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Public Policies and Interventions for Diabetes in Latin America: a Scoping Review

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Abstract
Purpose of Review Successful interventions are needed to diagnose and manage type 2 diabetes (T2DM) in Latin America, a region that is experiencing a significant rise in rates of T2DM. Complementing an earlier review exploring diabetes prevention efforts in Latin America, this scoping review examines the literature on (1) policies and governmental programs intended to improve diabetes diagnosis and treatment in Latin America and (2) interventions to improve diabetes management in Latin America. It concludes with a brief discussion of promising directions for future research.

Recent Findings Governmental policies and programs for the diagnosis and treatment of diabetes in different Latin American countries have been implemented, but their efficacy to date has not been rigorously evaluated. There are some promising intervention approaches in Latin America to manage diabetes that have been evaluated. Some of these utilize multidisciplinary teams, a relatively resource-intensive approach difficult to replicate in low-resource settings. Other evaluated interventions in Latin America have successfully leveraged mobile health tools, trained peer volunteers, and community health workers (CHWs) to improve diabetes management and outcomes.
Summary There are some promising approaches and large-scale governmental efforts underway to curb the growing burden of type 2 diabetes in Latin America. While some of these interventions have been rigorously evaluated, further research is warranted to determine their effectiveness, cost, and scalability in this region.

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Introduction

Type 2 diabetes (T2DM) is an epidemic affecting 422 million people globally [1], and with particularly serious effects in Latin America (LA). Between 1980 and 2008, the average body mass index (BMI) of Latin Americans rose by 1 kg/m^2 per decade, which is twice as fast as the global average. While some other regions are expecting to see a plateau in increasing obesity prevalence, the rates in most of LA are projected to continue to rise [2]. This increase has largely been attributed to higher wages, more sedentary lifestyles requiring less rigorous

physical labor, and an increase in calorically dense food consumption [1].

Access to and consumption of low-cost, highly processed food in Latin America has increased dramatically [3]. For example, Mexico now leads the world in sugary-drink consumption, Peru has the highest density of fast food restaurants, and the average Chilean diet includes more than 50% processed foods [4]. Between 1998 and 2009, Venezuela saw a 27% increase in caloric intake, which was coupled with subsidies for less expensive, less healthy foods [5]. Unsurprisingly, rates of T2DM are expected to exponentially rise as a result of rising rates of unhealthy eating and obesity, with an expected increase in diabetes of 60% (24.1 to 38.5 million people) in Central and South America by 2035. This is compared to an expected increase of 37% in North America and the Caribbean [2].

Latin American governments face significant challenges to marshal the necessary resources to address adequately this growing rate of T2DM. T2DM patients in Latin America are managed by primary care structures that are overstretched, under-funded, and often fail to provide adequate care [6]. From detection to treatment, there is a paucity of healthcare services to counter this epidemic. It is estimated that T2DM is undiagnosed in more than 45% of populations in South and Central America [5], and more than half the cases of hypertension and diabetes are not diagnosed until complications appear [7]. And the costs of treatment are high and climbing, with "catastrophic expenditures for health systems and patients" [7] expected as a result of this disease burden. Public health systems in Latin America cannot afford to implement the comprehensive multidisciplinary team approach for T2DM treatment often used in high-income countries [8]. Low-cost, high-yield interventions are needed to address the T2DM disease burden across Latin American countries.

This paper provides a review of existing approaches to T2DM diagnosis in South and Central America (Latin America) and examples of some governmental interventions to assist individuals living with T2DM. Additionally, this paper provides an overview of existing diabetes intervention studies in Latin America, with an emphasis on those interventions offering low-cost or innovative solutions that have not been previously tested. Lastly, this review highlights promising directions for future work in this area.

Methods

Literature Search

This is a scoping review of programs and interventions in Latin America addressing T2DM *diagnosis* and *treatment*; an earlier review by Heisler et al. [9••] stemmed from the same search strategy and reported on T2DM *prevention* efforts in Latin America and among Latinos in the USA. Our review was guided by the Arksey and O'Malley framework for scoping reviews [10]. An initial broad search of the literature was conducted in September/October 2015 by a health sciences informationist (GKR) to identify potentially relevant papers. Search updates using the same search strategy to identify additional relevant results were conducted in January 2016 and September 2016. Discrete searches were conducted of the peer-reviewed literature in the Medline (Ovid interface), Scopus, CINAHL, and EMBASE databases. We also conducted a search of gray literature repositories and Google Scholar. Broad search strategies were created to identify potentially relevant literature. The primary search focused on identifying intervention studies on diabetes management and assessments of models of care in South and Central America. Where possible, search strategies were limited to randomized controlled trials or quasi-experimental studies using "publication type" limiters, using validated filters or expressed as subject headings. In databases where publication type limiters or validated filters were not available, keywords were used to identify randomized clinical trials or quasi-experimental studies.

The search strategies consisted of controlled vocabulary terminology and keywords representing search concepts in diabetes, Latin American regions, and non-pharmacological management interventions. Search concepts included but were not limited to keywords and subject headings representing concepts of health education, health behavior, health promotion, peer support, faith-based programs, patient compliance, patient care plans, community health, exercise therapy, and nutrition therapy.

The original Medline search strategies, conducted in September 2015, using the Ovid interface are included below. Full search details, including search process and additional search strategies, are available from the authors upon request.

Study Eligibility and Selection Criteria

Two reviewers (MH and EK) independently screened titles and abstracts for eligibility. Articles were included if (1) the intervention was conducted in South or Central America; (2) the intervention's objective was diabetes management with one or more of the following outcomes: a reduction in hemoglobin (A1c), fasting glucose, blood pressure, cholesterol, or weight; improved physiological outcomes often impaired by diabetes such as endothelial function; and improvements in diabetes-related distress; (3) the participants were 18 years or older and diagnosed with type 2 diabetes; and (4) the study utilized a randomized or quasi-experimental trial design. Studies not meeting these criteria (e.g., observational designs) were excluded.

Data Extraction

We used a standardized form adapted from the Cochrane Collaboration [11] to extract data from the included studies. First, we used the Template for Intervention Description and Replication (TIDieR) checklist and guide to identify key elements of interventions [12]. These included the following: why was the intervention done; what was done (materials and procedures); who delivered the intervention; how, where, when, and how much was done in the intervention; and what tailoring or modifications were made to an existing intervention. Second, we extracted the following data: study design, setting, population characteristics, intervention design and duration, outcome measures, and major findings. Because our focus was identifying elements of effective interventions in Latin America, we included only interventions with statistically significant positive findings that provide lessons for future interventions and directions for future research. Table 1 includes the studies based in Latin America that were extracted and described in this review. The literature search produced 819 articles across the 4 databases. After removal of duplicates, there were 582 unique articles. Eighteen abstracts were selected for full article review, seven of which did not ultimately meet exclusion criteria. Eleven articles were fully assessed and described in the table.

Results

Existing Policies and Governmental Programs

Efforts to Improve Diagnosis of T2DM

Central to efforts to improve management of T2DM in Latin America is improving rates of detection of those who have T2DM and could benefit from treatment. Some Latin American countries are using the Finnish Diabetes Risk Score (FINDRISC) as a screening tool for detection of new cases of T2DM [5]. Although this tool has not been validated in Latin America, it has been modified for use in Latin America and several validation studies are underway. The modified FINDRISC has demonstrated improved rates of identification of impaired glucose regulation in women compared to prior practices and found a similar performance to the original FINDRISC in men.

Efforts to Improve Management of T2DM

There have been efforts across Latin America to improve management of T2DM. The Latin American Diabetes Association (Asociación Latinoamericana de Diabetes, ALAD), composed of medical associations from 17 Latin American countries, has produced a consensus statement on the treatment of T2DM [3]. This includes practical recommendations and a simple decision-making process for physicians in these countries to manage patients with T2DM. Presented as relevant clinical questions, ALAD provides an algorithm for T2DM treatment that is based on earlier guidelines and data from recent randomized controlled trials. Lack of education for Latin American providers on T2DM management is cited as a significant barrier to achieving treatment goals [6], making a simple treatment algorithm a potentially fruitful innovation to address physicians' lack of knowledge. To our knowledge, however, the use and effectiveness in practice of the ALAD guidelines have not yet been studied.

Individual Latin American countries are attempting various strategies to aid in the detection and management of diabetes among their citizens, taking into consideration the capacity and resources available within their public health systems. The Brazil Society of Diabetes (BDS), composed of medical students, residents, and specialists (general practitioners, cardiologists, and endocrinologists), periodically releases guidelines for the prevention and treatment of diabetes in Brazil [8]. These guidelines are adapted from those of the American Diabetes Association, the European Association for the Study of Diabetes (EASD), and the American Association of Clinical Endocrinologists. They are based on the resources and therapies available through Brazil's public health system, the Sistema Único de Saúde (SUS). The SUS has been increasing assistance for the treatment of T2DM, including offering free oral antihyperglycemic agents through the Brazilian Popular Pharmacy Program, which subsidizes some diabetes medications such as metformin and glibenclamide. Through the Family Health Strategy (FHS), multidisciplinary health teams consisting of a physician, nurse, two nurse assistants, and four to six community health agents (CHAs—Brazilian term for community health worker [CHW]) provide primary care services to specific geographic catchment areas for each primary care center [13•]. This community-based approach is intended to provide comprehensive health support, including between-visit monitoring by CHAs.

In 2013, the Mexican Ministry of Health (MOH) launched a pilot program employing a system of primary health clinics focused on the treatment of obesity, T2DM, high blood pressure, and dyslipidemia [14]. Teams consisting of a psychologist, nurse, social worker, dietician, and physician have improved guidelines for prevention, detection, and control of non-communicable diseases, including T2DM and are operating in most states of the country. To our knowledge, the impact of this initiative has not yet been studied. Additionally, primary care physicians and members of these teams are trained in virtual courses related to diabetes management, such as motivational interviewing training. The MOH also created a public health campaign called "Five Steps for Your Health," which promotes healthy behaviors and is broadcast across televisions and through radio broadcasts daily.

Table 1 Evaluations of diabetes management programs in Latin America

Authors	Participation characteristics	Who delivered, how, and where	Intervention components, duration, and dose	Comparison group	Main results
Barceló (2010) [16] Mexico	Patients with diabetes at 10 of 23 public health centers in the cities of Xalapa and Veracruz randomly Selected and invited to participate. Three hundred seven patients involved in the study—196 from the intervention group, 111 from the usual care group	A total of 43 primary care teams participated in the project; teams consisted of physicians, nurses, and, in some centers, other professionals such as nutritionists and psychologists.	An 18-month intervention with three learning sessions: a structured patient diabetes education program (based on the Diabetes Education Program of Latin America), training in foot care, and training for primary care personnel in diabetes management. Support also provided by specialists and case management.	All patients offered two glycosylated hemoglobin (A1c) tests and a lipid profile test at baseline and end of project. The comparison group received usual care.	The proportion of people with good glycemic control (A1c <7%) among those in the intervention group increased from 28% pre intervention to 39% post intervention. Patients achieving three or more quality improvement goals increased from 16.6 to 69.7% ($p < 0.001$) among the intervention group while the usual care group experienced a non-significant decrease from 12.4 to 5.9% ($p = 0.118$).
Cani (2015) [18•] Brazil	70 adults, 45 years or older, with type 2 diabetes taking insulin and with an A1c level exceeding 8%	Clinical pharmacists worked with multidisciplinary care team of physicians, nurses, psychologists, dieticians, and podiatrists.	6-month intervention with individualized pharmacotherapeutic care plan and diabetes education. Pill organizers given to patients with verbal directions on assembly. Written prescription guidance provided at each consultation.	Usual care	Intervention group knowledge score increased from 9.91 ± 2.69 to 15.74 ± 3.03 and medication knowledge increased from 4.47 ± 0.84 to 6.58 ± 1.29, and medication adherence improved significantly. No changes observed in control group for knowledge outcome or medication adherence. The A1c level changed to 9.53 ± 1.68 in the control group, but the intervention group saw a significant decrease of 0.57% (9.21 ± 1.41). In the intervention group, diabetes-related quality of life improved significantly, whereas the control group had a significant decrease in quality of life.
Chaves-Fonseca (2009) [17] Brazil	Subjects over 30 years old with type 2 diabetes according to Brazilian Diabetes Society diagnostic criteria (fasting plasma glucose >7.0 mmol/l and/or a random postprandial glucose >11.1 mmol/l). Performed in two municipalities in the state of Bahia, involving 100 patients with type 2 diabetes in each municipality.	A multidisciplinary team consisting of a doctor, a nurse, a pharmacist, and health technicians.	An 18-month observational cohort study of one municipality with healthcare professionals trained with staged diabetes management (SDM) [29–31] customized protocols	Basic standard diabetes care without implemented protocols (control municipality)	Improvement in the metabolic profile in the intervention municipality. There was a significant 2.2 mmol/l decrease in mean random glucose ($p = 0.004$), a 1.6% decrease in A1c ($p < 0.001$), an 8-mmHg decrease in systolic blood pressure ($p = 0.006$), and a 9-mmHg decrease in diastolic blood pressure ($p < 0.001$). There was no significant improvement in any metabolic parameter and a deterioration in mean cholesterol and systolic blood pressure in the control municipality.
da Silva (2012) [19] Brazil	31 patients with metabolic syndrome and type 2 diabetes. Patients were of both genders, aged between 40 and 65 years	Patients completed physical activity program at the Section of Prevention and Cardiovascular Rehabilitation Unicardio, at the Hospital Santa Catarina. The exercise test was performed by a cardiologist. Lab examination was performed at the Laboratory Santa Catarina	Patients randomized for a 6-week intervention of high-intensity aerobic training (HI 80% maximum heart rate, $n = 10$), low-intensity aerobic training (LI 55% of maximum heart rate, $n = 10$), or control ($n = 11$). All patients underwent initial clinical examination with a cardiologist. Before and after intervention, the patients performed the maximal exercise test, physical exam, laboratory exams, and evaluation of endothelial function.	The control group did not receive 6-week exercise training intervention.	High-intensity aerobic training improved the functional capability and endothelium-dependent vasodilator response, but did not improve the endothelium-independent vasodilation in patients with type 2 diabetes and metabolic syndrome. The percentage diameter difference of the vessel after hyperemia was significantly higher for the high-intensity group (HI before 2.52 ± 2.85% and after 31.81 ± 12.21%; LI before 3.23 ± 3.52% and after

Table 1 (continued)

Authors	Participation characteristics	Who delivered, how, and where	Intervention components, duration, and dose	Comparison group	Main results
					20.61 ± 7.76%; controls before 3.56 ± 2.33% and after 2.43 ± 2.14%; $p < 0.05$).
Goldhaber-Fiebert (2003) [21] Costa Rica	Patients with type 2 diabetes from three small communities in the central valley of Costa Rica	Nutrition classes taught by nutritionists in a nutrition Master's degree program. Dietary curriculum refined to local customs. Local volunteer community leaders led the walking groups.	12-week randomized controlled pilot study. All participants received basic diabetes education. The intervention group participated in 11-weekly nutrition classes (90/class), and subjects were encouraged to bring family members. Subjects for whom exercise was deemed safe also participated in triweekly walking groups (60 min/session).	Basic diabetes education and usual care	The intervention group lost 1.0 ± 2.2 kg compared with weight gain in the control group of 0.4 ± 2.3 kg ($p = 0.028$). Fasting plasma glucose decreased 19 ± 55 mg/dl in the intervention group and increased 16 ± 78 mg/dl in the control group ($p = 0.048$). Glycosylated hemoglobin decreased 1.8 ± 2.3% in the intervention group and 0.4 ± 2.3% in the control group ($p = 0.028$).
de Sousa (2014) [20] Brazil	Forty-four patients with diabetes aged 48–68 with a BMI of 32.9 ± 1.1 kg/m^2 and A1c of 7.3 ± 0.3%	Screening by echocardiography and medical examination, followed by assessment of anthropometric parameters, aerobic capacity, and biochemical profile. Prescription of individual diets based on a complete food history	12-week recreational football training combined with calorie-restricted diet (football + diet group (FDG))	Calorie-restricted diet alone (diet group (DG))	After 12 weeks, maximal oxygen uptake (VO_2max) was elevated ($p < 0.05$) by 10 ± 4% in FDG but not in DG (−3 ± 4%, $p < 0.05$). After 12 weeks, reductions in blood triglycerides (0.4 ± 0.1 mmol/l), total cholesterol (0.6 ± 0.2 mmol/l), low-density lipoprotein, and very low-density lipoprotein levels were observed only in FDG. Fat mass decreased ($p < 0.05$) by 3.4 ± 0.4 kg in FDG and 3.7 ± 0.4 kg in DG. The lower ($p < 0.05$) glucagon and homeostatic model assessment of insulin resistance indicated an improvement in insulin sensitivity in FDG.
Piette et al. (2012) [24] Honduras and Mexico	Patients between 18 and 80 years of age were eligible if they had access and were able to use either a cell phone or landline telephone and had an SBP suggesting hypertension (i.e., SBP ‡130 mmHg if diabetic or ‡140 mmHg if non-diabetic).	Calls deployed from a server in the USA to diabetes patients in Honduras. Intervention patients were given an electronic home blood pressure (BP) monitor and written instructions for checking BP at home.	This 6-week RCT evaluated the efficacy of a cloud computing model using automated self-management calls plus home BP monitoring as a strategy for improving systolic BPs (SBPs) and other outcomes of hypertensive patients in two LMICs. Participants received weekly automated monitoring and behavior-change calls.	Usual care	At follow-up intervention patients' SBPs decreased 4.2 mmHg relative to controls (95% confidence interval 9.1, 0.7; $p = 0.09$). In the subgroup with high information needs, intervention patients' average SBPs decreased 8.8 mmHg (−14.2, −3.4, $p = 0.002$). Compared with controls, intervention patients at follow-up reported fewer depressive symptoms ($p = 0.004$), fewer medication problems ($p < 0.0001$), better general health ($p < 0.0001$), and greater satisfaction with care (p £ 0.004).
Piette et al. (2011) [23] Honduras	Adult patients with diabetes and access to a cellular phone in a semi-rural region of Honduras identified at outpatient primary care visits	Delivered using a telecommunications infrastructure maintained on a US server, with calls directed to patients' cell phones	A single group pre-post study providing 6 weeks of weekly IVR disease management calls to patients with automated follow-up emails to clinicians and voicemail reports to family members.	N/A	98% of participants reported improvement in aspects of diabetes management. Mean A1c decreased from 10.0 to 8.9% ($p < .01$).
Gagliardini et al. (2013) [27] Argentina	People with type 2 diabetes 25–75 years old followed for at least 2 years with more than 2 diabetes-related encounters	Delivered by professional educator or trained peers with excellent diabetes control	A structured diabetes education program implemented by trained peers with diabetes that also provided ongoing peer support	A structured diabetes education program implemented by professional educators	Both groups had positive results at the end of the program on psychological, metabolic, and clinical outcomes. Over the following year, peer-educated patients had lower A1c and systolic blood pressure and showed higher adherence to

Table 1 (continued)

Authors	Participation characteristics	Who delivered, how, and where	Intervention components, duration, and dose	Comparison group	Main results
					exercise routine and better control of hypoglycemic episodes.
Micikas et al. (2015) [28] Guatemala	Type 2 diabetes patients over the age of 18 who had at least one clinic visit in the past year	CHWs trained in behavioral counseling provided weekly "diabetes club" meetings and home visits.	A one-group pretest-posttest design	NA	A significant decrease in mean A1c at follow-up ($p = .001$). Other study findings were not significant.
Do Valle Nascimento et al. 2017 [13•] Brazil	Type 2 diabetes patients over the age of 18 who had poor glycemic control and received care at a primary care center	CHWs employed by a primary care center trained in Motivational Interviewing-based approaches who made monthly home visits	A one-group pretest-posttest design	NA	Patients reported improvements over the 6-month period in quality of diabetes care received ($p < .001$)), increases in physical activity ($p = .001$), consumption of fruits and vegetables ($p < .001$), and medication adherence ($p = .002$), but no decreases in consumption of high-fat foods ($p = .402$) or sweets ($p = .436$). Participants had mean 6-month A1c levels 0.34% points lower than at baseline ($p = .08$) and improved mean LDL (−16.1 mg/dl, $p = .005$) and triglyceride levels (−38.725 mg/dl, $p = .002$).

Chile's Social Health Insurance program ensures that its 17 million people have nearly universal health coverage [7, 15]. The country provides a two-tier, private-public health program. Since 2005, Chileans have had access to a basic public health package that now includes coverage for 80 health problems including diabetes. This program has preset wait time restrictions for diagnosis, treatment, and follow-up, and a cap for out-of-pocket costs. A review by Arredondo (2016) discusses these and other public health efforts in Latin American countries to curb the growing diabetes rate and concludes that despite these efforts to improve diabetes treatment, the rates continue to rise [15].

Intervention Approaches

Multidisciplinary Management Teams

Another promising approach being evaluated in some Latin American countries is the use of multidisciplinary management teams to carry out T2DM interventions. Multidisciplinary management teams employ various types of health professionals to help with disease management. These professionals may include but are not limited to nurses, physicians, pharmacists, dieticians, podiatrists, psychologists, occupational therapists, and/or trained diabetes educators. Studies in this review that have found promising results from the care team approach can be found in Table 1 [16, 17, 18•]. Notably, in Brazil, Cani et al. (2015) utilized a clinical pharmacist and a care team including other physicians, nurses, psychologists, dieticians, and podiatrists to provide a pharmacotherapeutic care plan and diabetes education to adults with diabetes over a 6-month period [18•]. Participants were also given pill organizers and written guidance on prescriptions at each visit. This study found a significant reduction in A1c and an increase in diabetes knowledge and medication adherence. Another promising RCT was the VIDA Project, an 18-month intervention based in Mexico that provided structured diabetes education, training in foot care, and an in-service for providers on diabetes management [16]. The proportion of patients with good glycemic control (A1c <7%) increased from 28 to 39%, and the proportion of patients achieving three or more quality improvement goals improved from 16.6 to 69.7%. While these results are promising, interventions employing multidisciplinary teams are resource-intensive, and access to specialists is often limited in many regions of Latin American countries [8], especially in rural areas. It is necessary to implement and rigorously evaluate a range of interventions that can be implemented in low-resource settings in which health professional resources may be scarce.

Diet and Exercise Interventions for the Management of T2DM

Interventions in Latin America focused on examining the effects of different diet and/or exercise programs on improving diabetes outcomes may help inform lower-cost approaches to improving diabetes management and outcomes. da Silva et al. (2012) conducted an RCT in Brazil exploring the effects of high-intensity and low-intensity aerobic training on the endothelial function of patients with metabolic syndrome and T2DM [19]. As compared to the control, high-intensity training improved the functional capabilities and endothelium-dependent vasodilator response, but did not improve the endothelium-independent vasodilation. A study by de Sousa et al. (2014) in Brazil examined the effects of a 12-week soccer training program combined with calorie restriction versus a calorie restriction-only arm [20]. The combined program enhanced oxygen uptake, and reduced blood triglycerides and total cholesterol. These results were not seen in the calorie restriction only arm, although both study arms found a significant decrease in fat mass. A 12-week RCT in Costa Rica for patients with T2DM that incorporated weekly nutrition courses (which welcomed participants' family members) with triweekly walking groups found that the intervention group lost 1.0 ± 2.2 kg compared with weight gain in the control group of 0.4 ± 2.3 kg ($p = 0.028$) [21]. Intervention participants' fasting plasma glucose decreased (19 ± 55 mg/dl) in the intervention group also compared to an increase in the control group (16 ± 78 mg/dl, $p = 0.048$). Glycosylated hemoglobin decreased significantly more in the intervention than control groups (1.8 ± 2.3 and 0.4 ± 2.3%, $p = 0.028$).

Use of Mobile Health Technology in T2DM Management

Diabetes interventions utilizing mobile health technology provide significant promise for Latin American countries and other low-resource settings. Cell phone use is widespread; there are more than 6 billion users worldwide, with three quarters of users living in low and middle income countries (LMICs) [22]. Such high rates of cell phone use can provide means of increasing access to health education and communication with healthcare providers among patients in areas lacking in health infrastructure and resources. Moreover, the use of existing technology has the potential to make interventions low-cost. Some diabetes interventions utilizing mobile health technology have been evaluated and found positive results among Latinos with T2DM [22]. While most of these types of interventions have been evaluated in the USA, a few have been tested in Latin America. One pre-post study of delivering interactive voice response calls (a structured series of recorded messages triggered by patients' responses on their touch-tone key pad) to patients with diabetes in Honduras found that at 6-week follow-up, patients had significant improvements in A1c, as well as improvements in self-care and perceived health [23]. An RCT utilizing IVR with patients with poorly controlled hypertension in Honduras and Mexico found that patients in the intervention group had systolic blood pressures that were 4.2 mmHg lower on average than control patients, and intervention patients had better overall perceived health, greater satisfaction with care, fewer depressive problems, and fewer medication problems at follow-up [24].

Community Health Worker-Led Interventions

A promising intervention approach frequently used in many Latin American countries yet of which there are few rigorous evaluations in the peer-reviewed literature is the incorporation of community health workers (CHWs) or other lay health supporters into routine diabetes care. CHWs typically reside in the communities in which they work, and share vital characteristics with the patients, such as culture, language, and socio-economic background [25]. In low-resource communities, in which populations may face financial, cultural, and linguistic barriers to health care, CHWs can fill an important gap in the provision of culturally sensitive health education, self-management support, and other healthcare-related assistance [26]. Familiarity and shared experiences can foster trusting relationships between patients and CHWs, allowing CHWs to serve as a successful bridge between the health centers and patients. Studies by Gagliardino et al. (2013) in Argentina and Micikas et al. (2015) in Guatemala have found promising results with the use of peer support (peer educators and CHWs) for diabetes management [27, 28]. Gagliardino et al. found that a structured diabetes education program led by trained peers with diabetes who also provided ongoing peer support was equally effective as professional educators in improving A1c and other outcomes right after the program. And participants in the peer-led group sustained improvements in A1c and systolic blood pressure better than those in the professional-led group [27]. Similarly, Micikas et al. found that CHW-led weekly group diabetes self-management support sessions and home visits led to improved glycemic control, although there was no control group [28]

As a number of countries in Latin America have incorporated CHWs into healthcare teams in routine primary care, a key challenge will be to evaluate the implementation of diabetes management support efforts led by these CHWs. They often make regular home visits to patients and are thus in a good position to provide ongoing support and behavioral counseling. A 2017 pilot study in one public primary care center serving a low-income neighborhood in the city of São Paulo, Brazil, examined the acceptability and feasibility of training all CHWs employed as part of the center's healthcare teams in Motivational Interviewing [13•]. This 6-month pilot study evaluated the outcomes of training CHWs in motivational interviewing-based counseling on the quality of diabetes care provided to patients, as well as changes in patients'

reported self-management behaviors, and clinical indicators including A1c, blood pressure, triglycerides, and cholesterol. This pilot found that patients reported improvements in the quality of diabetes care received ($p < .001$), increased physical activity ($P = .001$), medication adherence ($p = .002$), and fruit and vegetable consumption ($P < .001$), but no decrease in consumption of sweets or high-fat foods. For clinical indicators, participants had improved mean LDL ($p = .005$) and triglyceride levels ($p = .002$). Participants also had improved A1c levels (mean 0.34% points lower than baseline) that were not statistically significant ($p = .08$). CHW-led programs in Latin America such as the one described in this pilot study need to be scaled up and their effectiveness rigorously evaluated in comparison with usual care and other approaches.

Conclusion

Diabetes rates in Latin America are growing exponentially, and innovative, efficacious interventions are critically needed to improve health outcomes. There are now initiatives in and across Latin American countries to improve diabetes diagnosis and management through governmental policies and programming, but few to date have been described and rigorously evaluated. Evaluation of the effectiveness of existing programs is needed, as well as increased investigation into low-cost interventions to improve provider education and practices surrounding disease diagnosis and management. There have been a number of diabetes management interventions tested in Latin America that have been shown to be effective in reducing A1c, improving blood pressure and or endothelial functioning, and decreasing weight, among other positive health outcomes. In already strained health systems, it is especially important to develop and evaluate interventions that are not resource-intensive and make creative use of available human and other resources. There is evidence that multidisciplinary team interventions can be effective for diabetes management in Latin American countries; however, lower-cost interventions such as those focused on improving diet and/or increasing exercise and mobile health interventions providing education and/or outreach through the cell phones that most adults in Latin America use may be more easily implemented at a large scale in these countries.

The use of CHWs to provide diabetes management support has been rigorously evaluated in a number of countries. CHWs are lay health supporters who are able to establish rapport with patients in the communities they serve in part because of their shared characteristics and experiences and have been shown to improve a wide range of diabetes-related health outcomes. While CHWs indeed are already employed in health systems in a number of Latin American and Caribbean countries and some evaluations have been conducted, there is a pressing need to rigorously evaluate more of these existing programs and test the effectiveness of different types of lay health workers, including peer volunteers, and especially as they relate to providing diabetes management support. The combination of lay health worker approaches with innovative use of mobile health technologies is especially promising to improve diabetes management and outcomes in Latin America. A key next step in Latin America is to evaluate the implementation and effectiveness of current programs and policies while continuing to develop and test new strategies that effectively leverage available resources.

Compliance with Ethical Standards

Conflict of Interest Elizabeth Kaselitz, Gurpreet K. Rana, and Michele Heisler declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- •• Of major importance

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