children aged 5-18 includes more than 59 minutes of medium to high intensity activity accumulated throughout the day. The importance of such activity is justified in terms of weight control, better cardiovascular fitness, muscular strength as well as improved psychological well being and better academic success (WHO 2004). The WHO

also states the important role schools play in their ability to offer opportunities for physical activity to children. The Public Health Agency of Canada recommends at least 60 minutes of moderate activity and an additional 30 minutes of intense activity for youth in addition to reducing time spent doing sedentary activities (PHAC 2002). International recommendations for increased activity and decreased sedentary behaviors would also be appropriate goals for sedentary Barbadian children to strive towards achieving.

2.3 Consequences of obesity

The consequences of obesity on health have been extensive and long lasting with increases in DM2, cardiovascular disease, hypertension, certain types of cancer, decreases in quality of life and substantial increases in national health care costs. In addition to general poor health, OWOB can lead to a shorter lifespan and less disability free years of life (WHO 2010). Childhood consequences of OWOB include early maturation and menarche, dyslipidemia, impaired glucose tolerance, fatty liver disease, gallstones, high blood pressure, sleep apnea, orthopedic problems, polycystic ovary syndrome (Dietz 1998), chronic inflammation, psychological harm, asthma (Reilly 2006), metabolic syndrome and development of obesity in adulthood (Biro and Wien 2010). The early onset of child obesity can manifest through a wide range of consequences in childhood that may have lifelong health implications for obese children (Wabitsch 2000). The health consequences of overweight in childhood are less well known or understood, especially with regards to health implications later on in life. Nevertheless, excess weight accrued during childhood is a risk factor for OWOB in adulthood, and the health consequences of the latter have been established.

2.3.1 Economic

The burden of obesity on both public and private health care in the U.S has been estimated at \$147 billion in 2008 or 10% of total health care spending (Finkelstein, Trogon et al. 2009). These figures are likely to be proportional in countries with equivalent rates of prevalence and will likely represent the health

care costs of Barbados in the near future as the prevalence of obesity increases. In fact, 7% of the health care spending in the Caribbean can already be linked to obesity and related morbidities (Fraser 2003). Recent projections expect that the cost of overweight adolescents today in the USA will reach \$254 billion from the combined loss of productivity and medical costs by the time this population reaches adulthood in the years 2020 to 2050 (Lightwood, Bibbins-Domingo et al. 2009). Substantial savings can be imagined if nations were to invest seriously in public health initiatives to combat the obesity epidemic. Programs would need to be well-planned and based on reasonably strong evidence, as many interventions may not be cost-effective. For example, family-based interventions to reduce child obesity, public campaigns to reduce TV viewing, and school based programs for overweight children 7-10 years old were both cost effective and cost savers while an afterschool program was not, according to an analysis published by the Revista Española de la Salud Pública in 2009 (Caro and Lopez-Valcarcel 2009). Similarly, a program to promote active transportation in school children in Australia was not considered cost-effective in terms of the modest health related improvements (Moodie, Haby et al. 2011).

2.3.2 Non-communicable diseases

Epidemiological transition has already been noted in Barbados and now the 4th pattern of the nutrition transition is occurring as evidenced by the high amounts of fats and sugars in Barbadian diets and the increases in obesity. The NCD commonly associated with excess body weight are DMT2, hypertension, and cardiovascular disease, as well as certain cancers (WHF 2010). As OWOB increase, the prevalence of NCD will follow. Both obesity and the related health complications will likely affect a greater number of women than men in certain parts of the world, especially in Latin America and the Caribbean where female obesity outnumbers male obesity. This is an alarming reality and of particular concern when considering that health outcomes of children are linked to maternal health status (Al-Saleh and Di Renzo 2009). Maternal weight status is also an indicator for childhood obesity (Rowland and Wallace 2009). As obesity rates

increase, co-morbidities are expected to increase in number and severity and will likely afflict individuals at younger ages (EASO 2005).

Studies conducted over the last few decades confirm the health risks are serious for the Black Caribbean population. The links between BMI and health risks for Barbadians and Jamaicans were particularly strong for diabetes and cardiovascular disease (Fraser 2003). Similarly, Black Americans who are affected by the highest obesity rates in the U.S also experience the highest prevalence of certain NCDs (CDC 2009). In Barbados, DMT2 affects 1/5 adults over 40 years old (Hennis, Wu et al. 2002) and 17.3% of men and 28.8% of women were diagnosed with hypertension (National Nutrition Centre, Ministry of Health et al. 2005). The relationship between DMT2 and obesity is extremely strong. The extent of this link can be seen with the exponential increase of DMT2 with BMI (Mokdad, Ford et al. 2003). Morbidly obese women are 90 times more at risk for developing DMT2 than normal weight women (Fraser 2003). Cardiovascular disease is another NCD common in Barbados and the Caribbean that can in part be attributed to obesity as well as DMT2. The quality of life of individuals with obesity and co-morbidities can be greatly reduced and their disability free life expectancy can also be shortened (Dietz, 1998).

2.3.3 Maternal obesity and child health outcomes

Health complications associated with obesity in pregnancy are well known. Extremely obese women are more likely to give birth to babies who will also be obese as early on in life as in infancy (Nohr, Timpson et al. 2009). A major health concern is that increasing numbers of women at young ages are developing NCD. The danger of OWOB women of childbearing ages developing hypertension or gestational diabetes during pregnancy is high. Maternal obesity related health risks that may carry over to the fetus include macrocosmic deliveries, pre-eclampsia and gestational diabetes (Baeten, Bukusi et al. 2001). Morbidly obese women have an increased risk of pregnancy complications which include stillbirth, shoulder dystocia, caesarean delivery, premature neonatal death and large for gestational age (Cedergren 2004). Maternal BMI ≥ 27 kg/m² is a risk

factor for childhood obesity (Bergmann, Bergmann et al. 2003). In Barbados OWOB are increased in women with poorer SES (NNC, Ministry of Health et al. 2005) and low maternal SES is an additional risk factor for early childhood obesity (Bergmann, Bergmann et al. 2003). Moreover, the implications of OWOB women having children can potentially impact the child's health throughout their lifespan. Overweight and obese women who give birth will have babies that will be at increased risk of adverse health outcomes in infancy, childhood, adolescence, and potentially adulthood. There is also increasing evidence that the experience in the womb affects children's health outcomes throughout life. The fetal experience is in fact considered a modifiable risk factor for childhood obesity (Han, Lawlor et al. 2010). Focus on preventing children, especially girls, from becoming obese early in life could help the avoidance of health problems in childbearing years as well as being passed down to the next generation.

2.4 Conclusions

Barbados has a documented high prevalence of OWOB in adults, and possibly one of the highest obesity prevalence rates for women in the Americas (Ono, Guthold et al. 2003). If children follow the same trend of the rapid increase in OWOB prevalence of adults, it is likely that OWOB prevalence in children will also be high. No comprehensive studies have been conducted with primary school children in recent years, leaving a 30-year knowledge gap about child OWOB in Barbados. Rates of OWOB in Barbados are suspected to be more comparable to the rates seen in the USA or Canada rather than some of its neighboring Caribbean countries such as Jamaica. Obesity influences are numerous and trends may differ between countries and ethnic or cultural groups, making it important to gather specific data about a particular nation or population. Commonly known child obesity influences seen in other populations may not be relevant in Barbados.

Due to the alarming increase in obesity over the last several decades, rapidly developed countries such as Barbados, that experienced nutrition transition are at great risk for high levels of childhood obesity. The lifelong health

implications for OWOB children can be very serious and can considerably reduce an individual's quality of life as well as disability free years (Dietz 1998). The burden of childhood OWOB on national health care budgets and productivity is also expected to be astronomical in the future, when these children become adults (Lightwood, Bibbins-Domingo et al. 2009).

To prevent NCDs and maintain a good quality of life, Barbados would be well served by a study that can provide baseline data on childhood OWOB. Considering the gap in literature about child obesity in Barbados, it would be valuable to simultaneously collect details about certain risk factors such as TV viewing, physical activity frequency, socioeconomic status, family characteristics, and maternal weight. These details would help direct researchers and policy makers with regards to childhood obesity monitoring, health promotion and prevention programs.

III. LINKING STATEMENT I

Groups that would likely benefit the most from obesity prevention and health promotion programs are women of childbearing age and children. It is imperative to direct programs at youth since weight status in childhood and adolescence is an indicator for adulthood weight status and health. A major obstacle with prevention is convincing institutions and governments to invest funding in the prevention of NCD, before the health consequences, loss of productivity, and economic impact of these diseases become overtly apparent. Governments are more likely to invest in obesity prevention if the true severity of the situation can be drawn accurately. Obtaining an accurate measurement of obesity in children in Barbados is the first step to inducing change for improved health outcomes. Equally important, would be to understand some of the drivers behind child OWOB in Barbados by examining obesity influences that are commonly seen elsewhere.

The Barbados Children's Health and Nutrition Study (CHNS) began in 2009 with two pilot projects (Phase I) assessing the feasibility of a larger more comprehensive study. The purpose of the CHNS was primarily to assess the

nutrition status of Barbadian primary school children along with general health indicators such as blood pressure and pre-existing medical conditions. Following the pilot studies, researchers made the decision to focus resources for phase II of the CHNS on one sample of children in public schools from class three (grade five in the North American educational system). Phase II included many components: anthropometric indices (height, weight, waist circumference, and bioelectric impedance analysis), dietary measures (24-hour food recalls), parenting behaviors, attitudes towards physical activity, physical activity frequency, and the identification of child OWOB influences. Central to all these components was the assessment of the prevalence of OWOB in the sample. The following manuscripts encompass the results of Phase II of the Barbados CHNS pertaining to the prevalence of OWOB in grade five students and the identification of OWOB risk factors.

IV. MANUSCRIPT I

Changes in childhood overweight and obesity between 1981 and 2010; results from the Barbados Children's Health and Nutrition Study

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4.1 Abstract

Few data on child overweight and obesity (OWOB) have been collected since 1981 in Barbados. This study sought to obtain insight on the current state of child OWOB in Barbados by determining the prevalence of OWOB in a survey of grade five students. Heights and weights were taken for 255 boys and 325 girls using standard procedures. The prevalence of OWOB was calculated using the World Health Organization's (WHO) body mass index (BMI) for age z-scores, the Center for Disease Control (CDC) growth percentiles, the International Obesity Task Force (IOTF) OWOB cut-offs and Harvard weight (wt)/height (ht) for age growth standards. Based on WHO references, the overall weighted prevalence was 3.30 % (95% CI; 1.91, 4.69), 17.38 % (95% CI; 14.30, 20.46) and 17.40 % (95% CI; 14.38, 20.48) for undernutrition, overweight and obesity respectively. The prevalence of undernutrition since the 1981 has decreased by more than half, while the prevalence of OWOB has more than tripled. The percent increment of OWOB from 1981 to 2010 in boys was 379 in boys compared to 226 in girls. The overall prevalence of undernutrition and OWOB in this survey is comparable to the rates seen in the Americas. The exceptionally high percent increment in child OWOB in Barbados warrants immediate public health attention to address the rapidly rising child obesity epidemic.

4.2 Introduction

Overweight and obesity have become major health concerns in contemporary society, leading to rises in non-communicable diseases (NCD), decreased quality of life (Dietz 1998) and increased health care costs (Lightwood, Bibbins-Domingo et al. 2009). In the past, obesity was considered an affliction of wealthy adult populations; however, OWOB has increasingly affected individuals at younger ages, and has reached pandemic proportions in developed and developing nations alike (Prentice 2006). Excess weight in childhood is often carried into adulthood, and this is the primary concern for the healthcare providers of the overweight youth (Stovitz, Pereira et al. 2008). With excess weight, metabolic disorders such as glucose intolerance, dyslipidemia, hypertension,

polycystic ovarian syndrome, non-alcoholic fatty liver disease, and cardiovascular disease may develop in adulthood (Garvey 2011). Even in children, there is very strong evidence supporting the association between obesity and the risk of developing sleep apnoea, insulin resistance, hypertension, or dyslipidemia during childhood (Han, Lawlor et al. 2010).

The rates of OWOB have been increasing globally since the 1960s, and some of the highest rates in children are seen in North America (EASO 2005), with OWOB prevalence above 25% in Canada, Mexico and the United States (IASO [unknown date]). The velocity of the increase in OWOB prevalence, however, is expected to be greater in middle income nations and emerging economies (Caballero 2005). Countries in South America and the Caribbean may be at risk for high prevalence of OWOB.

Many small and developing countries do not have national child obesity monitoring programs or gather enough data to make decisions about beneficial high impact health promotion programs. Such limitations make it impossible to assess the severity of weight status in children or make inferences about whether interventions and prevention programs are needed to curb the obesity epidemic. Complicating matters, various standards and methods have been used to quantify child OWOB over the last several decades, making it more difficult to track its progression over time and make international comparisons.

In England (Stamatakis, Wardle et al. 2010), Australia (Olds, Tomkinson et al. 2010), South Korea (Khang and Park 2011), France (LioRET, Touvier et al. 2009), and Japan (Yoshinaga, Ichiki et al. 2010), regular national surveys were successful in tracking child OWOB and in revealing a possible stabilization or slowing of the upward trend in OWOB rates. The most recent trends showing a plateau in child OWOB prevalence are promising, but it remains to be seen whether they remain stable or continue in a downward direction and whether this tendency will also apply to other nations globally. It is important to monitor these trends at national levels especially in countries where there may be a greater risk of very high OWOB prevalence.

The overall prevalence of adult OWOB in Barbados from the most recent adult health survey in 2000 was comparable to other developed countries (NNC, Ministry of Health et al. 2005). It is clear that OWOB affects significantly more women than men in Barbados. The disparity increases for obesity (OB), with 15.4% of OB men compared to 29.6% of OB women (NNC, Ministry of Health et al. 2005). When the rates are adjusted for age, global comparison estimates, and projected to 2010, it was estimated that 65.5% of men would be OWOB compared to over 83.3% of women (Ono, Guthold et al. 2005).

There is no information available about child OWOB in Barbados or whether the youth follow the same pattern of gender disparity. The last nationally representative data collected on child weight status in Barbados date from 1981, a period when undernutrition was the primary concern (Ramsey, Damas et al. 1986). In recent years, UNICEF has indicated that undernutrition has almost disappeared in Barbados and that obesity is a rising problem for adolescents in the Eastern Caribbean (UNICEF 2011). There have been documented concerns in Barbados over the rising child obesity epidemic (Ramsey, Damas et al. 1986); however, these concerns have not been quantified with more recent studies nor have they been validated in primary school children in Barbados. The first step in assessing the state of child obesity in Barbados was to obtain a measure of the prevalence of OWOB in the pediatric population. The Children's Health and Nutrition Study (CHNS) of Barbados started in 2009 with two pilot studies which tested the feasibility of nutrition assessment in Barbados public schools. The present study was part of the CHNS and proposed to obtain a baseline measure of the prevalence of child OWOB in Barbados by using a survey of grade five children between September and December 2010.

4.3 Methods

4.3.1 Sample size and selection

A sample size was calculated based on expected prevalence of OWOB of less than or equal to the rates reported for non-Hispanic black American boys

(36.4%) and girls (38.9%) (Ogden, Carroll et al. 2010) to yield a proportion with a 95% confidence interval and a margin width of $\pm 5\%$. The sample size was adjusted for small populations because the sample calculated represented a very high proportion of the population, exceeding 5% of the entire grade five population in Barbados (Bartlett, Kotrlik et al. 2001). The targeted sample size was 288 boys and 294 girls.

A list of public primary schools with their estimated populations from 2009 was obtained from the Barbados Ministry of Education. From this list 15 schools were selected based on probability proportionate to size sampling methodology, allowing for larger schools to have a greater chance of being selected. To satisfy the targeted sample size it was estimated that approximately 20 boys and 20 girls were required from each of the 15 schools. Several schools had very small populations. Therefore, the seven schools that had grade five populations with less than 80 students were matched with a second school and a total of 22 schools were contacted. The final sample consisted of 255 boys and 325 girls and came from 21 schools. One school could not be surveyed because consent forms were not disseminated to grade five teachers and students by the school's administration in time for data collection.

4.3.2 Recruitment

Based on experience from one of the CHNS pilot studies (Carter, Levesque et al. 2009), participation hinged not only upon parental consent, but also cooperation and support from both classroom teachers and school principals. The pilot project obtained a 30.2% response rate, and this study hoped to increase the response rate to about 50% through public awareness. The CHNS research team enlisted the help of the media by participating in interviews for a local television show, newspaper articles and a radio show. In addition, members of the research team held assemblies with grade five students and teachers to discuss the purpose of this research project, when permitted. A raffle was held at each school to encourage children to return signed consent forms to their classroom teachers regardless of whether the parents agreed to let their child participate. All children

whose parents consented to their participation in the study and who were available during the school visits were measured. Depending on the size of the school and the number of consent forms returned, between one to three visits were made at each school. One subject was excluded because of a cast on a broken arm. The final response rate was approximately 47%, an improvement from the 2009 pilot study.

4.3.3 Ethics approval

Ethics approval for this study was obtained by the McGill Research Ethics Board III and the University of the West Indies Internal Review Board. In addition, permission to gain entry into the schools was granted by the Barbados Ministry of Education.

4.3.4 Measurements

All measurements were taken between September and December of 2010 and were done in the mornings as per a modified National Health and Nutrition Examination Survey anthropometry procedures manual (NHANES 2000). For ethical and privacy reasons children could not be measured in their underwear. All excess clothing was removed and samples of school uniforms were weighed and subtracted to estimate nude weights. A maximum of two investigators each measured the height and weight to minimize inter-investigator variability for all 580 subjects: coefficient of variation (CV) of 0.06% for height and CV 0.09% for weight. Body mass index was calculated as wt in kilograms (kg)/ht in meters squared (m^2).

4.3.5 Prevalence of overweight and obesity calculations

The prevalence of OWOB was calculated using the following growth references to allow for international and historical comparisons: WHO BMI for age z-scores (BAZ), CDC growth percentiles, IOTF OWOB cut-offs, and Harvard wt/ht for age growth standards. In addition, the change in OWOB and underweight were calculated based on the prevalence rates reported in the 1981

Barbados National Health and Nutrition Survey. Overall prevalence rates were weighted to reflect the gender proportions observed in the primary school population (Economic Affairs Division 2010).

4.3.6 Statistical Analysis

SAS version 9.2 (SAS Institute Inc., Cary, NC) was used for statistical analyses (SAS 2008) to calculate IOTF prevalence rates, Harvard wt/ht for age growth standards, and to determine relationships between variables. WHO AntroPlus v3.2.2 (WHO 2009) was used to determine BAZ and the CDC Macro for SAS was used to obtain growth percentiles. Student t-tests and Chi-squared (χ^2) tests were used to compare differences between boys and girls. Significance level was set at $p < 0.05$.

4.4 Results

4.4.1 Sample characteristics

All subjects were in grade five; 44.1% were males and 55.9% were females. The mean age was 9.70 years for boys and girls. The mean height, weight, and BMI were 1.39 m, 34.96 kg, and 17.88 kg/m² for boys and 1.41 m, 37.35 kg, and 18.46 kg/m² for girls (Table 3).

Table 3. Means of descriptive characteristics of anthropometric measures for grade five Barbadian children			
	All children n=580	Boys n=255	Girls n=325
Age (years)	9.70 (0.36 SD)	9.70 (0.36 SD)	9.70 (0.36 SD)
Height (m)	1.40 (0.073 SD)	1.39 (0.066 SD)	1.41 (0.076 SD)
Weight (kg)	36.30 (10.32 SD)	34.96 (10.31 SD)	37.35 (10.23 SD)
BMI (kg/m²)	18.21 (3.99 SD)	17.88 (3.94 SD)	18.46 (4.01 SD)
BMI z-scores	0.46 (1.47 SD)	0.39 (1.56 SD)	0.51 (1.41 SD)
BMI percentiles	55.48 (33.40 SD)	52.75 (33.73 SD)	57.62 (33.03 SD)

4.4.2 WHO BMI for age growth references

The overall prevalence of thinness (< -2 SD), overweight (> 1 SD), type I obesity (> 2 SD), and type II obesity (> 3 SD) were 3.30% (95% CI: 1.91-4.69), 17.38% (95% CI: 14.30-20.46), 12.96 (95% CI: 10.23-15.69), and 4.44% (95%

CI: 2.77-6.11) respectively (Table 4). The prevalence of OWOB was 32.42% (95% CI: 26.73-38.53) for boys and 37.235 (95% CI: 31.96-42.74) for girls, but there was no significant difference in prevalence between the sexes (Table 5).

Table 4. Prevalence of overweight and obesity in grade five Barbadian children using WHO BMI for age Z-scores

	Prevalence % (95% Confidence Interval)			
	Underweight (< 2 SD)	Overweight (> 1 SD)	Obese I (> 2 SD)	Obese II (> 3 SD)
All children	3.30 (1.91, 4.69)	17.38 (14.30, 20.46)	12.96 (10.23, 15.69)	4.44 (2.77, 6.11)
Boys	3.52 (1.26, 5.78)	14.84 (10.47, 19.19)	12.11 (8.11, 16.11)	5.47 (2.68, 8.26)
Girls	3.08 (1.19, 4.27)	20.00 (15.65, 24.35)	13.85 (10.09, 17.61)	3.38 (1.42, 5.34)

Table 5. The prevalence of overweight and obesity in grade five Barbadian children using various growth references and differences between boys and girls

	Prevalence % (95% CI)			
	All children	Boys	Girls	<i>p</i> -value
WHO	34.79 (30.91, 38.66)	32.42 (26.73, 38.53)	37.23 (31.96, 42.74)	0.062
CDC*	29.05 (25.35, 32.74)	25.88 (22.61, 31.72)	32.31 (27.25, 37.69)	0.015
IOTF*	29.95 (26.23, 33.68)	25.00 (19.82, 30.77)	35.08 (29.89, 40.54)	< 0.001

* indicates significant differences between the proportion of overweight and obese boys and girls

4.4.3 CDC BMI for age percentiles

The CDC BMI growth percentiles defined OWOB at values $> 85^{\text{th}}$ percentile, revealing a prevalence of 25.55% (95% CI: 22.31-29.45) and 32.31% (95% CI: 27.23-37.39) for boys and girls respectively and an overall prevalence of 29.05% (95% CI: 25.36-32.74). There was a significant difference ($p = 0.015$) between the proportions of OWOB boys and girls (Table 5). There were also significant differences ($p < 0.05$) in OWOB prevalence between American 6-11 year old children and Barbadian 8-11 year olds for all children, boys, and girls (Table 6).

Table 6. Comparison of overweight and obesity prevalence between Barbadian 8-11 year old and American 6-11 year old children using CDC BMI percentiles (≥ 85 th)

	Prevalence % (95% CI)		
	All children*	Boys*	Girls*
Barbadians	29.1 (25.4, 32.7)	25.6 (22.3, 29.5)	32.3 (27.2, 37.4)
Non-Hispanic Blacks†	37.6 (32.7, 42.5)	36.4 (28.7, 44.0)	38.9 (29.6, 48.3)

*Significant differences in OWOB prevalence between Americans and Barbadians $p < 0.05$

† (Ogden, Carroll et al. 2010)

4.4.4 IOTF cut-offs

Using IOTF BMI cut-offs, 25.00% (95% CI: 19.69-30.31) of boys and 35.08% (95% CI: 29.89-40.27) of girls and an overall prevalence of 29.95% (95% CI: 26.23-33.67) children were OWOB (Table 5). There was a significant difference ($p < 0.001$) between the percentage of boys and girls who were OWOB (Table 5). Boys had a slightly lower mean BMI than girls by 0.58 BMI units ($p = 0.082$) (Table 7). There was significant difference in OWOB status when IOTF cut-offs were used; boys had a lower risk of being OWOB compared to girls (RR = 0.71; 95% CL 0.55-0.92) (Table 7).

Table 7. Gender differences and relative risk of overweight and obesity in boys compared to girls based on different measurement criteria

	Student's t-test		Relative Risk	
	Units	p-value	RR	(95% CL)
BAZ	-0.12	0.33	0.87	(0.69, 1.09)
BMI	-0.58	0.082	0.71	(0.55, 0.92)*
BMI percentiles	-4.87	0.081	0.80	(0.62, 1.04)
% wt/ht	-6.60	0.0043*	0.68	(0.55, 0.87)*

* Indicates significant differences between boys and girls $p < 0.05$

WHO body mass index for age z-scores (BAZ); body mass index kg/m (BMI); CCD BMI for age percentiles (BMI percentiles); Harvard percent wt/ht for age growth standards (% wt/ht)

4.4.5 Harvard weight/height for age standards and the change in prevalence of overweight and underweight since 1981

Using historical cut-offs based on Harvard based criteria underweight was defined as $< 80\%$ and overweight was defined as $\geq 120\%$ of wt/ht for age

standards. The prevalence of underweight and overweight were 4.69% (95% CI 2.10-7.28) and 25.39% (95% CI 20.06-30.72) for boys, 4.62 (95% CI 2.34-6.90) and 37.54% (95% CI 32.28-42.80) for girls, and 4.65% (95% CI 2.94-6.36) and 31.27 (95% CI 27.5-35.04) overall (Table 8). There was a significant difference in percent wt/ht for age of -0.066 units ($p < 0.01$) between boys and girls. There was also a lower risk of OWOB for boys compared to girls (RR = 0.68; 95% CI 0.55-0.87) (Table 7). There has been a 379 percent increment in OWOB in boys and a 226 percent increment in OWOB in girls from 1981 to 2010 (Table 9). In addition, there appears to be a decrease in the prevalence of underweight from 10.5% in 1981 to 4.65% in 2010 (Table 9).

Table 8. Change in underweight and overweight from 1981-2010 based on Harvard weight/height for age standards

		All children	Boys	Girls
		Prevalence % (95% CI)	Prevalence % (95% CI)	Prevalence % (95% CI)
Underweight	2010	4.65 (2.94, 6.36)	4.69 (2.10, 7.28)	4.62 (2.34, 6.90)
	1981	10.5 (7.3, 13.7)	10.0 (5.49, 14.51)	11.0 (6.45, 17.45)
	change	-5.85	-5.31	-6.38
Overweight	2010	31.27 (27.50, 35.04)	25.39 (20.06, 30.72)	37.54 (32.28, 42.80)
	1981	8.52 (5.60, 16.13)	5.3 (1.93, 8.67)	11.5 (6.87, 16.13)
	change	22.75	20.09	26.04

Table 9. Percent increment in child overweight and obesity in selected countries over last 30-40 years

	Boys	Girls
Barbados (1981-2010) 5-14 and 8-11 year olds¹	379	226
USA (1976/1980²-2007/2008³) 6-11 year olds	80	123
Canada (1978/79 -2004) 2-17 year olds⁴	39	65
Chile (1987-2000) 6 year old⁵	85	114
Cracow, Poland (1971-2000) 7-12 year olds⁶	107	158

¹(Ramsey, Demas et al. 1986), ²(Troiano, Flegal et al. 1995), ³(Ogden, Carroll et al. 2010), ⁴(Shields and Tremblay 2010), ⁵(Kain, Uauy et al. 2002), ⁶(Chrzanowska, Koziel et al. 2007)

4.5 Discussion

4.5.1 Prevalence of child overweight and obesity in Barbados

The prevalence of OWOB in grade five students is very high in Barbados at around 34% and is likely to be much higher than most Caribbean nations. A recent study in Jamaica showed that child OWOB was only 11% in a nationally representative sample of 10-11 year olds (Dubois, Francis et al. 2011). The same study compared the Jamaican sample to a provincially representative sample of 10 year olds in 2008 from Quebec, Canada, reporting prevalence rates of OWOB of 26% in the Quebec group. The prevalence of child OWOB in Barbados may be more comparable to North America or even countries such as Brazil in South America than some of its Caribbean neighbours such as Jamaica. Data from Caribbean countries that are very similar to Barbados like the Bahamas are outdated and it is difficult to make comparisons. Nevertheless, the OWOB prevalence in the Bahamas in 1994-1995 was 14.9% in 4-9 year old children (CFNI, Penn et al. 2003) and 5.1% in Guyana in 10-14 year olds in 1996-1997 (CFNI, Howard et al. 2003). The prevalence of OWOB in the Barbadian grade five survey is comparable to the rates seen in the Americas for similar aged children: USA, 35.5% in 6-11 year olds 2007/2008 using CDC percentiles; Canada, 26.0 % in 6-11 year olds 2004 using IOTF cut-offs (Shields [date unknown]); Mexico, about 29.0% in 6-17 year olds 2006 using IOTF cut-offs (IASO 2009); Chile, about 28% in 6 year olds 2000 using CDC cut-offs (Kain, Uauy et al. 2002). Despite representing the OWOB prevalence results of the CHNS using various cut-offs, comparisons to other studies may remain superficial because of different time points and age groups presented in other surveys.

4.5.2 Differences in overweight and obesity prevalence between genders and cut-offs

As seen in Table 6, there were variations between the prevalence in OWOB when different criteria defining OWOB were used. The WHO references

reveal the highest rates of OWOB and the smallest difference between boys and girls. The IOTF and CDC rates show very similar prevalence of OWOB overall and for boys, as well as significant differences between boys and girls. These results are in accord with other child OWOB prevalence studies conducted in Canada (Shields and Tremblay 2010), Chile (Kain, Uauy et al. 2002) and Saudi Arabia (El Mouzan, Foster et al. 2010). In the present study the IOTF cut-points were the only international criteria that showed a significant lower risk in OWOB in boys compared to girls. There may be important differences between cut-points that should be considered when reporting and comparing rates over time and internationally. Nevertheless, regardless of which cut-offs are used it is evident that the prevalence of OWOB in the grade five Barbadian survey is very high. Furthermore, the trend across cut-offs show that a higher percentage of girls are OWOB compared to boys.

The gender trend of more OWOB girls and women than boys or men is consistently seen in Caribbean countries. Jamaica, Guyana, British Virgin Islands, Bahamas, and St. Vincent all demonstrate a higher prevalence of OWOB in girls compared to boys (Xuereb, Johnson et al. 2001). It is also consistent with the adult trends in this area of the world (CFNI, Frazer et al. 2003; CFNI, Howard et al. 2003; CFNI, Penn et al. 2003). England (Stamatakis, Wardle et al. 2010), Australia (Olds, Tomkinson et al. 2010), and Chile (Muzzo, Burrows et al. 2004) all show a trend of a greater OWOB prevalence in girls as well. In contrast, trends in other developed countries indicate a higher prevalence of OWOB among boys. American boys tend to carry more excess weight than American girls, with the exception of non-Hispanic Black Americans (Ogden, Carroll et al. 2010). Similar trends are seen in Canada (Shields and Tremblay 2010) and South Korea (Khang and Park 2011).

There is a much larger gender gap in Barbados between boys and girls than in the reference population. Taking into consideration the homogeneity of the sample (97% of African ancestry), it can be assumed that the cohort studied had a similar genetic background as the non-Hispanic Black American reference group. The much larger gender disparity in OWOB prevalence in the Barbadian cohort

with 25.6% in boys compared to 32.3% in girls (Table 6). These results are in contrast to the relatively narrow gender gap seen in the reference non-Hispanic Black Americans with an OWOB prevalence of 36.4% in boys and 38.9% in girls (Table 6). The wider gender gap in Barbadian children compared to American children indicates that environment as opposed to genetics may be a significant influence driving weight related gender differences in Barbados.

4.5.3 Comparisons to reference populations in the USA

The reference population used for comparison was non-Hispanic Black Americans 6-11 years old from NHANES 2007-2008 (Ogden, Carroll et al. 2010). This group was chosen from the USA because it consisted of a large sample of an ethnic group that has been tracked over time. In addition, it is fair to assume that Barbadians have closer demographic and cultural resemblances to the non-Hispanic Black Americans than to ancestral populations in Africa or neighbouring nations with populations of mixed origins within the Caribbean and Latin America. The reference group had significantly higher rates of OWOB than the Barbadian survey (Table 6). Although OWOB is very high in Barbados, it is still lower than the rates seen in the USA.

4.5.4 Increases in overweight and obesity and decreases in underweight since 1981

When the grade five student survey is compared to national prevalence data from 1981 it would appear that there has been a dramatic increase in the prevalence of OWOB by over 20 percentage points if the same Harvard standard cut-offs are used. In addition, the prevalence of underweight appears to have decreased by more than half over the same period of time. The results illustrating these changes in Table 8 should be interpreted with caution. It is necessary to point out that the present study is not a national representation of all Barbadian children and is limited to grade five public school students. In addition, although the 1981 survey was a national survey the results represented a relatively small sample ($n = 352$) of children 5-14 years old. Nevertheless, there appears to have

been a shift from under-nutrition to over-nutrition over the last 30 years which is indicative of the fourth phase of the nutrition transition (Popkin 2010) and it may be predictive of the pending increase in obesity related NCD.

The rate of increase in OWOB was much higher in Barbados than the American reference group (Table 9). The huge percent increment in OWOB since 1981 is exceptional compared to other nations in the Americas, as well as similarly developed nations in the world. Chile and Poland were chosen for comparison because of their development and economic similarity to Barbados. According to the Human Development Index (HDI), a ranking of 169 countries based on human development indicators comprising health, education and living standards that are defined by the World Bank, Barbados ranks high to very high in the Americas, after the USA and Canada. Chile, Poland, and Barbados all had very similar ratings of high to very high in 2010 with HDI ranks of 45, 41, and 42 respectively (UNDP 2010). These three nations are also considered middle-high income countries (The World Bank 2010). The rates of increases, however, in child OWOB in Chile and Poland are less than half of the rate of increase seen in Barbados. This may indicate that even though education, health, living standards, and wealth are very similar in these countries, the driving forces on OWOB or the impact of these factors are likely to be very different in Barbados than in similarly developed nations. The contrast in the OWOB rates between Barbados and the two similarly developed nations further validates that OWOB influences may not be generalizable across nations.

4.6 Limitations

The main limitation for this study was obtaining consent for the participants, which inhibited the ability to select a truly random sample. There is a possibility for a slight bias of children whose parents signed consent forms, in addition to the bias of using schools where principals and teachers were more cooperative. Due to the nature of agreement with the Ministry of Education, only public schools were included in the sample. This neglects access to 20% of children who did not attend public schools and who are likely living in higher

income households. It has also been observed that very few white children attend public schools in Barbados. It is likely that the CHNS did not reach minority groups (white, foreign, and mixed race children) or the children from higher SES households. The homogeneity of the sample with regards to race, ethnicity and age can also be considered as strength for the CHNS but it is not a national representation.

4.7 Conclusion

There is a rapid increase in OWOB in children in Barbados, particularly considering that the overall prevalence is comparable to similarly developed nations, but the rate of increase is more than double that of the U.S.A and Chile. In various countries, there is evidence that the increase in prevalence seen over the last several decades may be abating (Olds, Tomkinson et al. 2010; Stamatakis, Wardle et al. 2010). Not enough data are available to suggest that the trend of OWOB attenuation is occurring in Barbados. It is doubtful that the rate of OWOB has attenuated considering that the percent increment has been exceptionally high since 1981 and the increases in OWOB for adults have also been very high with no indication of slowing. An expansion of the current study to other age groups in addition to child OWOB monitoring in the coming years is warranted in order to comprehend the factors driving the obesity epidemic in Barbados. If the rate of increase in OWOB prevalence continues, Barbadian children are likely to surpass American children in the very near future.

4.8 Disclosure

The authors declared no conflicts of interest.

V. LINKING STATEMENT II

Conducting a cross-sectional study on the prevalence of child OWOB using the grade five population in Barbados has provided insight into the current state of nutrition status of children. It has also given an idea about the degree of change that has occurred over the last three decades. These are important first steps in understanding the child obesity epidemic in Barbados. Surveying the prevalence of OWOB in a sample of children, however, limits understanding the problem at hand if other measures are not studied simultaneously. The following manuscript will illustrate the complexity of OWOB in Barbados by identifying influences that can act as risk factors or protective agents on child OWOB, thereby providing an indication of what is driving the OB epidemic.

VI. MANUSCRIPT II

High parental education, low income, access to sedentary entertainment, infrequent family dinners, and inactive transport are associated with overweight and obesity in Barbados

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Running title: Child overweight and obesity influences in Barbados

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6.1 Abstract

Few surveys have been conducted concerning overweight and obesity (OWOB) risk factors in Barbados and no surveys have been conducted with primary school children since 1981. This study aimed to gather information about possible risk factors of child obesity by interviewing children and their guardians with regards to media access and usage, daily activities, eating habits, maternal weight status, and household demographic variables. A sample of 494 children were interviewed simultaneous to school visits for height and weight measurements during the Barbados Children's Health and Nutrition Study (CHNS) and a second sample of 229 guardians were interviewed over the phone. Results from these interviews were compared to children's body mass index (BMI) and weight status, based on the World Health Organization (WHO) BMI for age growth references. Low income was associated with a greater risk of both underweight (RR (relative risk) = 2.11; 95% CL (confidence limit) 1.15-3.89) and obesity (RR=3.29; 95%CL 1.63-6.64). Active transport and family dinners had protective effects on OWOB. Sedentary behaviors and involvement in sports did not appear to have any influence; however, access to sedentary entertainment was directly correlated to OWOB. Interventions directed at low income families are advised to decrease the vulnerability of this group to both underweight and obesity. Understanding child OWOB influences in Barbados is necessary in planning intervention and prevention programs.

6.2 Introduction

Child OWOB have become global concerns, in both developed and developing nations (Bleich, Cutler et al. 2008). The implications of the rising child obesity epidemic have both immediate morbidity and long-term mortality consequences. Obese children are at risk for a wide range of physical and metabolic disorders including sleep apnea, hypertension, insulin sensitivity, gallstones, and dyslipidemia (Wabitsch 2000). Excess weight over the course of childhood increases the risk of a child becoming an obese adult (Whitaker, Wright

et al. 1997), leading to long term non-communicable disease (NCD) and poor socioeconomic outcomes (Reilly 2006).

In theory, OWOB is a simple problem of positive energy balance resulting from either increased energy intake or inadequate energy output or a combination of both (Molnar and Livingstone 2000). The forces pushing individuals towards high energy intake or decreased activity, however, are extremely complex. The Foresight Organization's obesity systems map attempts to illustrate the complicated nature of energy balance (Vandenbroeck, Groossens et al. 2007). The map effectively shows the multitude of influences causing increased intake or decreases in activity, which, ultimately lead to excess weight gain. Each of these influences affects communities and individuals differently. In general, it has been very difficult to isolate single causal risk factors that lead to obesity, due the complexity of the problem. Even when single risk factors or influences can be isolated, there is great difficulty in defining a mechanism by which these factors act on individuals or on populations consistently. For example, television (TV) viewing has been consistently associated with OWOB; however, the mechanisms of the affects of media are not fully understood (Robinson 2001; Communications and Media 2011). The lack of certainty about the strength and direction of obesity influences as well as interactions between influences have been a major limiting factor in designing successful prevention and intervention studies. Without evidence of successful outcomes and a strong cost-benefit ratio, it is difficult to convince governing bodies to commit financially to obesity prevention.

There has been a great deal of epidemiological research and evidence identifying various risk factors for OWOB (Durantauleria, Rona et al. 1995; Livingstone 2000; Sobal 2001; Celi, Bini et al. 2003; Ford and Mokdad 2008): eating behaviors (Buddeberg-Fischer, Bernet et al. 1996; Veltsista, Laitinen et al. 2010), parental weight (Li, Law et al. 2009), socioeconomic factors (McLaren 2007; Oh, Cho et al. 2011), the built environment (Bell, Wilson et al. 2008), TV viewing (Ekelund, Brage et al. 2006; Danner 2008; Jago, Page et al. 2008), physical inactivity (Sallis, Zakarian et al. 1996; Scully, Dixon et al. 2007; Ward, Tarasuk et al. 2007), and short sleep duration (Sekine, Yamagami et al. 2002;

Gangwisch, Malaspina et al. 2005). Many countries, in fact, have excellent data relating some of the risk factors to obesity in children. The National Health and Nutrition Examination Survey (NHANES) in the U.S, the National Diet and Nutrition Survey in England, the Canadian Community Health Survey (CCHS), the *Étude nationale nutrition santé* (ENNS) in France, the *Encuesta Nacional de Salud y Nutricion* (ENSANUT) in Mexico, and the China Health and Nutrition Survey are just a few examples of large surveys that have gathered national statistics about obesity at various points in time contributing to global insight on child obesity.

Even though many of the national surveys provide excellent data and insight into obesity influences, there are limited examples of actual mechanisms making it very difficult to apply these data to other nations or even different communities within the same nation. Interactions between socioeconomic variables and obesity in American adults have shown to be inconsistent between genders and ethnic groups. For example, in the USA high education may be protective for women but not for men, low income may be a risk factor for women but not for men, and high income may be a risk factor for non-Hispanic Blacks and Mexican American men but not for non-Hispanic White men (Ogden, Lamb et al. 2010). In Canada, off-reserve youth of aboriginal descent had obesity prevalence 2.5 times higher than for average Canadians and the obesity prevalence of Southeast/East Asian youth was significantly lower (Shields [date unknown]). In some communities, lifestyles are very different and risk factors would be difficult to compare to the average Canadian. It cannot be assumed that obesity influences which are common for a general population in a particular nation would remain consistent throughout that nation or that commonly seen OWOB risk factors found throughout the world will have the same effects in Barbados. It is therefore important to identify risk factors relevant to the Barbadian context of child obesity. In conjunction with baseline data on weight status collected during Phase II of the Barbados CHNS, a sample of subjects and a sample of guardians were interviewed to identify possible child OWOB risk factors and gender differences.

6.3 Methods

6.3.1 Interviews

During the Barbados CHNS from September to December of 2010, children who were available on days that investigators took height and weight measurements during school visits were interviewed in person, resulting in 494 interviews at 20 public schools with 222 boys and 272 girls. Three attempts over the telephone were made to interview the guardians of children who participated in the CHNS and who agreed to being contacted by telephone. A total of 229 telephone interviews were completed with guardians. Questions about children's activities and habits were asked during the 10 minute school interview. Telephone interviews lasted between 5-10 minutes, during which questions about family characteristics and demographic variables were asked to subjects' guardians. All interviews with children and parents were conducted by one investigator. School interviews took place during school hours from Monday-Friday, and telephone interviews were conducted mornings, afternoons, and evenings on weekdays and weekends at times requested by the guardians. All interview responses were recorded on pre-coded bubble sheets, which were read using optical recognition software and verified by an investigator. Guardian and school interviews were designed by the CHNS research team to fit the time restrictions and resources of the study.

6.3.2 Ethics approval

Ethics approval for this study was obtained by the McGill Research Ethics Board III and the University of the West Indies Internal Review Board. In addition, permission to gain entry into the schools was obtained from the Barbados Ministry of Education. Consent to interview children was granted by parents and informed consent from children was obtained before interviews began. Parents indicated their interest and agreement to participate in a telephone interview by signing the telephone interview section of their child's consent form

and providing telephone numbers and times to be contacted as well as verbal permission over the phone to use their responses as part of the Barbados CHNS.

6.3.3 Statistical analysis

SAS Version 9.2 (SAS Institute Inc., Cary, NC) was used for all statistical analyses (SAS 2008). WHO AntroPlus was used to determine weight status of subjects (WHO 2009). Student's *t*-test was used to check for differences in BMI between groups of subjects and genders, and non-parametric data was transformed using $\log_{10}$ for groups with small sample sizes (McDonald 2009). Chi-squared (χ^2) tests were used to identify differences between groups of observations that deviated from what would be expected by chance alone. Unadjusted relative risk (RR) was determined from 2x2 contingency tables. The binary and nominal nature of the variables, small sample size, and missing observations did not allow for good model fit or convergence when all variables were imputed into logistic regression models. Models were only reported if they satisfied convergence and the goodness of fit test requirements. To meet these requirements *p*-values were all < 0.05 for the Likelihood Ratio χ^2 test, The Score χ^2 test, and the Wald χ^2 (Chen, Ender et al. 2003). Responses from guardian interviews and school interviews were analyzed separately. A complete case analysis was conducted for the school interviews resulting in 423 complete interviews (Howell 2009). Student's *t*-test and χ^2 tests were conducted between the 423 subjects whose school interviews were included in the analyses and the 157 subjects who were not interviewed or whose interviews were not included in analyses. The telephone interviews consisted of a smaller sample and although there were relatively few missing observations, there were many uncategorized responses due to the respondents' inability to answer certain questions. A complete case analysis or guardian interviews would have reduced the sample size to 119, thereby seriously impeding the power of analyses; therefore, missing observations were compared to the non-missing observations for variables with significant amounts of missing data: SES, maternal BMI, parental education, and parental employment. In addition, groups of respondents were compared to non-

respondents for both parent and school interviews to verify whether respondent bias existed using Student's *t*-tests for BMI and χ^2 tests for nominal variables. Odds ratios (OR) were derived from logistic regression models for selected variables (Chen, Ender et al. 2003). Spearman correlation tests were used between ordinal variables when one or more variables contained non-parametric data. Analyses including all children were weighted to reflect the population gender ratio (Economic Affairs Division 2010). Statistical significance was set at $p < 0.05$.

6.4 Results

6.4.1 Guardian interviews

6.4.1.1 Characteristics

Telephone interviews were conducted with 229 parents or 39.41% of the subjects' guardians. The majority of respondents were the mothers of the subjects (83.84%) and a very high percentage of homes were headed by women (46.67%); either the child's mother or grandmother. Only 30.70% of guardians were married. A higher percentage of mothers (48.65%) compared to fathers (28.41%) had at least some post-secondary education and less than 5% of guardians had no secondary education whatsoever. Education information could not be obtained for 23.14% of subjects' fathers. Similar numbers of mothers (82.74%) and fathers (80.18%) declared they were employed. Employment information could not be collected for 17.18% of fathers compared to just 2.64% for mothers. Guardians reported that 30.13% of homes housed 6 or more individuals and there was a mean of 4.96 (SD 1.89) individuals living in the subject's households. The majority of respondents (60.14%) indicated that their child had access to a safe outdoor recreational space to play freely near the home. Maternal weights and heights were obtained from 72.93% of mothers interviewed. Household income data was obtained from 81.66% of guardians interviewed.

6.4.1.2 Demographic variables

Overweight and obesity in children was not significantly related to the subjects having parents who were married. Boys whose parents were married, however, had a greater risk of being OWOB than boys whose parents were not married with a RR = 1.82 (95% CL 1.09-3.05; n = 110) (Table 10).

It was noted that subjects from families where both parents had some post-secondary education (n = 43) had a greater risk of being OWOB than children from families where only one or neither parent had some post-secondary education (n = 131), RR = 1.71 (95% CL 1.03-2.85) (Table 10). Even when marital status, unemployment, poverty, maternal BMI, female headed homes, household crowding and gender were held constant in logistic regression models, the relationship between high parental education and OWOB remained significant with an OR = 2.11 (95% CL 1.01-4.42) (Table 11).

No relationships between the employment status of parents, matriarchal-headed households, household crowding, the number of dependents in a home, family vehicle ownership, or access to a safe outdoor play space and the weight status of the subjects were noted.

6.4.1.3 Household income

There was no significant correlation between annual household income and the weight status of children. Relationships, however, were prominent between certain weight status categories and low income groups. Children from very low income families (household income below BD \$9000/year) were at greater risk of being underweight compared to children from families that were not low income (household income $\geq$ BD \$9000/year), RR 3.21 (95% CL 1.57-6.57; n = 187) (Table 10). From the entire sample only 3.27% (n = 19) of the subjects were categorized as underweight and income information was only available for nine of the families of these underweight children. From this group, 6/9 of the underweight children lived in very low or low income households (household income under BD \$15 000/year). Very low income boys had a significantly greater risk of underweight with a RR = 3.87 (95% CL 1.53-9.73; n

Table 10. Unadjusted relative risk (RR) for selected demographic variables from guardian interviews for overweight and obesity in grade five children

Variables	All Children		Boys		Girls	
	RR (95% CL)	n	RR (95% CL)	n	RR (95% CL)	n
Married parents	1.32 (0.89-1.95)	229	1.82 (1.09-3.05)*	110	0.84 (0.45- 1.59)	118
Both parents with some post-secondary education	1.75 (1.05-2.92)*	174	2.05 (0.95-4.42)	82	1.48 (0.74-2.93)	92
Both parents with jobs	1.07 (0.93-1.22)	185	1.12 (0.93-1.34)	88	1.02 (0.83- 1.25)	97
> 5 persons in a household	1.11 (0.84-1.47)	229	1.27 (0.87-1.87)	110	0.95 (0.63-1.42)	119
> 1 dependent in a household	1.03 (0.88-1.20)	215	1.06 (0.82-1.36)	105	0.99 (0.82-1.18)	110
Female headed household	0.77 (0.55-1.08)	119	0.65 (0.37-1.14)	110	0.89 (0.59-1.36)	119
Very low income	1.61 (0.90-2.90)	187	1.21 (0.48-3.07)	90	2.15 (0.97-4.78)	97
Very low income (obesity)	2.12 (1.15-3.89)*	187	2.26 (0.94-5.42)	90	1.95 (0.83-4.61)	97
Very low income (underweight)	3.29 (1.63-6.64)*	187	3.87 (1.54-9.73)*	90	2.74 (0.94-7.97)	97
Maternal obesity	1.31 (0.77-2.23)	165	0.86 (0.40-0.86)	75	2.63 (1.13, 6.07)*	90
Safe outdoor recreational space	1.08 (0.87-1.33)	229	1.09 (0.81-1.47)	110	1.07 (0.78-1.46)	119
Family vehicle ownership	1.18 (0.92-1.53)	229	1.31 (0.91-1.89)	110	1.05 (0.73-1.50)	119
Interview bias	0.80 (0.63, 1.02)	581	0.79 (0.55-1.15)	256	0.82 (0.61-1.12)	325

* Indicates significant relative risk

Table 11. Logistic regression analyses examining demographic variables associated with overweight and obesity

Variable	Adjusted odds ratio*	95% Wald confidence limits
two parents with post-secondary education[†]	2.114	(1.012-4.416)
two parents employed	1.554	(0.792-3.051)
married parents	1.294	(0.674-2.487)
household crowding (> 5 individuals in a home)	1.163	(0.674-2.487)
low income < \$9000 BD[†]	2.689	(1.209-5.984)

*All variables in the model were controlled for post-secondary education, employment status, marital status, crowding, and low income

[†] Indicated significance with $p < 0.05$

s = 90) compared to boys who were not from very low income households (Table 10).

In addition, children living in very low income households were at higher risk of being obese compared to children not living in households with very low incomes with a RR = 2.10 (95% CL 1.14-3.87; n=187) (Table 10). After controlling for parental employment, post-secondary education, marital status, and household crowding in logistic regression models, the relationship between OWOB and low income remained significant with an OR = 2.69 (95% CL 1.21-5.98) (Table 11).

6.4.1.4 Maternal weight status

Based on self reported weights and heights, 62.42% (95% CI 55.03-69.81; n = 165) of mothers interviewed were OWOB. In addition, 10.9 % (95% CI 6.14-15.66) of these mothers were classified in obese II (BMI > 35 kg/m²) and obese III (BMI > 40 kg/m²) categories.

There were no relationships between the weight status of mothers and sons. In contrast, the mothers of OWOB girls (n = 17) had a significantly higher mean BMI by more than 3.0 BMI units compared to mothers of normal weight girls (n = 73), $p = 0.015$ (Table 12). Girls also had a greater risk of being OWOB

Variables n1/n2	All Children		Boys		Girls	
	BMI units†	(p-value)	n1/n2			
Married parents/unmarried parents	-0.00427 (0.72)	70/158	0.0189 (0.25)	36/74	-0.0337 (0.055)	34/84
Both parents with post-secondary education/one or no parents with post-secondary education	0.0271 (0.065)	43/131	0.0244 (0.23)	19/63	0.0296 (0.17)	24/68
Both parents employed/one or more parents unemployed	0.0123 (0.43)	151/34	0.0134 (0.56)	73/15	0.0114 (0.60)	78/19
Family vehicle ownership/no family vehicle	0.00317 (0.77)	118/111	0.0202 (0.19)	56/54	-0.0178 (0.26)	62/57
Safe outdoor recreational space/no safe space	0.00380 (0.74)	140/89	-0.00987 (0.54)	70/40	0.0208 (0.12)	70/49
Female headed household/male headed or mixed household	-0.00371 (0.74)	105/124	-0.0122 (0.43)	49/61	0.00594 (0.71)	56/63
Very low income/not low income	0.0191 (0.21)	36/151	0.0130 (0.53)	17/73	0.0259 (0.26)	19/78
Obese mothers/overweight and normal weight mothers	0.0189 (0.15)	41/124	-0.00870 (0.64)	24/51	0.0371 (0.063)	17/73
Overweight and obese children/ normal weight children‡	0.0247 (0.09)	48/117	0.000406 (0.99)	21/54	0.0448 (0.015)*	27/63
Interviews/non-responders	-0.0172 (0.02)*	229/352	0.0140 (0.20)	110/146	-0.0183 (0.073)	119/206

† BMI units after log₁₀ transformation

* Indicates significant differences between n1/n2 $p < 0.05$

‡ BMI units of the mother's of obese children compared to the BMI units of the mothers of normal weight children

if their mothers were obese with a RR = 2.63 (95% CL 1.13-6.07; n=90) (Table 10). Overall relationships between maternal BMI or weight status and children's weight status were either not significant or not well defined, with the exception of girls.

6.4.2 School interviews

6.4.2.1 Family setting, eating habits, and sleep

Less than half of the children interviewed (44.74%) said they lived in a home with both of their parents but no relationships were noted between the family setting (living with their mother, father, both parents, or neither parent) and weight status.

Children who said they ate their dinner every evening with their family had a lower risk of being OWOB than children who did not eat dinner every evening with their families with RR = 0.66 (95% CL 0.49-0.88; n = 423) (Table 13). Boys and girls who ate dinner every evening with their families showed similar trends with RR = 0.61 (95% CL 0.38-0.97; n = 189) for boys and RR = 0.70 (95% CL 0.48-1.01; n = 234) for girls (Table 13). There was also a significantly lower BMI in the group of children regularly eating dinner together with families of 1.14 BMI units ($p < 0.005$) (Table 14). No significant relationships between OWOB and breakfast eating were noted.

There was a very weak negative correlation between snacking frequency while watching TV and BMI $r = 0.14$ ($p = 0.048$) for boys only. Boys who always or often snacked while watching TV had a lower risk of OWOB RR = 0.51 (95% CL 0.28-0.95; n = 189) (Table 13) and a lower BMI of 1.52 BMI units ($p = 0.009$) (Table 14) than boys who never or sometimes snacked while watching TV. There were no differences in weight status between children who received an adequate amount of sleep the night before the interview (10-11 hrs (CDC 2010)) and those who did not get adequate amounts of sleep. There was also no relationship between the amount of sleep and children's BMI.

Table 13. Unadjusted relative risk (RR) of selected variables from school interviews for overweight and obesity in grade five children

Variables	All Children			Boys		
	RR (95% CL)	n	RR (95% CL)	n	RR (95% CL)	n
Child lives with both parents	1.23 (0.98-1.53)	423	1.28 (0.91-1.83)	189	1.16 (0.88-1.53)	234
Family meals every night	0.66 (0.49-0.88)*	423	0.61 (0.38-0.97)*	189	0.70 (0.48-1.01)	234
Ate breakfast the morning of the interview	0.99 (0.95-1.03)	423	1.03 (1.00-1.06)	189	0.95 (0.88-1.02)	234
Often or always snacked while watching TV	0.86 (0.60-1.25)	423	0.52 (0.28-0.95)*	189	1.51 (0.93-2.47)	234
Just 1 TV at home	0.68 (0.48-0.97)*	423	0.75 (0.45-1.24)	189	0.62 (0.38-1.01)	234
≤1 computers at home	0.91(0.79-1.04)	423	1.01 (0.83-1.20)	189	0.81 (0.67-0.98)*	234
Internet access at home	1.19 (1.01-1.40)*	423	1.08 (0.82-1.43)	189	1.29 (1.05-1.58)*	234
Adequate sleep	0.95 (0.75-1.21)	423	0.81 (0.57-1.167)	189	1.14 (0.83- 1.57)	234
Active transport to go to school	0.66 (0.49-0.88)*	423	0.54 (0.33-0.86)*	189	0.81 (0.57-1.17)	234
Total sedentary activities ≤ 2 hours on a school day	0.92 (0.69-1.21)	423	0.88 (0.56-1.33)	189	0.96 (0.65-1.42)	234
Total sedentary activities ≤ 2 hours on Sunday	0.84 (0.66-1.05)	423	0.84 (0.58-1.21)	189	0.83 (0.62-1.12)	234
Member of a school sports team	0.95 (0.78-1.16)	423	0.90 (0.67-1.21)	189	1.01 (0.77-1.33)	234
Plays group sports with friends in free time	0.97 (0.87-1.08)	423	0.96 (0.85-1.08)	189	0.99 (0.84-1.18)	234
Enrolled in instructor led sports	1.07 (0.85-1.34)	423	0.98 (0.67-1.46)	189	1.12 (0.86-1.47)	234
Children interviewed / not interviewed or not analyzed	1.20 (0.95-1.51)	581	1.02 (0.68-1.52)	256	1.32 (0.99-1.76)	325
boys/girls	0.88 (0.73-1.08)	581				

* Indicates significant relative risk

Table 14. Student t-tests showing differences in BMI between groups of variables from school interviews

Variables n1/n2	All Children		Boys		Girls	
	BMI units	(p-value)	n1/n2			
Living with both parents / just one parent or another family member	0.23 (0.56)	185/238	0.45 (0.47)	76/113	-0.0098 (0.98)	109/125
Family dinners every night / sometimes or never	-1.14 (0.0042)*	165/258	-1.42 (0.025)*	71/118	-0.87 (0.071)	94/140
Breakfast the morning of the interview /no breakfast†	-0.012 (0.57)	405/17	0.060 (0.20)	185/4	-0.034 (0.15)	220/13
TV snacking often-always / sometimes-never	-0.67 (0.11)	101/322	-1.52 (0.0092)*	51/138	0.40 (0.51)	50/184
Just 1 tv at home / > 1 tv	-0.79 (0.066)	123/300	-0.79 (0.24)	57/132	-0.79 (0.15)	66/168
No computers at home/ ≥ 1 computer	-0.42 (0.33)	121/302	-0.46 (0.49)	58/131	-0.38 (0.50)	63/171
Internet access at home/ no internet access	0.59 (0.13)	242/181	0.63 (0.32)	100/89	0.54(0.29)	142/92
Inadequate sleep/ adequate sleep	-0.10 (0.80)	180/243	-0.25 (0.687)	129/93	0.074 (0.88)	94/140
Active transport to school/motorized transport	-0.74 (0.065)	162/261	-1.40 (0.026)*	74/115	-0.030 (0.95)	88/146
Sedentary activities on a school day ≤ 2 hours / > 2 hours	-0.36(0.38)	149/274	-0.45 (0.48)	71/118	-0.26 (0.63)	78/156
Sedentary activities on weekends ≤ 2 hours / > 2 hours	-0.39 (0.32)	197/226	-0.56 (0.36)	84/105	-0.22 (0.66)	113/121
Member of a school sports team / no school sports teams	-0.014 (0.97)	216/207	0.019 (0.98)	100/89	-0.033 (0.95)	116/118
Group sports with friends in free time/no sports	-0.013 (0.98)	333/90	-0.047 (0.96)	166/23	0.052 (0.92)	167/67
Instructor led physical activity lessons/ no instructor led lessons	-0.036 (0.93)	186/237	0.19 (0.76)	72/117	-0.24 (0.63)	114/120
Children interviewed / not interviewed or not analyzed	-0.38 (0.31)	423/158	0.61 (0.21)	189/67	-1.10 (0.026)*	231/91
boys/girls	0.58 (0.082)	256/325				

* Indicates significant differences between n1/n2 $p < 0.05$

† BMI units transformed with $\log_{10}$

6.4.2.2 Active transportation

There was a significant but very weak negative relationship with $r = -0.18$ and $p = 0.013$ between BMI and the time spent utilizing active methods of transportation to go to school for boys only ($n = 201$). Similarly, the group of boys using active transportation to go to school ($n = 79$) had a significantly lower BMI than the group of boys who used motorized transport ($n = 122$) by 1.40 BMI units ($p = 0.026$) (Table 14). In addition, boys who used active transport to get to school had a lower risk of OWOB than boys who used motorized transport ($RR = 0.53$; 95% CL 0.33-0.86) (Table 13). There was also a lower risk of OWOB for all children who engaged in active methods of transportation ($RR = 0.66$; 95% CL 0.49-0.88) (Table 13). A protective trend in the same direction was seen in girls ($RR = 0.81$; 95% CL 0.56-1.17) (Table 13).

6.4.2.3 Sedentary activities and sports

No relationships were found between sedentary activities done on weeknights or Sundays, such as TV viewing, screen usage (computer and or video games), reading or doing homework, and weight status. About 60% of children watched TV, used a computer, or played video games for two hours or less on either schooldays or Sundays.

No relationships were found between engagement in sporting activities and weight status. About 50% of both boys and girls played on one or more of their school's sporting teams: soccer, cricket, field hockey, netball, etc. More boys than girls reported they engaged in non-instructor led group sporting games such as cricket or soccer ($p < 0.001$) (Table 14). Conversely, more girls than boys reported they were enrolled in instructor led physical activity sports or classes outside of school such as dance, tennis, and swimming ($p = 0.029$) (Table 14).

6.4.2.4 Media and sedentary entertainment access

All children interviewed said they had at least one TV in their home. Children living in a home with just one TV had a lower risk of OWOB than children that lived in homes with two or more TVs ($RR = 0.68$; 95% CL 0.48-

0.97; $n = 423$) (Table 13). The group of children that only had one TV at home ($n = 123$) also had a lower mean BMI of 0.79 BMI units ($p = 0.066$) (Table 14) than the group of children with more than one TV at home ($n = 300$).

Less than 30% of children did not live in households with any computers, and 28.99% of children lived in homes with at least two computers. Girls living in homes with one or less computers had a lower risk for OWOB than girls living in homes with more than one computer ($RR = 0.88$; 95% CL 0.67-0.98) (Table 13). Similarly there was a significant weak positive relationship between the number of computers and BMI for all children ($r = 0.12$; $p = 0.013$) and for girls ($r = 0.14$; $p = 0.027$) (Table 14).

There was a significant relationship ($p = 0.031$) (Table 14) between weight status and children living in homes with internet access. Children with access to the internet had a slightly greater risk of OWOB ($RR = 1.19$; (95% CL 1.01-1.41) (Table 13). The same relationship was seen in girls ($p = 0.017$; $RR = 1.29$; 95% CL 1.05-1.58) but not boys (Table 13).

The combined number of sedentary entertainment options (TVs, computers, and the internet) was very weakly but positively correlated to BMI for all children ($r = 0.14$; $p < 0.005$) and for girls ($r = 0.17$; $p = 0.011$). In addition, the number of options were also correlated to total time spent doing sedentary activities (TV, video screen time, and homework) on Sundays ($r = 0.14$; $p < 0.005$), and total video screen time (computers and video games) on schooldays ($r = 0.17$; $p < 0.001$) and Sundays ($r = 0.20$; $p < 0.001$). For boys, similar weak direct correlations were seen for total sedentary activities on Sundays ($r = 0.19$; $p = 0.008$) and total video screen time on schooldays ($r = 0.19$; $p = 0.007$) and Sunday ($r = 0.24$; $p = 0.001$). For girls, only relationships between sedentary entertainment options and video screen time on schooldays ($r = 0.15$; $p = 0.020$) and Sundays ($r = 0.18$; $p = 0.006$) were significant. When sex and total sedentary activity on both schooldays and Sundays were held constant in logistic regression modelling, there was a significant increase in risk for OWOB $OR = 1.17$ (95% CL 1.05-1.31) (Table 11) for every additional sedentary entertainment option.

6.4.3 Bias

The group of children whose parents responded to telephone interviews ($n = 229$) had a slightly lower mean BMI by 0.77 BMI units ($p = 0.022$) than the children of parents who were not interviewed ($n = 352$). There were no significant differences in weight status between the groups of missing observations and analysed observations in χ^2 analyses for the variables education ($p = 0.54$), employment ($p = 0.21$), income ($p = 0.67$), and maternal BMI ($p = 0.95$). There were also no differences in subject BMI for variables with missing observations versus analysed observations: education ($p = 0.84$); employment ($p = 0.71$); income ($p = 0.82$); and maternal BMI ($p = 0.32$). With regards to school interviews, there was a significant difference in BMI ($p = 0.026$) by -1.10 BMI units in the group of girls included in the complete case analysis compared to the group of girls who were not included or not interviewed. There were no differences in BMI for boys or for the entire group of children.

6.5 Discussion

The demographic variables that had the greatest impact on the weight status of the subjects were high parental post-secondary education and poverty. Married status of parents also had an upward impact on boys' weight status. Maternal obesity on the other hand did not appear to affect the weight status of boys, whereas it more than doubled the risk of OWOB in girls. Crowding, the number of dependents in a household, as well as family vehicle ownership, and access to a safe outdoor recreational space did not appear to have any effect on subjects' weight status. Family meals were a protective factor for all children. Snacking and active transport were inversely related to weight status for boys but not girls. The number of sedentary entertainment options in a home had a direct relationship to BMI, however, the time spent doing sedentary activities did not reveal any relationships.

6.5.1 Demographic variables

The relationships between demographic variables and child obesity have been difficult to define and have shown inconsistent results depending on gender, age, race, or the sample studied (Sobal and Stunkard 1989). Even the use of dichotomous cut-offs (weight status) versus continuous variables (BMI) can result in inconsistent findings between genders or groups within the population studied (Shrewsbury and Wardle 2008). The literature generally supports an inverse relationship between education and obesity (Wardle, Waller et al. 2002; Shrewsbury and Wardle 2008), although the measures used to determine education and usages of the terms are often mixed and not well defined. In the Shrewsbury and Wardle (2008) review, it was noted that parental education was an SES indicator for child OB in the De Spiegelaere, Dramaix et al. (1998) study, when parental occupation may have been a more appropriate descriptor. The inverse association between obesity and education has been documented in various studies dealing with adult populations (Wardle, Waller et al. 2002; Faeh, Braun et al. 2011), adolescents (Goodman, Adler et al. 2003; Oh, Cho et al. 2011), and children (Giampietro, Virgone et al. 2002; Amin, Al-Sultan et al. 2008). Even when other related demographic variables were held constant, the relationship between high parental education and child OWOB remained consistent in the CHNS. Even though this finding is contradictory to the vast majority of literature on this topic, it is plausible. For example, if both parents had a high level of education, it could mean more demanding jobs and less time to be engaged in healthy family activities such as cooking and potentially making these families more reliant on fast and processed foods. Although logistic regression analysis controlled for unemployment, the effects of job categories, working outside the home, and seasonal employment were not considered. Different types of employment may also have had an impact on daily family activities. The CHNS may be unique in demonstrating parental post-secondary education as a risk factor for OWOB in a developed country and certainly adds to the inconsistencies in relationships between demographic variables and OWOB between populations.

Contrary to what is often seen in the literature, boys in the CHNS had a greater risk for OWOB if their parents were married. Relationships between marital status and OWOB remain inconsistent. Nevertheless, direct relationships between single parents and child OWOB have been established (Strauss and Knight 1999; Gibson, Byrne et al. 2007; Greves Grow, Cook et al. 2010). A similar result of lower overweight prevalence was seen in the Caribbean for Jamaican adults who lived in couples (Ichinohe, Mata et al. 2005).

Poverty was shown to be a significant risk factor for both obesity and underweight, indicating that very low income families in Barbados are a population at risk for malnutrition in both directions. Obesity in children from low income and low SES families has been well-documented in developed nations over the years (Strauss and Knight 1999; Costarelli 2009) including England (Stamatakis, Primatesta et al. 2005), Sweden (Sundblom, Petzold et al. 2008), and the Russian Federation (Wang 2001). In Canada, however, OWOB risk was higher in children from middle income backgrounds (Shields [date unknown]). The relationship between low income and weight status appears to be prominent in boys in France (LioRET, Touvier et al. 2009), and increases in obesity prevalence from 1999-2003 were only seen in boys from low income groups in Sweden (Sundblom, Petzold et al. 2008). In Barbados, there does not appear to be any gender differences in OWOB risk for low income groups, however it does appear that boys may have a greater vulnerability towards underweight.

The poverty line in Barbados which was set at just over BD\$ 5,000.00 after a comprehensive poverty survey in 1996/97, was thought to be an overestimation of poverty at the time (ILO 1999). This was the only poverty line study conducted in Barbados (ECLAC 2001), and the data is still used even though it is likely that line has not been adjusted in a decade (GB, EC 2007). If only inflation was taken into account, the poverty line at the time of the Barbados CHNS in 2010 was likely closer to \$BD 7500.00 (Thomas 2009). In 2003, a small national survey was conducted estimating that about 8.7% of households fell below the 1996/97 poverty line, amounting to about 35,000 Barbadians or 13.9% of the population (Browne 2004). In 2002, a private poverty report on Barbados

and Guyana stated that there was not a gender gap in the poverty line in Barbados after urbanization and striations in poverty were considered (Henry-Lee and Franc 2002). This latter report is contrary to the study by Brown (2004), who reported that households vulnerable to poverty were likely to be female-headed, house more than 5 people, over-represent elderly, and be situated in urban Barbados. Urban dwelling children was not a variable studied in the CHNS, but female headed homes, household crowding and the number of elderly people in a home were not found to be related to OWOB. Income gradients also did not show any significant relationships to BMI or weight categories. Nonetheless, when the lowest income group (BD\$ 9,000 or less) was used as a cut-off, there was significant risk for children living in these homes to be obese, OWOB, and underweight. These latter findings indicate that even children living in homes well above the established poverty line of (BD\$ 5,300) are vulnerable to malnutrition.

The extreme dichotomy of risk of both obesity and underweight is not surprising in this study group. Underweight may result from extreme food insecurity while obesity may be an indication of affordability, limiting household access to the least expensive nutrient-poor/high-energy foods (Costarelli 2009). It is known that the sugar and vegetable oils are the cheapest ingredients on the market making many of the most affordable foods very high in energy and low in nutritional value (Drewnowski 2007). Previous work has shown that limited income may promote a high energy diet pushing these groups towards obesity (Darmon, Ferguson et al. 2003). Additionally, there is suggestion that increasing fruit and vegetable intake can help combat child obesity (WHO 2003). Jamaican adults showed an inverse relationship between BMI and fruit and vegetable consumption (Ichinohe, Mata et al. 2005). Unfortunately, in Barbados, fresh fruits and vegetables are expensive because most of these foods are imported at a very high cost, limiting the access of this high quality food group to Barbadians with higher incomes. In 1981, close to half of households had a kitchen garden growing a variety of fruits, vegetables, ground provisions and legumes, and about 8% of households grew crops outside of kitchen gardens (Ramsey, Demas et al. 1986). Opportunities for kitchen gardens may be lacking with high land costs and

lack of place to expand on the densely populated island. Household food production has decreased significantly from 74% in 1969 to 30% in 2000, likely due to land acquisition difficulties (NNC, Ministry of Health et al. 2005), notwithstanding the possible lack of interest and time. Community gardens could be a solution for low income families to gain access to lower energy food sources; however, the cost of land use and personal tastes for traditionally grown foods may be a barrier. Steps should be taken to review food insecurity in lower income homes in Barbados including diet quality, especially considering that healthful food are likely to increase in cost in the future (Monsivais, McLain et al. 2010) and may aggravate the vulnerability of low income children to malnutrition in Barbados.

6.5.2 Maternal BMI

Parental weight status is a very strong indicator for children to become obese adults, especially in children under 10 years (Whitaker, Wright et al. 1997). Both mothers and fathers who were OWOB before pregnancy significantly increased risk of their children being OWOB by the age of 16 in Finland (Jaaskelainen, Pussinen et al. 2011). Parental obesity or excess weight has been consistently associated with offspring obesity around the world (Yi, Yin et al. 2012; Guigliano and Carneiro 2004; Gibson, Byrne et al. 2007). The results from the Barbados CHNS only showed a link between maternal obesity and OWOB in daughters. The correlation between maternal-daughter BMI was positive but very weak. Nevertheless, there was significant evidence that girls had more than a 2.5-fold greater risk of OWOB if their mothers were obese. Mothers of OWOB girls also had significantly higher BMIs. It is uncertain whether there is no relationship between the weight status of Barbadian mothers and sons or whether this relationship could not be detected with the small sample size. An earlier study with 11-16 year old Barbadian boys and girls found a significantly high risk of OWOB in youth with obese mothers (Gaskin, Broome et al. 2008). The positive association seen between mothers and daughters is consistent with the literature

indicating that maternal obesity has a direct effect on children's weight status (MacDonald, Baylin et al. 2009).

6.5.3 Protective effects on overweight and obesity of family dinners

The protective effect of children eating dinner with their families every night in the CHNS was strong and consistent between boys and girls. Travers et al. (2005) found an OR of 0.85 (95% CI: 0.76-0.96) for children 9-14 years old to be OWOB if they had dinner every day or most days compared to some days or never (Taveras, Rifas-Shiman et al. 2005). Taveras et al. (2005) was criticised for having ambiguous categories in a study conducted by Sen (2006). The latter study was retrospective and made use of carefully defined groups for family dinner frequency and successfully showed a reduced risk of OWOB with increased number of nights per week an adolescent had a family meal. While the relationship was strong and there was no ambiguity in categories, the relationship was only noted in whites and non-existent for Blacks and Hispanics (Sen 2006). More recently, family meals at home were found to be inversely associated to BMI in both adults and adolescents in the US (Chan and Sobal 2011) and family meals in Ottawa, Canada were protective against OWOB in females but not in males (Goldfield, Murray et al. 2011). Even though the CHNS found a consistent relationship between family meals and OWOB for both boys and girls, the categories used may have been ambiguous as they were limited to always, sometimes, and never. The results reported in the present study compared children who always ate dinner with their families to children who only ate family dinners sometimes or never.

6.5.4 TV snacking and sedentary entertainment usage

A surprising finding was that increased snacking frequency while watching TV was negatively associated with BMI in boys only. A major caveat of this finding is that the groups were not well defined, and a distinction between snacks consumed either often or sometimes may have been left to the subjectivity of the child. In addition, the quality of the snacks was not studied. These findings

are counterintuitive to the majority of the literature about snacking especially while watching TV. Australian 6-7 year olds showed a direct relationship between watching TV and snacking (Brown, Nicholson et al. 2011). Snacking frequency and TV viewing are both risk factors for child obesity (Locard, Mamelie et al. 1992; Robinson 2001). Snacking while TV viewing is a separate risk factor for OWOB that may influence weight gain by providing eating cues from advertisements in addition to the displacement of physical activity (Halford, Gillespie et al. 2004). The lower BMI in children who snack frequently while watching TV may suggest other factors in the home environment of boys are interacting with TV snacking resulting in a protective effect.

Time spent watching TV as well as video screen time were reviewed and did not show any association to OWOB. This former observation may reflect the finding that more than 70% of Barbadian children watch two hours or less of TV/day, which is in concert with AAP recommendations (American Academy of Pediatrics 2001). Most families in Barbados only have access to one TV channel, the local Caribbean Broadcasting Corporation (CBC), which broadcasts cost-free to all homes on the Island. The time spent watching TV found in the present study may be an underestimation, but the limited access to TV channels could explain in part why relatively few (29%) Barbadian children watch more than two hours of TV per day. These numbers are drastically less in contrast to other developed countries; for example, more than 60% of Canadian grade 6-10 children (Mark, Boyce et al. 2006) and almost 80% of Americans children under five years old (CDC 2010) watch more than 2 hours of TV a day. Child obesity intervention trials aimed at reducing TV viewing have shown success (Robinson 2001), but these approaches may not be relevant in Barbados (Gaskin, Lai et al. 2010).

In retrospect, not surveying children as to whether they had cable or satellite TV in their homes was a study limitation. Access to cable or satellite TV in a home could influence OWOB by increasing the number of sedentary entertainment option available to children considering that the CHNS discovered a direct relationship between BMI and the number of sedentary entertainment options in a home. Direct correlations also existed between the number of

sedentary entertainment options and total time spent doing sedentary activities on Sundays as well as total video screen time. Trends were seen for dichotomous variables such as having more than one computer, more than one TV, or access to the internet and OWOB. While none of the dichotomous variables showed any significant relative risk for OWOB in the boys they did share trends in the same protective direction. When sex was held constant there was a significant increased risk with every sedentary entertainment option for OWOB, providing evidence that having multiple venues for sedentary activities can influence OWOB in grade five Barbadian children. The relationship between other forms of media entertainment besides TV and child OWOB has not been well established, but it is a rising area of research (Communications and Media 2011). The media access findings of the CHNS are similar to the studies relating bedroom TV access (Cillero and Jago 2011; Sisson, Broyles et al. 2011) and household availability of media to technology usage (Devis-Devis, Peiro-Velert et al. 2009) and OWOB (Jago, Page et al. 2008; Pate, Mitchell et al. 2011).

6.5.5 Active transportation

Worldwide, between 18.6%-84.8% of youth walk or ride bicycles to school, with the lowest rates in the United Arab Emirates and the highest rates in China (Guthold, Cowan et al. 2010). In the CHNS, about 25.5% of children walked or rode their bikes to school, with an additional 12.8% of children using a combination of walking and buses. Children who used active methods of transport were less likely to be OWOB, as well as have lower BMIs. These latter results, however, were not significant for girls; even though a similar number of boys and girls used active transportation and time spent doing active transport was similar between sexes. Despite the lack of significance seen in girls, the trend was in the same direction. Globally, active transportation rates were lowest in the Americas. The percentage of youth participating in active transport in Barbados was similar to those seen in neighbouring countries of St. Lucia and Trinidad and Tobago, but lower than Guyana and St. Vincent and the Grenadines (Guthold, Cowan et al. 2010). In Brazil, children and adolescents using less active transport were

associated with greater OWOB (Duncan, Duncan et al. 2011) and adolescents in the Netherlands who cycled to school had a lower risk of being OWOB (Bere, Seiler et al. 2011). A school-based active transportation intervention model estimated a reduction of 0.01-0.07 BMI units for 10-11 year old children in Australia who used buses or walked to school three days a week for 40 weeks (Moodie, Haby et al. 2011). Even though this model predicted positive health outcomes, caution should be in mind when planning an intervention as considerable financial support from the education sector was not considered to be cost-effective. The school based active transportation model in Australia was not considered to demonstrate a great enough impact on BMI to warrant implementation, even though there were many unmeasured community wide-benefits (Moodie, Haby et al. 2011).

6.6 Limitations

The CHNS researcher team was able to survey about 1/3 of the subjects' parents, and most surveys were 100% complete, but there were still many answers for income, paternal education, and paternal unemployment in unclassifiable categories. These responses were left out of analyses and were not thought to generate bias, but reduced the sample size and power of the analyses. There was, however, non-respondent bias for guardian interviews, characterised by higher BMI risk in the group of children whose parents did not respond to telephone interviews. This may actually give the results a slight bias towards children with more diligent and involved parents. Similarly, there was a lower BMI for girls in the group of children whose school interviews were analyzed compared to the group that was not analyzed or not interviewed. This may have created a bias towards leaner girls in the school interview results reported.

It should be noted that due to limited time and resources, the use of lengthy validated sedentary and physical activity surveys were not suitable. Therefore, it is possible that the CHNS was not able to capture any activity associations through the methods used. The general lack of a validated questionnaire is a major limitation; however, this should not negate the findings.

The results disseminated by the CHNS should be interpreted with caution as used as a starting point to direct further research.

6.7 Conclusions

The household eating and media environment appear to be important factors in child OWOB as evidenced by the relationship between family meals and reduced OWOB risk as well as access to sedentary entertainment and increased risk for OWOB. Investigation into interactions between family activities and child OWOB would be a venue for future research in Barbados to help understand how child health can be promoted at the family level. This is particularly important when considering interventions for vulnerable children living in low income households who are vulnerable not only to obesity but also underweight. Understanding the counter-intuitive nature of the associations between high parental education and OWOB as well as frequent TV snacking with low OWOB risk are possible venues for future research. Promoting walking or even taking the bus to school in Barbados may be a seemingly inexpensive way to increase non-planned physical activity in areas of Barbados where safe walking infrastructure already exists; however, feasibility, acceptability and cost would still need to be assessed. The influences pushing children towards obesity start at a young age, and garnering a better understanding of them is an important element in planning nation-wide prevention and promotion programs in Barbados.

6.8 Disclosure

The authors declared no conflict of interest.

VII ADDITIONAL METHODOLOGY

7.1 Study population

Class 3, the equivalent of the Canadian grade 5 in primary school, students were selected to participate in this study as a convenience sample. The final year students in class 4 (grade 6) and their teachers were deemed to be too preoccupied with high school entrance exam preparations to participate in a study. Therefore, class 3 students were thought to be the next best alternative since they are between the ages of 8 and 11, had the cognitive abilities to respond to investigator led questions, and the understanding to give informed assent.

Approximately 80% of primary school-aged children attend public schools in Barbados. The majority of students not enrolled in public schools attend private schools, while a minority is home-schooled. The Ministry of Education in Barbados granted the CHNS research team access to survey public schools. Separate permissions would have been needed to gain access into each private school and was not feasible for this project.

7.2 Sample size

Boys and girls were treated as two separated samples. When a proportion (p) is not known in a population, 50% should be used considered as the “worst case scenario”. Although a relatively high proportion of child OWOB was expected in Barbados, it was expected to be lower than 50%. The rate of child OWOB in the USA was considered to be one of the highest in the world for children. In addition, they were one of the few nations that have calculated separate prevalence rates for different ethnicities that were similar to Barbadians. Non-Hispanic black children are the ethnic group with the highest rates child OWOB in the USA. This group was used as a reference population both because of the similar ethnic composition as well as the need to use a sample that would give enough power to detect the “worst case scenario”. Based on the closest age group to class 3, NHANES data from the last survey 2007-2008, prevalence of overweight and obesity rates for boys and girls in the 6-11 group were 36.4% and

38.9% respectively. Overweight and obesity was defined by the CDC as having a BMI > 85th percentile. Sample sizes for boys and girls were calculated as per categorical data (Bartlett, Kotrlik et al. 2001). Taking into consideration the small population and the large sample, a correction calculation was also applied. The sample exceeded 5% of the population therefore an adjusted sample size was calculated as per Bartlett et al. (2001). A margin of error of 5% was used for the confidence interval, because a smaller margin would have required a disproportionately large sample of the population.

Equation: $n = (t)^2 pq / d^2$

t = 1.96 for a two sided test at 95%

p = proportion = 38.9% for girls and 36.4% for boys (Ogden, Carroll et al. 2010)

q = 1- p

d = acceptable margin of error = +/- 5%

n = 366 girls and 356 boys

Population of class 3 children: 3038 (approximately 1519 girls and 1519 boys)

366/1519 = about 24% of girls > 5%

356/1519 = about 23% of boys > 5%

Correction formula: $n_c = n / (1 + n/N)$

Corrected sample size n_c = 294 girls and 288 boys

7.3 Recruitment

The Ministry of Education of Barbados collaborated with the research team and sent out circulars to the principals of the schools selected in the sample. The circulars served both to educate the school administration about the study and to inform them of the research team's visit(s) in the fall. Schools were visited about one week in advance to the scheduled measurements to distribute consent forms (Appendix 1) and information pamphlets (Appendix 2) meet the school principle or head teacher, and when possible the grade 5 classroom teachers.

7.4 Anthropometric measurements

All children who had signed consent forms from guardians indicating permission to participate in the study and who signed assent forms were included in the study. All height and weight measurements were taken as per NHANES guidelines and the anthropometric procedures manual was used for training investigators (NHANES 2000).

7.4.1 Height

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, stand on the base of the stadiometer, place heels together and toes at 60 degree angle while touching the base of the vertical rod, place arms at sides with palms facing in to the thighs, stand with the head, scapula and buttocks touching the vertical rod if possible, and look straight ahead with their head erect in the Frankfurt plane. The investigator checked to see that the child was positioned correctly and asked the child to inhale. The vertical rod was descended to the crown of the child's head until it lightly depressed the hair at the end of the exhalation and the height was recorded to the nearest 0.1 cm. The procedure was repeated and a second measurement was recorded. A third reading was taken if the first two measurements were not within 0.5 cm of each other. The closest two measurements were recorded and the two measurements were averaged.

7.4.2 Weight

A Tanita TBF-300A professional scale was used. Accuracy of the scale was tested with standardized weights. Every morning, the scale was set up and the level was checked to ensure the ground was flat. The estimated weight of the clothing was entered and the scale was zeroed before each weight. Children were asked to step onto the foot shapes on the scale look straight ahead with arms relaxed by their sides. The weights were automatically taken and electronically recorded when the scale sensed the subject was still and balanced.

7.4.3 Inter-investigator reliability

All investigators were trained to take anthropometric measurements and reliabilities between investigators were tested prior to the commencement of the study. Although all investigators were trained, only two investigators measured heights and two investigators measured weights.

7.5 Questionnaires

7.5.1 School interview

In the afternoon, participants were interviewed for approximately 10 minutes. The participants chosen for interviews were selected based on both the interviewer and the participants' availabilities. As many children as possible were interviewed from each school given the time availability of the investigator. The investigator asked questions about their habits, family characteristics, time spent doing sedentary activities, and involvement in organized sports (Appendix 3).

7.5.2 Guardian telephone interview

Consent for the guardians to be contacted by telephone was included on the consent forms along with preferred telephone numbers and times of contact. The response rate for parents willing to be contacted was 87%; however, due to time constraints, a maximum of three attempts were made to contact each parent resulting in a participation rate of 39%. Interviews were primarily geared towards the mother; however, when the mother was not the primary guardian or not available another guardian was interviewed. Interviews took approximately 10 minutes to collect information about demographic variables and maternal weights and heights (Appendix 4).

7.6 Consent and assent

Consent for the children to participate in the study was obtained through consent forms sent home to children's parents via classroom teachers. Children were given an oral description of the study and the use of the results and were

asked to sign an informed consent form to ensure their willingness to participate in the study prior to measurements being taken (Appendix 5). Guardians were given a verbal description of the study over the telephone and explained how the results would be used. Their verbal agreement to proceed with the telephone interview was used as assent to include them in the study. Written permission to contact them was obtained through the child's consent form.

VIII. OVERALL SUMMARY AND CONCLUSIONS

8.1 Conclusions

The results outlined in Manuscript I and Manuscript II of this thesis have alluded to the complexity of factors that influence obesity. The complexity of obesity as a global problem cannot be overstressed considering that its intricacy is indeed in line with other major complex worldwide issues such as climate change and food security (Finegood, Merth et al. 2010). As such, traditional obesity solutions need to be reconsidered in order to address the complexity of the original problem. Complex solutions that touch on all facets of society and include all levels of stakeholders into the equation are necessary. It must be reminded, however, that obesity remains contextual and it is necessary to acquire a solid understanding of these contextual intricacies in communities and various populations.

The results of manuscript I illustrate very clearly, that not only was child OWOB very high in Barbados, but there has been a greater increase in OWOB in this country than seen in many other similar nations. The results point to the possibility that the environment in Barbados is particularly obesogenic for children. A higher percentage of girls compared to boys were OWOB was also noted, which may indicate the gender disparity in weight status is already present in primary school-aged children. In manuscript II, parental education and access to media were identified as risk factors for OWOB. Whereas, family dinners and

active transportation were protective factors. Finally, children from lower income families were at greater risk for both obesity and underweight.

8.2 Summary of contributions

This present study is the first time in close to 30 years that weight status in Barbadian primary school children was assessed. The results presented in this thesis represent important baseline data about the prevalence of child OWOB in Barbados. This data is not only important to Barbados, but it is also relevant for similar countries in the Caribbean as it draws attention to the status of child OWOB in this part of the world. The identification of OWOB influences is an important step to understanding the tide of child OWOB in Barbados and the Caribbean.

The discovery about the high prevalence of OWOB and the rapid rate of increase is significant for public health professionals because it provides them with solid evidence to present to decision makers in Barbados about the seriousness of the state of child OWOB. The few risk and protective factors for OWOB identified in the study provide key insights into the modifying influences of OWOB in Barbados. Data on the prevalence, rate of increase, and influences of OWOB provide a starting point for further child OWOB research as well as to shape prevention and promotion programs. The difference in OWOB prevalence and influences between boys and girls sheds some light onto the complexity of gender differences involved in the development of obesity in the Caribbean. These results begin to bridge the knowledge gap that currently exists about child obesity in Barbados.

8.3 Future research

Although the study undertaken provided essential baseline data, the use of one age group was a major limitation in the generalizability of the results; however, the data do illustrate a very important need for further investigation. Next steps for research would need to include a comprehensive survey of all age groups from infants and preschool to adolescents. In addition, the development of

a monitoring program for weight status at regular intervals is highly recommended. For example, systematic yearly measurements of all children entering preschool, primary, and high schools would be valuable to monitor the progression of OWOB as well as get a sense of whether future prevention programs have impacts on child weight status.

The findings about risk and protective factors of OWOB in manuscript II were very interesting. The intention of this part of the study was to: 1) garner a broader understanding of the prevalence of child OWOB; and 2) verify whether OWOB influences seen in other nations are also apparent in Barbados. The results were intended to be used to help shape intervention and health promotion programs; however, inconsistencies and contradictory results with current literature do not make the finding easily transferable into practical knowledge. The results on sedentary entertainment and physical activities were not comprehensive and remain inconclusive. Whereas, the finding that high parental education was related to increased OWOB risk challenges what is generally found in the literature and would need to be further investigated to be confirmed and fully understood. The reduced OWOB risk for boys who snacked frequently while watching TV is highly surprising. Snacking as a protective factor would need to be authenticated with the use of a validated questionnaire. Some of the relationships uncovered in the present thesis add to the inconsistencies in the literature about childhood OWOB influences.

Findings that show promise for incorporation into future health promotion and planning programs include the relationship between active transportation and reduced OWOB risk, the positive association between sedentary media access and BMI, and the high risk of malnutrition for low income children. Research studies building on data from the present thesis that include the use of systematic and validated questionnaires to explore interactions between OWOB and demographic variables, media access and usage, the transportation environment, and sedentary and physical activities are warranted in order to steer health promotion and to push policies in the appropriate direction.

The most important need for research lies with the interactions between lower income households and child malnutrition within those households. A major finding described in the present thesis found that children, even if they were not living below the poverty line, were at significant risk for both underweight and obesity. Investigation regarding the major influences for these latter additional health risks in the lower income households is urgent and strongly advised.

IX. REFERENCES

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X. APPENDICES

Appendix 1



CHNS

The Barbados Children's Health and Nutrition Study

PARENTAL CONSENT FORM

Project Title: Weight Status and Child Characteristics of Class 3 Students

Principal Investigator(s):

Melissa Fernandez, Dr. Stan Kubow, JaDon Knight, Dr. Pamela Gaskin

Background: It is thought as elsewhere in the world that levels of overweight among our children have reached epidemic proportions in Barbados. We however lack clear evidence and documentation on this vital matter. If we are to address this pressing concern, one area of importance would be for us to collect information on weight status, sedentary activity level and family demographics.

Purpose: The purpose of this prevalence study is to assess weight status of class 3 students in Barbados, in a manner consistent with the schools work day, as it may pertain to the emerging epidemic of overweight and obesity in Barbados.

Procedures: Participation in this study will require your child to have anthropometric measures taken (weight and height) and they will fill out a questionnaire about their sedentary activities. **Your child will not be placed in harmful or compromising situations.** Anthropometric measures will be performed using a weigh scale, tape measure and stadiometer (for measuring height).

The identity of your child will be kept confidential by the use of a number code. **The key to the code will be kept in the locked office and only Dr. Gaskin and Melissa Fernandez will have access to the identifying information.** The data collected will remain stored for at least 3 years on an electronic database and can be used for academic purposes.

There are no benefits for your child to participate in this survey and your child's participation is voluntary. Your child may withdraw at any time as well as refuse to answer any questions. By participating in this survey your child will receive a certificate of appreciation from the University of West Indies and McGill University.



CHNS

The Barbados Children's Health and Nutrition Study

Consent Statement:

I allow my child _____ to take part in this study.
(child's name)

I understand that participation in this study is completely voluntary.

Signature of Parent or Guardian: _____

Date: _____

I _____ (child's guardian's name) would like to participate in a 10 minute telephone interview about my family characteristics.

☐ Yes, you may reach me at the following phone number

The best time to call me is between _____ and _____ (day/evening/weekend)

☐ No, I do not wish to participate in a telephone interview

If you have any questions or concerns about your child's rights or welfare as a participant in this research study please contact the McGill Research Ethics Officer at 001-514-398-6831 or the West-Indies Cave Hill/Barbados Ministry of Health Research Ethics Committee at (246) 417-4000.

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Appendix 2

What is the CHNS?

The Children's Health and Nutrition Study will look at:

- Diet
- Height
- Weight
- Waist Size
- Body Composition
- Child Activities
- Family Traits
- Chronic diseases

How will the CHNS team use the info?

- > Nutritional status - to help assess the health of children in Barbados and to make recommendations for policy makers.
- > Child disease information - to inform child health services.



When?

September - November 2010

Where?

15 Primary Schools

Who?

University of the West Indies

- Dr. Pamela Gaskin
- Dr. Anne St. John
- JaDon Knight

McGill University

- Dr. Stan Kubow
- Melissa Fernandez
- Nutrition students

Ministry of Education



For More Information

Contact the CHNS team at
429-5112

(Dr. Pamela Gaskin)
barbadoschns@google.com

The Barbados Children's Health and Nutrition Study (CHNS)



A joint project between
The University of the
West Indies
&
McGill University

Why do the CHNS?

1. Diet

Our team would like to find out about the foods that Barbadian children eat.



2. Activities

Our team would like to find out how much TV and video games Barbadian children are looking at and what kind of activities they like to play.



3. Chronic diseases

Our team is working with a local Doctor to find out:

- diseases Barbadian children have, like asthma or bronchitis.
- which symptoms children commonly feel, like cough or headaches.



4. Nutritional status

We would like to measure height, weight, waist and body composition in order to compare our children's nutritional status to that of other children around the world.



5. Family traits

The CHNS team wishes to to learn about the every day life of class three children to see if there are any healthy habits that can be promoted in Barbados.



Appendix 3

CHNS ANTHROPOMETRY and SCHOOL INTERVIEW

Student ID

School ID

Date: (day/month/year)
____ / ____ / 2010

Date of birth (day/month/year)
____ / ____ / ____

-
- ☐ Anthropometry ____Ht ____Wt
☐ Interview

Student ID: _ _ _ _

CHNS

1. Student ID

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

2. School ID

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

3. Gender

- ① male
② female

4. Observed ethnicity

- ① black
② white
③ Asian
④ Indian
⑤ mixed
⑥ other

5. Weight 1 (kg)

(Mark results of print-out into bubbles below)

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

6. Weight 2 (kg)

(Mark results of print-out into bubbles below)

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

7. Height 1 (cm)

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

8. Height 2 (cm)

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

9. Who do you live with?
(prompt child to find detailed information)

- ① your mom
② your dad
③ your mom and dad
④ extended family (aunt, uncle, grandparent)
⑤ someone else

10. How many televisions are there in your home?

- ① 0 televisions
② 1 television
③ 2 televisions
④ 3 televisions
⑤ > than 3 televisions

11. How many computers are there in your home?

- ① 0 computers
② 1 computers
③ 2 computers
④ 3 computers
⑤ > than 3 computers

Student ID: _ _ _ _

CHNS

12. Does your family have internet at home?

- ① yes
- ② no

13. Does your family eat food (term used for dinner) together every evening?

- ① yes
- ② no
- ③ sometimes

14. Did you eat breakfast today?

- ① yes
- ② no

15. Do you eat snacks while you watch TV?

- ① always
- ② most of the time
- ③ sometimes
- ④ never

16. What time did you go to bed last night?

1. _ _ : _ _

What time did you wake up this morning?

2. _ _ : _ _

How many hours did the child sleep?

- ① 0 ② 0 ③ 0
- ④ 1 ⑤ 1 ⑥ 1
- ⑦ 2 ⑧ 2 ⑨ 2
- ⑩ 3 ⑪ 3 ⑫ 3
- ⑬ 4 ⑭ 4 ⑮ 4
- ⑯ 5 ⑰ 5 ⑱ 5
- ⑲ 6 ⑳ 6 ㉑ 6
- ㉒ 7 ㉓ 7 ㉔ 7
- ㉕ 8 ㉖ 8 ㉗ 8
- ㉘ 9 ㉙ 9 ㉚ 9

17. How do you get to school?

- ① walk
- ② walk and bus/taxi
- ③ bus/taxi
- ④ car
- ⑤ other

18. How many minutes does it take you to get to school this morning?

- ① 0 ② 0 ③ 0
- ④ 1 ⑤ 1 ⑥ 1
- ⑦ 2 ⑧ 2 ⑨ 2
- ⑩ 3 ⑪ 3 ⑫ 3
- ⑬ 4 ⑭ 4 ⑮ 4
- ⑯ 5 ⑰ 5 ⑱ 5
- ⑲ 6 ⑳ 6 ㉑ 6
- ㉒ 7 ㉓ 7 ㉔ 7
- ㉕ 8 ㉖ 8 ㉗ 8
- ㉘ 9 ㉙ 9 ㉚ 9

19. How much time did you spend watching tv yesterday?

- ① none
- ② 0-30 mins
- ③ 31 – 60 mins
- ④ 1-2 hours
- ⑤ 2-3 hours
- ⑥ 3-4 hours
- ⑦ 4-5 hours
- ⑧ > 5 hours

20. How much time did you spend watching tv on Sunday?

- ① none
- ② 0-30 mins
- ③ 31 – 60 mins
- ④ 1-2 hours
- ⑤ 2-3 hours
- ⑥ 3-4 hours
- ⑦ 4-5 hours
- ⑧ > 5 hour

21. How much time did you spend using the computer or playing video games yesterday?

- ① none
- ② 0-30 mins
- ③ 31 – 60 mins
- ④ 1-2 hours
- ⑤ 2-3 hours
- ⑥ 3-4 hours
- ⑦ 4-5 hours
- ⑧ > 5 hours

Student ID: _ _ _ _ _

CHNS

22. How much time did you spend using the computer or playing video games on Sunday?

- ① none
- ① 0-30 mins
- ② 31 – 60 mins
- ③ 1-2 hours
- ④ 2-3 hours
- ⑤ 3-4 hours
- ⑥ 4-5 hours
- ⑦ > 5 hours

23. How much time did you spend doing homework or reading yesterday?

- ① none
- ① 0-30 mins
- ② 31 – 60 mins
- ③ 1-2 hours
- ④ 2-3 hours
- ⑤ 3-4 hours
- ⑥ 4-5 hours
- ⑦ > 5 hours

24. How much time did you spend doing homework or reading on Sunday?

- ① none
- ① 0-30 mins
- ② 31 – 60 mins
- ③ 1-2 hours
- ④ 2-3 hours
- ⑤ 3-4 hours
- ⑥ 4-5 hours
- ⑦ > 5 hours

25. Do you play on one of your school sports teams (organized competitive sports)?

- ① yes
- ② no
- ③ not now, but will when the season starts

26. Do you ever play team sports with your friends in your free time? (cricket, football etc.)

- ① yes
- ② no
- ③ occasionally

27. Do you take any sports lessons (tennis, dancing swimming, etc.)

- ① yes
- ② no
- ③ not right now, but intends to

Appendix 4

Guardian Telephone Interview

Script for interviewer in bold font

**Good morning/evening/night, may I speak to _____ (name of child's guardian).
Hello _____ (name of child's mother), My name is Melissa, I am a graduate
student from McGill University and I am working with Dr. Pamela Gaskin of the
University of the West Indies to collect information about households of the children
involved in a study called Weight Status and Activity Levels of Class 3 Students. On
_____ (date consent was given) you signed a consent form telling us you
would like to be part of this survey. I want to ensure you all your answers will be
completely confidential and your name will remain anonymous. Would you like to continue
with the survey, it will take about 10 minutes?**

**If mother says no, Thank you for your time _____ (name of child's mother). Have
a good evening.**

If mother says yes, follow directions below.

1. Student number

0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

2. School ID

0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9

3. What is your relationship to _____ (child's name)?
If parent does not answer, prompt. Are you his/her

- ① mother
 - ② grandmother
 - ③ aunt
 - ④ step-mother
 - ⑤ father
 - ⑥ other
-

4. What is your marital status?

- ① Married
 - ② Separated or divorced
 - ③ Single
 - ⑤ Other
-

4. How many people live in your household?

- ①
- ②
- ③
- ④
- ⑤
- ⑥
- ⑦
- ⑧
- ⑨ 9 people or more

5. Who runs the household?
(Prompt to find head of the household)

- ① Child's mother
 - ② Child's father
 - ③ both parents
 - ④ grandmother
 - ⑤ Other
-

6. What was the last level of education completed by the child's mother?

- ① No formal education
- ② Primary school
- ③ Secondary school
- ④ Some college
- ⑤ Some university
- ⑥ None of the above
- ⑦ not applicable

7. What is the last level of education completed by the child's father?

- ① No formal education
 - ② Primary school
 - ③ Secondary school
 - ④ Some college
 - ⑤ Some university
 - ⑥ None of the above
 - ⑦ not applicable
 - 8. Is the child's mother employed?
① Yes
 - ② No
 - ③ Not applicable (specify)
-

9. Is the child's father employed?

- ① Yes
 - ② No
 - ③ Not applicable (specify)
-

10. Does someone in your household own a car?

- ① yes
- ② no
- ③ no, but I has access to a car

11. Is there a safe place for your child to play outside directly outside your home that is large enough to run about and play a game of cricket

- ① Yes
- ② No
- ③ sometimes

12. How many people that live in your home are over 65 years old

- ☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9 for nine or more people

13. How many adults live in your home (between 19 and 65 years old)

- ☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9 for nine or more people

14. How many young people between the ages of 12-18 live in your home

- ☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9 for nine or more people

15. How many children between 4-11 years old live in your home

- ☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9 for nine or more people

16. How many children in your home are between 0-3 years old

- ☐ 0
☐ 1
☐ 2
☐ 3
☐ 4
☐ 5
☐ 6
☐ 7
☐ 8
☐ 9 for nine or more people

17. How much do you weigh?

_____ kg x 2.2 =

_____ lbs

(maternal weight only)

- ☐ 0 ☐ 0 ☐ 0 ☐ 0
☐ 1 ☐ 1 ☐ 1 ☐ 1
☐ 2 ☐ 2 ☐ 2 ☐ 2
☐ 3 ☐ 3 ☐ 3 ☐ 3
☐ 4 ☐ 4 ☐ 4 ☐ 4
☐ 5 ☐ 5 ☐ 5 ☐ 5
☐ 6 ☐ 6 ☐ 6 ☐ 6
☐ 7 ☐ 7 ☐ 7 ☐ 7
☐ 8 ☐ 8 ☐ 8 ☐ 8
☐ 9 ☐ 9 ☐ 9 ☐ 9

18. How tall are you? ____ feet

x 12 + ____ inches

(maternal height only)

- ☐ 0 ☐ 0 ☐ 0 ☐ 0
☐ 1 ☐ 1 ☐ 1 ☐ 1
☐ 2 ☐ 2 ☐ 2 ☐ 2
☐ 3 ☐ 3 ☐ 3 ☐ 3
☐ 4 ☐ 4 ☐ 4 ☐ 4
☐ 5 ☐ 5 ☐ 5 ☐ 5
☐ 6 ☐ 6 ☐ 6 ☐ 6
☐ 7 ☐ 7 ☐ 7 ☐ 7
☐ 8 ☐ 8 ☐ 8 ☐ 8
☐ 9 ☐ 9 ☐ 9 ☐ 9

19. What is the approximate yearly income of your household? If the respondent does not know, break it down by asking monthly, weekly or bi-weekly. Then convert to yearly income, by adding monthly income of all household residents.

Monthly: _____ + _____ + _____
+ _____ x 12 = _____/yr

OR

Weekly: _____ + _____ + _____
+ _____ x 52 = _____/yr

OR

Select a range below

- ☐ 1 less than BBD 9,000/yr
☐ 2 BBD 9,000 – BBD 15,000/yr
☐ 3 BBD 15,001 – 25,000/yr
☐ 4 BBD 25,001 – 49,200/yr
☐ 5 BBD 49,201 – 100, 000/yr
☐ 6 more than BBD 100, 000 yr
☐ 7 rather not say

Appendix 5



CHNS

The Barbados Children's Health and Nutrition Study

The Barbados Children's Health and Nutrition Study

CHILD PARTICIPANT ASSENT

(Approximate ages 8-11)

We want to tell you about a research study we are doing. We are trying to find out more about the health, nutrition status and activities that Barbadian children normally do. Your school has been chosen to be part of the Barbados Children's Health and Nutrition Study and we would like to know if you want to participate. You will be asked lots questions about your activities and we will measure your height and weight.

Check whether or not you want to participate in this research study:

☐ Yes, I want to participate

☐ No, I don't want to participate

Child's Name

Person obtaining assent

Date

Student ID Assigned