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Understanding the Causal Factors of Obesity Using the International Classification of Functioning, Disability and Health (ICF)

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Abstract

Purpose—Behavioural, personal, psychological, sociodemographic, environmental, biological, and childbearing factors have been associated with obesity among women. This study quantitatively explored the effects of these factors on predicting body mass index (BMI) in U.S. women using the International Classification of Functioning, Disability and Health (ICF) and determined the effectiveness of using the ICF with population-level data.

Methods—We used the ICF Core Sets for Obesity, and data from the 1999-2006 National Health and Nutrition Examination Survey (NHANES) in a sample of 8,766 U.S. women to quantify the impact of all associated causal factors. Linear regression was used in the analyses.

Results—Body image perceptions (42%) was the most significant contributor, followed by hypertension (12%), general health condition (11%), diabetes/borderline diabetes (10%), arthritis (9%), and performing vigorous activity (9%).

Conclusions—In order to decrease obesity prevalence rates in U.S. women, obesity prevention and treatment programs should parallel the contributory effects of its most significant causal factors of psychological, biological, and behavioural. Additionally, more research and data are needed to explore the relationship between BMI in women and the multiple influencing factors by going beyond the more frequently available information of age, gender, race, education, income, and parity.

INTRODUCTION

Women have the highest prevalence of obesity (35%) and extreme obesity (6%) in the United States, with the highest obesity prevalence rates occurring among Mexican American and African American women^{1,2,3}. Recent efforts to stem the rise in obesity have been impaired by the complex nature of obesity. Behavioural, personal, biological, psychological, environmental, sociodemographic, and childbearing factors have all been associated with obesity among women⁴⁻⁸. Obesity is a multi-level problem with numerous attributing

causal factors and resulting health effects⁹ including disability¹⁰, decreased physical function, and increased bodily pain¹¹.

As more adults are becoming obese and remaining obese for longer periods of time, the association with disabilities may be increasing. In addition, there is some concern for the effect cumulative obesity exposure may have on risks for disabilities¹² such as metabolic syndrome (insulin resistance, hypertension, and dyslipidemia), type 2 diabetes mellitus, coronary heart disease, cardiovascular disease (CVD), stroke, gallbladder disease, infertility, hyperuricemia and gout, osteoarthritis, sleep apnea, and certain cancers such as endometrial, breast, colon, gall bladder, and prostate^{13,14,15,16,17}. While obese persons may be living longer, there is increased risk of functional limitations (i.e., walking short distances, lifting or carrying small weights, and standing) and limitations with activities of daily living (i.e., ability to dress, groom/bathe, feed/eat, walk on a level surface or up/down a flight of stairs, or get in and out of a chair without assistance), affecting an individual's length of time free of disabilities and ability to live independently^{12,18,19,20}.

In order to decrease obesity prevalence, emphasis has been placed on moving beyond traditional obesity prevention and treatment methods, to new approaches that reflect the complexity of obesity^{17,21,22}, such as the World Health Organization (WHO)'s International Classification of Functioning, Disability and Health (ICF), a classification and coding system to measure the spectrum of problems in functioning among patients with disabilities. The ICF was initially intended for addressing disability, including needs assessment, intervention studies, quality care assessment, rehabilitation treatment strategies, and outcome evaluation^{23,24} and used primarily in clinical settings at the individual level. However, because obesity has increasingly become a cause of disability and decreased quality of life, the ICF has begun to be applied to other health conditions including obesity in the form of Core Sets^{10,25}.

The ICF Core Sets for obesity provide a category listing of the typically encountered problems for obesity that includes an exploration of the interactions between genetic, metabolic, environmental, and personal aspects of an individual's life^{10,25}. The ICF includes a Brief ICF Core Set of the usual problems associated with obesity and the Comprehensive Core Set that provides a comprehensive listing of ICF categories needed for multi-level assessment of the typical issues identified by obese individuals^{23, 24}.

The purpose of this study was to determine the extent behavioural, personal, biological, psychological, environmental, sociodemographic, and childbearing factors have on predicting obesity in women using the ICF and population-level data and body mass index (BMI), a useful method for monitoring weight status by classifying individuals into broad categories of overweight and obesity²⁶. We addressed the following questions: (i) What factors better predict BMI in US women? and (ii) Can the ICF be used to address obesity among women using population-level data?

Although all aforementioned factors have been found to have a role in obesity among women, we hypothesized that race and the environmental factors would be the biggest predictors of BMI and that the ICF and population-level data could be used to understand

obesity. Environmental factors play a major role in inhibiting physical activity and healthy nutrition practices⁷ among women. The environment can be considered in many ways—built environment, food environment, and an individual's personal and social environment. The built environment includes urban design, land use, the transportation system, and patterns of activity within the physical environment²⁷. The food environment includes types and amounts of foods consumed, eating locations (i.e., restaurants), societal influences from media messages, portion sizes served in restaurants, cultural norms and expectations²⁸, food production and distribution²⁹, and accessibility and affordability of food (i.e., food security)^{30, 31}. An individual's personal and social environment includes interpersonal factors such as their social support system—family, friends, and community^{32, 33}.

METHODS

The International Classification of Functioning, Disability and Health (ICF)

The ICF is an interaction between an individual's health conditions and situations that affect human functioning. The ICF conceptual framework (Figure 1) consists of two parts: 1) Functioning and Disability; and 2) Contextual Factors. The first part, Functioning and Disability, is comprised of two components: 1) Body Functions and Structures; and 2) Activities and Participation. Body Functions and Structures are the physiological functions of the body systems and the anatomical parts of the body. Activities are individual execution of tasks and participation is involvement in life situations. The second part of the ICF framework, Contextual Factors components include 1) Environmental; and 2) Personal factors³⁴. The Environmental Factors include the physical, social, and attitudinal environment and Personal Factors are age, gender, education, work experience, and disease coping style^{23,35}.

The components of the ICF are comprised of various domains: body functions and body structures, life areas, and external and internal influences on functioning and disability. Within each domain, there are categories that are the units of classification. For the purposes of this study, the domains and components for each component were used as a guide to categorize the questionnaire from a national dataset into four groups corresponding to the components according to the Comprehensive Core Sets for Obesity. The health condition of interest in the study was BMI.

Data Source

The National Health and Nutrition Examination Survey (NHANES) is a stratified, national, multistage, probability sample of the civilian, noninstitutionalized U.S. population conducted by the National Centre for Health Statistics. NHANES is used to annually assess the health and nutritional status of U.S. adults and children and one of the most common data sources used to report obesity prevalence in the U.S.³⁶ NHANES includes objective measures of BMI in addition to demographic, socioeconomic, dietary, and health-related information through a combination of interviews and physical examinations^{36, 37}. Trained interviewers survey the participants using a computer-assisted personal interview (CAPI) system. Survey participants sign an interview consent form. Upon completion of the interview, participants are asked to complete the physical examination component.

Data were obtained from NHANES conducted between 1999 and 2006, from physical examinations completed in mobile examination centers (MEC) by trained health professionals or at the participant's home if they are unable to leave the home. We examined approximately 200 questions pertaining to Body Functions and Structures based upon the physiological and psychological functions of the body systems, the anatomical parts of the body, and impairments that inhibits functioning of the body. Approximately 54 questions corresponding to Activities and Participation included the participants' difficulty in executing certain activities and issues being a part of life situations. Nineteen Environmental Factors questions involved the facilitating or hindering aspects of the participants' immediate environment and health services. Personal Factors dealt with personal attributes such as sociodemographic characteristics (i.e., age, race, etc.).

Data Analysis

Data were analysed to determine the extent that the Comprehensive ICF Core Sets for Obesity component variables independently contributed to the prediction of log of BMI. The NHANES measurements for BMI were obtained during the MEC exam. BMI is a calculation of body weight in kilograms divided by body height in meters squared. BMI was classified as underweight (< 18.5), normal weight (18.5-24.9), overweight (25.0-29.9), obese (30.0), and extremely obese (40.0). Analyses were conducted using Stata SE 9.2 statistical software (StataCorp LP, College Station, Texas). Multiple linear regression analyses were performed separately by each of the ICF components and potential confounders with log of BMI as the dependent variable. Log of BMI was obtained using a data transformation of BMI. The log of BMI, rather than BMI, was used to ensure a straight line adequately described the relationship between the dependent and independent variables. Independent variables were the NHANES questions³⁷⁻⁴¹ that were grouped with the ICF components using the Comprehensive ICF Core Sets for Obesity. Potential confounders included age, race/ethnicity, income, education, parity, smoking status, and self-reported coexisting health conditions (diabetes, arthritis, heart disease, stroke, hypertension, and cancer). The t statistic obtained in multiple linear regression analysis was also used to determine the significance of the inclusion of the variable in the models. The results of the t statistic were considered significant at p=0.05.

Eligible participants consisted of U.S. adult women, aged 18 years and above who completed both the interview and physical examination component of NHANES 1999-2006 (N=10,438). Women who did not complete the MEC exam for the body measures component were excluded. The physical examinations were conducted by health professionals, and thus not self-reported. After excluding cases with missing data of the variables of interest including BMI, age, race, income, education, and smoking status, the final study sample for this study was 8,766 women (Table 1).

RESULTS

Characteristics of the study sample according to their BMI categories are shown in Table 1. Prevalence of overweight, obesity and extreme obesity was highest among women 55 years of age and older (36%). Prevalence of obesity was highest among non-Hispanic White

women, although extreme obesity was also high among non-Hispanic Black women. BMI was higher among women with income levels $\leq \$55,000$ (26%) and greater than a high school education (43%). Women who had smoked at least 100 cigarettes during their lifetime were more likely to be underweight or normal weight (40%), while women who had been pregnant were more likely to be overweight or obese (90%). Other coexisting health conditions among the participants included disability-related diseases and conditions such as arthritis (28%), asthma (13%), and diabetes/borderline diabetes (11%).

Effect of Personal Factors

Age, income, and race were significant in the regression model of log of BMI by Personal Factors variables. Multiple linear regression was performed on each variable as one categorical variable and as multiple variables. R^2 increased with the use of multiple variables for age, income, race, and smoking status. Table 2 displays the final model of log of BMI and the Personal Factors variables. When the sociodemographic variables were divided into multiple indicator variables—18 to 29 and ≥ 30 years, education, and income levels of less than \$10,000 and greater than \$15,000—the t statistics were not significant. Because of their increased percentage of R^2 , these variables were kept in the model. In addition, smoking status was not a significant contributor to the model as determined by the t statistic. However, because of the importance of smoking as a component of predicting log of BMI, R^2 increasing with its inclusion in the model, and also as a result of smoking status being a potential confounder, it was retained in the core model. The overall R^2 of the model indicates that 8% of the variance of the log of BMI can be explained by the influence of the Personal Factors, the core model.

Effect of Body Functions and Structures with the Personal Factors

The most significant contributors of the Body Functions and Structures component to the Personal Factors are shown in Table 3. The question, “Do you consider your weight to be overweight, underweight, or about the right weight?” accounted for the most variance of the log of BMI. Multiple linear regression was performed on this question as a categorical variable and multiple indicator variables. Analyzed as one question, how the participants considered their weight explained 42% of the variance in the model. As indicator variables for participants who reported considering their weight as underweight, the right weight, and overweight, the variables accounted for 15%, 31%, and 40% of the variance in the model, respectively. Most of the coexisting health conditions similarly accounted for the variance in the model of log of BMI and the Personal Factors. Participants diagnosed with hypertension (12%) and diabetes or borderline diabetes (10%) contributed to the highest amount of variance in the model.

Effect of Activities and Participation with the Personal Factors

Significant contributors of the Activities and Participation component with the Personal Factors and log of BMI included the variables performance of physical activity, diet, access to healthcare, and ability to physically function. All variables shown in Table 3 were significant contributors to the model as determined by the t statistic. Dietary health behaviors such as eating out at restaurants, physical activity, and ability to physically

function variables accounted for some of the variance in the model of Activities and Participation and Personal Factors ranging from 8-9%.

General health condition variables were also significant contributors to the Core Model, accounting for 11% of the variance of the model of log of BMI, the Personal Factors, and Activities and Participation component. In addition, variables regarding ability to participate in their environments were also significant. These variables included the participants requiring special healthcare equipment, which contributed to the variance in the model by 9.05%. Dietary health behaviors also significantly contributed to the model with the number of times the participant ate restaurant food influencing 8.16% of the variance in the model.

Effect of Environmental Factors with the Personal Factors

Access to and receiving healthcare were significant contributors to the Core Model and increased the variance in the relationship between log of BMI, the Personal Factors, and the Environmental Factors component. The amount of time since the last healthcare visit, routine place to go for healthcare, and being an overnight patient at a hospital within the last year each accounted for 8% of the variance of the model.

DISCUSSION

To our knowledge, this is the first study to demonstrate the extent to which factors identified as causes of obesity have in predicting BMI, and use the ICF framework to characterize obesity in women. In the onset of this study, we had two hypotheses—1) race/ethnicity and the Environmental Factors would be important in the prediction of the log of BMI and the contribution to the variance of the model using NHANES data (1999-2006); and 2) the ICF and population-level data could be used to understand obesity. However, the amount of variables used in the Personal Factors was restricted by limitations in acquiring social and cultural values so we were not truly able to see the effect race and ethnicity may have on obesity. Nevertheless, potential confounders cited in the literature—age, race, education, income, parity, smoking status, and coexisting health conditions—were able to be determined from the NHANES and were used in the models. Also, with the exception of variables regarding health services, there were few environmental variables in the NHANES that met the ICF's guidelines. Most of those environmental variables that did meet the ICF guidelines did not have enough responses to be analyzed so were not included in the models. However, many variables were available in the NHANES corresponding to the Body Functions and Structures and Activities and Participation component. This is primarily due to these two factors fitting more with the overall objective of the NHANES, which is to describe the overall health and functioning of the U.S. population. As a result, more information was available for these two factors and accounts for most of the analyses as they relate with the Core Model containing the log of BMI and the Personal Factors.

The Body Functions and Structures and the Activities and Participation components were major components, with the most questions from the NHANES for the years 1999 to 2006. Body Functions and Structures contained many variables related to psychological issues, coexisting health conditions, and physical functioning. Surprisingly, of all questions in the NHANES, perceptions of body weight were the biggest contributor to predicting BMI

among women in the study. Based on the dearth of obesity literature about the effect of other causal factors such as behavioural, sociodemographic, and environmental, we hypothesized the environmental factor would be most significant. With the addition of body weight perceptions—how the participants viewed their weight—to the core model of the log of BMI and the Personal Factors, R^2 increased significantly, explaining nearly a half of the variance in the model. This finding corresponds with research that suggests self-perception of body weight may influence health practices, thereby affecting obesity among women. Social and cultural influences have been determined to be contributing factors to body weight and image perceptions^{42,43}. Though they could not be analyzed in this study, an adjustment was made for numerous variables that influence body weight perceptions including race, age, income, and education. This demonstrates the increased importance of body weight over other causal factors and its relation to the prediction of the log of BMI.

Coexisting health conditions did contribute to the variance in the relationship between the log of BMI and the Personal Factor. Hypertension, diabetes and borderline diabetes, cardiovascular diseases, arthritis, and asthma increased the variance in the core model, albeit slightly. However, this study in addition to other research shows these conditions are significantly associated with BMI and obesity in women^{11, 44}. Additionally, coexisting health conditions are considered as one of the most important components in managing obesity because of their strong relationship with disability^{10, 25, 45} and continued complications. Problems with physical functioning affect quality of life and the ability to engage in healthy behaviors to prevent and control obesity such as physical activity⁴⁶. Chronic health conditions in U.S. women account for a considerable portion of disability by causing activity limitations^{44, 46}. The relationship of the log of BMI and to the coexisting health conditions was still significant even after the adjustment of potential confounding variables in the Personal Factors was made; thus suggesting an important relationship with BMI.

Physical functioning variables were also included in the Activities and Participation component, which impact the ability of the women to participate in their lives and environments. Consistent with the literature, engaging in physical activity was significant in predicting BMI in women. The combination of physical activity and proper diet is essential to prevention and control of obesity^{47,48}. All types of physical activity including moderate, vigorous, and walking or riding a bicycle were significant contributors to the model. In addition, the whether the women ate at a restaurant versus at home was a significant contributor to the model. While it was unknown the types of restaurant that were frequented (e.g., fast food) by the women, research has shown a relationship between the availability of and accessibility to fast food restaurants and increased food portion sizes and obesity²⁹. More information in the NHANES regarding restaurant types may provide a better understanding of the relationship between eating at restaurants and obesity in women.

Psychosocial issues were the next biggest contributor to the variance in the model and prediction of the log of BMI. In this study, women reporting excellent, very good, or good health generally had a body mass index of normal weight, whereas women who specified fair or poor health were mostly overweight or obese. This corresponds with research on the negative impact of obesity on individual feelings of health⁴⁹.

Access to healthcare is a leading health indicator and determinant of health status. The relationship between access to healthcare and health disparities is well-known and has been documented extensively⁵⁰. This study demonstrates that having a routine place for healthcare, having to stay overnight in a hospital, and particularly the length of time since the last healthcare visit are extremely important in explaining obesity in women. Patients who prolong or delay seeking medical care have longer hospital stays, more severe complications at presentation, and serious consequences⁵¹. This is demonstrated by the number of coexisting conditions that many of the women in the study reported.

For our second hypothesis, we were able to demonstrate the effectiveness of the ICF conceptual framework with a population-level dataset such as NHANES. Based upon the results of the study and the obesity literature, the ICF has potential in predicting and addressing obesity in women. Although the study was limited by the availability of variables to sufficiently examine all factors, we were able to quantitatively demonstrate the influence of many factors commonly cited in the literature as contributing to BMI and obesity in U.S. women at the population level, and demonstrate the influence of body image perceptions as key to reducing obesity prevalence in women. As this study utilized data from a commonly used source for assessing obesity and related health conditions, the NHANES, it is a first step in beginning to understand the impact of behavioural, personal, psychological, sociodemographic, environmental, biological, and childbearing factors play in the incidence and prevalence of obesity in women. Additionally, prevention and treatment programs should parallel the contributory effects of its most significant causal factors of psychological, biological, and behavioural.

Further, this study has shown the need for more comprehensive surveys that include variables related to environmental and personal factors given the dearth of information and citations of their importance as well as the results which demonstrate their importance. It should be noted that previous years of the NHANES (i.e., 1999-2001) collected data on occupation, food security, and social support, which have all been associated with obesity in women. This was discontinued in the 2002-2003 surveys and reinstated in the 2004-2006 surveys. As this study included variables available during all survey years, these variables could not be used in analyses presented here. Consequently, more research and data are needed to explore the relationship between BMI in women and the multiple influencing factors by going beyond the more frequently available information of age, gender, race, education, income, and parity.

Obesity among U.S. women is a complex issue with many underlying factors believed to play a role in its onset and progression. While the World Health Organization has developed the ICF to reflect the complexity of disabilities, more population-level studies are needed to test its use beyond the individual level for which it has primarily been utilized. However, the ICF is a good first step in looking at new ways to deal with multi-level problems in the U.S. such as obesity to which research and available data should follow suit.

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Figure 1.
Illustration of interaction of components in the International Classification of Functioning, Disability and Health (ICF).²⁹

Table 1

Percentage Distribution of Sociodemographic Characteristics According to Body Mass Index Category.

Characteristic	Body Mass Index (kg/m ²)				
	<18.5 (n=163)	18.5-24.9 (n=2,716)	25.0-29.9 (n=2,659)	30.0 (n=3,228)	40.0 (n=629)
Age					
18-24	23	15	9	9	9
25-34	28	22	21	19	19
35-44	15	17	17	18	21
45-54	11	13	14	18	19
55	24	33	40	36	32
Race/Ethnicity					
Non-Hispanic White	70	61	49	42	38
Non-Hispanic Black	10	13	18	28	38
Mexican American	12	17	24	21	18
Other Hispanic	3	4	5	4	3
Other Race *	8	6	4	3	3
Household Income					
<\$15,000	17	15	18	20	23
\$15,000 to <\$25,000	17	15	17	18	20
\$25,000 to <\$35,000	11	13	13	13	13
\$35,000 to <\$55,000	14	17	20	20	21
\$55,000	37	38	30	26	21
Education					
<High School	22	22	32	32	30
High School including GED	21	24	23	25	23
>High School	58	54	45	43	47
Smoked 100 cigarettes during lifetime	50	40	38	38	41
Ever Pregnant	76	83	90	90	85
Coexisting Health Conditions					
Arthritis	18	22	27	34	39
Asthma	15	11	12	17	23
Cancer	14	9	9	8	7
Diabetes/Borderline Diabetes	3	5	10	17	22
Heart Disease ^a	9	8	12	14	14
Hypertension	14	21	31	42	52
Stroke	3	2	4	3	3
How do you consider your weight					
Underweight	53	7	1	--	--
Right Weight	47	67	34	8	2
Overweight	1	27	65	91	98

Note. Percentages may not sum to 100% owing to rounding.

* Including Multi-Racial.

^a Heart disease was based upon 4 questions—congestive heart failure, coronary heart disease, angina/angina pectoris, and heart attack.

Table 2

Log of BMI by Variables in the Personal Factors (Core Model)

Variable	t statistic
Age [§]	
18-24	0.68
25-29	-1.32
30-34	-3.80 *
35-39	-3.77 *
40-44	-5.16 *
45-49	-6.42 *
50-54	-7.20 *
55-59	-8.50 *
60-64	-7.56 *
65-69	-6.71 *
70-74	-3.40 *
75-79	-2.31 *
85	1.20
Education	
High School (incl. GED)	-0.32
> High School	1.95
Household Income	
\$0 to \$4,999	0.13
\$5,000 to \$9,999	-0.78
\$10,000 to \$14,999	-2.22 *
\$15,000 to \$19,999	-0.66
\$20,000 to \$24,999	-1.36
\$25,000 to \$34,999	-0.30
\$35,000 to \$44,999	-0.58
\$45,000 to \$54,999	-0.35
\$55,000 to \$64,999	0.46
\$65,000 to \$74,999	0.18
> \$75,000	1.97 [§]
Race/Ethnicity	
Non-Hispanic White	-3.86 *
Non-Hispanic Black	-10.24 *
Mexican American	-6.19 *
Smoking	1.87 [§]

Variable	t statistic
Overall R ²	7.61%

*
p<0.05

§
p<0.10

Table 3

Log of BMI by Variables in Body Functions and Structures, Activities and Participation, and Environmental Factors

Component	ICF Codes	Variables	R ² Contribution (%)
Body Functions and Structures	b164	How do you consider your weight?	42%*
		Underweight	15%*
		Right Weight	31%*
		Overweight	40%*
		Coexisting health conditions	
	b410-b429	Angina/Angina Pectoris	8%*
	b710-b729	Arthritis	9%*
	b440-b449	Asthma	8%*
	b410-b429	Congestive heart failure	8%*
	b410-b429	Coronary heart disease	8%*
	b540-b559	Diabetes/Borderline	10%*
	b410-b429	Heart attack	8%*
	b420	Hypertension	12%*
Activities and Participation	d430-d469	Vigorous activity over past 30 days	9%*
	d430-d469	Moderate activity over past 30 days	8%*
	d430-d469	Activity comparison last month—last year	8%*
	d430-d469	Activity comparison with others the same age	9%*
	d435; d450	Walked or bicycled over past 30 days	8%*
	d550; d560	Eating out at a restaurant/not at home	8%*
	d570	General health condition	11%*
	d570	Health compared to 1 year ago	8%*
	d230; d240	Limitations due to physical, mental, or emotional problems	8%*
	d465	Require use of special equipment	8%*
Environmental	e580	Routine place to go for healthcare	8%*
	e580	# of times received healthcare over past year	8%*
	e580	Overnight hospital patient in last year	8%*

* p<0.05