

TITLE: The Diabetes Epidemic, Interventional Strategies, and Related Economic Factors

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The Diabetes Epidemic, Intervention Strategies, and Related Economic Factors

This paper presented demographic data illustrating the extent of the current international diabetes epidemic and explored current opinion related to the impact of contemporary therapeutic lifestyle interventions on diabetes and related health concerns. Lifestyle intervention with type 2 diabetes, in particular, was reviewed. Outcome research data from the Marshall University Diabetes Exercise and Cardiac Rehabilitation Center were also presented.

Therapeutic lifestyle interventions can significantly reduce premature all-cause mortality and disability, improve quality of life, and increase chances for longevity in the population at large. These benefits are presumed for diabetes patients as well, but such interventions are not without risk. For this reason, the importance of screening participants with a thorough medical history and physical examination prior to initiating their programs was emphasized with a unique case study presentation. Although lifestyle and related interventions have consistently proven effective, mainstream health and medical educators, many times, are not convinced of their efficacy unless related outcomes impact the financial bottom-line. Accordingly, this paper presented data showing significant improvements in the economic domain resulting from clinical and lifestyle interventions.

The objectives of this presentation were to:

- ✓ Illustrate the magnitude of the diabetes epidemic in the world
- ✓ Review the impact of this epidemic on co morbid clinical states
- ✓ Illustrate the alarming increase of type 2 diabetes in children
- ✓ Demonstrate the effectiveness of therapeutic lifestyle intervention
- ✓ Illustrate the importance of screening these individuals prior to their program
- ✓ Illustrate the impact of therapeutic interventions in the economic domain

Introduction

The prevalence of diabetes is increasing in epidemic proportions relative to population growth, aging, urbanization, and increases in obesity and physical inactivity (1). Because most data sources do not distinguish between type 1 and type 2 diabetes, it is not possible

to delineate between diabetes subtypes. Because type 2 diabetes accounts for more than 90% of diagnosed diabetes cases (2), this paper will concentrate primarily on type 2 diabetes mellitus.

Type 2 diabetes is the result of an interaction between genetic predisposition and behavioral and environmental risk factors. Although the genetic basis of type 2 diabetes has yet to be identified, there is extensive evidence that modifiable risk factors such as physical activity and obesity are the primary nongenetic disease determinants (3, 4).

The Extent of the Problem

Table 1 shows the *International Diabetes Institute* estimate of approximately 239,250,000 cases of diabetes in the world by 2010. This is contrasted with 110,186,000 and 175,331,000 cases, respectively, in 1994 and 2000.

Table 1. GLOBAL PREVALENCE OF DIABETES**			
Diabetes 1995 to 2010: Estimates and Projections <i>International Diabetes Institute [IDI] WHO Collaborating Centre</i> Melbourne, Australia [www.idi.org.au]			
World/ Region	People with diabetes:1994	People with diabetes:2000	People with diabetes:2010*
World	110,186,000	175,331,000	239,250,000
Africa	5,299,000	12,091,000	18,823,000
Asia	51,237,000	94,732,000	138,145,000
North America	15,085,000	16,976,000	18,868,000
Latin America	12,605,000	16,469,000	20,248,000
Europe	18,460,000	23,714,000	27,994,000
Former USSR	6,636,000	10,251,000	13,852,000
Oceania	64,000	1,098,000	1,320,000

*The WHO estimates that up to 300,000,000 will have diabetes by 2025.
**This statistical summary prepared by *wpm* from IDI data on June 3, 2000.

A study (1), using *World Health Organization* (WHO) data for 191 member states applied to United Nations' population estimates for 2000 and 2030, arrived at similar figures, but extended the estimates to 2030, with a figure of 366,000,000 people (Table 2). They also suggest that these figures underestimate future diabetes prevalence.

One reason for underestimation is that data are more limited for younger and older age groups. As well, the metabolic syndrome and other forms of glucose intolerance, forms of pre-diabetes, are present in almost 50,000,000 adult Americans (5). The burgeoning overweight/obesity epidemic will likely have a monumental impact on these numbers. Recent research (6) indicates that 65% of adults aged at least 20 years and 31% of children aged 6 through 19 years are overweight or obese. Vasan (7) estimates the future burden of obesity and related conditions to be even greater. Data from the Framingham Heart Study shows that 9 out of 10 young to middle-aged men and 7 out of 10 women are likely to become overweight/obese over the next 30 years.

The prevalence of type 2 diabetes and impaired glucose metabolism (i.e., prediabetes) among US adolescents aged 12-19 is also substantial. Recent research estimates that 134,071 have diabetes – 95,066 with type 1 and almost 40,000 with type 2. The latter figure is particularly disturbing because type 2 diabetes has historically and clinically been considered adult onset diabetes. Of even greater concern is the estimate of US youth with prediabetes – 2,769,736 (8).

Table 2. Countries with Highest Estimated Diabetes Cases [millions] 2000 - 2003

Ranking	2000		2030	
	Country	Cases	Country	Cases
1	India	31.7	India	79.4
2	China	20.8	China	42.3
3	U.S.	17.7	U.S.	30.3
4	Indonesia	8.4	Indonesia	21.3
5	Japan	6.8	Japan	13.9
6	Pakistan	5.2	Pakistan	11.3
7	Russian Fed.	4.6	Russian Fed.	11.1
8	Brazil	4.6	Brazil	8.9
9	Italy	4.3	Italy	7.8
10	Bangladesh	3.2	Bangladesh	6.7
World Total [millions]		177	366	

Adapted from: Wild S et al. *Diabetes Care* 27:1047-1053, 2004.

Roglic and colleagues provide the first global estimates of mortality attributable to diabetes. They report that approximately 2.9 million died of diabetes in 2000, 3 times previous estimates. This would make it the fifth leading cause of death (9). More recent research provides greater cause for concern in the United States (US), suggesting that the number of individuals with diabetes in the US will increase by 198%, from 16.2 million in 2005, to 48.3 million in 2050. This would more than double the number of US citizens with diabetes, 12% of the population. (10).

Cardiovascular disease is characterized by an accelerated atherosclerosis in diabetes and is the leading cause of morbidity and mortality in these patients. Heart disease and stroke account for almost 70% of diabetes mortality. And research has shown that type 2 diabetes patients who have not previously experienced a myocardial infarction (MI) have the same risk of an MI as nondiabetics with a prior history of MI (2, 11).

Diabetes is the leading cause of blindness and end-stage renal disease, and up to 70% of those with diabetes have peripheral neuropathy, a leading cause of lower extremity amputations. More than 60% of nontraumatic lower extremity amputations occur in diabetics – 82,000 such procedures were performed in 2002 (2). The impact on premature disability, death, and quality of life is substantial. A recent study by Booth and colleagues concluded that diabetes confers an equivalent risk to aging 15 years (12).

Clinical Therapeutic Lifestyle Intervention

Research has clearly shown that intensive medication therapy and therapeutic lifestyle intervention, alone or combined, can prevent, cure, or correct type 2 diabetes and substantially reduce the microvascular and macrovascular complications related to type 1 diabetes (13, 14).

Current opinion holds that a comprehensive program of exercise should be an integral part of patient care, and that low cardiorespiratory fitness and physical inactivity are independent predictors of all-cause mortality in type 2 diabetes mellitus (15). Intervention studies in the United States (16), Sweden (17), China (18), and Finland (3) have convincingly demonstrated that regular physical activity, either alone or combined with other strategies, can delay or prevent type 2 diabetes and related complications in high-risk subjects. In a recent editorial on the role of physical fitness in managing patients with diabetes, Clark (19) commented: “The data supporting the health benefits of physical activity are overwhelming. We must move from demanding more data to learning how to apply what we already know.”

The well-documented link between obesity, cardiovascular disease, and diabetes also mandates the inclusion of weight management and obesity prevention in therapeutic lifestyle intervention programs. It is imperative that these programs be established to reverse the epidemics of obesity, metabolic syndrome, and diabetes with their accompanying metabolic disorders, sometimes in the form of insulin resistance (4). Failure to do so may result in our health care systems being overwhelmed with the astronomic numbers shown in Tables 1 and 2.

Figure 1. Impact of the Diabetes Prevention Program On the metabolic syndrome [red] and t2DM [green]

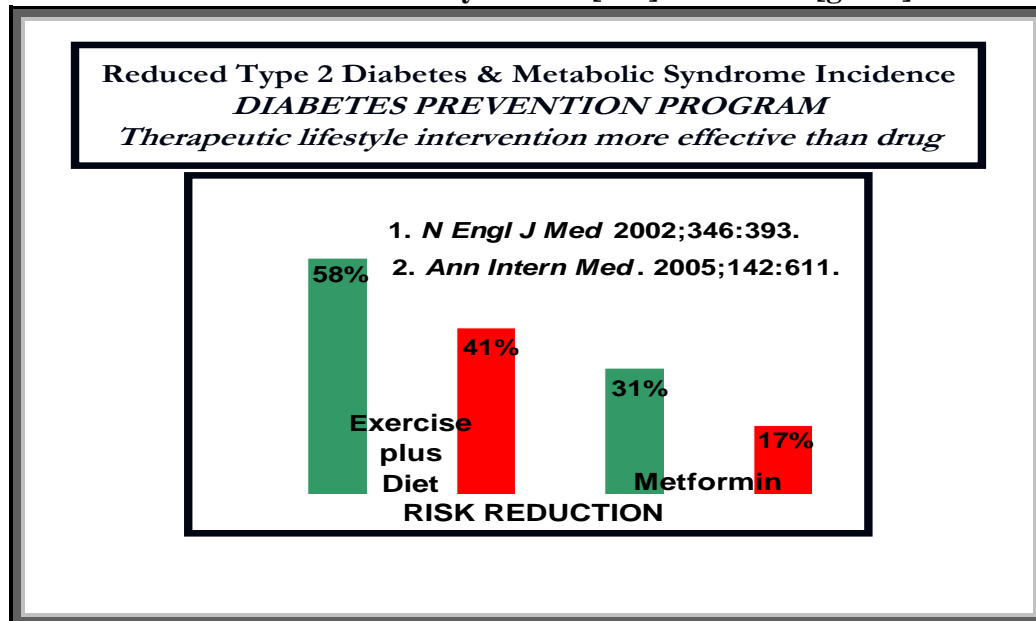


Figure 1 illustrates the Diabetes Prevention Program (16) impact on type 2 diabetes and the metabolic syndrome, considered to be a form of pre-diabetes. Therapeutic lifestyle intervention that included exercise and weight reduction was twice as effective as medication (i.e., metformin/glucofage) in preventing type 2 diabetes and even more effective in preventing the metabolic syndrome. And clinicians know that patients who establish sensible lifestyles usually require less medication when it is required.

Table 3 lists some benefits that may contribute to these favorable clinical outcomes. The *Handbook of Exercise in Diabetes* provides a more comprehensive review (20).

Table 3.

Benefits of exercise for patients with type 2 diabetes

- Improved insulin sensitivity
- Improved blood glucose control
- Improved cardiovascular risk factor status
- Improved fibrinolytic mechanism
- Improved psychological status
- Increased muscle mass
- Reduced bodyfat

Adapted from: Marley WP et al.
Canadian J Diab. 26:241-5, 2002.

The Importance of Screening

Exercise, however, is not without risks, and patients with diabetes should be screened carefully for existing macro- and microvascular complications prior to beginning an exercise program. A thorough medical history and physical examination, which focuses on signs and symptoms of diseases affecting the cardiovascular system, eyes, kidneys, and nervous system, should be part of the pre-participation medical profile. A graded exercise test may prove useful for some patients (**Table 4**).

Table 4.

Exercise testing may benefit these type 2 patients.

- Age >35 years
- Type 2 diabetes >10 years
- Known or suspected CVD
- Prevalence of CHD risk factors
- Microvascular disease/disorder
- Autonomic neuropathy & incompetence

Adapted from: Marley WP et al.
Canadian J Diab. 26:241-5, 2006.

Absolute contraindications to exercise participation include severe hyperglycemia, ketosis, recent significant electrocardiographic changes, unstable angina pectoris, uncontrolled cardiac arrhythmias causing hemodynamic compromise, untreated high-risk proliferative retinopathy and retinal hemorrhage.

Comorbid conditions such as hypertension, dyslipidemia, retinopathy, renal disorders, peripheral and autonomic neuropathy, previous myocardial infarctions (MI) and a history of revascularization procedures, are commonly observed in patients with type 2 diabetes. It is also not uncommon for these patients to have occult ischemic heart disease relative to cardiac autonomic neuropathy (CAN) and concomitant myocardial ischemia. They may be asymptomatic, even during a conventional multi-stage exercise test (MSET), in

the presence of significant ischemia observed on the electrocardiogram (ECG). Not surprisingly, sudden death has been associated with CAN in such patients (20, 21).

A Case of Cardiac Autonomic Neuropathy (CAN)

A recent publication (22) by the author outlines such a case (Table 5). Following successful coronary artery bypass graft surgery recommended as the result of our screening procedures, this patient safely entered our program and continues to be active.

Table 5. Multi-Stage Exercise Test Findings: Case Example A 65 Year-Old Male With Type 2 Diabetes & PVD	
Resting BP: 148/82	Peak BP: 204/96
Resting HR: 62	Peak HR: 127
	%APHR: 82%
Stopping Codes:	Post BP: 180/88 Post HR: 82
	Sig. contour changes 4mm]
	and silent ischemia [CAN]:
Clinical outcome:	Contraindication and referral
	Positive angiogram and
	referral for CABGSx5
Marley WP, Marsh LA. Type 2 diabetes and exercise: The importance of screening. <i>Canadian Journal of Diabetes</i> . 2002;26:241-5.	

Table 6 shows some of his clinical data for a subsequent 4-year period. Examination of these data underlines the importance of a lifetime commitment to a therapeutic lifestyle.

Table 6. HbA1c & FBG: Case Example 65 Year-Old Male With Type 2 DM				
Variable	Baseline	2yr	3yr	4yr
HbA1c*	0.078[7.8]	0.085[8.5]	0.088[8.8]	0.069[6.9]
FPG	14.2[256]	9.9[178]	6.7[121]	5.1[92]
*mmol/L [mg/dl]				
Medications: Felodipine 10mg QD, Glipizide 10 mg BID; lovastatin 40 mg QD; Cilostazol 100 mg QD; ASA 325 QD.				
Marley and Marsh, <i>Canadian Journal of Diabetes</i> . 2002.				

Related Economic Factors

The estimated annual cost of diabetes to our health care systems is \$132 billion. This includes direct medical costs of \$92 billion and \$40 billion in indirect costs (e.g., disability, work loss, premature mortality) (2).

What about the bottom line for intervention? Research (23) in the Diabetes Exercise and Cardiac Rehabilitation Center at Marshall University has shown that improved clinical profiles achieved by cardiac patients with comorbid diabetes in a multifactorial cardiac rehabilitation program reduced their dependence on the health care system in several

ways. This included significant reductions in medication, emergency room visits, hospital admissions, and visits to their physicians. See (Table 7).

Sidorov (24) and colleagues analyzed the economic impact of a disease management program on medical costs for diabetes patients. They report savings in paid claims of \$108 per member per month for intervention patients compared to controls. That would translate to more than \$100,000 annual savings in paid claims for the 82 patients currently enrolled in our program.

Variable	Economic Domain Medical System Utilization		
	Pre	Post [P<0.01]	N
Medication	7.94	7.36	37
ER Visits	1.68	0.78	33
Hospital Admissions	1.08	0.27	33
Physician Visits	8.39	3.31	31

Marley WP, et al. *J Cardiopulm Rehab.* 2006;26:262.

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