Socio-economic determinants of obesity of Namibian women in the reproductive age group: A binary logistic regression model

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Abstract
Obesity leads to reduced lifer expectancy, increased likelihood of a wide range of diseases Obesity also lowers self-esteem and has negative consequences on the cognitive and social development of a person. World-wide, obesity is a leading yet preventable cause of death and its prevalence both in children and adults is increasing day by day. Compared to men, women have a relatively higher burden of disease attributable to overweight and obesity.
This paper establishes the socio-economic factors influencing obesity in women in Namibia using logistic regression. The outcome variable was Obesity (1 for Obese, 0 for Not obese). The independent variables included the total number of children ever born to the woman, her place of residence; current age of the woman, her highest level of education, her economic status, contraceptive use, smoking habits, age of the woman at first birth, place of residence, region, and religion.
Results indicate that in Namibia, obesity of a woman is associated with the age of the woman, her highest level of education, her economic status, contraceptive use, smoking habits, and the age of the woman at first birth. Policy and intervention programs to reduce obesity should focus on encouraging women to delay onset of child-bearing, to embark on lifelong regular exercise and diet programs. Even though smoking was inversely related to obesity, women should be encouraged to stop smoking because of its other devastating health effects.

Introduction
Obesity is a non-communicable medical condition whereby excess body fat has piled up to the extent that it may cause health effects, leading to reduced lifer expectancy ,increased likelihood of heart disease ,Type II diabetes, obstructive sleep apnea ,some types of cancer, and osteo arthritis (WHO Report,2000). It is measured using the Body Mass Index (BMI) which is given by the mass of a person in kilograms divided by height in metres squared. An individual is classified as obese if his or her BMI>30kg/m2 and as overweight if his or her BMI>24 kg/m2. Obesity also lowers self-esteem and has negative consequences on the cognitive and social development of a person (Haslam and James, 2005).

Compared to men, women have a relatively higher burden of disease

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attributable to overweight and obesity (Muening et al. 2006). There is a high correlation between high fat diet and the development of obesity Ali and Crowther (2009). The Body Mass Index (BMI) is significantly higher among low socio-economic groups with the lower socio-economic status being associated with accelerated weight gain during adulthood. In many populations, the level of education is inversely proportional to obesity especially in women, while husband's education was found to be negatively correlated with the prevalence of obesity. Women with more than 12 years of education had a higher BMI than those with between 1 and 12 years of education. A possible explanation was that women with lower education tend to perform higher levels of manual labour than the more educated women Pouoane et al. (2002).

Genetic factors may act as determinants of BMI by affecting the energy balance and it has been estimated that 30-70% of variation in BMI can be explained by genetic factors. Females have a higher prevalence of obesity than their male counterparts and it has been suggested that this may be related to gender differences in the brain's response to hunger and satiety (Ali and Cowther, 2009). The authors suggested that BMI increases with age because as people get older, their metabolic rate falls and energy expenditure decreases. Psychological status can affect eating habits because most people eat more in response to negative emotions e.g. stress increases food consumption and also shifts consumption towards high caloric foods that are usually avoided under normal circumstances. Depression and some neurological conditions can also promote overeating which will cause obesity. Ali and Crowther (2009) also noted that family influences which lead to overeating include regressive coping styles such as stress eating, lack of self-esteem, unsatisfactory personal relationships, and stigmatization of the obese individuals. They further cited other factors influencing BMI as sleep duration, smoking, pharmaceuticals, environmental temperature, and reproductive fitness. BMI was inversely correlated with sleep duration. Smokers were less obese than non-smokers. A number of drug types lead to increased weight gain and these included contraceptives, cortisteroids, anti-diabetic agents, and medications used for hypertension. In humans who are constantly within thermal-neutral zones (TNZ), through the use of air conditioning, energy expenditure is reduced and this pre-disposes to weight gain at lower levels of energy intake when compared to subjects who do not spend much time in TNZs. The BMI of parents was shown to be positively related to increased number of offspring for both mothers and fathers (Ali and Crowther, 2009).

In Iran, the prevalence of obesity was 24.5%. Employed women were about 4% and 10% less overweight and obese than housewives respectively. Housewives versus employed women had the adjusted Odds Ratio (OR) 1.39 for obesity. Older women, with higher educational level, and socio-economic status, lower physical activities and those living in urban areas were at risk of obesity. The authors recommended that preventive health care programs to reduce the risk of obesity in women should be applied considering their occupation for achieving more effectiveness Navadeh (2011).

Thirty one per cent of obese adults reported a doctor diagnosis of arthritis compared with only 16% of non-obese adults. Studies have also shown that women with diagnosis of knee Osteo Arthritis (OA) have an average BMI that

is 24% higher than women without OA (Kulie et al., 2011). Obese girls frequently experience onset of puberty at a younger age than their normal weight peers. Studies have also revealed that hormonal contraceptives are less effective in obese women. The IUD was the only device that did not seem to be affected by BMI. However, contraceptive product inserts rarely comment on the weight specific guidelines (Kulie et al., 2011). The authors also established that obesity during pregnancy is highly related to overall healthcare expenditures measured by the length of stay in hospital after delivery and the use of other medical services. Maternal obesity was associated with decreased intention to breastfeed, decreased initiation of breastfeeding and decreased duration of breastfeeding.

Although many social, psychological and cultural factors likely to contribute to the development of depression in obese women, one argument is that the stigma towards obese individuals in American society leads to low self-esteem and ultimately depression. It is also argued that obesity is not stressful per se, but the pressure to fit a norm and continued dieting leads to depression. Unlike the ratings of black women, white women rated large women lower on attractiveness, intelligence, job success, relationship success, happiness and popularity than they did for average or thinner women. The authors attributed the differences in rating to differences in Black and White women's social role models, weight salience, sub-cultural beliefs covering obesity and dis-identification from main stream values Hebl and Heatherton,1998). In Nigeria, overweight and obesity was found in 53% and 21% respectively with a significantly higher prevalence in females compared to males (over-weight: 62% versus 41.9%, $p<0.001$; obesity:29.8% versus 9.3%, $p<0.001$). The odds of obesity were higher in women and in the presence of hypertension, and in the presence of hyperruricaemia. There was a high prevalence of obesity in Northern Nigeria and women were significantly more affected. This high prevalence was independently associated with females, hypercholesterolemia, and hyperuricaemia. The authors recommended that public health interventions were urgently needed in order to reduce this burden and to prevent other non-communicable cardio-vascular disorders (Wahab et al, 2011). Almost similar studies were conducted by Santos and Barros (2003) in an urban sample of Portuguese adults. Their results indicated that the prevalence of obesity was higher in women than men (26.1% versus 13.9%). Regardless of gender, obesity increased with age, decreased with education, and was more frequent in married, blue-collar workers and unemployed adults. Smoking was more prevalent in adults of normal weight, and a higher proportion of those reporting no regular exercise were obese. Compared with adults of normal weight, obese men showed a significantly higher prevalence of hypertension (53.3% versus 26.1%) and hypertriglyceridemia (23.4% versus 9.0%).

Wamala et al, (1997) found that low socio-economic status was a strong determinant of overweight and obesity among middle aged healthy Swedish women. The odds of being overweight or obese increased with lower social position. After adjusting for age, the odds ratios for overweight and obesity among women in a low versus high position were 2.2 and 2.7 respectively. Both low social position and obesity were related to reproductive history (higher parity and earlier age at menarche), unhealthy dietary habits, and unfavourable psychosocial factors (poor quality of life, low self-esteem, and

job strain. The authors concluded that dietary habits and psychosocial stress were potentially modifiable factors, which should be taken into account in intervention programs among women with low socio-economic status. Obesity was high among women who lived in urban areas, and well educated women. Obesity differed by religion, age caste, work-status and by region. The authors noted that although India is in the traditional phase of health transition from communicable diseases to cardio-vascular diseases, states such as Punjab and Kerala, had already completed this phase of transition and cardio-vascular diseases were now the major risk factors for adult mortality there. They recommended that in order to prevent high risk of adult mortality and ensure higher longevity, obesity should be the major concern to be addressed for saving lives of the adult population (Ubaidullah, 2002).

Trends in obesity and the determinant factors in Latin America were studied by Kain, Vio and Albala (2003). They used country level data from the Latin American countries. They established that obesity rates had increased markedly in Latin America especially during the last 10 to 15 years, becoming a public health problem in most countries. The prevalence of obesity among pre-school children remained low, while among school children it increased considerably. Prevalence of obesity was high in the adult population, especially in women with less schooling. Due to the fact that chronic diseases are the main cause of death in the region, and obesity is one of the main risk factors for these diseases, the authors recommended that polices should be put in place to improve economic and educational levels, and that the implementation of health promotion and prevention of obesity should be a priority in every country.

Affenito et al., (2012) stated that the ecological model of obesity is best described as multi-level (e.g. regions, nations, states, cities and neighbourhoods taking into consideration the multicultural components (e.g. physical environment, socio-economic status, and social capital) and multifactorial lifestyle behaviours (e.g. diet, physical activity, and stress) at multi-institutional (e.g. school, local government, family, and local agency) levels. The ecological approach accounts for interrelationships among these influences to better understand and measure the behavioural factors that negatively influence weight. Behavioural influences on energy intake and expenditures that pointed to obesity promoting behaviours included frequent fast food consumption, eating occasions away from home, large portion sizes, high consumption of beverages high in sugar, and breakfast omission. Physical and environmental factors included proximity to large supermarkets, concentration of fast food establishments and restaurants in the area, availability of recreational areas for physical activity, and socio-economic status.

According to Biddle et al., (2010), in Canada there was evidence of an inverse relation between the prevalence of obesity and leisure time physical activity. Considerable physical inactivity, sedentary behaviours and screen time, socio-economic status and community level factors were reported as having as negatively impacting on obesity. Hammond and Levine (2010) highlighted some of the negative effects of obesity as increased direct medical costs and medical costs associated with incidence of obesity-related diseases, incidence of diseases associated with obesity, productivity loss due to obesity, absenteeism due to obesity, presenteeism leading to productivity loss if obese people are less

present while present at the workplace, disability, premature mortality, and increased health insurance.

A lot of negative consequences of obesity have been established from various studies outlined above in different parts of the world with some risk factors identified. Such studies are lacking so far in Namibia making it interesting and necessary to examine the prevalence and determinants of obesity in Namibia.

Methods

This cross sectional study examined the obesity status of women in the reproductive age group (age 15-49) in Namibia and identified socio-economic factors associated with this challenge of obesity, by fitting a binary logistic regression model to a stratified multistage cluster sample of 9804 women's data from the Namibia National Health and Demographic Survey (NDHS) of 2006-2007. The outcome variable was Obesity (1 for Obese, 0 for Not obese). The independent variables, chosen based on the basis of literature review and availability of data in the NDHS included the total number of children ever born to the woman, her place of residence, and the woman's current occupation; labour force participation current age of the woman, her highest level of education, her economic status, contraceptive use, smoking habits, the age of the woman at first birth, partner's educational level, place of residence, region, and religion.

The Wealth index (a proxy for the standard of living of the household) was based on household ownership of consumer goods, dwelling characteristics, type of drinking water source, toilet facilities and other characteristics related to the household's socio-economic status. The index was constructed by assigning a weight (factor score) to each of the assets, generated through principal component analysis and the resultant asset scores were standardized in relation to a normal distribution with a mean zero and standard deviation of one (Gwatkin et al., 2000). The asset scores were then summed for each household and individuals were ranked according to their household total score. The sample was then categorized into quintiles from one (Poorest) to 5 (Richest).

A Binary logistic regression model was fitted to establish the determinants of obesity, since the outcome variable (Obesity) can take the value 1 (if the individual is obese) with a probability of success θ or the value 0 (if the individual is not obese) with probability of failure 1-θ. A general form of the logistic regression equation is:

$$\mathbf{logit}\left[\theta(\mathbf{x})\right] = \mathbf{log}\left[\frac{\theta(x)}{1-\theta(x)}\right] = \alpha + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_i x_i$$

Where α = the constant of the equation and, β = the coefficient of the predictor variables.

The logistic regression model is not rigid since it does not make any assumption about the distribution of the independent variables. The independent variables do not have to be normally distributed, linearly related or homoscedastic within each group. The Wald statistic and its corresponding significance level test, was

used to test the significance of each of the coefficients of covariate and dummy independent variables in the model. If the p-value was found to be less than 0.05, then the parameter is significant in the model. Evaluation of the goodness of fit of the full model was based on the Likelihood ratio test and the Hosmer-Lemshow goodness of fit test.

Results

Socio-demographic characteristics of the sample

With regard to age group, most of the women (41.6%) were in the young category (15-24). The other age-groups were 25-29 (15.9%), 30-34 (14.5%), 35-39 (11.0%), 40-44 (9.7%) and 45-49 (7.3%). All the thirteen administrative regions of the country were equitably represented according to the sampling design as Zambezi (6.7%), Erongo (6.2%), Hardap (5.6%), !Karas (5.0%), Kavango (10.2%), Khomas (10.2%), Kunene (4.4%), Ohangwena (10.2%), Omaheke (5.0%), Omusati (9.7%), Oshana (10.4%), Oshikoto (9.2%) and Otjozonjupa (7.2%). More than half of the women (55.9%) were based in rural areas. The majority of women (65.4%) had achieved at least secondary or higher level of education. However 7.9% of the women had no formal education. The most popular religious denomination was protestant (77.4%). The socio-economic status (measured by the wealth index) of the women ranged from the poorest (16.3%), poorer (17.9%), middle (22.7%), richer (25.0%), to the richest (18.2%) (Namibia Demographic and Health Survey, 2006/7).

A very large percentage of the women (71.7%) reported that they used contraceptives, and only very few of the women (5.3%) were cigarette smokers. Over half (52.9%) of the women said their partners had at least secondary or higher education level. Slightly more than half (52.8%) of the women were employed. The main languages spoken at home by the women were: Oshiwambo (50.4%); Damara/ Nama (16.7%), Afrikaans (10.2%); Herero (9.0%); Kwangali (6.6%) and the remainder of the women (7.2%) either spoke English, Subiya, San, or Lozi. With regard to marital union status, most of the women (63.5%) were not in union at the time of the survey; with 15.5% married with a certificate; 4.9% married customarily; and 16% "living with a man". The prevalence of obesity was 11.7%. The average age of the women was 32.36 years with a standard deviation of 8.47 years. The average number of children born to the women was 3 with a standard deviation of 2 children. The average age of the women at first birth was 20.24 years with a standard deviation of 4.06 years.

Bivariate analysis

Results from independent sample t-tests indicated significant mean age difference between those obese and those not obese ($t=-29.141$, $p<0.001$). The average age for non-obese women in the sample was 27.57 years, while that of obese women was 35.38 years, suggesting that obesity increases with age. On the other hand, the average number of children born to obese women was 3 children, compared to an average number of children of about 2 children for non-obese women. This difference in average number of children born between the two groups was statistically significant ($t=-17.122$, $p<0.001$).With regard to the age of the woman at first birth, among obese women, the average age at first birth was 20.29 years, while that of non-obese women was 20.23 years. However this age difference at first birth was not statistically significant ($t=-0.473$, $p=0.636$) at 5% level. The outcome variable, obesity classification, was cross-tabulated

with its potential categorical risk factors and Chi-square tests of association were conducted to establish whether significant relationships existed between them. The results are summarised in Table 1.

Table 1: Results of Chi-square test of association between obesity and individual potential categorical predictors.

Categorical predictor of obesity	**Chi-Square statistic**	**Degrees of freedom**
Age Group 652.760***	652.760***	6
Region	353.964***	12
Place of residence	152.681***	1
Highest educational level	125.740***	3
Religion	4.458*	1
Wealth Index	418.932***	4
Contraceptive Use	177.021***	1
Cigarette Smoking	5.032*	1
Current marital union Status	299.475***	2
Partner's educational level	57.505***	2
Employment status	118.451***	1
Main language Spoken at home	385.61***	5
*p<0.05, **p<0.01 ***p<0.001		

The relationships between obesity classification and age group, region, place of residence, highest level of education, wealth index, contraceptive use, current marital union status; partner's educational level, employment status and the main language spoken at home were all significant even at 0.1% level of significance. The association between obesity classification and religion as well as cigarette smoking status was also significant at 5% level.

Binary logistic regression Results

The results of binary logistic regression are summarized in Table 2.

Table 2. Odds ratios of risk factors for obesity in Namibian Women in the fertility category

Risk factor for obesity	**Odds Ratio**
Age of the woman at interview	1.091*
Number of children born to the woman	0.986
Age of the woman at first birth	0.939***
Age in 5-year Age groups	
15 - 19	0.549
20 - 24	1.742
25 - 29	2.163
30 - 34	1.728
35 - 39	1.830

40 - 44	1.641*
45 - 49 (Ref)	1.000
Region	
Caprivi	1.770
Erongo	1.250
Hardap	1.732*
Karas	1.492
Kavango	0.749
Khomas	1.375
Kunene	1.134
Ohangwena	1.148
Omaheke	1.088
Omusati	0.850
Oshana	0.894
Oshikoto	0.949
Otjozonjupa	1.000
Place of residence	
Urban	1.333
Rural (Ref)	1.000
Highest Educational Level	
No Education	0.692
Primary	0.736
Secondary	0.798
Higher (Ref)	1.000
Religion	
Roman Catholic	1.055
Protestant (Ref)	1.000
Wealth Index	
Poorest	0.230***
Poorer	0.297***
Middle	0.551**
Richer	0.945
Richest (Ref)	1.000
Contraceptive Use	
No	0.681*
Yes (Ref)	1.000

Smokes cigarettes	
No	1.959***
Yes (Ref)	1.000
Partner's Educational Level	
No education	0.810
Primary	0.800
Secondary or Higher (Ref)	1.000
Employment Status	
Unemployed	0.964
Employed	1.000
Main language spoken at home	
Afrikaans	0.908
Damara/ Nama	1.570**
English, Subiya, San, Silozi	0.980
Herero	2.595***
Kwangali	0.687
Oshiwambo (Ref)	1.000
Current Marital Union Status	
Currently married with a certificate	1.974**
Currently married by custom	1.536
Living with a man	1.170
Not in Union (Ref)	1.000
*p<0.05, **p<0.01, ***p<0.001	
Chi-square=489.214***, -2 log likelihood =2658.317	
Ref=Reference Category	

Logistic regression results indicate that generally obesity in women increases with age (OR=1.091). However, women in the 40-44 years age-group were about twice more likely to be obese than their counterparts in the 45-49 age group (reference category).

The geographical region where the woman came from did not have considerable impact on obesity except for Hardap region, where the women were about twice more likely to be obese compared to their counterparts in the Otjozonjupa region (OR=1.732), the reference category.

The woman's wealth index, which is an indicator of her economic status, was a significant predictor of obesity. The poorest women (OR=0.230), the poorer women (OR=0.297) and those women in the middle wealth index quintile (OR=0.551) were less likely to be obese compared to the richest women.

The age of the woman (OR=1.091) and the age of woman at first birth (OR=0.939) were significant determinants of obesity in women. Older women were more likely to be obese than younger women. Women with younger ages at first birth were less likely to be obese than women who had their first births at older ages.

With regard to contraceptive use, women who reported that they were not using contraceptives were less likely to be obese (OR=0.681), compared to those women using contraceptives. It was also interesting to note that those women who did not smoke were twice more likely to be obese compared to their smoking counterparts. (OR=1.959).The main language spoken at home by the woman, which is an indicator of the cultural dimension, was a significant predictor of obesity. Herero speaking women (OR=2.595) were two and a half times more likely to be obese compared to Oshiwambo speaking women. Damara Nama speakers were also one and a half times more likely to be obese compared to Oshiwambo speaking women (OR=1.570)

The type of marital union status of the woman also had a significant impact on obesity. Women married with a certificate (OR=1.974) were about twice more likely to be obese compared to women who were not in any type of marital union at the time of the survey. Obesity in women was not significantly determined by the woman's place of residence (p=0.318), her religion (p=0.678), the woman's level of education (p=0.521), the total number of children born to the woman (p=0.665), the partner's educational level (p=0.213) and the employment status of the woman (p=0.742) at 5% level of significance.

Discussion

Results indicated that older women were more likely to be obese compared to younger women. These findings are in agreement with those from similar studies conducted elsewhere and can be partly explained by increased morbidity and reduced quality of life. (; Karbonits, 2008; Navadeh, 2011; Santos & Barros, 2003; Ogden, Carroll, Kit & Flegal, 2012). Older women tend to be less active than their younger counterparts.

The geographical region was not a significant predictor of obesity status. Women from the Hardap region were about twice more likely to be obese compared to their counterparts in the Otjozonjupa region. This could be due to the differences in economic activities and the differences in economic well-being in the two regions. Studies in the USA and Canada (Chapman, 2008; Ogden, Carroll, Kit & Flegal, 2012) where obesity different by region or urban rural setting. With regard to the relationship between obesity and economic status, again in Namibia results were different from those of the developed world. The poor were less likely to be obese compared to their rich counterparts. This is expected since the poor in Namibia experience food security challenges and therefore are unlikely to be obese. In the developed world, those referred to as poor may not be facing food security challenges at all. Women who reported that they were not using contraceptives were less likely to be obese compared to those women using contraceptives; and who did not smoke were twice more likely to be obese compared to their smoking counterparts. This is expected since contraceptives have been documented to increase body weight since they affect the hormones, while smoking reduces body weight because it lowers

appetite. Successes of the stop-smoking campaign are being hindered by a subsequent weight gain on the part of the previous smokers. (Ali & Crowther, 2009). Even though obesity seemed to increase with the highest educational level of the woman, the differentials were not significant in Namibia. In the developed and industrialized world results indicate an inverse relationship between educational level and obesity. (Ali and Crowther, 2009; Shields et al, 2006, Wamala et al., 1997). A possible explanation could be that in industrialized countries, educational levels are higher and they therefore have a more pronounced influence on decisions regarding dietary issues, exercise, and health effects of obesity. In Namibia, like in other developing countries this heath education still needs to be emphasized and promoted among women.

The main language spoken at home (a proxy for the cultural factor) is linked to the cultural context of the woman in the sense that people of the same language normally share the same culture, history, beliefs, norms and diet and ancestry and these can cause differentials in obesity. The Damara/Nama and Herero women were more likely to be obese compared to the Oshiwambo. This differential could mainly be due to their different diets and stature. In Namibia, the Herero diet mainly comprises of meat and milk. The Damara / Nama high BMI relative to the Oshiwambo can be explained by their relatively shorter stature since BMI is inversely related to the square of the height.

Women with younger ages at first birth were less likely to be obese than women who had their first births at older ages. Adolescent pregnancy has been associated with subsequent obesity (Herman, 1997). This can be explained by the fact that women who have their first births early tend to have higher fertility (Oyefara, 2012), and with each additional birth, an increase in body mass. Kulie, et al, (2011) explained that maternal obesity was associated with decreased intention to breastfeed, decreased initiation of breastfeeding and decreased duration of breastfeeding.

Conclusion and Recommendations

Obesity in Namibian women was determined by the age of the woman, her economic status, age of the woman at first birth, contraceptive use, smoking status, current marital status, and cultural factors. Policy and intervention programs to reduce obesity should focus on encouraging women to delay onset of child-bearing, to embark on lifelong regular exercise and diet programs. Even though smoking was inversely related to obesity, women should be encouraged to stop smoking because of its other devastating health effects.

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