THE CENTRAL AFRICAN JOURNAL OF MEDICINE

Vol. 59, Nos. 5/8 May/August 2013

CONTENTS

Glucose tolerance study in low and normal birth weight young adults

*ZAR GOMO, **K NYATANGA, **J CHIFAMBA, **HM CHINYANGA, **T TADERERA, **LT GWAUNZA, **T MUSHAYAMANO, **C MAHACHI

Abstract

Objective: To determine blood glucose levels by conducting an oral glucose tolerance test in low and normal birth weight young black adults.

Design: A case control study was done. Seventy students in the College of Health Sciences who had neonatal clinic cards as proof of birth weight were recruited into the study. Blood glucose levels were measured before, during and after the oral glucose tolerance test.

Setting: Department of Physiology, University of Zimbabwe, College of Health Sciences, Harare, Zimbabwe.

Main Outcome Measures and Results: A total of 70 young adult participants, 47(67%) females and 23(33%)males with mean age 20.28±0.19 years were recruited. 30 had Low Birth Weight (LBW, 21 females and 9 males) and 40 had Normal Birth Weight (NBW,26 females and 14 males).LBW individuals had significantly elevated ($p<0.05$) mean blood glucose levels at 30minutes(9.41±0.91 for LBW and 7.24±0.28 for NBW, $p=0.029$) and 60 minutes (9.22±0.75 for LBW and 7.57±0.36 for NBW, $p=0.035$) after the oral glucose tolerance test. Oral glucose tolerance testing detected 1case of type II diabetes (LBW individual),

Correspondence to:

Jephat Chifamba
Department of Physiology Department
University of Zimbabwe, Faculty of Medicine
P O Box MP167, Harare, Zimbabwe.
Email: chifamba@medic.uz.ac.zw

**Department of Chemical Pathology*
University of Zimbabwe, College of Health Sciences
PO Box A 178
Avondale, Harare
Zimbabwe
***Department of Physiology*
University of Zimbabwe, Faculty of Medicine
P O Box MP167
Mount Pleasant, Harare
Zimbabwe

13cases of impaired glucose tolerance (9 LBW and 4 NBW individuals)and 1 case of impaired fasting glucose (LBW individual).LBW was associated with an odds ratio of 3.1 for impaired glucose tolerance and it was statistically significant, $p<0.05$ ($p=0.027$).

Conclusion: Low birth weight was associated with glucose intolerance and significantly higher mean blood glucose levels at 30 and 60 minutes after glucose loading in young adults.

Cent Afr J Med 2013;59(5/8):38-42

Introduction

Birth weight is an important marker and predictor of the future health status of an individual.[1] The incidence of low birth weight is becoming an important public health issue in developing countries.[2] The prevalence of low birth weight in Zimbabwe is 10%and its prevalence is higher in females than males.[3] Type II diabetes is one of the major health problems in the whole world. [4,5] Low birth weight is linked to glucose intolerance which leads to type II diabetes.[6-8] Numerous epidemiological and experimental studies have demonstrated that there is a significant physiological predisposition to glucose intolerance resulting from Low Birth Weight (LBW), a marker of adverse intrauterine environment.[9,10]

Previous studies were conducted largely in the western Caucasian communities and have suggested that individuals born with low birth weight (LBW) have higher blood glucose levels than those born with Normal Birth Weight (NBW).[11-13] Most of these studies were conducted in older adults[14,15] and few studies were done in young adults.[15] The onset and extent of metabolic disorders may vary with age and further investigation still need to be done.

There is still limited data from Africa on low birth weight and its association with glucose intolerance despite the fact that the prevalence of LBW is higher in the continent.[2,15] In developing African communities, the incidence of diabetes is also increasing.[2,4,15]

The relevance of carrying out a 75g oral glucose tolerance test for 120 minutes is that it is a simple laboratory test and with the American Diabetes Association guidelines; it is a standard test to assess glucose metabolism.[1,16] The purpose of the study was to determine the association of low birth weight and glucose intolerance in young black adults.

Research question:
Is low birth weight a significant risk factor for developing glucose intolerance in young black adults?

Materials and Methods

A case control study was done. The study was conducted in the Department of Physiology, University of Zimbabwe, College of Health Sciences, Harare, Zimbabwe. All participants volunteered and gave informed consent to take part in this study. Participants were selected using knowledge of birth weight, as the primary inclusion criterion, evidenced by possession of the neonatal Ministry of Health and Child Welfare birth cards. A self-administered questionnaire was used to obtain variables such as age, diabetes or cardiovascular diseases and any form of diseases in the participant. Ethical permission was granted by Joint Parirenyatwa Hospital and College of Health Sciences Research Ethics Committee (JREC)and the Medical Research Council of Zimbabwe (MRCZ).Validation of the glucometers used for this experiment was done at the Department of Chemical Pathology, University of Zimbabwe, Medical School, PO Box A 178 Avondale, Harare, Zimbabwe.

A total of 30 participants out of 40 who had LBW were randomly selected. LBW was defined as birth weight of <2500g at term. The participants were put into two groups; which were LBW and NBW groups. For each LBW participant, a control match for gender, age (± 0.5yrs) ,body mass index (±1)-for normal and underweight individuals only(BMI<24.5kg/m^2) and familial history of diabetes(at least one first degree or two second degree relatives with the disease);wasselected from the relatively much larger normal birth weight (NBW) group, birth weight ≥2500g at term.

Experimental Protocol

Anthropometric Measurements
Weight and height were measured with the participants putting on light clothing and without shoes. The recorded weight and height were used to calculate body mass index (BMI) in kilograms per square meters (kg/m^2).

Glucose Tolerance Test
All participants had their fasting blood glucose levels measured and underwent a75-gram oral glucose tolerance test for 2 hours according to the World Health Organization standards and American Diabetes Association criteria.[1,16] Impaired glucose tolerance was defined as a postprandial blood glucose level of >7.8mmol/l up to 11.1mmol/l and diabetes, >11.1mmol/l.[1]

Data Analysis
SPSS software version 16.0 (SAS Institute, Cary, NC, USA) was used to analyze the data. Independent samples two-tailed t-test at 5% level of significance was used to compare the various means of metabolic parameters between the two grouping variables, i.e. LBW and NBW. Odd ratios were calculated using Pearson chi-square in SPSS. Participants' demographic characteristics and all additional data are reported as means ± S.E.M. The data is represented on graphs

generated using SPSS 16.0 and Ms Excel 2010.

Demographic Data

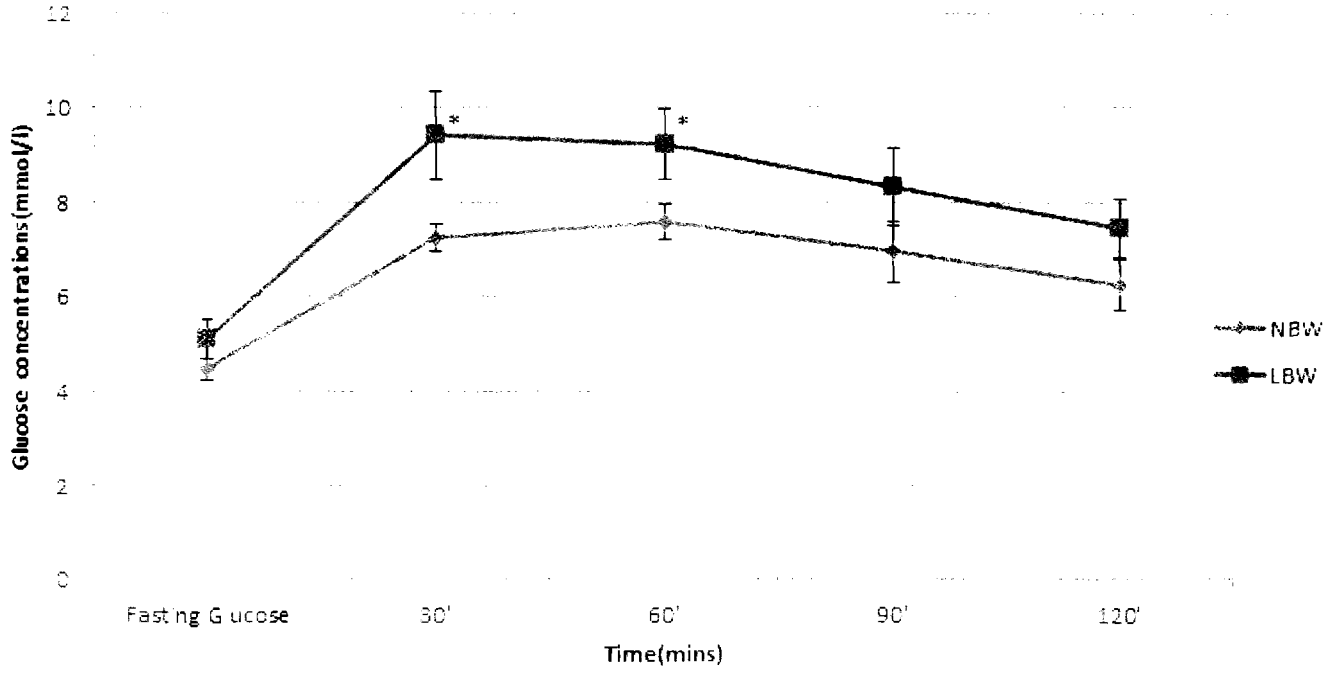
A total of 70 young black adults, 47 females and 23 males with mean age 20.28±0.19 years were recruited; 30 had low birth weight (LBW) and 40 had normal birth weight (NBW). Thirty (15 LBW and 15 NBW individuals) participants out of the 70 had a family history of diabetes (at least one first degree or two second degree relatives with the disease). Table I shows the baseline characteristics of the study sample.

Table I: Results and demographics of study sample.

Variables	Total (n=70) mean ± SEM	NBW (n=40) mean ± SEM	LBW (n=30) mean ± SEM	p value
BMI (kgm^{-2})	21.06 ± 2.0	20.44 ± 2.31	21.68 ± 1.55	0.095
Age/years	20.28 ± 0.19	20.12 ± 0.22	20.44 ± 0.16	0.442
Fasting blood glucose levels (mmol/l)	4.79 ± 0.27	4.47 ± 0.12	5.11 ± 0.42	0.159
Glucose levels after 30 mins (mmol/l)	8.33 ± 0.59	7.24 ± 0.28	9.41 ± 0.91	0.029*
Glucose levels after 60 mins (Mmol/l)	8.40 ± 0.56	7.57 ± 0.36	9.22 ± 0.75	0.035*
Glucose levels after 90 mins (Mmol/l)	7.59 ± 0.56	6.95 ± 0.24	8.32 ± 0.83	0.119
Glucose levels after 120 mins (Mmol/l)	6.85 ± 0.43	6.25 ± 0.24	7.45 ± 0.62	0.081
Birth weight (grams)	2.72 ± 0.05	3.19 ± 0.06	2.24 ± 0.03	0.0001*

*P<0.05; significant difference between NBW and LBW individuals.

Figure I: Mean blood glucose levels of fasting blood glucose and the oral glucose tolerance test in NBW and LBW individuals.



Data presented as mean standard error of the mean. LBW = low birth weight participants; NBW = normal birth weight participants; Following administration of glucose: 30' = blood glucose levels after 30 minutes;60' = blood glucose levels after 60 minutes*; 90' = blood glucose levels after 90 minutes; 120' =blood glucose levels after 120minutes; * p<0.05 NBW vs. LBW*

Discussion

This particular study was aimed at comparing an oral glucose tolerance test in LBW and NBW individuals to investigate the association of birth weight and glucose intolerance. LBW was associated with an odds ratio of 3.1 for impaired glucose tolerance and it was statistically significant, $p<0.05$ ($p=0.027$). The oral glucose tolerance test showed that there were significant differences, $p<0.05$ in mean blood glucose

levels between LBW and NBW individuals at 30 and 60 minutes after glucose loading(p=0.029 for 30mins and p=0.035 for 60mins) (Figure I). This phenomenon was in line with the evidence that LBW individuals are programmed in utero for future metabolic disorders such as glucose intolerance.[9,10,17] After 90mins and 120mins, the oral glucose tolerance test showed no significant difference, p>0.05 (p=0.119 for 90mins and p=0.081 for 120mins) in the blood glucose levels between the two groups, although they remained high in the LBW group. (Figure I) The mean postprandial blood glucose levels in LBW individuals were higher than in NBW individuals and close to 7.8mmol/l which demonstrated that there may be an increased risk of developing glucose intolerance. LBW individuals have an increased sympathetic nerve activity and insulin levels may be normal or elevated.[18] The higher glucose levels in this group of LBW young adults may be as a result of insulin resistance which causes glucose intolerance and leads to type II diabetes.

A previous study done in Africa demonstrated that low birth weight was associated with glucose intolerance in young adults.[15] In the same study, mean blood glucose levels after glucose loading in LBW and NBW individuals had no significant difference for 2hrs of the OGTT unlike in this study. The study population was historically disadvantaged and a potential bias was also noted as LBW and NBW older adults were traced in the analysis.[15] Of all the oral glucose tolerance tests conducted in previous studies, this particular study is the first to indicate a significant difference in blood glucose levels 30 and 60 minutes after glucose loading in low and normal birth weight young adults.

Conclusions

Low birth weight was associated with glucose intolerance and significantly higher mean blood glucose levels at 30 and 60 minutes after glucose loading in young adults. However, a study with a larger sample size is needed to further elucidate the relationship and measure insulin and or sympathetic activity.

Acknowledgements

E Nhandara and DK Sajeni for their technical assistance and V Chikwasha for statistical analysis. The study was funded by the National Institute of Neurological Disorders and Stroke (NINDS), Office of the Director National Institutes of Health (OD) and National Heart, Lung, and Blood Institute (NHLBI) through a Medical Education Partnership Initiative (MEPI) Grant to the University Of Zimbabwe College Of Health Sciences. Authors declare no conflicts of interest.

References

1. Carlsson S, Persson P, Alvarsson M, Efendic S, Norman A, Svanstrom L, *et al.* Low birth weight, family history of diabetes, and glucose intolerance in Swedish middle-aged men. *Diabetes Care 1999;*22:1043-7.
2. Longo-Mbenza B, Vangu Ngoma D, Mbungu Fuele S. Low birth weight, metabolic syndrome and their associations with the global crisis of 1930-1945, rapidly growing economy and coronary heart disease in Central Africa. *Int J Nutr Metab* 2010;2:001-10.
3. United Nations Children's Fund and World Health Organization. Low Birth Weight: country, regional and global estimates. UNICEF, New York, 2006.
4. Okafor CI. The metabolic syndrome in Africa: current trends. *Indian J Endocr Metab* 2012; 16(1):56-66.
5. Whiting DR, Guariguata L, Weil C, Shaw J. IDF Diabetes Atlas: global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes Res Clin Pr* 2011;94:311-32.
6. Thomas GN, Schooling CM, McGhee SM, Sai-Yin H, Cheung BMY, Wat NM, *et al.* Identification of factors differentially associated with isolated impaired fasting glucose and isolated post-load impaired glucose tolerance: the Hong Kong cardiovascular risk factor study. *Eur J Endocrinol* 2006;155:623-32.
7. Eriksson JG, Osmond C, Kajantie E, Forsén TJ, Barker DJP. Patterns of growth among children who later develop type 2 diabetes or its risk factors. *Diabetologia* 2006;49:2853-8.
8. Coutinho GV, Coutinho FR, Faiad JZ, Taki MS, de Lima Reis SR, Ignácio-Souza LM, *et al.* Intrauterine protein restriction combined with early postnatal overfeeding was not associated with adult-onset obesity but produced glucose intolerance by pancreatic dysfunction. *Nutr Metab* 2013;10(1):5.
9. Calkins K, Devaskar SU. Fetal origins of adult disease. *Curr Probl Pediatr Adolesc Health Care 2011;41:158-76.*
10. Schwartz J, Morrison JL. Impact and mechanisms of fetal physiological programming. *Am J Physiol Regul Integr Comp Physiol* 2005;288(1):R11-5.
11. Birgisdottir BE, Gunnarsdottir I, Thorsdottir I, Gudnason V, Benediktsson R. Size at birth and glucose intolerance in a relatively genetically homogeneous, high-birth weight population 1-3. *Am J Clin Nutr* 2002;76:399-403.
12. Xiao X, Zhang Z, Cohen HJ, Wang H, Li W,Wang T, *et al.* Evidence of a relationship between infant birth weight and later diabetes and impaired glucose regulation in a Chinese population. *Diabetes Care* 2008;31:483-7.
13. Saldana TM, Siega-Riz AM, Adair LS, Savitz DA, Thorp JM. The association between impaired glucose tolerance and birth weight

among black and white women in central North Carolina. *Diabetes Care* 2003;26:656-61.

14. Salmi I, Hoy WE, Kondalsamy-Chennakesavan S, Wang Z, Gobe GC, Barr ELM, Shaw JE. Disorders of glucose regulation in adults and birth weight. *Diabetes Care* 2008;31:159-64.
15. Levitt NS, Lambert EV, Woods D, Hales NC, Andrew R, Seckl JR. Impaired glucose tolerance and elevated blood pressure in low birth weight, non-obese, young South African adults: early programming of cortisol axis. *J Clin Endocrinol Metab* 2000;85:0021-972X.
16. Executive Summary: Standards of Medical Care in Diabetes - 2013. *Diabetes Care* 2013;36:1.
17. Fowden AL, Giussani DA, Forhead AJ. Intrauterine programming of physiological systems: causes and consequences. *Physiology* 2006;21:29-37.
18. Ijzerman RG,Stehouwer CD, de Geus EJ. Low birth weight is associated with increased sympathetic activity: dependence on genetic factors. *Circulation* 2003;108(5):566-71.