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Addressing noncommunicable diseases in primary care: the case of type 2 diabetes

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ABSTRACT The rapid growth of noncommunicable diseases represents a formidable global health challenge. Here we use type 2 diabetes as a case study to illustrate the rise of noncommunicable diseases and call attention to the important role of primary care systems in addressing these diseases in low- and middle-income countries. Comprehensive screening for diabetes should be implemented through primary care systems to increase early detection of prediabetes and undiagnosed diabetes – a first step to diabetes prevention and management. In addition, primary care systems should strengthen and expand capacity to link patients to appropriate interventions based on their diabetes status and provide care coordination (e.g. leveraging task-shifting and technology), and integrate clinic and community resources for diabetes prevention and control. Additional strategies should include continuous quality improvement, health systems strengthening, workforce development, and affordable and sustainable financing. Together, these actions could elevate the role of primary care in addressing diabetes in low- and middle-income countries and help advance global progress towards reducing diabetes complications, and also preventing or delaying diabetes among those at risk.

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GLOBAL BURDEN OF NONCOMMUNICABLE DISEASES AND THE CASE OF TYPE 2 DIABETES

The past few decades have witnessed impressive economic growth, increases in life expectancy, and progress in population health worldwide. Globally, present trends show steady declines in child and maternal mortality and substantial reductions in deaths and morbidity due to infectious diseases.[1–3] However, noncommunicable diseases (NCDs) are rising rapidly across the world, with a disproportionate burden falling on developing countries. According to a report from the World Health Organization, six of the top 10 risk factors for mortality are related to NCDs.[4,5] In addition, NCDs are now the leading cause of death and disability worldwide, and nearly 80% of deaths due to chronic disease occur in low- and middle-income countries (LMICs).[5,6] Furthermore, NCDs are extremely costly to individuals, families, and national healthcare systems.[5] Identifying strategies to prevent and control NCDs, particularly in LMICs where programmes and policies are most underdeveloped, is an urgent global priority.

In this paper, we use type 2 diabetes as a case study to illustrate the rise of NCDs and draw attention to the important role of primary care systems in addressing these diseases in LMICs. Encouragingly, several high-income countries have achieved notable declines in diabetes-related mortality and complication rates.[7,8] Many of these improvements are due to widespread implementation of proven clinical interventions to control risk factors and to prevent diabetes complications.[7,8] Within LMICs, recent data suggest that similar improvements in diabetes can be achieved through evidence-based interventions, including screening, lifestyle programmes, and diabetes care quality improvement initiatives. We contend that LMICs could leverage primary care to implement and scale up these interventions and advance primary and secondary prevention of diabetes.

First, comprehensive screening for diabetes could be widely implemented through primary care systems in LMICs, substantially increasing the early detection of prediabetes and undiagnosed diabetes – a prerequisite for the prevention and management of the disease. Second, because patients at all stages along the continuum of prediabetes and diabetes interact with primary care systems, primary healthcare providers are well positioned to link patients with the appropriate

care (for example, evidence-based lifestyle interventions to prevent diabetes and coordinated clinic-based care and disease management support to prevent diabetes complications).

TYPE 2 DIABETES – A PANDEMIC

Type 2 diabetes is an enormous and growing problem worldwide.[9–11] Around 415 million adults are living with diabetes, and according to recent projections this number will rise to 642 million by 2040.[11] While the prevalence of diabetes continues to increase in almost every country in the world, developing countries are facing particularly dramatic increases.[12] Furthermore, the spread of diabetes in LMICs is pervasive with both urban and rural areas experiencing alarming increases in diabetes prevalence.[13] Over the last 25 years, for example, the prevalence of diabetes increased fivefold in rural areas in LMICs.[12] The risk of diabetes and related complications (including premature death, cardiovascular disease, kidney disease, blindness, amputations, poor mental health, and low quality of life) varies considerably across populations.[14,15] The socially disadvantaged are often most vulnerable to developing diabetes and suffering from multiple disease related complications due to limited access to preventative care, low education, and resource constraints.

Globally, diabetes is now a major cause of death and morbidity. The high medical costs and reduced productivity associated with diabetes pose a major economic burden for individuals and families and drive the poorest households into deeper poverty.[11] Diabetes also strains already weak health systems and threatens economic development.[5] In 2010, an estimated 12% of total health expenditure worldwide was attributable to diabetes.[16] Furthermore, because the number of people with diabetes, and thus those with diabetic complications, continues to rise, future health expenditures are projected to reach even higher levels.

EVIDENCE FOR DIABETES PREVENTION

There is strong evidence that in high-risk individuals (e.g. those with impaired glucose tolerance) type 2 diabetes can be prevented or delayed through lifestyle interventions (programmes that train individuals to achieve modest weight loss through diet and physical activity) and/or metformin.[17] Results from several randomised controlled trials demonstrate that lifestyle interventions targeting people at high risk for diabetes reduces diabetes incidence.[17,18] A large multicentre study of the US Diabetes Prevention Program (DPP) showed that participants enrolled in a lifestyle intervention reduced their risk of developing diabetes by 58% compared to standard lifestyle advice.[19] Lifestyle interventions also reduce cardiometabolic risk factors (e.g. weight, systolic and diastolic blood pressure, inflammatory markers, development of metabolic syndrome, prevalence of urinary incontinence, and mortality, retinopathy, and chronic kidney disease) while improving quality of life.[14,20] Additionally, economic evaluations show that lifestyle interventions are cost-effective.[14,21]

The proven benefits of lifestyle interventions for people with prediabetes have prompted the translation of lifestyle interventions into real-world settings.[22,23] A systematic review and meta-analysis of 28 studies concluded that lifestyle interventions modelled on the DPP and implemented in non-experimental settings in the USA achieved clinically significant weight loss in individuals at high risk for diabetes.[24] A growing body of literature from LMICs indicates that lifestyle interventions are also effective for diabetes prevention in low-resource settings.

In India, a recent randomised controlled trial, the Diabetes Community Lifestyle Improvement Program (D-CLIP), tested the effectiveness of a step-wise diabetes prevention model (intensive lifestyle intervention plus the addition of metformin, when appropriate) among Asian Indian adults with isolated IGT (iIGT), isolated impaired fasting glucose (iIFG), or IFG +IGT.[25,26] To assess eligibility for the study, participants underwent a two-phase screening process: community-based screening followed by a clinic-based full evaluation. A total of 578 participants were randomised to receive standard lifestyle advice (control) or the step-wise diabetes prevention model. The intervention comprised culturally-tailored lifestyle education classes based on the DPP in combination with metformin when needed. Participants attended core classes weekly for six months, followed by eight maintenance classes for five to six months. Participants were given two goals: lose > 7% baseline body weight and exercise > 150 mins per week at moderate intensity. Starting at four months after implementation of the classes, participants were prescribed metformin (500 mg twice daily) if they were found to be at high risk of conversion from prediabetes to diabetes (IFG and either $HbA_{1c} \geq 5.7\%$ or IGT). Data were collected at baseline, four months (post-core intervention of weekly classes), six months (post-maintenance), and every six months until the end of the study. Diabetes incidence (the primary outcome) was measured by a single oral glucose tolerance test annually or a semi-annual fasting plasma glucose test.

Over a three-year follow-up period, over 25% of individuals in the intervention developed diabetes, compared to nearly 35% of individuals in the control group. The risk of diabetes in overweight or obese adults with prediabetes was reduced by 32%, with the strongest relative risk reduction found in participants 50 years or older, male, or obese or those with combined IGT and IFG or IGT alone. The study found

that treating ten participants for three years led to the prevention of one case of diabetes. Overall, the findings from this large, randomised trial demonstrate that lifestyle interventions are effective for addressing diabetes in a resource-challenged setting like India and spur optimism for the health benefits of these interventions in other LMICs.[26]

Connecting people with prediabetes to evidence-based lifestyle interventions like D-CLIP should be a priority for primary healthcare providers. This requires lifestyle programmes to be certified and providers to be aware of such programmes, refer eligible patients, and encourage participation. Ideally, providers should also follow up with patients to ensure they are participating and taking the appropriate steps to prevent diabetes and its complications. In communities where lifestyle interventions either do not exist or have reached capacity, providers could drive up demand for these community resources and motivate and advocate for an increase in the supply of certified lifestyle programmes.[27,28]

EVIDENCE FOR PREVENTION OF DIABETES COMPLICATIONS

Considerable evidence shows that mortality and morbidity from diabetes can be reduced through good control of glucose, blood pressure, lipids, use of aspirin and reno-protective drugs, and regular screening for eye, kidney, and foot complications.[15,29–31] Furthermore, research from high-income countries has found that implementing these strategies systematically, and in combination with ongoing quality improvement approaches, can reduce diabetes-related deaths and morbidity in real-life settings.[7,8,32–34]

In LMICs, emerging evidence now indicates that clinic-based quality improvement (QI) interventions to address patient and provider barriers to diabetes care are feasible, acceptable, effective, and have the potential for scale-up. In ten clinics in India and Pakistan, the CARRS (Center for cArdio-metabolic Risk Reduction in South Asia) trial tested the effect of a multicomponent QI strategy compared to usual care in patients with poorly controlled diabetes and an additional cardiovascular risk factor (i.e. high blood pressure or high cholesterol).[35,36] In total, 1,146 patients were randomly assigned to a multicomponent care model or usual care and followed for 2.5 years. The care model combined care coordination by non-physicians and decision-support electronic health records for physicians, with the aim of enhancing monitoring and treatment by providers and promoting better self-care among patients. While risk factors improved in both control and intervention groups, among intervention participants, the study found relatively greater reductions in HbA_{1c} level (-0.50%), systolic BP (-4.04 mmHg), diastolic BP (-2.03 mmHg), and LDLc level (-7.86 mg/dL), compared to those receiving usual care. In addition, intervention participants reported greater improvements in health-related quality of life and treatment satisfaction.[36]

The results of the CARRS trial provides evidence that a multicomponent QI intervention addressing multiple barriers to care can support patients with diabetes in achieving their care goals, even in low-resource healthcare settings.[36] Additionally, the results show that the health benefits that accrue to patients participating in the QI intervention can be sustained for more than two years.[36] Since intervention participants covered the costs of all the treatment and follow-up (with the exception of the yearly study visits), the findings are generalisable to real-world clinical settings. Implementing and scaling up QI strategies found to be effective in CARRS is a promising approach for closing the gap in achievement of diabetes care goals in LMICs.

OPPORTUNITIES TO ADDRESS DIABETES THROUGH POLICY

With strong evidence available for effective delivery of diabetes prevention and care through primary care systems, the challenge is to systematically scale up a primary care-based model that integrates diabetes prevention and control strategies (Figure 1). Early detection of people at risk is the first step to rolling out such a model, since it functions to increase the number of people with detected prediabetes or diabetes and promote available interventions, thereby addressing both demand- and supply-side factors.[37] Primary care systems should also establish partnerships and processes for linking people to appropriate care and ensuring care coordination (e.g. through the use of technology, such as electronic health records and task-shifting). Further steps should include continuous quality improvement, strengthening primary care systems, workforce development, and adequate affordable financing – all of which are essential for the successful implementation and sustainability of the model.

Early detection

Globally, an estimated 50% of the 415 million people with diabetes are not aware of their status,[11] and even in a high-income country like the USA approximately 25% of diabetes cases and 93% of prediabetes cases are undiagnosed.[38,39] There is an even larger detection gap in LMICs where health services are often limited and underdeveloped.[37] However, people's diabetes status must be known if health systems are to link them with the appropriate programmes and services. Thus, the implementation of a systematic and organised policy for diabetes screening in primary care systems is a critical first step in the delivery of high-quality evidence-based diabetes prevention and care.

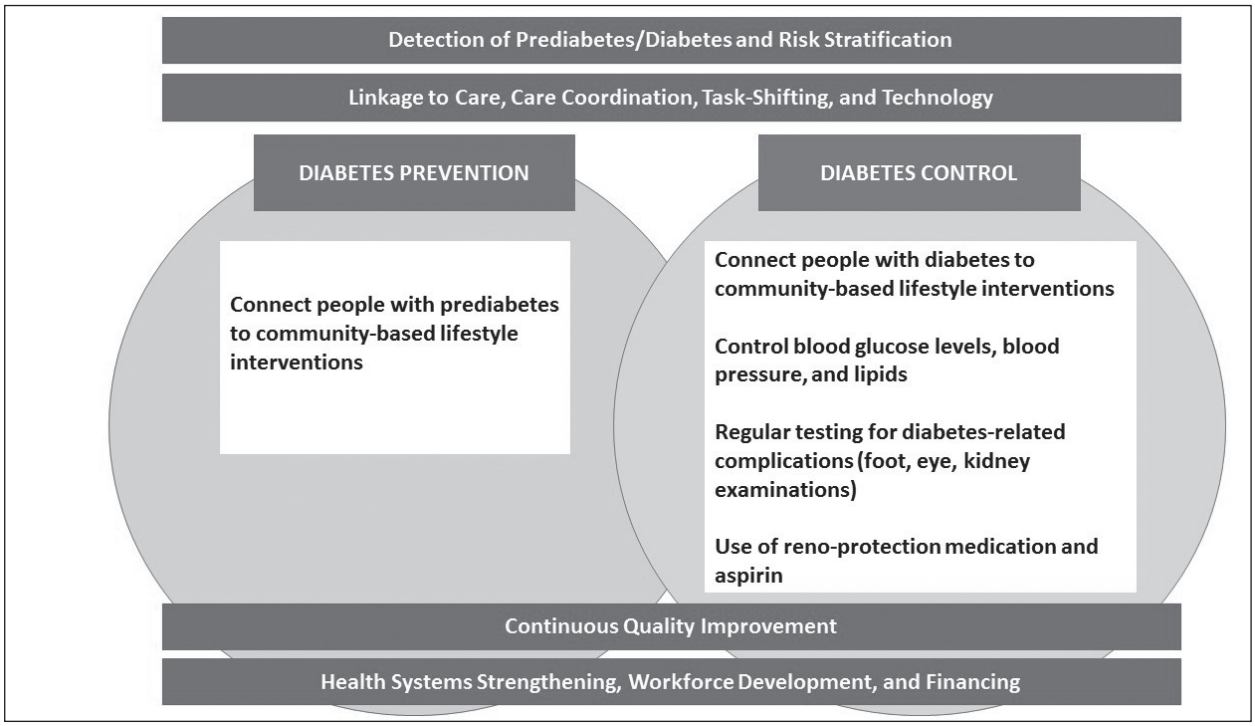

FIGURE 1 A framework for the role of primary care systems in diabetes prevention and control. This shows the role of primary care systems in addressing diabetes in LMICs. Primary care systems should integrate clinic and community resources for diabetes prevention and control. Cross-cutting strategies should include: detection of prediabetes or diabetes and risk stratification; linkage to care and care coordination (e.g. leveraging task-shifting and technology); continuous quality improvement; and health systems strengthening, workforce development, and financing.

Successfully implementing such a policy requires overcoming important barriers. First, screening for diabetes remains a topic of intense debate and different expert groups promote disparate guidelines. Second, existing screening guidelines focus on detecting diabetes in people who are at high risk for the disease. Third, screening is of little value, and arguably unethical, if primary care systems do not refer people identified as high risk for diabetes to effective preventive interventions, and deliver high-quality care for those diagnosed with diabetes. Finally, the cost of screening, prevention and treatment is often very high and, in some cases, unaffordable.

Increasing early detection is essential if primary care systems are to expand the population that accesses and benefits from available evidence-based and cost-effective interventions to prevent diabetes and its complications.[21] Given the high proportion of people with undetected prediabetes and diabetes, implementation of broad policies for screening has the potential to benefit millions. Data from three large South Asian cities alone showed that six out of every ten adults have prediabetes or diabetes.[40] Safe and reliable hyperglycaemia screening tests are currently available.[41] Additionally, several systematic reviews have found that screening for hyperglycaemia combined with subsequent treatment with lifestyle intervention or metformin for people with prediabetes and diabetes may be a cost-effective strategy.[41]

Integrating clinic and community resources, and emphasising coordination and quality improvement

In high-income countries, such as the USA, diabetes prevention and control initiatives are starting to bring together public and private stakeholders to integrate healthcare and community-based resources. For example, the YMCA (the worldwide community-based organisation) is implementing and scaling up a structured lifestyle programme for diabetes prevention, in partnership with local healthcare systems.[22] When healthcare providers identify patients with prediabetes, they can refer their patients to a lifestyle programme in the community. This initiative improves coordination between the healthcare system and community-based resources and helps ensure continuity of care for people with prediabetes. To ensure the quality of lifestyle programmes delivered through community-based organisations like the YMCA, the US Centers for Disease Control and Prevention recognises programmes that meet quality assurance standards set out by the agency. The Centers for Disease Control and Prevention also supports training of lifestyle coaches to expand the number of people equipped to deliver lifestyle programmes and promotes awareness of recognised programmes among healthcare providers and the public.[27]

Primary care systems in LMICs should adopt a strategy similar to that of the YMCA and play a leadership role

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in bringing together multiple stakeholders to integrate clinic and community resources for diabetes prevention and control. Such an initiative should be complemented by well-developed and efficient processes for linking people with prediabetes or diabetes to the appropriate care and supporting the coordination of that care. Additionally, quality improvement initiatives, combined with strengthening health systems, workforce development, and financing, are critical for ensuring the availability and implementation of high quality care.

CONCLUSION

NCDs have emerged as a new global challenge. We argue that primary care offers a promising means of successfully addressing NCDs like diabetes in LMICs. We propose a comprehensive framework for improving primary and secondary prevention of diabetes through primary care systems. Specifically, we contend that primary care systems should strengthen and expand capacity to offer screening, link patients to appropriate interventions, and provide care coordination. In addition, the health community should galvanise new commitments from stakeholders in the public and private sectors and facilitate the integration of clinic and community resources for diabetes prevention and control. Finally, quality improvement, strengthening health systems, workforce development, and affordable and sustainable financing are important strategies for ensuring the success of a primary care-based model for the prevention and control of diabetes. Together, these actions could elevate the role of primary care systems in addressing diabetes in LMICs and help advance global progress towards curbing the diabetes epidemic. Furthermore, the recommended actions presented in this paper can be implemented by primary care systems to tackle other NCDs that threaten the health and wellbeing of individuals and societies.

EDUCATION

REFERENCES

1 Kassebaum NJ, Bertozzi-Villa A, Coggeshall MS et al. Global, regional, and national levels and causes of maternal mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2014; 384: 980–1004. http://dx.doi.org/10.1016/S0140-6736(14)60696-6

2 Liu L, Oza S, Hogan D et al. Global, regional, and national causes of child mortality in 2000-13, with projections to inform post-2015 priorities: an updated systematic analysis. *Lancet* 2015; 385: 430–40. http://dx.doi.org/10.1016/S0140-6736(14)61698-6

3 GBD 2013 Mortality and Causes of Death Collaborators. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2015; 385: 117–71. http://dx.doi.org/10.1016/S0140-6736(14)61682-2

4 *Global health risks: mortality and burden of disease attributable to selected major risks*. Geneva: World Health Organization; 2009. http://www.who.int/healthinfo/global_burden_disease/GlobalHealthRisks_report_full.pdf

5 Narayan KM, Ali MK, Koplan JP. Global noncommunicable diseases – where worlds meet. *N Engl J Med* 2010; 363: 1196–8. http://dx.doi.org/10.1056/NEJMp1002024

6 Daar AS, Singer PA, Persad DL et al. Grand challenges in chronic non-communicable diseases. Nature 2007; 450: 494–6.

7 Gregg EW, Li Y, Wang J et al. Changes in diabetes-related complications in the United States, 1990–2010. *N Engl J Med* 2014; 370(16): 1514–23. http://dx.doi.org/10.1056/NEJMoa1310799

8 Narayan KM. Type 2 Diabetes: Why We Are Winning the Battle but Losing the War? 2015 Kelly West Award Lecture. *Diabetes Care* 2016; 39: 653–63. http://dx.doi.org/10.2337/dc16-0205

9 Zimmet PZ, Magliano DJ, Herman WH et al. Diabetes: a 21st century challenge. *Lancet Diabetes Endocrinol* 2014; 2: 56–64. http://dx.doi.org/10.1016/S2213-8587(13)70112-8

10 Chen L, Magliano DJ, Zimmet PZ. The worldwide epidemiology of type 2 diabetes mellitus--present and future perspectives. *Nat Rev Endocrinol* 2012; 8: 228–36. http://dx.doi.org/10.1038/nrendo.2011.183

11 International Diabetes Federation. *IDF Diabetes Atlas*, 7th ed. Brussels: International Diabetes Federation; 2015. http://www.diabetesatlas.org

12 Hwang CK, Han PV, Zabetian A et al. Rural diabetes prevalence quintuples over twenty-five years in low- and middle-income countries: a systematic review and meta-analysis. *Diabetes Res Clin Pract* 2012; 96: 271–85. http://dx.doi.org/10.1016/j.diabres.2011.12.001

13 Zabetian A, Sanchez IM, Narayan KM et al. Global rural diabetes prevalence: a systematic review and meta-analysis covering 1990–2012. *Diabetes Res Clin Pract* 2014; 104: 206–13. http://dx.doi.org/10.1016/j.diabres.2014.01.005

14 Narayan KM, Gujral UP. Evidence Tips the Scale Toward Screening for Hyperglycemia. *Diabetes Care* 2015; 38: 1399–401. http://dx.doi.org/10.2337/dc15-0856

15 Gregg EW, Sattar N, Ali MK. The changing face of diabetes complications. *Lancet Diabetes Endocrinol* 2016; 4: 537–47. http://dx.doi.org/10.1016/S2213-8587(16)30010-9

16 Zhang P, Zhang X, Brown J et al. Global healthcare expenditure on diabetes for 2010 and 2030. *Diabetes Res Clin Pract* 2010; 87: 293–301.

17 Gillies CL, Abrams KR, Lambert PC et al. Pharmacological and lifestyle interventions to prevent or delay type 2 diabetes in people with impaired glucose tolerance: systematic review and meta-analysis. *BMJ* 2007; 334: 299.

18 Schellenberg ES, Dryden DM, Vandermeer B et al. Lifestyle interventions for patients with and at risk for type 2 diabetes: a systematic review and meta-analysis. *Ann Intern Med* 2013; 159: 543–51. http://dx.doi.org/10.7326/0003-4819-159-8-201310150-00007

19 Knowler WC, Barrett-Connor E, Fowler SE et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 2002; 346: 393–403.

20 Mudaliar U, Zabetian A, Goodman M, et al. Cardiometabolic Risk Factor Changes Observed in Diabetes Prevention Programs in US Settings: A Systematic Review and Meta-analysis. *PLoS Med* 2016; 13: e1002095. http://dx.doi.org/10.1371/journal.pmed.1002095

21 Narayan KM, Weber MB. Screening for hyperglycemia: the gateway to diabetes prevention and management for all Americans. *Ann Intern Med* 2015; 162: 795–6. http://dx.doi.org/10.7326/M15-0798

22 Ackermann RT, Finch EA, Brizendine E et al. Translating the Diabetes Prevention Program into the community. The DEPLOY Pilot Study. *Am J Prev Med* 2008; 35: 357–63. http://dx.doi.org/10.1016/j.amepre.2008.06.035

23 Whittemore R. A systematic review of the translational research on the Diabetes Prevention Program. *Transl Behav Med* 2011; 1: 480–91. http://dx.doi.org/10.1007/s13142-011-0062-y

24 Ali MK, Echouffo-Tcheugui J et al. How effective were lifestyle interventions in real-world settings that were modeled on the Diabetes Prevention Program? *Health Aff* 2012; 31: 67–75. http://dx.doi.org/10.1377/hlthaff.2011.1009

25 Weber MB, Ranjani H, Meyers GC et al. A model of translational research for diabetes prevention in low and middle-income countries: The Diabetes Community Lifestyle Improvement Program (D-CLIP) trial. *Prim Care Diabetes* 2012; 6: 3–9. http://dx.doi.org/10.1016/j.pcd.2011.04.005

26 Weber MB, Ranjani H, Staimez LR et al. The Stepwise Approach to Diabetes Prevention: Results From the D-CLIP Randomized Controlled Trial. *Diabetes Care* 2016; 39: 1760–7. http://dx.doi.org/10.2337/dc16-1241

27 Narayan KM, Echouffo-Tcheugui JB, Mohan V et al. Analysis & commentary: Global prevention and control of type 2 diabetes will require paradigm shifts in policies within and among countries. *Health Aff* 2012; 31: 84–92. http://dx.doi.org/10.1377/hlthaff.2011.1040

28 Narayan KM, Williamson DF. Prevention of type 2 diabetes: risk status, clinic, and community. *J Gen Intern Med* 2010; 25: 154–7. http://dx.doi.org/10.1007/s11606-009-1148-9

29 Gaede P, Vedel P, Larsen N et al. Multifactorial intervention and cardiovascular disease in patients with type 2 diabetes. *N Engl J Med* 2003; 348: 383–93.

30 Narayan KM, Benjamin E, Gregg EW et al. Diabetes translation research: where are we and where do we want to be? *Ann Intern Med* 2004; 140: 958–63.

31 Garfield SA, Malozowski S, Chin MH et al. Considerations for diabetes translational research in real-world settings. *Diabetes Care* 2003; 26: 2670–4.

32 Saaddine JB, Cadwell B, Gregg EW et al. Improvements in diabetes processes of care and intermediate outcomes: United States, 1988–2002. *Ann Intern Med* 2006; 144: 465–74.

33 Saaddine JB, Engelgau MM, Beckles GL, et al. A diabetes report card for the United States: quality of care in the 1990s. *Ann Intern Med* 2002; 136(8): 565–74.

34 Ali MK, Bullard KM, Saaddine JB et al. Achievement of goals in U.S. diabetes care, 1999–2010. *N Engl J Med* 2013; 368: 1613–24. http://dx.doi.org/10.1056/NEJMsa1213829

35 Shah S, Singh K, Ali MK et al. Improving diabetes care: multi-component cardiovascular disease risk reduction strategies for people with diabetes in South Asia – the CARRS multi-center translation trial. *Diabetes Res Clin Pract* 2012; 98: 285–94. http://dx.doi.org/10.1016/j.diabres.2012.09.023

36 Ali MK, Singh K, Kondal D et al. Effectiveness of a Multicomponent Quality Improvement Strategy to Improve Achievement of Diabetes Care Goals: A Randomized, Controlled Trial. *Ann Intern Med* 2016: 165: 399–408.

37 Ali MK, Narayan KM. Screening for Dysglycemia: Connecting Supply and Demand to Slow Growth in Diabetes Incidence. *PLoS Med* 2016; 13: e1002084. http://dx.doi.org/10.1371/journal.pmed.1002084

38 Ali MK, Bullard KM, Gregg EW et al. A cascade of care for diabetes in the United States: visualizing the gaps. *Ann Intern Med* 2014; 161: 681–9. http://dx.doi.org/10.7326/M14-0019

39 Li Y, Geiss LS, Burrows NR et al. *Awareness of Prediabetes – United States, 2005–2010.* Centers for Disease Control and Prevention; 2013. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6211a4.htm

40 Deepa M, Grace M, Binukumar B et al. High burden of prediabetes and diabetes in three large cities in South Asia: The Center for cArdio-metabolic Risk Reduction in South Asia (CARRS) Study. *Diabetes Res Clin Pract* 2015; 110: 172–82. http://dx.doi.org/10.1016/j.diabres.2015.09.005

41 Echouffo-Tcheugui JB, Ali MK, Griffin SJ et al. Screening for type 2 diabetes and dysglycemia. *Epidemiol Rev* 2011; 33: 63–87. http://dx.doi.org/10.1093/epirev/mxq020