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INSIGHTS INTO METABOLIC SYNDROME: A REVIEW OF CRURRENT UNDERSTANDING AND EMERGING PERSPECTIVES

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Abstract:
Metabolic Syndrome (MetS) is an escalating global problem and a growing public health challenge worldwide. It is defined as a group of interrelated conditions that significantly increase the risk of cardiovascular disease and Type-2 diabetes. It is characterized by central obesity, dyslipidemia, hypertension and insulin resistance. The prevalence of metabolic syndrome is increasing worldwide with significant differences between regions and populations. The aim of this review study is to summarize current knowledge about the prevalence of MetS in the general population. The main risk factors are sedentary lifestyle, poor diet, genetic predisposition and socio-economic status. The pathophysiology of MetS involves complex interactions between genetic, environmental and lifestyle factors leading to insulin resistance and chronic inflammation. Effective management strategies include lifestyle changes such as diet and exercise, pharmacological interventions and public health policies aimed at reducing risk factors. Further research is needed to better understand the underlying mechanisms and to develop more effective prevention and treatment strategies. Early recognition of Metabolic Syndrome (MetS) can decrease its prevalence and reduce its impact on morbidity and mortality.

Keywords: Metabolic syndrome, prevalence, risk factors, public health, prevention.

Introduction:

The Metabolic Syndrome (MetS) is a clustering of insulin resistance, hypertension and dyslipidemia; has become a major public health issue worldwide. MetS consists of central obesity, glucose intolerance, diabetes, lower high density lipoproteins, high triglycerides and hypertension. MetS is a widely prevalent and multi-factorial disorder and the prevalence of each of these diseases as well as the MetS is increasing worldwide. An association between certain metabolic disorders and cardiovascular disease has been known since 1940s. In 1980s, this association became more clearly defined and the term Metabolic Syndrome (also known as Syndrome X) was coined to designate a cluster of metabolic risk factors that come together in a single individual. In 1988, Reaven outlined ‘Syndrome X’ and the association between glucose intolerance, hypertension and dyslipidemia, with insulin resistance suggested as the underlying cause. The term "Metabolic Syndrome (MetS)" dates back to late 1950s, but came into common usage in late 1970s to describe various associations of risk factors with diabetes that had been noted as early as the 1920s

(Joslin,1921). The terms Metabolic Syndrome, Insulin Resistance Syndrome, Dysmetabolic Syndrome, Obesity Syndrome, Reaven's Syndrome and Syndrome X are now used specifically to define a group of abnormalities that are associated with increased risk for the development of Type-2 Diabetes and atherosclerotic vascular disease (e.g., heart disease and stroke). Singer (1977) used the term for associations of obesity, gout, diabetes mellitus, and hypertension with hypolipoproteinemia. Phillips (1978) developed the concept that risk factors for myocardial infarction concur to form a "constellation of abnormalities" (i.e., glucose intolerance, hyperinsulinemia, hypercholesterolemia, hypertriglyceridemia and hypertension). The primary objective of this review was to synthesize and analyze existing literature on metabolic syndrome (MetS) to determine the current prevalence and trends of MetS in various populations globally, highlighting demographic variations and potential changes over time.

Methodology

The objective of this study was to systematically analyze the prevalence of Metabolic Syndrome (MetS) in the general population. MetS is a cluster of conditions that occur together, increasing the risk of heart disease, stroke, and Type-2 diabetes. This review synthesizes key findings from literature, focusing on epidemiology and management strategies for MetS.

The three criteria are used for defining MetS are shown in Table (Deepa 2007).

Table: Definitions of the Metabolic Syndrome

	Risk factors	IDF Consensus (2005)	ATP-III criteria (2001)	WHO Criteria (1999)
1	Obesity/abdominal obesity	Waist circumference ≥90 cm (m), ≥80 cm (f)—South Asians	Waist circumference ≥102 cm (m), ≥88 cm (f)	Body mass index (BMI) ≥30 kg/m^2 and/or waist-to-hip ratio >0.90 (m), >0.85 (f)
2	Blood pressure	≥130/≥85 mmHg	≥130/≥85 mmHg	≥140/≥90 mmHg or on medication
3	Fasting glucose	≥5.6 mmol/L or pre-existing diabetes	≥6.1 mmol/L or on medication for diabetes	Diabetes, impaired glucose tolerance or insulin resistance
4	Microalbuminuria	Not used for diagnosis	Not used for diagnosis	Urinary albumin excretion rate ≥20 μg/min
5	Triglycerides	≥1.7 mmol/L	≥1.7 mmol/L	Triglycerides ≥1.7 mmol/L and/or HDL-C <0.91 mmol/L (m), <1.01 mmol/L (f)
6	HDL cholesterol	<1.04 mmol/L (m), <1.3 mmol/L (f)	<1.04 mmol/L (m), <1.3 mmol/L (f)	
Metabolic Syndrome-definition		**Abdominal obesity plus two or more risk factors**	**At least three risk factors**	**Diabetes, impaired glucose tolerance or insulin resistance plus any two or more risk factors**

Results and Discussion

In 1998, the World Health Organization (WHO) was the first organization to provide a definition of the Metabolic Syndrome (MetS). In response, the European Group for the Study of Insulin Resistance countered with a modification of the WHO definition (WHO, 2000). In 2001, the National Cholesterol Education Program (NCEP) released its definition. Subsequently, the American Association of Clinical Endocrinologists offered its views regarding the definition of MetS. The proliferation of definitions suggested that a single unifying definition was desirable. In the hope of accomplishing this, the International Diabetes Federation (IDF) proposed a new definition of the Metabolic Syndrome (MetS). in April 2005 (Deepa et al 2007).

This new definition requires a fresh assessment of the prevalence of the Metabolic Syndrome as well as of the magnitude of the morbidity and mortality associated with it. As the criteria for

defining MetS have been recently laid down, studies of its prevalence in India are few. Diabetes Mellitus and MetS have reached global pandemic proportions with India being designated 'Diabetes Capital' of the world. In India, it is estimated that 32 million people suffer from diabetes and the number is projected to increase to 69.8 million by 2025 (Enas et al, 2007).

The MetS is increasing in prevalence worldwide as a consequence of increasing obesity prevalence. MetS is likely to have a marked impact on the prevalence of cardiovascular disease and Type-2 Diabetes worldwide in the next two decades. The International Diabetes Federation estimates that one-quarter of the world's adult has MetS (IDF, 2005). Obesity, hypertension, dyslipidemia and diabetes are no longer diseases of the wealthy. By 2025, three out of four people with diabetes will be living in third world countries and similar trends are likely for the other components of the syndrome.

The MetS is a group of obesity, hyperglycemia, decreased high density lipoprotein (HDL), increased triglyceride, and high blood pressure (Magliano et al, 2006). MetS as a driver of current epidemics of diabetes and cardiovascular diseases (CVD) has become a major challenge to public health around the world (Zimmet et al, 2001 and Grundy et al, 2004). In the semi-rural areas of Turkey the prevalence of MetS was 27.6% by NCEP Criteria (Arikan et al, 2009). The prevalence of MetS varies globally but is increasing due to rising obesity rates and sedentary lifestyles. Studies before 2020 indicated that the prevalence in adults was about 25%, with higher rates in urbanized and industrialized regions (Grundy et al., 2006). The National Health and Nutrition Examination Survey (NHANES) showed a significant rise in MetS among U.S. adults from 1988 to 2012 (Ford et al., 2008).

Metabolic syndrome (MetS) is increasing in prevalence, paralleling an increasing epidemic of obesity. In the United States, where almost two thirds of the population is overweight or obese, more than one fourth of the population meets diagnostic criteria for MetS (Misra and Khurana, 2009). In the United States, data from a 1999-2000 survey showed that the age-adjusted prevalence of MetS among adults aged 20 years or older had risen from 27% (data from 1988-1994) to 32%. (Chow et al, 2004).

Nearly 50-60% of people with diabetes will come from Asia, in particular from India and China. Human gene pool may have been unable to cope with changes in both lifestyle and socio-economic status from a hunter-gatherer to a more sedentary way of life. In developing countries, the lifestyle changes resulting from industrialization and rural-urban migration involve decreased levels of physical activity and the increased intake of energy.

In a survey in Singapore in 2004, the prevalence of MetS varied between the three major ethnic groups – from the Chinese at 15% and Malays at 19%, to the Indians at 20%. All these studies have used either WHO or ATP-III criteria for defining MetS. It was estimated that 20%–25% of South Asians have developed MetS and many more may be prone to it (Cameron et al, 2004).

India is a middle-income country in rapid economic and epidemiologic transition. Decades of economic development have led to dramatic changes in life expectancy, lifestyle and diet. An older more sedentary population finds itself increasingly more burdened by diseases of its new found wealth obesity, diabetes and MetS which already approach those found in industrialized nation in both Europe and the USA. The increasing prevalence of cardio-metabolic risk factors has resulted in an unprecedented rise in the incidence of cardiovascular disease. The Indians have proven themselves capable of bringing rapid large-scale socioeconomic change. However, the ability of the government to respond and control such an epidemic will depend on whether or not it approaches the task with the same vigor it has approached economic development. In India, 25% of subjects had the MetS by IDF criteria (Sachdev et al, 2009), another study done by NCEP criteria reported its prevalence by 9.3% in rural central India (Kamble et al, 2010). Earlier studies described one or more components of this syndrome. Prevalence rates have varied (11– 41%) depending on the definition and cut-offs used as well as population characteristics (Deepa et al, 2007).

Using NCEP-ATP-III criteria, Ramachandran et al. 2003 reported MetS prevalence 41% in Chennai, while Gupta et al., 2004 reported 31% in Jaipur. Prabhakaran et al. 2007 reported its

prevalence 24.6% from Delhi, with three-fold higher prevalence in urban as compared to rural areas. Prevalence of metabolic syndrome was 23.2%, 18.3% and 25.8% according to WHO, ATP-III and IDF definitions respectively (Deepa et al, 2007). Misra et al. 2004 have reported 28% prevalence of insulin resistance in urban children and young adults. Of the 150 million diabetics in the world, Indians alone account for 40 million cases. It is distressing to learn that diabetes in India would increase by 150-200% by 2025, means by 2025 every fourth person to be labeled a diabetic in the world, will be an Indian. The picture looks gloomier when we realize that many of our people with diabetes are still undiagnosed. Diabetics apart, there is another subset of people with impaired glucose tolerance (IGT) or impaired fasting glucose (IFG). These people are now labeled as Prediabetes.

Dr. Ramachandran (2003) presented the Indian viewpoint of the prevalence of prediabetes and Metabolic Syndrome (MetS). According to Ramachandran, both impaired fasting glucose (IFG) and impaired glucose tolerance (IGT) were highly prevalent in India (8.7% and 8.1%, respectively), with 33% overlap between populations. IGT was common in all areas and at all ages, whereas diabetes was more prevalent in people over 40 years (24%, diabetes vs. 15.7%, IGT) with only 5% of diabetic patients aged less than 40 years. Preventive action is urgently needed, and studies in China and India have proven to be effective.

Table- Prevalence of Metabolic Syndrome from various studies

- Prevalence of metabolic syndrome.
- Crude prevalence.
- Age-adjusted prevalence
- Age standardised prevalence rate.

Reference	City, Country	Year	Age (years)	Sample size	MetS Prevalence (%)	Diagnostic criteria
Abdul-Rahim HF, et al., 2001	Palestinian	1996–1998	30–65	Urban:492 Rural: 500	17% a	WHO
Ford ES, 2003	US	1988–1994	≥20	8608	ATPIII − 23.9%b; WHO − 25.1%b	ATP-III & WHO
Al-Lawati JA, et al., 2003	Nizwa City, Oman	2001	≥20	1419	17% a; 21% b	ATP-III
Resnick HE, et al., 2003	Arizona, Oklahoma & Dakota	1988	45–74	2283	35% a	ATP-III
Azizi F, et al., 2003	Tehran, Iran	1999–2001	≥20	9846	30.1%a; 33.7%c	ATP-III
Tan CE, et al., 2004	Singapore	1998	18–69	4723	Asian Indians: 28.8%a; Malays: 24.2%a Chinese:14.8%a	ATP-III
Oh J, et al., 2004	Korea	1997	30–80	655	Men: 29%a; Women: 16.8%a	ATP-III [modified]
Thomas GN, et al., 2005	Hong Kong	1994–1996	25–74	2843	21.9%c	ATP-III [modified]
Son LNTD, et al., 2005	Ho Chi Minh City, Vietnam	2001	≥20	611	18.5%a; 12.0%c	ATP-III
Gu D, et al., 2005	China (Inter-ASIA)	2000–2001	35–74	15 540	Men: 9.8%c; Women: 17.8%c	ATP-III
Ford ES, 2005	United States.	1999–2002	≥20	3601	ATPIII: 34.5%a; IDF: 39.0%a	ATP-III & IDF
Adams RJ, et al., 2005	South Australia	2005	≥18	4060	IDF: 22.8%a; ATPIII:15%a	ATP-III & IDF
Guerrero-Romero F, et al.,	Northern Mexico (Durango City)	2005	30–64	700	IDF:22.3%; ATPIII:22.6%a;	ATP-III & IDF WHO

2005					WHO: 15.4%a	
Shiwaku K, et al., 2005	Japan, Korea and Mongolia	1999–2003	30–60	1384	Japanese: 12%a; Koreans: 13%a; Mongolians:16%a	ATP-III [modified: BMI ≥ 25]
Scuteri A, et al., 2005	Cardiovascular Health Study (CHS)	1989–1990	≥65	2175	ATPIII: 28.1%a; WHO: 21%a	ATP-III & WHO
Bo S, et al., 2005	North-western Italy	2001–2003	45–64	1877	23.1%a	ATP-III
Mohan V, et al., 2001	Chennai, India	1996–1997	≥20	1262	11.2%a	EGIR
Ramachandran A, et al., 2003	Chennai, India	1995	20–75	475	41.1%a	ATP-III [modified]
Gupta R, et al., 2004	Jaipur, India	2004	≥20	1091	31.6%a; 24.9%b	ATP-III

Over the past two decades, there has been a striking increase in the number of people with the Metabolic Syndrome (MetS) in developing countries. However, precise figures for its prevalence are not available. The pathogenesis of MetS involves a complex interplay of genetic and environmental factors. Central obesity and insulin resistance are pivotal in its development. Insulin resistance leads to hyperinsulinemia, exacerbating hypertension and dyslipidemia. Adipose tissue, especially visceral fat, secretes adipokines and inflammatory cytokines, contributing to metabolic dysregulation (Grundy et al., 2005; Eckel et al., 2005). Management primarily focuses on lifestyle interventions such as diet, physical activity and weight loss. Pharmacological treatments target specific components like hyperglycemia, hypertension and dyslipidemia. Studies have shown the lifestyle modification programs are effective for reducing the prevalence of MetS. Nutraceuticals and personalized medicine are emerging areas with promising results in managing MetS (Grundy et al., 2005; Mottillo et al., 2010)

Conclusion:

The prevalence of Metabolic Syndrome (MetS) is high and increasing worldwide due to increasing obesity and sedentary lifestyles. Effective treatment of MetS requires a combination of lifestyle changes and medications. Lifestyle interventions such as diet and exercise are important, while drug therapy is important to control certain components such as hyperglycemia, hypertension and dyslipidemia. The findings highlight the urgent need for a comprehensive public health strategy to address the growing burden of MetS. These strategies should include the early identification and management of risk groups and continued research to understand the underlying mechanisms and develop innovative treatments. This study identified the gaps in the current research and proposed the directions for the future studies to better understand and address MetS in the general population.

References

1. Abdul-Rahim HF, Husseini A, Bjertness E, et al. The Metabolic syndrome in the west bank population: an urban-rural comparison. Diabetes Care 2001; 24: 275–279.
2. Adams RJ, Appleton S, Wilson DH, et al. Population comparison of two clinical approaches to the metabolic syndrome. Implications of the new international diabetes federation consensus definition. Diabetes Care 2005; 28: 2777–2779.
3. Alberti KG, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, et al.; Harmonizing the metabolic syndrome: A joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation.2009;120:1640-5.

4. Alberti KG, Zimmet P, Shaw J. Metabolic syndrome-a new world-wide defi nition. A Consensus Statement from the International Diabetes Federation. Diabet Med 2006 May; 23(5):469-80.
5. Al-Lawati JA, Mohammed AJ, Al-Hinai HQ, et al. Prevalence of the metabolic syndrome among Omani adults. Diabetes Care 2003; 26: 1781–1785.
6. Arikan I, Metintas S, Kalyoncu C, Colak O, Arikan U .Evaluation of metabolic syndrome prevalence in semi-rural areas of Central Anatolia, Turkey. Saudi Med J.2009, 30(8): 1073–1080.
7. Azizi F, Salehi P, Etemadi A, et al. Prevalence of metabolic syndrome in an urban population: tehran lipid and glucose study. Diabetes Res Clin Pract 2003; 61: 29–37.
8. Bo S, Gentile L, Ciccone G, et al. The metabolic syndrome and high C-reactive protein: prevalence and differences by sex in a southern-European population-based cohort. Diabetes Metab Res Rev 2005; 21: 515–524. Web of Science® Times Cited: 1895
9. Bou Zerdan, M., Bouferraa, Y., & Assi, H. I. (2022). Metabolic Syndrome: Updates on Pathophysiology and Management. International Journal of Molecular Sciences, 23(2), 786.
10. Cameron AJ, Shaw JE, Zimmet PZ .The Metabolic Syndrome: Prevalence in Worldwide Populations. Endocrinol Metab Clin North Am.2004, 33(2): 351–376.
11. Chow C. K., S. Naidu, K. Raju et al., "Significant lipid, adiposity and metabolic abnormalities amongst 4535 Indians from a developing region of rural Andhra Pradesh," Atherosclerosis, 2008, vol. 196, no. 2, pp. 943–952
12. 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(2): 127–134.
13. Eckel, R. H., Grundy, S. M., & Zimmet, P. Z. (2005). The metabolic syndrome. The Lancet, 365(9468), 1415-1428.
14. Enas, E. A. V. Chacko, S. G. Pazhoor, H. Chennikkara, and H. P. Devarapalli, "Dyslipidemia in South Asian patients," Current Atherosclerosis Reports, 2007, vol. 9, no. 5, pp. 367–374.
15. Ford ES, Giles WH. A comparison of the prevalence of the metabolic syndrome using two proposed definitions. Diabetes Care 2003; 26: 575–581.
16. Ford ES. Prevalence of the metabolic syndrome defined by the international diabetes federation among adults in the U.S. Diabetes Care 2005; 28: 2745–2749.
17. 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;287:356–359.
18. Ford, E. S., Giles, W. H., & Dietz, W. H. (2008). Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. JAMA, 287(3), 356-359.
19. Ford, ES, WH, Giles , AH ,Mokdad . Increasing prevalence of the metabolic syndrome among U.S. adults. Diabetes Care. 2004;27:2444–2449.
20. Grundy SM, Brewer B, Cleeman JI, Smith SC, Lenfant C. Definition of metabolic syndrome: report of the National Heart, Lung, and Blood Institute/American Heart Association conference on scientific issues related to definition. Circulation 2004, 109: 433–438.
21. Grundy SM. Metabolic syndrome: connecting and reconciling cardiovascular and diabetes worlds. J Am Coll Cardiol. 2006; 47:1093–1100.
22. Grundy, S. M., Brewer, H. B., Cleeman, J. I., Smith, S. C., & Lenfant, C. (2005). Definition of Metabolic Syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association Conference on Scientific Issues Related to Definition. Circulation, 109(3), 433-438.
23. Gu D, Reynolds K, Wu X, et al, For the InterASIA Collaborative Group. Prevalence of the metabolic syndrome and overweight among adults in China. Diabetes Res Clin Pract 2005; 67: 243–250.

24. Guerrero-Romero F, Rodriguez-Moran M. Concordance between the 2005 International diabetes federation definition for diagnosing metabolic syndrome with the national cholesterol education program adult treatment panel III and the world health organization definitions. Diabetes Care 2005; 28: 2588–2589.
25. Gupta R, Deedwania PC, Gupta A, et al. Prevalence of metabolic syndrome in an Indian urban population. Int J Cardiol 2004; 97: 257–261.
26. IDF 2005 consensus worldwide definition of the metabolic syndrome. International Diabetes Federation, 2005. Available www.idf.org/webdata/docs/IDF_Metasyndrome_definition.pdf
27. Joslin EP. The prevention of diabetes mellitus. JAMA 1921;76:79–84.
28. Kamble P, Deshmukh PR, Garg N . Metabolic syndrome in adult population of rural Wardha, central India. Indian J Med Res 2010, 132(6): 701–705.
29. Magliano DJ, Shaw JE, Zimmet PZ How to best define the metabolic syndrome. Ann Med 2006, 38: 34–41.
30. Misra A.and L. Khurana, "The metabolic syndrome in South Asians: epidemiology, determinants, and prevention," Metabolic Syndrome and Related Disorders, 2009, vol. 7, no. 6, pp. 497–514.
31. Misra, A. et al., High prevalence of insulin resistance in postpubertal Asian Indian children is associated with adverse truncal body fat patterning, abdominal adiposity and excess body fat. Int. J. Obes. Relat. Metab. Disord., 2004, 28, 1217–1226.
32. Mohan V, Shanthirani S, Deepa R, et al. Intra-urban differences in the prevalence of the metabolic syndrome in southern India–the Chennai urban population study (CUPS No.4). Diabet Med 2001; 18: 280–287.
33. Mottillo, S., Filion, K. B., Genest, J., Joseph, L., Pilote, L., Poirier, P., Rinfret, S., Schiffrin, E. L., & Eisenberg, M. J. (2010). The metabolic syndrome and cardiovascular risk: a systematic review and meta-analysis. Journal of the American College of Cardiology, 56(14), 1113-1132.
34. Oh J, Hong YS, Sung Y, et al. Prevalence and factor analysis of metabolic syndrome in an urban Korean population. Diabetes Care 2004; 27: 2027–2032.
35. Paudel, K. R., & Jha, S. K. (2023). Progress in Understanding Metabolic Syndrome and Knowledge of Its Complex Pathophysiology. Diabetology, 4(2), 134-159.
36. Phillips GB. "Sex hormones, risk factors and cardiovascular disease." The American journal of medicine, 1978, 65 (1): 7–11
37. Prabhakaran, D., Chaturvedi, V., Shah, P., Manhapra, A., Jeemon, ., Shah, B. and Reddy, K. S., Differences in the prevalence of mtabolic syndrome in urban and rural India: a problem of urbanization. hronic Illn., 2007, 3, 8–19.
38. Ramachandran A, Snehalatha C, Latha E, Vijay V, Satyavani K. Culstering of Cardiovascular risk factors in urban Asian Indians. Diabetes Care 1998; 21: 967-71.
39. Ramachandran A, Snehalatha C, Satyavani K, et al. Metabolic syndrome in urban Asian Indian adults–a population study using modified ATPIII criteria. Diabetes Res Clin Pract 2003; 60: 199–204.
40. Reaven GM. Role of insulin resistance in human disease. Diabetes, 1988;37:1595-607.
41. Resnick HE, Henderson J, Jones K, et al. Insulin resistance, the metabolic syndrome and risk of incident cardiovascular disease in non-diabetic American Indians–the strong heart study. Diabetes Care 2003; 26: 861–867.
42. Sachdev HP, Osmond C, Fall CH, Lakshmy R, Ramji S, et al. Predicting adult metabolic syndrome from childhood body mass index: follow-up of the New Delhi birth cohort. Arch Dis Child 2009, 94(10): 768–774.
43. Scuteri A, Najjar SS, Morrell CH, et al. The metabolic syndrome in older individuals: prevalence and prediction of cardiovascular events. Diabetes Care 2005; 28: 882–887.
44. Shiwaku K, Nogi A, Kitajima K, Anuurad E, Enkhmaa B, et al. Prevalence of the Metabolic Syndrome using the Modified ATP III Definitions for Workers in Japan, Korea and Mongolia. J Occup Health, 2005, 47: 126–135.

45. Singer P (May 1977). "Diagnosis of primary hyperlipoproteinemias.". Zeitschrift fur die gesamte innere Medizin und ihre Grenzgebiete 2005, 32 (9): 129–33 concl. PMID 906591.
46. Son Lent, Kuniia D, Hung NTK, et al. The metabolic syndrome: prevalence and risk factors in the urban population of Ho Chi Minh City. Diabetes Res Clin Pract 2005; 67: 243–250.
47. Tan CE, Ma S, Wai D, et al. Can we apply the national cholesterol education program adult treatment panel definition of the metabolic syndrome to Asians? Diabetes Care 2004; 27: 1182–1186.
48. The National Cholesterol Education Program (NCEP). Executive Summary of the Third Report. Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III) JAMA. 2001; 285:2486–2497.
49. Thomas GN, Ho SY, Janus ED, et al. The US National cholesterol education programme adult treatment panel III (NCEP ATPIII) prevalence of the metabolic syndrome in a Chinese population. Diabetes Res Clin Pract 2005; 67: 251–257.
50. World Health Organisation, Western Pacific Region. The Asia-Pacific Perspective. Redefining Obesity and its Treatment. WHO/IASO/IOTF: Melbourne: International Diabetes Institute, 2000.
51. Zimmet P, Alberti KG, Shaw J Global and societal implications of the diabetes epidemic. Nature 2001.414: 782–787