INTRODUCTION

Many studies have reported the impact of maternal body mass index (BMI) on the BMI of children, indicating that children born to obese parents are more likely to become obese than those not to.1-4 It is also reported that maternal pre-pregnancy and intra-pregnancy BMI have significant impact on the birth outcome and birth weight of the offspring and in turn effect on development of obesity beyond childhood.2,4-7 In developing countries, nutritional problems had hitherto been those of under-nutrition but emerging trends show a nutritional transition with double burden of malnutrition, the occurrence of both under- and over-nutrition in same population and even within the same household.8-10 There has also been documentation, although with varying results of the pattern of nutritional states between overweight/obese mothers and their children.11-13 In Nigeria, the prevalence of maternal overweight and obesity is on the increase,14 childhood nutritional states has been predominantly those of under-nutrition14 with prevalence of overweight and obesity in adolescents on the increase. This study was therefore designed to determine the pattern of overweight and obesity in mothers and relationship between maternal overweight/obesity and the anthropometric status of children in our environment.

MATERIALS AND METHODS

This was a cross-sectional descriptive study among mother-child pairs attending immunisation clinics and two pre-primary schools, conducted in Jos Nigeria. In all 262 consenting mother-child pairs were recruited over a 2-months period from the study sites. A semi-structured questionnaire was used to obtain information on socioeconomic status (SES) and child-feeding habits. Maternal and child anthropometric measurements were obtained using standard WHO methods. Child anthropometric Z scores were obtained from WHO Anthroplus while BMI of mothers were also determined. Totally, 262 mother-child pairs were recruited. Results: Mean maternal age and mean child age were 30.8 ± 6.3 yrs (15-47 yrs) and 22.3 ± 18.7 months (3-72 months). Prevalence of maternal underweight, overweight and obesity was 4.2% (11/262), 29.4% (77/262) and 25.9% (68/262), respectively. Child overweight/obesity was 5.4% (14/262), severe under-nutrition 5.7% (15/262). Mean maternal BMI was higher in the older, more educated and higher socioeconomic status (SES). Child mean birth-weight, weight-for-age Z-score and BMI-for-age Z-score (BAZ) were higher among mothers with BMI ≥ 25 kg/m². All large-for-age babies were in mothers with maternal BMI ≥ 25 kg/m². Childhood over-nutrition was more common in maternal BMI of ≥ 25 kg/m². Overall, BAZ was directly related with maternal BMI, maternal age and birth-weight, although it was inversely related with maternal BMI I ≥ 25 kg/m². Conclusion: Higher BMI is seen in educated and higher SES mothers and this impact on childhood anthropometry.

Key words: Maternal overweight, child anthropometry relationship
conducted according to standard procedures. Maternal weight was measured using a digital weighing scale, calibrating to 0.1 kg, and height was measured with a stadiometer to the nearest 0.1 cm. Weight of children was measured using a Bassinet weighing scale for those less than 2 years, with minimal clothing, to the nearest 0.1 kg. Length of children at the age of 0-23 months were measured using an infantometer while older children with the stadiometer, to the nearest 0.1 cm. Body mass index (BMI kg/m²) of mothers was calculated using EPI info 7 statistical software. The nutritional status of the children was calculated using the World Health Organisation Anthro software.

**Data analysis**

Data collected were entered into and analysed with both EPI Info 7 and Stata 12 SE software. *P*- value was set at <0.05 for statistical significance, means of variables were compared using Student ‘t’ test while other data were represented in frequency and 2 × 2 tables.

**Ethical approval**

Approval for the study was obtained both from the institutional review boards of the Nagasaki University Japan and Jos University Teaching hospital Jos, Nigeria.

**RESULTS**

Of the 262 mother-child pair, prevalence of overweight, obesity and under-nutrition were 29.4% (77/262), 25.9% (68/252) and 4.2% (11/262), respectively. Child overweight/obesity was 5.4% (14/262), severe under-nutrition 5.7% (15/262).

Among mothers with BMI ≥ 18.5 kg/m² (251/262) mean maternal age was 31.1 ± 6.2 years. Mothers with BMI ≥ 25 kg/m² were older, *P* < 0.0001. Similarly, those with BMI ≥ 25 kg/m² were more educated, *P* = 0.0002 and were in higher socioeconomic class *P* = 0.0035 [Table 1].

Mean child age was 22.3 ± 18.7 months, with children of mothers with BMI ≥ 25 kg/m² being older (26.5 ± 20.4 months vs. 16.7 ± 14.4 months, *P* = <0.0001).

Child anthropometric characteristics and differences between maternal BMI groups are presented in the Table 2 below.

Mean child height for age Z score (HAZ) was not significantly different between normal BMI mothers and in overweight/obese mothers, *P* = 0.6 but other anthropometric indices differed significantly as shown in Table 2.

Utilising BMI-for-age Z-score (BAZ) >1 as over-nutrition and BAZ < -1 as under-nutrition, Table 3 shows that childhood over-nutrition was more common in maternal BMI ≥ 25 kg/m² while under-nutrition was commoner in maternal BMI < 25 kg/m².

**DISCUSSION**

This study highlights the relationship between and impact of maternal overweight and obesity on the anthropometric status of children in Jos, in north central Nigeria. The prevalence of maternal overweight and obesity in the study population was higher than those of the republic of Benin as well as the Nigerian national average for overweight and
obesity as reported in the 2013 demographic health survey report but overall rates were lower than those among urban women in Ghana.

The high prevalence of maternal BMI > 25 kg/m² was observed in women with higher level of education (high school and above), older women and especially mothers in the middle SES strata. This is similar to the study conducted by Neuman et al., which showed that overweight and obesity increased with socioeconomic status in low and lower middle-income countries. However, the finding in our study is not the same as in developed countries as demonstrated by Bonaccio et al., where obesity was found more in those of lower socio-economic strata. This departure from common trend could be that the obesity epidemic begins from the higher social strata and later in the lower class in developing economies. The finding, however, is also contrary to the higher prevalence of overweight and obesity in mothers of lower educational attainment as reported by Johnson et al. On the other hand, regarding the age of mother, our study is consistent with the report of increased prevalence of obesity in older women. The older the mothers are, the more weight they have with higher BMI.

Mean child BMI for age (BAZ), weight for age Z score (WAZ) and mid upper arm for age Z score (MUACZ) differed significantly between those born to mothers with BMI < 25 kg/m² and BMI > 25 kg/m². Thus higher maternal BMI is associated with higher child anthropometric characteristics such as Mean child BMI for age (BAZ), weight for age Z score (WAZ) and mid upper arm for age Z score (MUACZ). This finding is consistent with studies that demonstrate that parental overweight is predictive of high anthropometric findings in children especially as it relates to childhood overweight and obesity.

In order to accommodate the various classes of childhood over-nutrition, the term over-nutrition was adopted in this study as BAZ > 1. Childhood over-nutrition was seen commonly in mothers with BMI > 25 while childhood under-nutrition occurred much more in children of mothers with normal BMI, being consistent with reports showing higher childhood anthropometry in maternal overweight and obesity. Our study also revealed that higher maternal BMI is responsible for childhood overweight and obesity.

Furthermore, we found higher maternal BMI was also associated with higher birth weight, though this was not statistically significant but prevalence of large-for-age babies was much more in maternal BMI > 25 kg/m² than in mothers with normal BMI. This finding is consistent with those of Kim and Sharma that higher maternal BMI was associated with increased frequency of LGA births. Prevalence of low birth weight was similar in the two maternal BMI group (Normal BMI, and BMI > 25).

Maternal BMI, maternal age and child weight at birth were positively correlated with childhood BAZ in linear regression model. However, higher maternal BMI > 25 kg/m² had an inverse linear relationship with childhood BAZ. This deviation is more pronounced in maternal BMI > 30 kg/m². Why this is so in obese mothers maybe due to some distancing of mother-child relationship and also that as mothers engage in sedentary jobs with more income, they experience a positive energy balance from less physical activity. It is also possible that the inverse relation between obese mothers and childhood BAZ may be from growth restriction (rather than macrosomia) in utero, with babies of such mothers showing reversed patterns of maternal-child BMI relationship while growing.

From the foregoing, we demonstrate higher BMI in older, middle SES and higher educated mothers as well as higher anthropometric characteristics such as BAZ, WAZ and MUACZ in children of such mothers. In the prevention of childhood overweight and obesity, maternal regulation of overweight and obesity is required.

Acknowledgement
I wish to acknowledge the residents and staff who helped during data collection.

REFERENCES
1. Birch LL, Fisher JO. Mothers’ child-feeding practices influence daughters’ eating and weight. Am J Clin Nutr 2000;71:1054-61.
2. Whitaker RC. Predicting preschooler obesity at birth: The role of maternal obesity in early pregnancy. Pediatrics 2004;114:e29-36.
3. Santos JL, Kain J, Domínguez-Vásquez P, Lera L, Galván M, Corvalán C, et al. Maternal anthropometry and feeding behavior toward preschool children: Association with childhood body mass index in an observational study of Chilean families. Int J Behav Nutr Phys Act 2009;6:93.
4. Linabery AM, Nathas RW, Johnson W, Choh AC, Towne B, Odegard AO, et al. Stronger influence of maternal than paternal obesity on infant and early childhood body mass index: The Fels Longitudinal Study. Pediatr Obes 2013;8:159-69.
5. Catalan PM, Ehrenberg HM. The short- and long-term implications of maternal obesity on the mother and her offspring. BJOG 2006;113:1126-33.
6. de Boo HA, Harding JE. The developmental origins of adult disease (Barker) hypothesis. Aust N Z J Obstet Gynaecol 2006;46:4-14.
7. Yu ZB, Han SP, Zhu GZ, Zhu C, Wang XJ, Cao XG, et al. Birth weight and subsequent risk of obesity: A systematic review and meta-analysis. Obes Rev 2011;12:525-42.
8. Popkin BM. The nutrition transition and obesity in the developing world. J Nutr 2001;131:871S-35.
9. Misra A, Singhal N, Khurana L. Obesity, the metabolic syndrome, and type 2 diabetes in developing countries: Role of dietary fats and oils. J Am Coll Nutr 2010;29:289S-301S.
10. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child nutrition study group: Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 2013;382:427-61.
11. Mamabolo RL, Alberts M, Steyn NP, de Waal HA, Levitt NS. Prevalence and determinants of stunting and overweight in 3-year-old black South African children residing in the Central Region of Limpopo Province, South Africa. Public Health Nutr 2005;8:501-8.
12. Jehn M, Brewis A. Paradoxical malnutrition in mother-child pairs: Untangling the phenomenon of over-and under-nutrition in underdeveloped economies. Econ Hum Biol 2009;7:28-35.
13. Steyn NP, Labadarios D, Nel J, Kruger HS, Maunder EM. What is the nutritional status of children of obese mothers in South Africa? Nutrition 2011;27:904-11.
14. National Population Commission (NPC) [Nigeria] and ICF International. Nigeria Demographic and Health Survey 2013. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International, 2014.
15. Frisancho AR. Anthropometric standards for the assessment of growth and nutritional status. Ann Arbor, MI: The University of Michigan Press, 1990
16. World Health Organization. AnthroPlus for personal computers Manual: Software for assessing growth of the world’s children and adolescents. Geneva; 2009. Available from: http://www.who.int/growthref/tools/en/. [Last accessed on 2014 July 13].
17. Gbary AR, Kpozehouen A, Houeihanou YC, Djrolo F, Amoussou MP, Tchabi Y, et al. Prevalence and risk factors of overweight and obesity: Findings from a cross-sectional community-based survey in Benin. Glob Epidemic Obes 2014;2:3.