



## India towards diabetes control: Key issues

Arun Kumar,<sup>1</sup> Manish K Goel,<sup>2</sup> Ram Bilas Jain,<sup>3</sup> Pardeep Khanna,<sup>3</sup> Vikas Chaudhary<sup>4</sup>

1. SHKM Govt Medical College Nalhar (Mewat) India, 2. Lady Hardinge Medical College, New Delhi,  
3. Pt BD Sharma PGIMS Rohtak, 4. ESI Model Hospital, Gurgaon, Haryana

### EDITORIAL

Kumar A, Goel MK, Jain RB, Khanna P, Chaudhary V. India towards diabetes control: Key issues. AMJ 2013, 6, 10, 524-531. <http://doi.org/10.21767/AMJ.2013.1791>

#### Corresponding Author:

Dr Arun Kumar  
Department of Community Medicine,  
SHKM Govt Medical College, Nalhar (Mewat)  
Haryana, India.

[Email: arun.pgims@gmail.com](mailto:arun.pgims@gmail.com)

### Abstract

The problem of mass diabetes is steadily increasing everyday. This editorial introduces key issues that need to be addressed to support the effective control of diabetes in India as well as globally. Issues like awareness generation for risk reduction, frequency of monitoring for selected parameters, standards for monitoring chronic complications in patients with diabetes, and current recommended targets of various parameters, amongst others, are presented along with extensions to the vaccinations recommended for diabetic patients.

#### Key Words

Diabetes, challenges, control, India, key issues, vaccinations, awareness.

### Introduction

Diabetes mellitus is a chronic non-communicable disease resulting in increased blood glucose levels. In diabetes there is deficiency of insulin secretion by the pancreas or ineffectiveness of secreted insulin, which can either be inherited or acquired. There are several forms of diabetes, such as:

- Type 1 diabetes mellitus or insulin dependent diabetes mellitus.
- Type 2 diabetes mellitus or non-insulin dependent diabetes mellitus (NIDDM) (other specific types include damage to pancreas by specific causes –

toxins, infections etc.).

- Impaired glucose tolerance ( $\geq 200$ mg/dL after 2h of 75g of glucose intake) and impaired fasting glucose ( $\geq 126$  mg/dL).<sup>1</sup>
- Gestational diabetes mellitus (only during pregnancy).

Approximately 177 million people worldwide are diabetic. This number is likely to double by 2030.<sup>2</sup> Diabetes is responsible for every 1 in 20 deaths from all causes and approximately four million annual deaths are because of complications of diabetes i.e. six deaths every minute or one death every 10 seconds.<sup>2</sup> More than 80 per cent of diabetes deaths occur in low- and middle-income countries.<sup>3</sup> The problem of diabetes is not homogenous in India. Currently, 4.0-11.6 per cent of India's urban population and three per cent of the rural population above the age of 15 has diabetes.<sup>5,6</sup> India has been called "the diabetes capital of the world," and it is estimated that 41 million Indians have the disease and "every fifth diabetic in the world is an Indian".<sup>7</sup> The prevalence of impaired glucose tolerance test (GTT) ranges from 3.6–9.1 per cent, which indicates a potential of further increase in the prevalence.<sup>5</sup> It is projected to increase to 70 million by 2025.<sup>6</sup> Due to these sheer numbers, the socio-economic burden due to diabetes in India is among the highest in the world.<sup>8</sup> The overall direct healthcare costs of diabetes mellitus ranges from 2.5–15 per cent of annual health care budgets. This burden is likely to only increase with the projected increase in the numbers of people with diabetes.<sup>9</sup> In low income families the cost of care of a diabetic adult is up to 25 per cent of the family income.

Usually, the importance of diabetes prevention is not realised by patients until they suffer from it. The main problem with diabetes is that it cannot be cured, it can only be managed. In India, the Chennai-based Diabetes Research Centre says that over 50 per cent of diabetes cases in rural India and about 30 per cent in urban areas go undiagnosed.<sup>6</sup> In another study, screening has shown that the unknown-to-known diabetes ratio is about 1.8:1 in urban areas, whilst it is as high as 3.3:1 in rural places.<sup>9</sup>



To tackle the rising prevalence of diabetes in India, the government started a National Diabetes Control Program in 1987 on a pilot basis in some districts of Tamil Nadu, Jammu and Kashmir and Karnataka. However, due to paucity of funds this program could not be expanded further in the following years. However, the budget allocation has subsequently been increased. The National Program for Prevention and Control of Diabetes, Cardiovascular Disease, and Stroke (NPCDCS), launched in January, 2008, had completed its pilot phase in 10 states and is now set to be extended to the whole country, with a special focus on risk reduction, early diagnosis and appropriate management of diabetes for the prevention of diabetes (along with other disorders, such as cancer, cardiovascular diseases, and stroke).<sup>10</sup> Apart from this, important issues like the prevention of diabetes are also not being adequately addressed by diabetes researchers.<sup>11</sup> Considering it the right time we planned to identify and address the key issues so that everyone i.e. physicians, public health professionals and the common man could play an efficient role in the effective implementation of the program to achieve better diabetic control in India.

## The key areas

### Awareness generation for risk reduction

We must generate awareness regarding the risk factors for diabetes. The risk factors for diabetes are:

- Physical inactivity or a sedentary lifestyle – which causes the development of insulin resistance, predisposing to NIDDM.
- Diet – higher saturated fatty acid intake results in the development of insulin resistance, hence predisposing to NIDDM and higher intake of unsaturated fatty acids which results in increased insulin sensitivity and reduces risk of NIDDM. Higher intake of dietary fibre results in better glucose tolerance.
- Obesity - a risk factor for diabetes both in India and in the West, but the disease appears at a lower threshold of obesity in India, as is also the case in China, Japan and other Asian countries thereby increasing the population at risk.<sup>12</sup>
- Urbanisation - a rise in living standards and increased sedentariness, and the availability of cheap calorie-rich, fatty, fast foods to rich and poor alike are a few of the reasons behind the diabetes epidemic worldwide.<sup>13-16</sup>
- Malnutrition – in early infancy and childhood results in partial  $\beta$  cell dysfunction. Low birth weight can lead to diabetes and metabolic syndrome. Though the genetic component of low birth weight cannot be altered, maternal

undernutrition can be alleviated by providing better maternal and child health care. Rotavirus vaccine can also help in reducing malnutrition by interrupting the malnutrition-infection cycle.<sup>17,18</sup> Also, evidence suggests that adiposity and overweight in children is rising.<sup>19</sup> There is a need to address the school structure to promote physical activity. The 'child-friendly school initiative' launched by the Indian Academy of Paediatrics (IAP) to support this goal is a welcome initiative. Children must be educated about the importance of healthy lifestyles.<sup>20</sup>

- Alcohol – excessive intake damages the pancreas and liver and also causes obesity.
- Viral infections – some viral infections e.g. Rubella, mumps, coxsackie B4 mediate  $\beta$  cell destruction in some immuno-genetically susceptible individuals.
- Toxic chemical substances – e.g. alloxan, cyanide producing foods etc. cause  $\beta$  cell destruction.
- Stress – may bring out the subclinical form of disease.
- Others – socio-economic status, religion, education etc. may be associated with diabetes because of changes in lifestyle associated with them.

Not only are there a huge number of people with diabetes in India but awareness levels are also low. The Chennai Urban Rural Epidemiology Study (CURES) reported that nearly 25 per cent of the population was unaware of a condition called diabetes. The knowledge of risk factors of diabetes was even lower with only 11.9 per cent of the study subjects reporting obesity and physical inactivity as risk factors for diabetes.<sup>21,22</sup> The International Diabetes Federation (IDF) (and its member associations) engages millions of people worldwide in diabetes advocacy and awareness in response to growing concerns about the escalating health threat that diabetes poses. For this, World Diabetes Day is also celebrated every year on 14 November since 1991- to raise public awareness of diabetes and its related complications as well as its prevention and care.<sup>23,24</sup>

### Current recommendations for the prevention of diabetes

Diabetes cannot be cured; it can only be prevented and managed. The following steps could be followed to avoid falling prey to the disease and to keep it under control:

- Exercise daily: Morning walk, yoga, running, aerobics can all help in preventing diabetes.
- Make healthy food choices: Choose foods with lower fat, saturated fat, calories, and salt. Try fresh vegetables and fresh fruits. Replace soft drinks with fresh juices and water.
- Try to eat sensible meals and snacks at regular



times throughout the day.

- Use stairs rather than a lift.
- Eat slowly: It takes 20 minutes for your stomach to send a signal to your brain that you're full.<sup>25,26</sup>

### Achieving better control of diabetes

Diabetes, in India, has extended from affluent and rich people to the middle income and poorer sections of society. In India there exists an overall poor standard of diabetes care<sup>27</sup> and considerable variability in the quality of diabetes care, which depends upon various factors such as:

- Accessibility to services. There is a good health care delivery system in place in India. A lot of community health programs are already running which provide an opportunity to reach out to the general population. However, in many places the post of medical officers is lying vacant. Moreover laboratory facilities are also in poor shape.<sup>28-30</sup> A large segment of the population is served by peripheral workers, who have little technical background knowledge. They cannot prescribe drugs to diabetics but they can at least identify individuals with a high risk of diabetes and provide health education regarding risk factors. Moreover, for the control of diabetes many interventions are non-pharmacological, and long-term adherence is crucial, therefore community health workers can play an important role through patient education or facilitating adherence to treatment.<sup>31</sup>
- Affordability of drugs. In India, essential drugs for the treatment of diabetes are available at lower than global prices, but are still too expensive for a significant proportion of patients.<sup>32</sup> Earlier, the low cost of domestically produced drugs together with government controlled prices, and the absence of patent regulations had made the Indian market less attractive for foreign anti-diabetic drug companies. But with the new patent laws in place the market scenario will change and will become attractive for foreign companies.<sup>33</sup>
- Quality of service. In India there is considerable variability in the quality of care and the overall standard of diabetes care.<sup>27</sup> Quality of care depends upon the quality of services i.e. the expertise available, attitudes and perceptions amongst diabetes care providers. There is also a lack of standardisation in laboratory techniques for the measurement of blood sugar levels and HbA1c levels. There is a lack of consensus for target values and standard management guidelines.<sup>34</sup> Results-oriented organised programs involving patient education along with updating the medical

fraternity on various developments and standard guidelines for management of diabetes.

- Newer research and initiatives. Opportunities to use and analyse newer treatment options in the form of observational studies and clinical trials are required to combat the diabetes epidemic in India.

Therapies are available in different indigenous systems of medicines in India. Knowledge and practices from these indigenous systems of medicine, including Ayurveda, Yoga etc. can be harnessed for devising preventive and treatment strategies<sup>35</sup> after being found effective in trials.

Diabetes management in Ayurveda includes diet, behaviour and herbal modalities. Various herbs have been described with anti-hyperglycaemic actions. Some of these like karela, turmeric, spinach, fenugreek seeds among others, can be part of a healthy diet.<sup>36</sup>

Yoga describes stretching and other exercises, besides meditation. These could be incorporated into a healthy lifestyle program.

Epidemiologic studies suggest that type 2 diabetes mellitus may be present for upto a decade before diagnosis.<sup>37</sup> The goals for diabetic control are:

- relief of symptoms;
- improving quality of life;
- prevention of acute and chronic complications; and
- correction of metabolic abnormalities.

To achieve the above mentioned goals it is essential that there should be regular screening/monitoring of blood levels of various parameters and other target parameters. (Tables 1 and 2). For older adults, screening/monitoring for diabetes complications should be individualised with particular attention to complications which would lead to permanent impairment. Currently recommended targets for effective diabetic control for the levels in venous whole blood sample and few others are as given in Table 3.<sup>1, 38</sup> Vaccinations recommended for diabetic persons are highlighted in Table 4.



**Table 1: The frequency of monitoring for selected parameters in patients with diabetes<sup>1</sup>**

Parameter to be monitored / screened	Frequency of monitoring / screening	
Body weight and height and calculate body mass index (BMI)	At least twice a year <sup>37</sup>	
Blood pressure	At least twice a year <sup>37</sup>	
Glycosylated HbA1C	At least twice a year (in patients who have stable glycaemic control), quarterly (in patients who are not meeting glycaemic goals or whose therapy has changed)	
Lipid profile	Annually (especially in adults)	
Urine albumin	Annually (in type 1 DM patients with diabetes duration of $\geq 5$ years, and in all type 2 DM patients)	
Serum creatinine	Annually (in all adults irrespective of their urine albumin excretion)	
Fundoscopy and visual acuity	At initial examination (in adults and children aged $\geq 10$ yrs with type 1 diabetes) thereafter, annually, or more frequently (if retinopathy is progressing) first trimester or even earlier (In women with preexisting diabetes who become pregnant or are planning pregnancy) Close follow-up (throughout pregnancy and for one year post partum)	
Neuropathy	Screening for distal symmetric polyneuropathy (DPN)	At diagnosis of type 2 diabetes, and five years after diagnosis of type 1 diabetes thereafter, at least annually
	Electrophysiological testing	If clinical features are atypical
	Screening for signs and symptoms of cardiovascular autonomic neuropathy	At diagnosis of type 2 diabetes, and five years after diagnosis of type 1 diabetes
Comprehensive Foot examination	Annually	
Peripheral arterial disease (PAD)	As and when required by the clinician	

**Table 2: Standards for monitoring of chronic complications of diabetes in children and adolescents<sup>1,37</sup>**

Complication	Indication of screening	Timing and/or Method of monitoring / screening
Nephropathy	Once the child is 10 years of age and has had diabetes for five years	Annual screening for microalbuminuria, with a random spot urine spot sample for albumin-to-creatinine ratio (ACR)
Dyslipidemia	If age of child is $> 2$ years and there is a family history of increased serum cholesterol levels or a cardiovascular event before age 55 years, or if family history is unknown	Fasting lipid profile soon after the diagnosis (after glucose control has been obtained)
	If such family history is not significant	Lipid profile at puberty ( $\geq 10$ years)
	Diagnosed with diabetes at or after puberty	Lipid profile soon after diagnosis of diabetes (after glucose control has been obtained)
	If lipid levels are abnormal	Annual lipid profile
	If LDL cholesterol levels are within accepted risk level (ie, $< 100$ mg/dL [2.6 mmol/l])	Lipid profile repeated every five years
Retinopathy	See Table 1	See Table 1
Celiac disease	In children with type 1 diabetes and with growth failure, failure to gain weight, weight loss, diarrhea, flatulence, abdominal pain, or signs of malabsorption, or in children with frequent unexplained hypoglycemia or deterioration in glycaemic control	Tissue transglutaminase or antiendomysial antibodies, with documentation of normal serum IgA levels, soon after the diagnosis of diabetes



Hypothyroidism	Children with type 1 diabetes	Thyroid peroxidase and thyroglobulin antibodies, TSH, soon after the diagnosis of diabetes [after glycaemic control has been established] If normal, recheck every 1-2 years [esp, when patient develops symptoms of thyroid dysfunction, thyromegaly, or an abnormal growth rate]
----------------	-------------------------------	---

**Opportunities for conjoint efforts by various stakeholders**

The government has an important role to play by showing strong political commitment towards achieving better control of diabetes. Affordable drugs and accessible, preventive and curative services could be provided to all sections of community – rural/urban, poor/rich, etc to fill the gaps. Hard to reach areas could be identified/mapped and the health workforce might be mobilised to those areas. Investing in awareness generation among patients and the general population through spreading key messages in local languages might be another useful step. Policies and programs could be made which focus on behaviour change from childhood. As children are considered potent carriers of targeted key messages, another potential step might be the involvement of schools to play roles in generating awareness among children, and then to the rest of the community. Such targeted interventions might be introduced into the newly launched NPCDCS.<sup>10</sup> Legislations could be made to target forced behaviour change e.g., higher tax on junk food, subsidised prices of healthy foods, etc. The government might also encourage researchers and provide financial support for clinical trials and operational research on diabetes and related programs respectively. Effective monitoring of the NPCDCS and addressing the potential barriers to diabetes care are warranted by the government and concerned health officials for improved outcomes.<sup>39, 40</sup>

Patients might contribute by spreading awareness and by motivating fellow patients for drug adherence and behaviour change towards a healthy lifestyle. They could also be sensitised to play important roles in generating awareness among community members for disease prevention and screening of blood sugar as recommended. Development of knowledge or awareness in turn evolves into improved self-care in diabetes.<sup>40, 41</sup>

**Table 3: Recommended targets for effective diabetes control in adults<sup>1,37</sup>**

Parameter	Target level
Glycosylated Hb (HbA1C)	<7% (or as suggested by health service providers)
Triglyceride level (fasting)	< 150 mg/dL
HDL cholesterol	> 40 mg/dL (in males); > 50 mg/dL (in females)
LDL cholesterol	< 100 mg/dL (individuals without overt CVD) < 70 mg/dL (individuals with overt CVD)
Body Mass Index (BMI)	<25 Kg/m <sup>2</sup>
Systolic BP	< 130 mmHg (or below the 90 <sup>th</sup> percentile for age, sex, and height, whichever is lower)
Diastolic BP	< 80 mmHg (or below the 90 <sup>th</sup> percentile for age, sex, and height, whichever is lower)
Protein intake	Reduction to 0.8 – 1.0 g/Kg body weight/day [in patients with diabetes and early stages of chronic kidney disease (CKD)] Reduction to 0.8 g/Kg body weight/day (in later stages of CKD)
Physical activity	At least 150 min/week of moderate-intensity aerobic physical activity (50-70% of maximum heart rate), spread over at least 3 days per week with no more than two consecutive days without exercise Resistance training at least twice a week [in type 2 diabetes and in the absence of contraindications (after consultation with clinician)]
Smoking	Cessation (if relevant)
Alcohol	≤ 2 standard drinks/day for adult men, ≤ 1 standard drink/day for adult women

As a shared responsibility, physicians and paramedical personnel could extend their services to counsel patients about dietary therapy also.<sup>42</sup> In a densely populated developing country like India which is already short of qualified doctors,<sup>43</sup> physician–patient contact time is limited. The skilled paramedic or educator could spend time with the patient and family to counsel and make an assessment of not only an individual’s knowledge/thinking about his illness and educational needs but also each person’s readiness to know.<sup>44</sup>





**Table 4: Recommended vaccinations for diabetic patients<sup>1</sup>**

Type of vaccine	Indication	Schedule
Influenza vaccine	All diabetic patients with $\geq 6$ months of age	Annually
Pneumococcal polysaccharide vaccine	All diabetic patients with $\geq 2$ months of age	Single dose or One-time revaccination if indicated*
Hepatitis B Vaccine	All adult diabetic patients with 19–59 years of age (may also be administered to unvaccinated adult diabetics who are aged $\geq 60$ years at the discretion of the treating clinician)	Three doses, i.e., at 0, 1, and 6 months <sup>†</sup> <small>42,43,44</small>

\*  $>64$  years of age previously immunised when they were  $<65$  years of age if the vaccine was administered  $>5$  years ago, patients with nephrotic syndrome, chronic renal disease, and other immunocompromised states, such as after transplantation.

<sup>†</sup> As per Centres for Disease Control and Prevention (CDC) Atlanta recommendations. More recommendations for special circumstances are available at website of Centres for Disease Control and Prevention (CDC) Atlanta ie, <http://www.cdc.gov/>

In a developing country, the introduction of skilled counsellors might be another alternative option to counsel diabetics and their family members according to the prescriptions of doctors. Hence, the feasibility of introducing skilled counsellors might be assessed to fill the gap of physicians and paramedics, particularly in resource constrained areas where the gap in qualified healthworkers is far greater.

### Conclusions

Apart from being limited to the standards of diabetes care in India, there is a distinct need for a comprehensive diabetes care program which must be more wide ranging. Essential diabetic care should be universally accessible, in terms of technology and expertise as discussed above, to the general population and acceptable to them at an affordable cost. To reduce morbidity and mortality due to diabetes, concerted efforts of consultants practicing diabetes care, family physicians, individuals with diabetes, the general population, relevant associations and those entrusted with public health in India are a must. In view of the gaps between the guidelines and real life practice<sup>45-48</sup> and in order to improve diabetes control in India, a balanced approach to improve awareness about diabetes and its control both among patients and the medical fraternity is the urgent need of the hour. For the Indian subcontinent also, the best fit applicability of product and

service design for patient centred diabetes care might be assessed<sup>49</sup> and awareness levels among the diabetic patients might be extended to involve them in their treatment plans.<sup>50</sup>

### References

1. American Diabetes Association. Executive summary: Standards of medical care in diabetes--2012. *Diabetes Care*. 2012;35 Suppl 1:S4-S10.
2. Vision Rehabilitation Centre. Diabetes and the Eye. Newsletter 12 [document on the Internet]. Hyderabad (India): Vision Rehabilitation Centre; 2003 [cited 2013 May 20]. Available from: <http://patientcare.lvpei.org/vision-rehabilitation/images/light-up12.pdf>
3. World Health Organization. Diabetes. Factsheet [document on the Internet]. Geneva: WHO; 2012 [[updated 2013 March; cited 2013 Jun 8]. Available from: <http://www.who.int/mediacentre/factsheets/fs312/en/index.html>
4. Arora V, Malik JS, Khanna P, Goyal N, Kumar N, Singh M. Prevalence of diabetes in urban Haryana. *Australas Med J*. 2010;3(8):488-94.
5. Park K. Epidemiology of chronic non-communicable diseases and conditions. Park's textbook of preventive and social medicine. 21st ed. Jabalpur: M/s Banarsidas Bhanot; 2011. P. 363-4.
6. India, world diabetes capital. *Hindustan Times* [newspaper on the Internet]. 2007 Sep 03 [cited 2013 May 25]; para 1-5. Available from: <http://www.hindustantimes.com/India-world-diabetes-capital/Article1-245889.aspx>
7. Joshi SR, Parikh RM. India - diabetes capital of the world: now heading towards hypertension. *J Assoc Physicians India*. 2007;55:323-4.
8. Joshi SR, Das AK, Vijay VJ, Mohan V. Challenges in diabetes care in India: sheer numbers, lack of awareness and inadequate control. *J Assoc Physicians India*. 2008;56:443-50.
9. Sadikot SM. The Indian task force on diabetes care in India [homepage on the Internet]. Mumbai: Diabetes India; [cited 2013 Jun 4]. Available from: <http://www.diabetesindia.com/diabetes/itfdci.htm>
10. Ministry of Health & Family welfare. National Programme for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases & Stroke (NPCDCS): operational guidelines [document on the Internet]. New Delhi: Government of India; 2010 [cited 2012 Dec 12]. Available from: <http://health.bih.nic.in/Docs/Guidelines-NPCDCS.pdf>.



11. Lakey WC, Barnard K, Batch BC, Chiswell K, Tasneem A, Green JB. Are current clinical trials in diabetes addressing important issues in diabetes care?. *Diabetologia*. 2013;56(6):1226-35.
12. Mohan V, Mathur P, Deepa R, Deepa M, Shukla DK, Menon GR, Anand K, Desai NG, Joshi PP, Mahanta J, Thankappan KR, Shah B. Urban rural differences in prevalence of self-reported diabetes in India--the WHO-ICMR Indian NCD risk factor surveillance. *Diabetes Res Clin Pract*. 2008;80(1):159-68.
13. Diamond J. Diabetes in India. *Nature*. 2011;469:478-9.
14. Gupta R. Smoking, educational status and health inequity in India. *Indian J Med Res*. 2006;124(1):15-22.
15. Ramachandran A. *Epidemiology of diabetes in India*. New Delhi: Jaypee; 2007.
16. Reddy KS, Prabhakaran D, Jeemon P, Thankappan KR, Joshi P, Chaturvedi V, Ramakrishnan L, Ahmed F. Educational status and cardiovascular risk profile in Indians. *Proc Natl Acad Sci USA* 2007; 104(41):16263-68.
17. Chandran A, Fitzwater S, Zhen A, Santosham M. Prevention of rotavirus gastroenteritis in infants and children: rotavirus vaccine safety, efficacy, and potential impact of vaccines. *Biologics*. 2010;4:213-29.
18. Schlaudecker EP, Steinhoff MC, Moore SR. Interactions of diarrhea, pneumonia, and malnutrition in childhood: recent evidence from developing countries. *Curr Opin Infect Dis*. 2011;24(5):496-502.
19. Marwaha RK, Tandon N, Singh Y, Aggarwal R, Grewal K, Mani K. A study of growth parameters and prevalence of overweight and obesity in school children from Delhi. *Indian Pediatr*. 2006;43(11):943-52.
20. Sachdev HP. Nutritional transition in the backdrop of early life origin of adult diseases: a challenge for the future. *Indian J Med Res*. 2004;119(4):iii-v.
21. Murugesan N, Snehalatha C, Shobhana R, Roglic G, Ramachandran A. Awareness, about diabetes and its complications in the general and diabetic population in a city in southern India. *Diabetes Res Clin Pract* 2007;77(3):433-7.
22. Mohan D, Raj D, Shanthirani CS, Datta M, Unwin NC, Kapur A, Mohan V. Awareness and knowledge of diabetes in Chennai--the Chennai Urban Rural Epidemiology Study [CURES-9]. *J Assoc Physicians India*. 2005;53:283-7.
23. International Diabetes Federation. World diabetes day 14 November [document on the Internet]. Belgium: International Diabetes Federation; 1991 [update 2013 May 15; cited 2013 Jun 5]. Available from: <http://www.idf.org/worlddiabetesday/>.
24. UN News Centre. On World Diabetes Day, Ban calls for global action to improve quality of life for millions [document on the Internet]. New York City: United Nations; 2012 Nov 14 [cited 2013 Jan 13]. Available from: <http://www.un.org/apps/news/story.asp?NewsID=43491&Cr=diabetes&Cr1#.Ua1cRdJkPng>.
25. Layton J. Could I lose weight just by eating slower?. *Anatomy & Physiology* [document on the Internet]. HowStuffWorks, Inc; 2006 Nov 23 [cited 2013 Jun 6] Available from: <http://science.howstuffworks.com/life/human-biology/eat-slower.htm>.
26. How can you get back in touch with your hunger signals?. *Food and recipes* [document on the Internet]. WebMD, LLC.; 2005 [updated 2011 Oct 21; cited 2013 Jun 5]. Available from: <http://www.webmd.com/food-recipes/healthy-eating-recognizing-your-hunger-signals#>.
27. Desai A, Tandon N. Challenges in prevention and management of diabetes mellitus and metabolic syndrome in India. *Current Science*. 2009;97(3):356-64.
28. Ministry of Health and Family Welfare. Guidelines for multipurpose health worker (male) 2010 [document on the Internet]. New Delhi: Government of India; 2010 [cited 2012 Dec 5]. Available from: [http://www.nihfw.org/pdf/Guidelines\\_MPHW\(M\)\\_29dec2011.pdf](http://www.nihfw.org/pdf/Guidelines_MPHW(M)_29dec2011.pdf).
29. Ministry of Health and Family Welfare. 4th Common Review Mission Report. Punjab [document on the Internet]. New Delhi: Government of India; 2010 [cited 2013 Jun 6]. Available from: [http://www.mohfw.nic.in/NRHM/CRM/CRM\\_files/4th\\_CRM/Statewise/Punjab%204th%20CRM%20Report.pdf](http://www.mohfw.nic.in/NRHM/CRM/CRM_files/4th_CRM/Statewise/Punjab%204th%20CRM%20Report.pdf).
30. National Rural Health Mission Division. 6th Common Review Mission Report 2012. New Delhi: Ministry of Health and Family Welfare, Government of India; 2012.
31. Renders CM, Valk GD, Griffin SJ, Wagner EH, Eijk Van JT, Assendelft WJ. Interventions to improve the management of diabetes in primary care, outpatient, and community settings: a systematic review. *Diabetes Care*. 2001;24(10):1821-33.
32. Srinath Reddy K, Shah B, Varghese C, Ramadoss A. Responding to the threat of chronic diseases in



- India. *Lancet*. 2005;366(9498):1744-9.
33. Corporate Catalyst India. A brief report on pharmaceutical industry in India [document on the Internet]. New Delhi: CCI; 2013 [cited 2005 Jun 30]. Available from: <http://www.cci.in/pdfs/surveys-reports/Pharmaceutical-Industry-in-India.pdf>.
  34. Dilley J, Ganesan A, Deepa R, Deepa M, Sharada G, Williams OD, Mohan V. Association of A1C with cardiovascular disease and metabolic syndrome in Asian Indians with normal glucose tolerance. *Diabetes Care* 2007;30:1527-32.
  35. Manyam BV. Diabetes mellitus, Ayurveda, and yoga. *J Altern Complement Med*. 2004;10(2):223-5.
  36. Elder C. Ayurveda for diabetes mellitus: a review of the biomedical literature. *Altern Ther Health Med*. 2004;10(1):44-50.
  37. Harris MI, Klein R, Welborn TA, Knudman MW. Onset of NIDDM occurs at least 4-7 yr before clinical diagnosis. *Diabetes Care*. 1992;15(7):815-9.
  38. Victorian Government Department of Human Services. Diabetes self-management: guidelines for providing services to people newly diagnosed with Type 2 diabetes [document on the Internet]. Melbourne: State Government of Victoria; 2007 [cited 2013 Jun 7]. Available from: <http://www.health.vic.gov.au/communityhealth/publications/diabetes.htm>.
  39. Alberti H, Boudriga N, Nabli M. Primary care management of diabetes in a low/middle income country: a multi-method, qualitative study of barriers and facilitators to care. *BMC Fam Pract*. 2007;8:63.
  40. Shrivastava SR, Shrivastava PS, Ramasamy J. Role of self-care in management of diabetes mellitus. *J Diabetes Metab Disord*. 2013;12(1):14.
  41. Golin CE, DiMatteo MR, Gelberg L. The role of patient participation in the doctor visit. Implications for adherence to diabetes care. *Diabetes Care*. 1996;19(10):1153-64.
  42. Wunschel IM, Sheikholislam BM. Is there a role for dietetic foods in the management of diabetes and/or obesity?. *Diabetes Care*. 1978;1(4):247-9.
  43. World Health Organization. Aggregated data: Density per 1000 by country. Data repository [document on the internet]. Geneva: WHO; 2013 [cited 2013 Aug 12]. Available from: <http://apps.who.int/gho/data/node.main.A1444>
  44. Dudley JD. The diabetes educator's role in teaching the diabetic patient. *Diabetes Care*. 1980;3(1):127-33.
  45. Chow CK, Raju PK, Raju R, Reddy KS, Cardona M, Celermajer DS, Neal BC. The prevalence and management of diabetes in rural India. *Diabetes Care*. 2006;29(7):1717-8.
  46. Nagpal J, Bhartia A. Quality of diabetes care in the middle and high-income group populace: the Delhi Diabetes Community (DEDICOM) survey. *Diabetes Care*. 2006;29:2341-8.
  47. Kapur A, Shishoo S, Ahuja MMS, Sen V, Mankame K. Diabetes care in India: Physicians perceptions, attitudes and practices. *Int J Diab Dev Countries*. 1998;18:124-30.
  48. Chuang LM, Tsai ST, Huang BY, Tai TY. The status of diabetes control in Asia—a cross-sectional survey of 24 317 patients with diabetes mellitus in 1998. *Diabet Med*. 2002;19:978-85.
  49. Varadarajan S, Fennessy L, McLean H. Product and service design for patient centered diabetes. *Australas Med J*. 2009;1(13):216-9.
  50. Ozolins LZ, Donald M, Mutch AJ, Crowther RE, Begum N. Who knows they have a treatment plan?. *Australas Med J*. 2010;1(2):153-9.
  51. Centers for Disease Control and Prevention (CDC). Use of hepatitis B vaccination for adults with diabetes mellitus: recommendations of the Advisory Committee on Immunization Practices (ACIP). *MMWR Morb Mortal Wkly Rep*. 2011;60(50):1709-11.
  52. Advisory Committee on Immunization Practices (ACIP). CDC Recommendation for Hepatitis B Vaccination among Adults with Diabetes: Grading of Scientific Evidence in Support of Key Recommendations [document on the Internet]. Atlanta: Centers for Disease Control and Prevention; 2012 [updated 2012 Aug 16; cited 2013 May 26]. Available from: <http://www.cdc.gov/vaccines/acip/recs/GRADE/hepB-vac-adults-diabetes.html>
  53. Centers for Disease Control and Prevention (CDC). Information for Diabetes Educators. Diabetes and Hepatitis B Vaccination [document on the Internet]. Atlanta: U.S. Department of Health and Human Services; 2012 [cited 2013 May 26]. Available from: [http://www.cdc.gov/diabetes/pubs/pdf/HepB\\_vaccination.pdf](http://www.cdc.gov/diabetes/pubs/pdf/HepB_vaccination.pdf)

#### PEER REVIEW

Not commissioned. Externally peer reviewed

#### CONFLICTS OF INTEREST

The authors declare that they have no competing interests.