Diabetes & Metabolic Syndrome: Clinical Research & Reviews xxx (2014) xxx–xxx

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Original Article

Prevalence and determinants of metabolic syndrome among newly diagnosed type 2 diabetic subjects according to different criteria

Sharmin Hossain [a,*], Kaniz Fatema [b], Kazi R. Ahmed [a], Jesmin Akter [c], Hasina A. Chowdhury [d], Md Shahjahan [e], Amitava Acharyya [f], M.A. Rahim [g], Liaquat Ali [h]

[a] Department of Health Promotion and Health Education, Bangladesh University of Health Sciences, Bangladesh
[b] Department of Epidemiology, University of New South Wales, Australia
[c] Department of Reproductive and Child Health, Bangladesh University of Health Sciences, Bangladesh
[d] Department of Biostatistics, Bangladesh University of Health Sciences, Bangladesh
[e] Department of Public Health, Daffodil International University, Bangladesh
[f] J.B. Ray State Ayurvedic Medical College & Hospital, India
[g] Department of Epidemiology, National Institute of Prevention & Social Medicine, Bangladesh
[h] Department of Biochemistry and Cell Biology, Bangladesh University of Health Sciences, Bangladesh

ARTICLE INFO

Keywords:
Metabolic syndrome criteria
Newly diagnosed type 2 diabetes
Prevalence
Determinants
Bangladesh

ABSTRACT

Background and aim: Metabolic syndrome (MS) is becoming a serious global public health problem. The prevalence of MS differs in different population by using different definitions. Present study aimed to find out the prevalence and determinants of MS among newly diagnosed type 2 diabetes (NDT2D) according to different criteria.

Subjects and methods: This cross-sectional analytic study was conducted among 281 subjects selected purposively from the OPD of BIRDEM. Information on lifestyle factors and disease history were collected using a semi-structured questionnaire by face to face interview. The three definitions of MS used in this study are from the International Diabetes Federation (IDF), a modified version of the ATP III criteria for Asian populations (modified ATP III) and World Health Organization (WHO) criteria.

Adjusted odds ratio and confidence limit were generated through logistic regression.

Results: The overall prevalence of metabolic syndrome among the study subjects according to modified ATPIII, WHO and IDF criteria were 79% (95% CI: 74.2-83.8), 81% (95% CI: 76.4-85.6) and 68% (95% CI: 62.6-73.5) respectively. The prevalence of metabolic syndrome among female were higher compared to males in all the criteria's. Female gender (OR = 5.93), family history of diabetes (OR = 1.92), overweight (OR = 6.2), and obesity (OR = 5.13) were found as important confounders associated with metabolic syndrome.

Conclusion: The prevalence of the metabolic syndrome among NDT2D is considerably higher in our population which may indicate considerable risk of cardiovascular diseases in future. Female gender, family history of diabetes, overweight and obesity are important confounders of MS in this population.

1. Introduction

The rapid emergence of metabolic syndrome (MS) has been recognized as a major public health problem which considered to be a driver of the modern day epidemics of diabetes and cardiovascular diseases (CVD) [1,2]. It is a frequent and increasing problem everywhere in the world, affecting around a quarter of the world's adult population [3]. On the other hand, many studies have shown that metabolic syndrome, irrespective of its definition, is an independent clinical indicator of macrovascular and microvascular complications in diabetics [4].

The metabolic syndrome (MS) is a cluster of several medical disorders that occur together, increasing the risk of cardiovascular disease (CVD) and diabetes [5]. The components of this condition are central obesity, hypertension, elevated insulin levels and dyslipidemia. Insulin resistance is the cornerstone of metabolic syndrome. Current epidemiological data suggested that, people with metabolic syndrome are twice as likely to die from and three times as likely to have a heart attack or stroke compared with people without the syndrome [3]. In addition, people with

* Corresponding author at: Sharmin Hossain, Department of Health Promotion and Health Education, Bangladesh University of Health Sciences (BUHS), 125/1, Darus Salam, Mirpur, Dhaka 1216, Bangladesh. Tel.: +880 1912028488.
E-mail address: shormybd@yahoo.com (S. Hossain).

http://dx.doi.org/10.1016/j.dsx.2014.04.016
1871-4021/

metabolic syndrome have a fivefold greater risk of developing type 2 diabetes [6]. A number of studies have confirmed that the risks of developing CVD, and of both cardiovascular and all-causes of mortality, are increased by the presence of MS [7–10].

The prevalence of metabolic syndrome in adult population worldwide varies from 8 to 24.2% [11,12] in males and from 7 to 46.5% [13,14] in females. South Asians have high prevalence of metabolic syndrome [15,16] and a usually high tendency to develop type 2 diabetes mellitus and atherosclerotic cardiovascular disease (ASCVD) [17]. Rapid demographic, nutritional, and economic changes as are occurring in South Asians. Most importantly, globalization of diets and consumption of nontraditional fast foods have occurred at a rapid place in urban areas. In addition, modern people are less physically active, and a sedentary lifestyle is increasing, migration from villages to cities is increasing. These intracountry migrants become urbanized and mechanized, resulting in nutritional imbalance, physical inactivity [18]. Recent studies have reported that physical activity and physical fitness are associated with lower prevalence and incidence of metabolic syndrome and individual CVD risk factors (e.g., high blood pressure, insulin resistance, abdominal adiposity, and dyslipoproteinemia [19]. In fact all expert groups [20–22] agree on the core components of the MS-visceral obesity, glucose intolerance, dyslipidemia and arterial hypertension. However, they provide different clinical criteria to identify such a cluster.

In our country, we do not have enough data on the metabolic syndrome of newly diagnosed diabetics which is responsible for increasing morbidity and mortality in all age groups. As metabolic syndrome is considered a global health problem it is required for more studies and control method in treatment regimes control diabetes, good quality of food and physical activity. The change in environmental condition and dietary habits among different population, which differ from one country to the other necessitate the determination of biochemical and anthropometric parameters which evoke metabolic syndrome among Bangladeshi NDDM population. The aim was to determine the prevalence and determinants of metabolic syndrome and its components in subjects newly diagnosed with type 2 diabetes.

2. Materials and methods

A cross-sectional study was carried out at the out patient department (OPD) of the Bangladesh Institute of Research & Rehabilitation on Diabetes, Endocrine and Metabolic Disorders (BIRDEM), Dhaka. Two hundred and eighty one (97 male and 184 female) newly diagnosed type 2 diabetic subjects, were selected purposively for this study. Age group in both male and female were taken from 25 to 60 years. Patients with incomplete information, type 1 diabetic, gestational diabetic cases, with serious comorbid diseases (infection, stroke, myocardial infarction, major surgery, malabsorption, etc.) and history of using insulin sensitizing drugs (like thiazolidinediones or metformin, oral contraceptive containing levonorgestrel, etc.) were excluded from the study. Newly diagnosed patients in the hospital routinely undergo thorough clinical and bio-chemical investigation for determination of diabetic profile and complication.

Data were collected using semi-structured questionnaire based on the objectives with simple and understandable language by face to face interview. All clinical and biochemical measurements data of first visit were retrieved from the patient's diabetic guidebook. Participants were identified as hypertensive according to the International Diabetic Federation (IDF) criteria if they were on antihypertensive medications or if they had a systolic blood pressure $\geq$130 mm Hg or diastolic blood pressure $\geq$85 mm Hg. Patient's glycemic status and all selected parameters of blood lipids (total cholesterol, triglycerides, high density lipoprotein cholesterol (HDL-C) were collected from their recent diagnosis report which was recorded in their guidebook.

Three definition of metabolic syndrome of three well accepted institutes were selected for diagnosis of metabolic syndrome. They are as follows: International Diabetes Federation (IDF)[20], World Health Organization (WHO) [21] and Modified NCEP ATP III [22].

Each of the participants was informed about the research objectives, methods and techniques in detailed and written informed consent were taken. Data were collected ensuring the privacy and confidentiality by face to face interview and document's review. The study approved by the Ethical Review Committee of Diabetic association of Bangladesh (BADAS).

After collection, all data were checked thoroughly for consistency and completeness. Data were cleaned, edited and verified daily to exclude any error or inconsistency. Statistical Package for Social Sciences (SPSS) for Windows version 11.5 was used to analyze the data. All the data were expressed as the mean $\pm$ SD, frequency and percentage as appropriate. Student's *t*-test was used to compare continuous variables. Comparisons were accomplished between male and female genders. Logistic regression was applied to estimate the odds ratio (OR) and corresponding 95% confidence intervals (CI) for the different explanatory variables used to predict the metabolic syndrome. A significance level of 0.05 was considered as proper, and thus *p*-values of less than 0.05 were considered statistically significant.

3. Results

Of the 281 newly diagnosed type 2 diabetic patients included in the study, 97 were male and 184 were female with a mean ($\pm$SD) age of 46 $\pm$ 11 years. Among the study subjects 93% were Muslim and 92% came from urban areas, 49% belonged to lower-middle income group and more than 60% of the participants had under graduate level (1–12 years) of education (Table 1).

A total of 225 (79%), 231 (81%) and 193 (68%) patients met the Modified ATPIII, WHO and IDF criteria for metabolic syndrome, respectively. Prevalence of metabolic syndrome was higher among female by all diagnostic criteria (Fig. 1).

Higher levels of mean BMI, waist circumference, waist-hip ratio, diastolic blood pressure, fasting blood glucose, were present in female subjects compared to their counterparts. The Mean $\pm$ SD

Table 1
Distribution of the study subjects according to their sociodemographic characteristics (n = 281).

Variables	Number (%)
Age (mean $\pm$ SD)	46 $\pm$ 11
Sex	
Male	97 (34)
Female	184 (66)
Living area	
Urban	260 (92)
Rural	21 (8)
Family income in BDT	
Low (<6000)	37 (13)
Lower middle income (6001-24000)	137 (49)
Upper middle income (24001-74000)	97 (35)
High income (>74,000)	9 (3)
Education	
Illiterate	63 (22)
Undergraduate	166 (60)
Graduate and above	52 (18)
Family history of diabetes	
Yes	112 (40)
No	169 (60)

Results are expressed as number (percentage) and mean $\pm$ SD.

Please cite this article in press as: Hossain S, et al. Prevalence and determinants of metabolic syndrome among newly diagnosed type 2 diabetic subjects according to different criteria. Diab Met Syndr: Clin Res Rev (2014), http://dx.doi.org/10.1016/j.dsx.2014.04.016

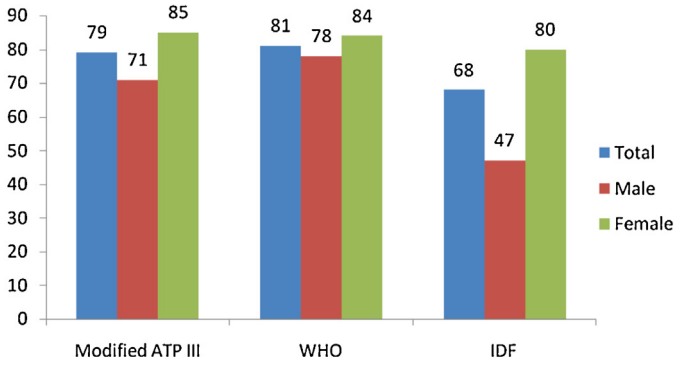

Fig. 1. Prevalence of metabolic syndrome among newly diagnosed type 2 diabetic subjects according to different.

BMI was statistically significant higher among female (26.2 ± 4.8) compare to male (24.9 ± 3.0) subjects. But a higher level of Mean ± SD TG was statistically significant in male compared to females (Table 2).

The binary logistic regression analysis showed the association between the prevalence of metabolic syndrome as defined by the modified ATPIII, WHO and IDF criteria with different independent variables of the study subjects. According to modified ATP III criteria, female gender and BMI category (overweight and obese) were the important correlates of metabolic syndrome among newly diagnosed type 2 diabetic subjects. The chance of developing metabolic syndrome was two times higher in female compare to their counterpart. Overweight subjects are seven times and obese subjects are six times more likely to develop metabolic syndrome than underweight and normal subjects. According to WHO criteria those who have positive family history of diabetes have 2 times more risk of developing metabolic syndrome. According to IDF criteria age, gender and BMI category (overweight and obese) were the important correlates of metabolic syndrome among the study subjects. The chance of developing metabolic syndrome was six times higher in female compare to their counterpart (Table 3).

Three diagnostic criteria, result showed that education, income, regular exercise habit and exposure to smoking does not have any

Table 2
Anthropometric, clinical and biochemical characteristics of the study subjects ($n = 281$).

Variables	Total	Male ($n = 97$)	Female ($n = 184$)	p-Value
BMI (kg/m^2)	25.8 ± 4.3	24.9 ± 3.0	26.2 ± 4.8	0.004
Waist circumference (cm)	91.3 ± 11.5	89.6 ± 9.5	92.1 ± 12.3	0.060
Waist-hip ratio	0.98 ± 0.06	0.97 ± 0.07	0.98 ± 0.08	0.505
SBP (mm of Hg)	112 ± 37	123 ± 12	122 ± 12	0.422
DBP (mm of Hg)	73 ± 26	78 ± 9	79 ± 14	0.639
Fasting blood glucose (mmol/L)	8.6 ± 3.9	8.2 ± 4.1	8.7 ± 3.7	0.313
Triglyceride (mg/dl)	202 ± 111	226 ± 143	189 ± 87	0.023
HDL (mg/dl)	35 ± 8	35 ± 6	34 ± 8	0.310

Results are expressed as mean ± SD. Independent sample t-test were performed for measure the level of significance ($p < 0.05$).

Table 3
Determinants of metabolic syndrome of the study subjects according to modified ATPIII, WHO and IDF criteria.

Variables	Modified ATP III criteria		WHO criteria		IDF criteria	
	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)
Age	0.440	1.0 (0.98-1.04)	0.981	1.0 (0.97-1.03)	0.132	1.3 (0.99-1.05)
Sex						
Male	*Reference*					
Female	0.039	2.2 (1.04-4.43)	0.405	1.4 (0.65-2.89)	0.000	6.0 (2.96-12.24)
Area						
Rural	*Reference*					
Urban	0.870	1.1(0.35-3.46)	0.644	1.4 (0.42-4.04)	0.322	1.8 (0.59-4.96)
Education						
Illiterate	*Reference*					
Primary to HSC	0.746	0.9 (0.37-2.03)	0.941	1.0 (0.42-2.24)	0.786	0.9 (0.41-1.97)
Graduate and above	0.281	0.6 (0.21-1.61)	0.266	0.8 (0.19-1.59)	0.489	1.5 (0.51-4.02)
Income	0.293	1.0 (1.00-1.00)	0.704	1.0 (1.00-1.00)	0.502	1.0 (1.00-1.00)
BMI						
Underweight	*Reference*					
Normal	0.114	3.6 (0.74-16.95)	0.702	1.4 (0.25-8.32)	0.047	9.4 (1.03-87.71)
Overweight	0.013	7.2 (1.51-34.09)	0.450	2.0 (0.35-11.26)	0.005	23.8 (2.60-218.75)
Obese	0.025	6.2 (1.3-10.69)	0.745	1.3 (0.23-7.92)	0.000	69.6 (7.08-68.4)
Family history of diabetes						
No	*Reference*					
Yes	0.318	1.5 (0.72-2.79)	0.083	1.9 (0.92-3.83)	0.195	1.5 (0.81-2.97)
Regular exercise						
Yes	*Reference*					
No	0.942	1.3 (0.51-2.08)	0.467	0.9 (0.39-1.55)	0.241	0.7 (0.34-1.31)
Smoking practice						
No	*Reference*					
Yes	0.339	1.4 (0.72-2.66)	0.760	1.1 (0.59-2.21)	0.232	1.5 (0.78-2.96)

Modified ATP III criteria, WHO criteria, and IDF criteria was taken as dependent variables whereas others taken as independent variables. Significant at p-value <0.05 levels, CI = confidence interval, OR = odds ratio.

Please cite this article in press as: Hossain S, et al. Prevalence and determinants of metabolic syndrome among newly diagnosed type 2 diabetic subjects according to different criteria. Diab Met Syndr: Clin Res Rev (2014), http://dx.doi.org/10.1016/j.dsx.2014.04.016

significant effect on developing metabolic syndrome among the study subjects (Table 3).

4. Discussion

The incidence and prevalence of type 2 diabetes mellitus and CHD have been increasing steadily in Bangladesh. Metabolic syndrome (MS) is a major public health challenge due to its increasing prevalence worldwide. The MS accelerates both macro- and micro vascular complications frequently observed in diabetes mellitus.

Of 281 newly diagnosed type 2 diabetic subjects, we have found the prevalence of MS according to modified ATPIII, WHO and IDF criteria were 79%, 81% and 68% respectively. The overall prevalence in each criteria was higher in female as compared to male. The reason seems to be a very high rate of BMI ($p < 0.004$) and waist circumference ($p < 0.060$) among female than their counterpart.

In a study at Shanghai, 1008 patients with type 2 diabetes over 30 years of age, prevalence of MS according to IDF criteria was 50% [23]. The prevalence of MS according to IDF criteria was 82.6% and females were significantly more affected than males. Therefore high prevalence of MS in type 2 diabetes seems to be a universal phenomenon.

This prevalence is nearly similar with the findings of Nahar et al. [24] study at Bangladesh. They found 81% (modified NCEP-ATP III), 82.5% (modified WHO), 61% (IDF) participants had coexisting metabolic syndrome among Bangladeshi newly diagnosed type 2 subjects by applying different criteria. Tankova et al. [25] found that prevalence of MS among newly diagnosed type 2 diabetes mellitus patients in Bulgaria was 89% according to IDF criteria. It was also observed those females are more affected by MS than male (71% vs 85%, 78% vs 84%, 47% vs 80%) by applying different criteria.

Binary logistic regression was conducted considering metabolic syndrome as dependent variable according to modified ATPIII, WHO and IDF criteria and age, sex, living area, education, family income, BMI category, family history of diabetes, regular exercise, active or passive smoking as independent variable. We found no significant association among smoking status, regular exercise and prevalence of metabolic syndrome. This was unexpected given the evidence of a possible link between smoking and insulin resistance and risk of type 2 diabetes [16]. This negative finding simply reflects the limited power of study to examine this issue. We found that female had a higher prevalence of the metabolic syndrome as compared with reference category of the male counterpart.

Our study also reveals that some gender differences in the risk of coexisting metabolic syndrome, the OR was found to be significant higher in female {5.92 (95% CI, 2.91-12.05, $p < 0.001$)} by adopting IDF criteria. The OR of diabetic female for developing metabolic syndrome was found 2.04 times higher than diabetic male by applying modified NCEP ATP III criteria and there was higher trend of significance in multivariate analysis. This finding is online with Tankova et al. [25], who also found similar results.

5. Conclusion

The prevalence of the metabolic syndrome among newly diagnosed type 2 diabetics is considerably high in our population which is implicative of an alarming risk of cardiovascular disease in future. The highest prevalence was observed following WHO criteria (as all patients were newly diagnosed diabetic subjects) compare to modified ATP III and IDF criteria. The prevalence of metabolic syndrome was more prominent in women. Age, gender, family history of diabetes and BMI are important confounders for development of metabolic syndrome for Bangladeshi newly diagnosed type 2 population.

Conflict of interest

The authors report no conflict of interest.

References

[1] Haffner SM, Cassells HB. Metabolic syndrome – a new risk factor of coronary heart disease. Diab Obes Metab 2003;5:359–70.
[2] Isomaa B, Almgren P, Tuomi T, Forsén B, Lahti K, Nissén M, et al. Cardiovascular morbidity and mortality associated with the metabolic syndrome. Diabetes Care 2001;24:683–9.
[3] Ford FS. Prevalence of the metabolic syndrome defined by the International Diabetes Federation among adults in the U.S. Diabetes Care 2005;28:2745–9.
[4] Alshkri MM, Elmehdawi RR. Metabolic syndrome among Type-2 diabetic patients in Benghazi-Libya: A pilot study. Libyan J Med 2008;3:177–80.
[5] Medline Plus: Metabolic Syndrome. Available at: http://www.nlm.nih.gov/medlineplus/metabolicsyndrome.html.
[6] Stern MP, Williams K, Gonzalez-Villalpando C, Hunt KJ, Haffner SM. Does the metabolic syndrome improve identification of individuals at risk of type 2 diabetes and/or cardiovascular disease? Diabetes Care 2004;27:2676–81.
[7] Hu G, Qiao Q, Tuomilehto J, Balkau B, Borch-Johnsen K, Pyorala K, et al. Prevalence of the metabolic syndrome and its relation to all-cause and cardiovascular mortality in nondiabetic European men and women. Arch Intern Med 2004;164:1066–76.
[8] Hunt KJ, Resendez RG, Williams K, Haffner SM, Stern MP, San Antonio Heart Study. National Cholesterol Education Program versus World Health Organization metabolic syndrome in relation to all-cause and cardiovascular mortality in the San Antonio Heart Study. Circulation 2004;110:1251–7.
[9] Lakka HM, Laaksonen DE, Lakka TA, Niskanen LK, Kumpusalo E, Tuomilehto J, et al. The metabolic syndrome and total and cardiovascular disease mortality in middle-aged men. JAMA 2002;288:2709–16.
[10] McNeill AM, Rosamond WD, Girman CJ, Golden SH, Schmidt MI, East HE, et al. The metabolic syndrome and 11-year risk of incident cardiovascular disease in the atherosclerosis risk in communities study. Diabetes Care 2005;28:385–90.
[11] Gupta A, Gupta R, Sarna M, Rastogi S, Grupta VP, Kothari K. Prevalence of diabetes, impaired fasting glucose and insulin resistance syndrome in an urban Indian population. Diabetes Res Clin Pract 2003;61:69–76.
[12] Ford ES, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults: findings from the Third National Health and Nutrition Examination Survey. JAMA 2002;287:356–9.
[13] Balkau B, Vernay M, Mhamdi L, Novak M, Arondel D, Vol S, et al. The incidence and persistence of the NCEP (National Cholesterol Education Program) metabolic syndrome. The French D.E.S.I.R. study. Diabetes Metab 2003;29:526–32.
[14] Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V. Metabolic syndrome in urban Asian Indian Adults – a population study using modified ATP III criteria. Diabetes Res Clin Pract 2003;60:199–204.
[15] Ramachandran A, Snehalatha C, Satyavani K, Sivasankari S, Vijay V. Metabolic syndrome in urban Asian Indian adults – a population study using modified ATP III criteria. Diabetes Res Clin Pract 2003;60:199–204.
[16] Deepa M, Farooq S, Datta M, Deepa R, Mohan V. Prevalence of metabolic syndrome using WHO, ATPIII and IDF definitions in Asian Indians: the Chennai Urban Rural Epidemiology Study (CURES-34). Diabetes Metab Res Rev 2007;23:127–34.
[17] Reddy KS, Yusuf S. Emerging epidemic of cardiovascular disease in developing countries. Circulation 1998;97:596–601.
[18] Timar O, Sestier F, Levy E. Metabolic syndrome X: a review. Can J Cardiol 2000;16:779–89.
[19] Churilla JR, Zoeller J, Robert F. Physical activity and the metabolic syndrome: a review of the evidence. Am J Lifestyle Med 2007;2:118–25.
[20] International Diabetes Federation. The IDF consensus worldwide definition of the metabolic syndrome, Retrieved from http://www.idf.org/webdata/docs/Metac syndrome def.pdf (10.06.05).
[21] World Health Organization. Definition, diagnosis and classification of diabetes mellitus and its complications: report of a WHO Consultation. Part 1: Diagnosis and classification of diabetes mellitus. Geneva, Switzerland: World Health Organization; 1999, Available at: http://whqlibdoc.who.int/hq/1999/WHO_NCD_NCS_99.2.pdf (accessed 12.12.03).
[22] Third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). Final report. Circulation 2002;106:3143–421.
[23] Cameron AJ, Shaw JE, Zimmet PZ. The metabolic syndrome: prevalence in worldwide populations. Endocrinol Metab Clin N Am 2004;33:351–75.
[24] Nahar S, Rahman MZ, Ullah M, Debnath BC, et al. Prevalence of metabolic syndrome in newly diagnosed type 2 diabetes mellitus. J Cardiovasc 2011;4(1):17–25.
[25] Tankova TI, Chakarova NY, Dakovska LN, Kalinov KB, Atanacsova IA. Assessment of the risk for metabolac syndrome in prediabetes and newly-diagnosed type 2 diabetes. Journal of Diabetology 2010;2(June):5.

Please cite this article in press as: Hossain S, et al. Prevalence and determinants of metabolic syndrome among newly diagnosed type 2 diabetic subjects according to different criteria. Diab Met Syndr: Clin Res Rev (2014), http://dx.doi.org/10.1016/j.dsx.2014.04.016