Journal of Diabetes Research

Global Diabetes Health

Lead Guest Editor: Gary Adams
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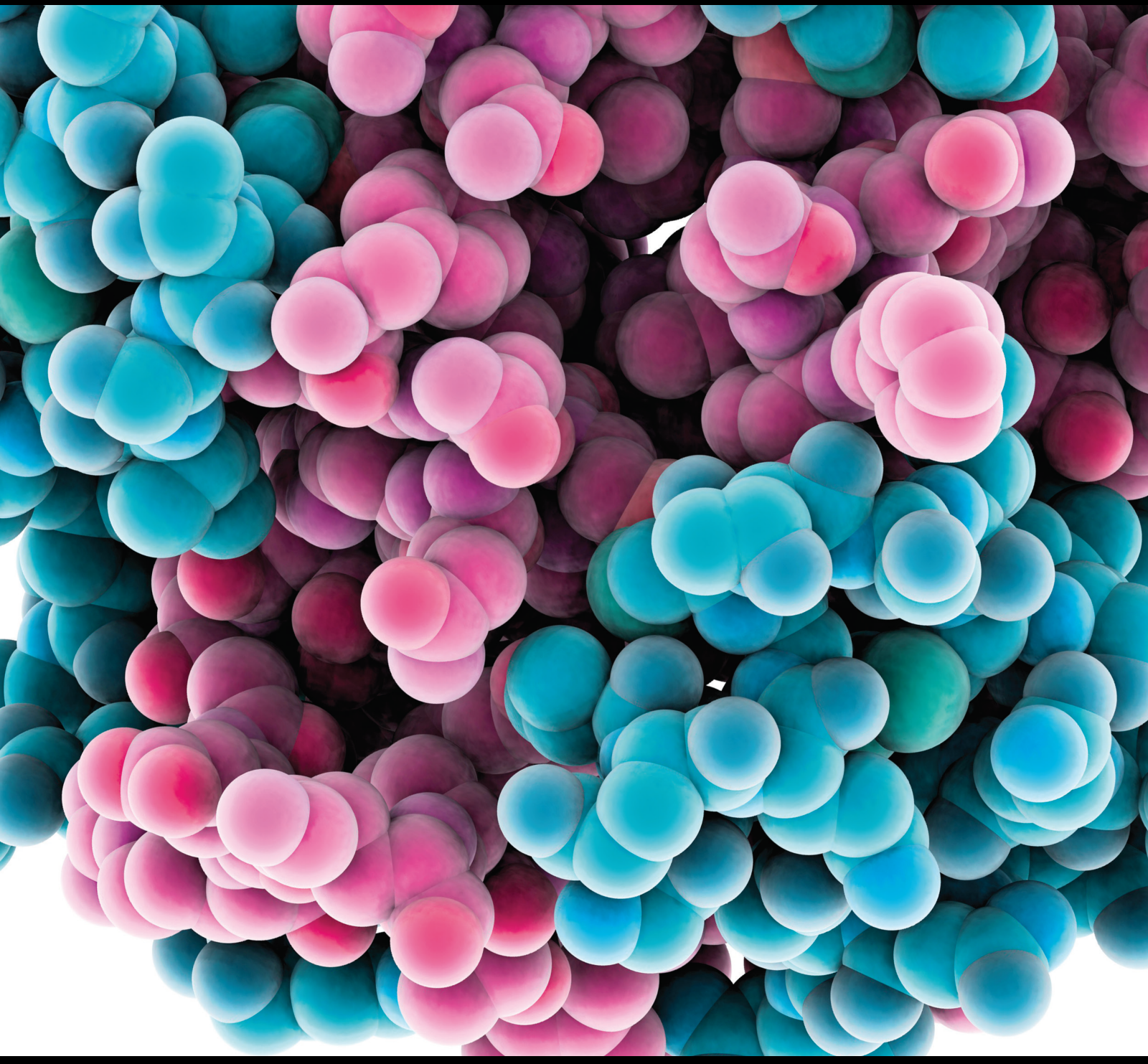

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Review Article

The Effects of Self-Efficacy and Physical Activity Improving Methods on the Quality of Life in Patients with Diabetes: A Systematic Review

Sajjad Hamidi,[1] Zahra Gholamnezhad,[2,3] Narges Kasraie,[4] and Amirhossein Sahebkar[3,5,6]

[1]*Department of Psychiatric Nursing, Iran University of Medical Sciences, Tehran, Iran*
[2]*Department of Physiology, Faculty of Medicine, Mashhad University of Medical Sciences, Mashhad, Iran*
[3]*Applied Biomedical Research Center, Mashhad University of Medical Sciences, Mashhad, Iran*
[4]*Rosenberg School of Optometry, University of the Incarnate Word, San Antonio, Texas, USA*
[5]*Biotechnology Research Center, Pharmaceutical Technology Institute, Mashhad University of Medical Sciences, Mashhad, Iran*
[6]*Department of Biotechnology, School of Pharmacy, Mashhad University of Medical Sciences, Mashhad, Iran*

Correspondence should be addressed to Zahra Gholamnezhad; gholamnezhadz@mums.ac.ir and Amirhossein Sahebkar; amir_saheb2000@yahoo.com

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Objective. The purpose of this systematic review is to study the impact of self-efficacy-improving strategies on physical activity-related glycemic control of diabetes. *Method*. This systematic review was conducted based on the PRISMA statement. ("Diabetes" OR "glycemic control") AND ("exercise" OR "physical activity") AND "self-efficacy" were searched as keywords in databases including PubMed, Google Scholar, Science Direct, Embase, Cochrane, Web of Science, and Scopus between 2000 and 2019 for relesvant articles. *Results*. Two reviewers independently screened articles ($n = 400$), and those meeting eligibility criteria ($n = 47$) were selected for data extraction using a predesigned Excel form and critical appraisal using the "Tool for Quantitative Studies." Different strategies and health promotion programs such as individual or group face-to-face education and multimedia (video conference, video, phone calls, short message service, and Internet-based education) were used in diabetes self-management education programs. The results of different interventions including motivational interviewing (7 studies), exercise (5 studies), multidimensional self-management programs (25 studies), and electronic education (11 studies) had been evaluated. Interventions with more social support, longer duration, combined educative theory-based, and individual education had better outcomes both in postintervention and in follow-up evaluation. *Conclusion*. A combination of traditional and virtual long-lasting self-care promoting (motivating) programs is needed to improve patients' self-efficacy for healthy habits like active lifestyle.

1. Introduction

Diabetes mellitus refers to a heterogeneous group of metabolic diseases commonly resulting in high blood glucose levels (hyperglycemia). Diabetic patients are at risk of various complications that decrease their quality of life and increase mortality rates [1]. Premature death and long-term disabling complications make diabetes an expensive illness with a significant economic burden, especially in low- and middle-income countries [2]. Chronic hyperglycemia in diabetic patients leads to vascular damage (macro and micro), which is the main factor for the induction of different cardiovascular, nephropathy, retinopathy, neuropathy, and other complications [3, 4]. Different kinds of synthetic antidiabetic drugs and herbal remedies with high antihyperglycemic activity [1, 5, 6] are in use for patients. However, current medications have not been able to slow down the development of the complications of diabetes [7]. Therefore, self-management and self-care strategies are recommended to improve the quality of life and slow down diabetic complications in patients [8]. Self-care behaviors in

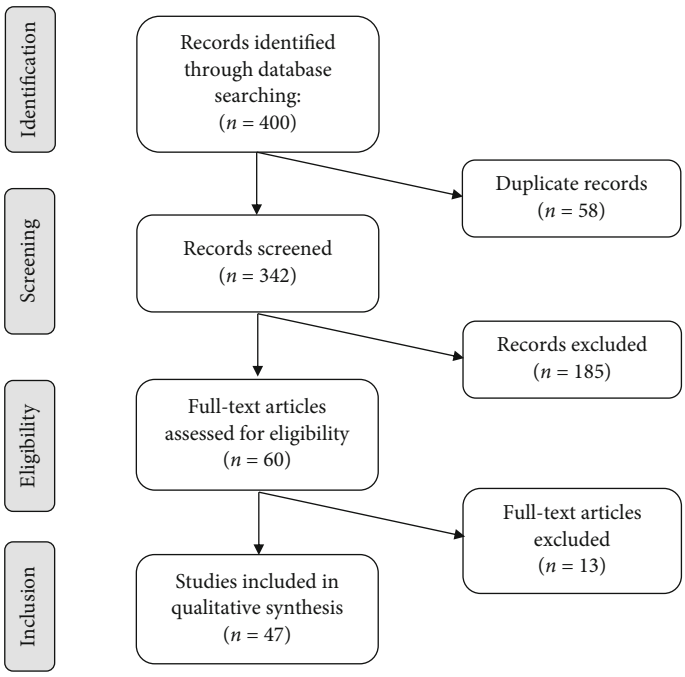

Figure 1: PRISMA flow diagram of the number of studies identified and included in the systematic review.

diabetic patients mean raising the level of knowledge and information about the complex nature of diabetes and taking actions such as controlling blood glucose, healthy eating, physical activity (PA), and foot care [9]. Although evidence suggests the positive effects of PA on diabetes management, studies have shown a low prevalence of PA in people with diabetes [3]. Improvement of patients' exercise self-efficacy might be influenced by behavior related to PA [10]. Improvement in self-efficacy would facilitate controlling the patient challenges of being physically active. Therefore, patient counselors/educators and other practitioners could beneficially construct efficacy-enhancing programs to improve patients' physical activation [11]. Moreover, recent studies suggest that self-efficacy is one of the most influential factors in the self-care of chronic diseases, especially diabetes [12]. Although several educational interventions based on the theory of self-efficacy have been done to improve self-management and glycemic control in diabetic patients, there is not enough literature review and critical appraisal interpreting the results of those studies. Therefore, a systematic review could help better evaluating the effectiveness of self-efficacy-based educational strategies. The purpose of this systematic review was to examine the impact of self-efficacy-improving strategies on PA-related glycemic control of diabetic patients.

2. Method

2.1. Protocol. This systematic review was conducted based on the Preferred Reporting Items for Systematic Reviews: the PRISMA Statement 15.

2.2. Search Strategy. MESH terms such as ("diabetes" OR "glycemic control") AND ("exercise" OR "physical activity") AND ("Self-efficacy") were searched in various search engines and databases including PubMed, Scopus, Science Direct, Embase, Cochrane, Web of Science, and Google Scholar between 2000 and 2019 for a relevant article. The full text of both the randomized controlled trial and pilot studies written in English was included, and non-English abstracts, original articles, reviews, and grey literature were excluded.

2.3. Eligibility Criteria and Study Selection. Four hundred articles were identified in the initial search. All search results were imported to EndNote X8 citation manager, and duplicate studies were removed. Two reviewers independently screened the titles and abstracts of studies to select relevant ones. Disagreements were resolved by consensus. This process resulted in the selection of forty-seven articles for review (Figure 1).

2.4. Data Extraction and Quality Assessment. Two reviewers separately collected data from the full texts of the included studies using a predesigned Excel form. Results were compared and double checked by the same reviewers. The data extracted included title, author, year, inclusion/exclusion criteria, design, subjects, strategies of intervention, instruments and measurement, outcome measures, conclusions, and keywords. The methodological quality and validity of each included study were evaluated independently by two reviewers using the "Tool for Quantitative Studies" [13] and Jadad score. Disagreements were resolved by discussion. Studies with no weak rating were defined as strong, with one weak rating as moderate quality, and with more than one weak rating as low (weak) quality. Meta-analysis and outcome measures were not done because of heterogeneity and low quality of the study. Publication bias and statistical analysis were not checked because of low quality and heterogenic studies.

3. Results

3.1. Self-Efficacy and PA Improvement in Diabetic Patients. Different strategies such as individual or group face-to-face education and multimedia electronic education (education), including video conference, video phone calls, short message service or SMS, and Internet-based education, have been used in diabetes self-management education programs. In addition, motivational interviewing (MI), exercise and education classes, Healthy Eating and Exercise Lifestyle program (HEELP), theory-based group workshops, narrative-based intervention program, peer education program according to health belief model (HBM), home-based exercise program, and other self-management programs had been mentioned in these studies for promoting self-efficacy-related behaviors such as PA in diabetic patients.

3.2. Role of MI. The effectiveness of MI in both patients and nurses to develop behavioral changes related to diabetes self-efficacy has been reported. Seven studies used MI as a single educational program or in combination with exercise training to improve self-efficacy and behavioral changes regarding to diabetes self-management. The summarized characteristics of the studies and their quality rating are shown in Table 1. Postintervention evaluation showed improvement of diabetes self-efficacy, active lifestyle, and glycemic control in 5 studies [14–17], and self-efficacy was determined as the main predictor of intention to PA [18]. The motivational intervention was more feasible in women and individuals with a higher educational level [16, 17]. The effect of self-efficacy and intention on exercise performance was mediated by planning strategies [18]. Although these studies reported the positive effect of MI on diabetes self-efficacy as the main predictor of PA intention, there are also negative results [19]. In addition, nurses training for MI of diabetic patients had no significant effect on lifestyle behaviors such as healthy diet, physical activity, and self-efficacy in patients [20].

3.3. Role of Health Promotion Programs. Although programs targeting only exercise behavior resulted in patients' active lifestyle behaviors, they did not improve patients' glycemic control. We found five studies using exercise training interventions targeting behavioral changes in diabetes control. Self-monitoring of exercise, home-based resistance training, home-based walking, combination of resistance, and endurance training were the related interventions. Although in some studies, exercise training improved PA self-efficacy [21, 2, 22], and baseline evaluation showed an association between walking ability and self-efficacy; however, in one study, exercise training did not improve self-efficacy-related outcomes of diabetic patients [23]. In addition, glycemic control index (HbA1C) and markers of cardiovascular risk changes were nonsignificantly changed in both intervention and control groups [2]. Low self-efficacy for resistance exercise was the most important predictor of patients' dropout [24], and effective interactions between patients and health care professionals are recommended to encourage patients for behavioral changes and overcoming the barrier to PA [21]. Moreover, it seems that the existence of an underlying disease associated with diabetes has a great impact on study outcomes. It was indicated that individuals without MetS had higher exercise self-efficacy than those with MetS and that home-based exercise programs are beneficial for individuals at risk for diabetes [22]. Table 2 shows a summary of studies using exercise interventions.

Health promotion programs also have been used to evaluate the role of self-efficacy and PA in diabetes management. Different long-term interventions, including Mediterranean Lifestyle Program [25], primary care-based walking program (24 weeks), education programs on exercise-related behavioral changes based on the HBM [26], Healthy Eating and Active Living for Diabetes in Primary care networks (HEALD) program [27], and proactive coping [28], have shown to improve the participants' quality of life (healthy diet, exercise, and stress management) and psychosocial factors (self-efficacy and problem-solving). In some studies, the beneficial effects were sustained even at follow-up evaluation [26], and postprogram contact with patients could improve those outcomes [27]. In another study, with a brief lifestyle self-management program, using follow-up phone calls induced effective lifestyle behavior changes; however, self-efficacy was not increased in the intervention group [29].

Moreover, a combination of theory-based group workshops and walking exercise had a better short-term impact on self-regulation/self-efficacy and PA than online education, but these beneficial effects declined at six-month follow-up [30]. The HEELP program also improved patients' exercise adherence and weight loss; however, the results showed that male gender, self-efficacy, time, and depressive symptoms are independent predictors for exercise duration or BMI change. In addition, lack of motivation and time was the most common exercise barriers at baseline, and there was a negative association between lack of motivation and exercise self-efficacy even after 12-month program [31]. Moreover, other baseline factors, including obesity, coronary heart disease, female gender, self-efficacy, and depressive symptoms, need more attention in designing such programs [32]. Familial factors also might influence the patient's adherence to lifestyle changes. The health stress of patients in the form of higher comorbidity number and specific stress of diabetes in both patients and spouse was inversely correlated with patient adherence to exercise and dietary programs. These effects were mediated by diabetes self-efficacy and depressive symptoms reported by couples [33].

The effectiveness of individual or group self-management improvement methods has been evaluated too. Two studies showed that the patient-centered group education and the structured goal-setting method would lead to better patients' self-management, and the effect of time-by-treatment interaction might partially be mediated via the development of self-efficacy [38] [34]. ,In another RCT study, individualized education (IE) had better outcomes compared to group education [35], and long-term evaluation indicated behavioral and psychological improvement in IE; however, this intervention did not show sustained improvement in HbA1c, nutrition, and PA scores

Table 1: Characteristics of studies using motivational interviewing in both patients and nurses.

Author, reference	Study design/subjects	Intervention	Instruments/measurements	Outcomes/finding	Quality rating
Swoboda et al. [14]	Randomized pretest-posttest controlled study; adults with ype 2 diabetes ($n = 54$)	One in-person motivational interviewing and decision support session followed by 7 biweekly telephone coaching calls (16 weeks)	The 8-item diabetes self-efficacy scale measures at baseline and upon completion of the 16-week intervention	↑ In diet quality, diabetes self-efficacy, and diabetes empowerment, and a ↓ in diabetes distress and depressive symptoms	Weak
Galle et al. [16]	Pilot quasiexperiment; 81 overweight type 2 diabetic patients	Nine-month multidisciplinary community-based educational (motivational, nutritional, and exercise) program	Satisfaction, worry, and embarrassment regarding their condition, together with disease-related behaviors and propensity towards physical activity	↑ Self-management and patient glycemic control, especially women and individuals with a higher educational level	Moderate
Soderlund et al. [17]	Latinas ($n = 12$) at risk/ diagnosed with type 2 diabetes mellitus	Two one-to-one MI and PA sessions were conducted over 2 months	PA, PA stage of change	↑ Adherence to PA in type 2 diabetic women	Weak
Pinidiyapathirage et al. [18]	Quasiexperiment; women with gestational diabetes mellitus ($n = 152$)	Participate in a survey 6–36 months postdelivery	Postal and telephone surveys that collected socio-cognitive and physical activity data	Identified predictors of physical activity among women with previous GDM	Moderate
Locke et al. [15]	Pilot study, type 2 diabetes (T2D) randomized to HIIT ($n = 15$) or MICT ($n = 17$)	Two-week 10 exercise sessions accompanied by a brief 10-minute counselling intervention	Self-efficacy and moderate to vigorous physical activity (MVPA) were measured at baseline. Postintervention and 24 weeks following a brief counselling intervention combined with either HIIT or MICT	Both groups increased in their self-regulatory and task self-efficacy postintervention, but both groups demonstrated similar decline at 24 weeks	Weak
Gillison et al. [19]	Pilot quasicontrol trial study; people at high risk of diabetes or heart disease ($n = 108$)	Eight-month group-based sessions designed to promote motivation, social support, self-regulation, and understanding of the behavior change process	Behavioral and physical activity changes were assessed by questionnaire at baseline, 4 and 12 months	↑ Self-efficacy and motivational factors related to dietary behaviors, it did not change the physical activity	Weak
Heinrich et al. [20]	Randomized controlled study; thirty-three nurses and 584 patients participated	Nurses training for motivational interviewing (MI) of diabetic patients aimed to develop behavioral	Self-administered, written questionnaire with mainly validated scales on self-management behaviors at baseline, after 12 months and after 24 months	MI had no significant effect on lifestyle behavior such as healthy diet, physical activity, and self-efficacy in patients	Moderate

Table 2: Characteristics of studies using exercise-based interventions.

Author, reference	Study design/subjects	Intervention	Instruments/measurements	Outcomes/finding	Quality rating
Gleeson-Kreig [21]	Randomized pretest-posttest controlled study; adults with type 2 diabetes ($n = 58$)	Six weeks of self-monitoring of exercise	The self-efficacy and physical activity index scale measured at baseline and upon completion of the 6-week intervention	↑ PA self-efficacy after daily activity recording	Weak
Plotnikoff et al. [2]	Randomized control trial; type 2 diabetic obese patients ($n = 48$)	Home-based resistance training (3 days/weeks for 16 weeks)	Muscle strength, glycemic control, and social cognitions (self-efficacy and intention) to perform exercise evaluated at baseline and postintervention	↑ Body strength, intention, and exercise self-efficacy	Moderate
Collins et al. [23]	Randomized control trial; diabetic patients ($n = 145$) with peripheral arterial disease	Home-based walking intervention for 6 months	Self-efficacy for managing chronic disease scale, mean maximal treadmill walking distance	Baseline evaluation showed an association between walking ability and self-efficacy, but intervention did not changed self-efficacy-related outcomes	Moderate
Nam et al. [24]	Randomized control trial; adult patients with type 2 diabetes ($n = 140$)	Exercise (combination of resistance and endurance training for 6-month, 3 times per week)	Mood states questionnaire, health survey, exercise self-efficacy scale, and insulin sensitivity check index	Low self-efficacy for resistance exercise was the most important predictor of patients' dropout	Moderate
Chen et al. [22]	Quasiexperiment; individuals with and without metabolic syndrome (MetS) ($n = 110$)	Three months of home-based exercise	Baseline and postintervention evaluated metabolic risk factors and exercise self-efficacy	Individuals without MetS had higher exercise self-efficacy than those with MetS; home-based exercise programs are beneficial for individuals at risk for diabetes	Weak

Table 3: Characteristics of studies using health promotion programs.

Author, reference	Study design/subjects	Intervention	Instruments/ measurements	Outcomes/finding	Quality rating
Clark et al. [29]	Randomized controlled trial; adults with type 2 diabetes ($n = 100$)	Three-month lifestyle (diet and PA) self-management program (brief tailored) plus follow-up phone calls for one year	Diabetes self-management, self-efficacy for physical activity, and barriers to diabetes self-care were evaluated at baseline, postintervention, and after follow-up	↑ PA and ↓ dietary fat in the intervention group	Moderate
Toobert et al. [25]	Randomized controlled trial; postmenopausal type 2 diabetic women ($n = 279$)	Mediterranean lifestyle program (6-month intervention to construct group coach and 12- and 24-month follow-up); videotapes also used for home-based practice (one hour per day)	Lifestyle behaviors (i.e., physical activity and stress management) and psychosocial variables (e.g., social support, problem solving, self-efficacy, depression, and quality of life), at baseline and 6, 12, and 24 months	↑ Quality of life (stress management, healthy diet, exercise), psychosocial factors (self-efficacy, problem solving, supportive resources), after 12 and 24 months of problem-solving	Moderate
Baghianimoghadam et al. [26]	Randomized controlled trial; diabetic patients ($n = 80$)	Education programs on exercise-related behavioral changes based on the health belief model (2 sessions+ reminders in 3 months)	Questionnaire based on the health belief model, a checklist related to patients practice (before and three months after intervention)	Conducting patient walking training method → ↑ self-efficacy and knowledge about the disease management	Weak
Mladenovic et al. [27]	Qualitative substudy; type 2 diabetic patients ($n = 13$) completed healthy eating and active living for diabetes in primary care networks (HEALD) program	HEALD (primary care-based walking for 24 weeks) program	Semistructured interviews with purposefully selected HEALD completers six months after the program ended	↑ Exercise-related motivation and self-efficacy behaviors and postprogram contact with patients could improve those outcomes	Weak
Olson and McAuley [30]	Randomized controlled trial; older adults with type 2 diabetes titrated physical activity	Eight-week intervention included walking exercise and theory-based group workshops	Self-efficacy, self-regulation, and physical activity were assessed at baseline, postintervention, and a follow-up (6 months)	↑ Self-regulation/self-efficacy and physical activity at a two-month evaluation; ↓ beneficial effects at follow-up	Strong
Alharbi et al. [31]	Quasiexperiment secondary analysis of data collected from RCT; overweight adult ($n = 134$) with heart disease and diabetes	Healthy eating and exercise lifestyle program (group-based supervised structured exercise sessions, 4 months) plus telephone follow-up calls (4 months)	Exercise, self-efficacy for weight loss, and depressive symptoms were measured at baseline, postactive phase (4 months), and postmaintenance phase (12 months)	↑ Exercise adherence and weight loss; male gender, self-efficacy, time, and depressive symptoms are independent predictors for exercise duration	Moderate
Alharbi et al. [32]	Quasiexperiment secondary analysis of data collected from RCT; patients with coronary heart disease and/or diabetes mellitus ($n = 134$)	One year healthy eating and exercise lifestyle program	Self-efficacy for exercise survey at baseline, at 4 months, and at 12 months	Negative association between lack of motivation and exercise self-efficacy	Moderate

Table 3: Continued.

Author, reference	Study design/subjects	Intervention	Instruments/ measurements	Outcomes/finding	Quality rating
Anderson et al. [33]	Quasiexperiment; dyadic data from 117 married couples in which one partner was diagnosed with type 2 diabetes	—	Survey of two exercise items (diabetes self-care activities); seven-item self-efficacy subscale of the multidimensional diabetes questionnaire	Health stress of patients in the form of higher comorbidities number and specific stress of diabetes in both patient and spouse ↔ ↓ patient adherence to exercise ↔ diabetes self-efficacy and depressive symptoms	Moderate
Thoolen et al. [28]	Randomized clinical trial; type 2 diabetic (intervention, $n = 78$ or control, $n = 102$)	Self-management program (based on proactive coping and self-regulation theory in a five-step plan) lasted 12 weeks	Proactive coping, goal achievement, and self-efficacy were evaluated at baseline and postintervention	↑ PA and diet behavior, weight loss, coping, goal achievement, and self-efficacy	Moderate
Naik et al. [51]	Randomized pilot clinical trial; type 2 diabetic patients ($n = 87$)	Four sessions of clinician-led, patient-centered group education targeting type 2 diabetes self-management (medications, exercise, diet, home monitoring, etc.) for 3 months	HbA1c, self-efficacy scale, and specific knowledge and understanding scale at baseline, postintervention, and at the 1-year follow-up	↑ Glycemic control, self-management, and effect of time-by-treatment interaction might partially be mediated via the development of self-efficacy	Strong
Rosal et al. [34]	Randomized clinical trial; low-income Latin diabetic patients ($n = 252$)	Group-based intervention (12 weekly and 8 monthly sessions and targeted knowledge, attitudes, and self-management behaviors)	HbA1c, diet, physical activity, blood glucose self-monitoring, diabetes knowledge, and self-efficacy at baseline and at 4- and 12-month follow-up	↑ Self-efficacy and PA management at 4 months → ↓ HbA1C; ↓ statistical differences at 12 months, but ↑ patients' knowledge about diabetes	Moderate
Sperl-Hillen et al. [35]	Randomized clinical trial; adults with type 2 diabetes ($n = 623$)	Individualized education (IE, 3 sessions of 1-hour individual education once a month), or group education (GE, sessions of 2-hour group education) or control (UC) for 1 year plus 6.8 months and 12.8 months	HbA1c, general health status, problem areas in diabetes, diabetes self-efficacy, recommended food score, and physical activity evaluated at baseline, 3.8 months, and 6.8 months after randomization	↓ HbA1c in all groups; ↑ exercise score, self-efficacy, and HbA1c level of individual training group compared to group education and control group	Strong
Sperl-Hillen et al. [36]	Substudy of RCT; adults with type 2 diabetes ($n = 623$)	Sperl-Hillen et al., 2011 study intervention	Follow up evaluation of Sperl-Hillen et al. (2011) study at 12.8 months	Behavioral and psychological improvement in IE compared to GE and UC groups; however, no sustained improvement in HbA1c, nutrition, and PA scores	Strong
Tan et al. [37]	Randomized clinical trial; Malaysian diabetic patients ($n = 151$)	Face-to-face education program targeting self-efficacy on self-care skills for 12 weeks	HbA1c and revised diabetes self-care activities questionnaires (monthly and postintervention follow-up)	↑ Glycemic control, diet, medication adherence, and PA	Moderate

Table 3: Continued.

Author, reference	Study design/subjects	Intervention	Instruments/ measurements	Outcomes/finding	Quality rating
Van Dyck et al. [38]	Randomized clinical trial; adults with type 2 diabetes ($n = 623$)	Social-cognitive-based method (face-to-face education, telephone follow-ups) for 24 weeks	PA (pedometer, accelerometer, and the IPAQ) and change in psychosocial factors were measured at postintervention and 1-year follow-up	↑ Patients' self-efficacy and ↑ PA	Moderate
Jelsma et al. [39]	Randomized controlled study; women with gestational diabetes mellitus ($n = 59$)	Lifestyle-counselling sessions for 6 months (two face-to-face +5 telephone +5 text messages+4 mailed postcards)	Psychosocial determinants related to physical activity and diet were measured with a self-administrated questionnaire (at baseline and six months)	↑ Patients' self-efficacy and reduced barriers to active lifestyle such as lack of motivation and energy	Weak
van der Wulp et al. [41]	Randomized controlled trail; adults with recently diagnosed type 2 diabetes ($n = 133$)	Self-management coaching program (peer-led) on lifestyle changes (3 home visits targeting practical goals)	Self-efficacy, coping, physical activity, dietary habits, psychological well-being, depressive symptoms questionnaires at baseline and 3- and 6-month postintervention	↑ Scores of people with lower self-efficacy and psychological well-being index	Weak
Steed et al. [42]	Randomized controlled trail; patient with type 2 diabetes ($n = 124$)	Five weekly sessions of social cognitive (self-efficacy) and self-regulatory (illness beliefs) theory-based program	Revised summary of self-care diabetes activities (at baseline, one week, three months, and nine months)	↑ Self-efficacy for exercise immediately and three-month postintervention; essential role illness beliefs in the patients' quality of life, and self-efficacy in self-management behaviors	Weak
Campbell et al. [43]	Randomized controlled trial; adults with type 2 diabetes ($n = 598$)	Three-week intervention program (diabetes factsheets and a DVD comprising patient stories (narratives) of type 2 diabetes management with follow-up at 4 weeks and 6 months)	Diabetes management self-efficacy scale (A/E DMSES) and self-care activities (SDSCA) at baseline and 4 weeks	↑ Self-efficacy behaviors	Moderate
Gamboa et al. [44, 45]	Randomized controlled trial; adults with type 2 diabetes mellitus ($n = 594$)	Spanish Diabetes Self-Management Program (SDSMP)	HbA1c; Spanish diabetes self-efficacy scale at baseline and 6, 12, and 24 months after SDSMP	↑ Self-efficacy and self-management for controlling the disease; exercise self-efficacy changes were not significant	Moderate
Cioffi et al. [47]	Randomized controlled trial; overweight Asian Indian adults with prediabetes ($n = 550$)	Four-month diabetes prevention program on self-efficacy	Exercise-related self-efficacy was measured at baseline, core intervention completion (4 months), and annually until the end of follow-up (3 years or diabetes diagnosis)	↑ Self-efficacy at treatment completion, but this effect was not sustained over longer follow-up	Moderate

Table 3: Continued.

Author, reference	Study design/subjects	Intervention	Instruments/ measurements	Outcomes/finding	Quality rating
Moungngern et al. [46]	Randomized controlled trial; prediabetes subjects ($n = 125$)	Six-month group activities of health promotion protocol (Health Belief Model, the Self-Efficacy Theory)	Diet and exercise behavior questionnaire, the self-efficacy questionnaire	↑ Awareness, ↑ self-efficacy, and a realization of the benefits of health behavior modification	Moderate
King et al. [48]	Quasiexperiment on baseline data; diabetic patients ($n = 463$) with elevated BMI	—	Physical activity, adherence to diabetes, self-efficacy, and social-environmental variables were measured with different questionnaire and scale	↑ Psychosocial and social-environmental factors→ ↑ diabetes self-management; but independent association between self-efficacy factors with exercise	Weak
Dyck et al. [49]	Quasiexperiment; type 1 diabetes (T1D, $n = 12$) and diabetes care providers (DCP, $n = 12$)	Four weekly group sessions to learn about exercise physiology and experience different exercise types	Diabetes distress screening scale; physical activity and exercise Counselling survey in DCP	Intervention did not improve exercise self-efficacy of TID but improves DCP self-efficacy in providing exercise advice to patients	Weak
Powell et al. [50]	Quasiexperiment; diabetic patient counselor/educators ($n = 119$)	—	Evaluation of delivering diabetes self-management/support in diabetes educators	Challenging barriers were lack of enough time for delivering patient visits and inability to encourage patients for physical activity	Weak
Miller et al. [40]	Randomized controlled trial; prediabetic university employees ($n = 68$)	Sixteen-week group-based diabetes prevention program +3-month follow-up	Self-efficacy, behavioral self-regulation, and goal setting determinants were assessed at baseline, postintervention, and 3-month follow-up	Improvement in behavioral outcomes such as physical activity and diet self-efficacy and goal commitment in the intervention group	Strong

[36]. Face-to-face education program targeting self-efficacy on self-care skills resulted in better patient glycemic control, diet, medication adherence, and PA improvement [37, 38]. Face-to-face and five telephone lifestyle counseling sessions on changing the psychosocial determinants of PA and diet also improved patients' self-efficacy and reduced barriers to active lifestyle such as lack of motivation and energy in the intervention group compared to the control [39]. In a RCT study, a program for improvement of worksite lifestyle in prediabetes employees resulted in better behavioral outcomes such as PA and diet self-efficacy and goal commitment [40].

A self-management coaching program on lifestyle changes had more impact on people with lower self-efficacy [41] and social cognitive (self-efficacy) and self-regulatory (illness beliefs) theory-based intervention programs caused a significant improvement in self-efficacy for exercise [42]. Data showed that illness beliefs play an essential role in patients' quality of life, while self-efficacy had a crucial role in self-management behaviors diabetes care providers [42].

Other interventions such as a narrative-based intervention program [43], Spanish Diabetes Self-Management Program [44, 45], nurse-managed health promotion program [46], and prevention program on self-efficacy [47] improved self-management and self-efficacy controlling the disease, although an independent association between social-environmental, problem-solving, and self-efficacy factors with exercise and diet-related behaviors has been reported. However, the development of these psychosocial and social-environmental factors could improve diabetes self-management [48]. Improvement of the knowledge about the importance of exercise and self-efficacy in diabetes care providers leads to better performance in patients' exercise learning [49]. Among diabetic patient counselors/educators, factors such as "time allotted for delivering diabetes self-management/support visits" and "inability to engage patients in physical activity" were identified as practice and challenging barriers. To improve physical self-efficacy in patients, educators challenging problems need attention [50]. Table 3 shows a summary of studies using health promotion programs.

3.4. Role of Multimedia and Education. The modulatory effect of self-efficacy on increasing self-care behaviors of diabetic patients was evaluated using different multimedia- and education-based interventions. Education of diabetic patients using a multimedia- (CD-) based health promotion

Table 4: Characteristics of studies using multimedia and education.

Author, reference	Study design/subjects	Intervention	Instruments/measurements	Outcomes/finding	Quality rating
Wangberg [55]	Two-group randomized trial; diabetes patients ($n = 64$) with highest self-efficacy (HSE) or lowest self-efficacy (LSE)	One month tailored Internet-based self-care management (diet, blood glucose or physical activity)	Diabetes self-care activities and competence scales	↑ Self-care behavior in both groups, but in HSE group was more than the LSE group	Weak
Sacco et al. [53]	Randomized control trial; diabetes patients ($n = 62$)	Telephone coaching intervention (brief and proactive) for 2 years	Glycemic control, diabetes self-care activities, self-efficacy, reinforcement for self-care activities, and awareness of self-care goals were measured	Awareness of self-care goals, self-efficacy, and reinforcement →↑ adherence to exercise and a healthy diet and ↓ medical complications and depression	Moderate
Lorig et al. [57]	Randomized control trial; diabetes patients ($n = 761$)	Online diabetes self-management program (with six trials and 18-month follow-up)	Health status, health behaviors, health care utilization, patient activation, and self-efficacy were measured	Improve HbA1C, exercise, patient activation, self-efficacy, and reinforcement or follow-up had no beneficial effect	Moderate
Wolever et al. [54]	Randomized clinical trial; patients with type 2 diabetes ($n = 56$)	Integrative health (IH) coaching (coaching was conducted by telephone for fourteen 30-minute sessions for six months)	Glycemic control, medication adherence, exercise frequency, patient engagement, and psychosocial variables were assessed	IH improved psychosocial outcomes (stress, exercise frequency, self-reported adherence, and self-efficacy)	Moderate
Khan et al. [60]	Randomized controlled trial; adults with type 2 diabetes ($n = 129$)	Computer multimedia diabetes education program (waiting room-administered, low-literacy)	Glycemic control, changes in behaviors, diabetes knowledge, self-efficacy, and medications prescribed were measured over 3 months	Multimedia-educated group had better adherence to oral medication but not for self-efficacy and other self-management behavior	Strong
Goodarzi et al. [58]	Randomized controlled trial; diabetic patients ($n = 81$)	Intervention group received 4 messages weekly about exercise, diet, and medication for 12 weeks	Patient's knowledge, attitude, practice, and self-efficacy were evaluated by questionaries	Smartphone communication increased the patients' self-efficacy in the intervention group	Moderate
Markowitz et al. [61]	Qualitative substudy diabetic patients completed and maintained physical activity after healthy eating and active living for diabetes program ($n = 13$)	Mobile-based healthy eating and active living for diabetes program	Interview questions focused on what participants liked or did not like about HEALD and their maintenance of physical activity six months after the program ended	This primary care-based walking program (24 weeks) was not effective to develop exercise-related motivation and self-efficacy behaviors	Weak
Block et al. [56]	Randomized controlled trial; prediabetes ($n = 339$)	Six-month online program (algorithm-driven) for prevention and improvement of diabetes	Five summary questions were asked on patients eating habits and one question on physical activity self-rated health status and self-efficacy	Improvement in achieving goals for self-efficacy and satisfaction, resulting in promoting physical activity behavior	Moderate
Lari et al. [52]	Randomized clinical trial study; adult with type 2 diabetes	Three-month education of diabetic patients using multimedia-(CD-) based health promotion model	Health promotion model questionnaires (self-efficacy; perceived benefits, barriers, and social support)	Intervention improved subjects' belief about PA and increase their adherence to exercise	Moderate
Lari et al. [59]	Randomized clinical trial study; adult with type 2 diabetes	Short message service-(SMS-) based model or multimedia counselling intervention	Health promotion model questionnaires (self-efficacy; perceived benefits, barriers, and social support)	Better effect of multimedia education on patients' self-efficacy and their belief about physical activity behavior than SMS	Moderate

model might improve subjects' beliefs about PA and increase their adherence to exercise [52]. Brief proactive telephone "coaching" interventions also increased patient adherence to exercise and a healthy diet and reduced medical complications and depression. Results showed the beneficial impact of awareness of self-care goals, self-efficacy, and reinforcement on foot inspection, psychological symptoms (depression), and PA [53]. Diabetes educators could apply integrative health coaching for the improvement of patient self-efficacy [54].

In a tailored Internet-based intervention, patients with the highest self-efficacy had better outcomes; therefore, self-efficacy may play a moderator role in intervention outcome and should be considered in tailoring educational intervention for diabetes [55]. In addition, online program (algorithm-driven) for diabetes prevention and improvement of diabetes self-management, self-efficacy and satisfaction, can result in promoting PA behavior [56]. However, although online education was shown to improve HbA1C, exercise, patient activation, and self-efficacy, but reinforcement or follow-up had no beneficial effect [57]. Smartphone communication also increased the patients' self-efficacy compared to the control group [58]. However, multimedia education had a better effect compared with short message service (SMS)-based model on patients' self-efficacy and their belief about PA behavior [59].

There are also studies with negative results. Computer-based multimedia program in the waiting administration room of diabetic patients had no significant difference in glycemic control, self-efficacy, and other self-management behavior related to diabetes [60]. Moreover, one-month mobile-based intervention pilot study did not show any significant changes in patients' glycemic control, self-efficacy about food intake, PA, and body mass index [61]. Table 4 shows a summary of studies using multimedia and education.

4. Discussion

Motivation had been introduced as a pivotal factor for the improvement of lifestyle, especially in behavioral and psychological aspects, because it increases the learner's effort and desire for a certain change and purpose [62]. MI as a single strategy or in combination with other programs (exercise, healthy diet) has been performed in seven studies. The duration of the studies (RCT and pilot) was between 2 and 12 months, and their population size was 12-152. Although four studies reported improved self-efficacy and PA, one study showed no change in PA. Encouragement of the patient in achieving the goals of diabetes self-management shall be considered as a cost-benefit method in education even with no change in HbA1c and PA.

Our search resulted in five studies with a population of 48-145 which evaluated the effect of endurance or resistance exercise behavior on health-related behaviors (e.g., exercise self-efficacy) and/or glycemic control. According to them, low efficacy of exercise has been proposed as a significant predictor of patients dropping out, and just one study reported the improvement in patients' self-efficacy but had no effect on glycemic control or other diabetes complications. The goal of active life is to improve metabolic status and reduce the complications of diabetes. Moreover, most people with diabetes or metabolic disease have low self-efficacy, quality of life, and knowledge/belief about their illness [22]. Therefore, multifaceted health promotion programs should be applied to cover all psychological and behavioral aspects of lifestyle and induce effective changes in patients' beliefs. A systematic review about lifestyle intervention in diabetic patients suggested future interventions targeting health promotion behaviors with emphasize on problem-solving skills and self-efficacy; but there was no recommendation for the best strategies [8].

A multiconceptual basis education strategy (a combination of goal system and social, cognitive, and ecological theory) was associated with better outcomes. In this survey, twenty-five studies with a sample size of 62-550 and a duration of 3 weeks to one year had been assessed, which used multidimensional self-management programs with both individual/group face-to-face sessions and multimedia training. According to the findings, interventions with more social support, longer duration, combined educative theory-based, and individual education had a better outcome after intervention and follow-up evaluation. In addition, the improvement of the knowledge and self-efficacy of diabetes care providers has not resulted in an increase of exercise self-efficacy in patients with diabetes.

Recently, researchers have been interested in educational technologies such as online and virtual training, multimedia, and smartphone health informative applications to provide more effective health promotion interventions. We found eleven trials with sample sizes of 56-760 and duration trials of 1-24 months. Although patients' feedback about participation in e-education was positive, however, as similar as face-to-face methods, two studies with a small study population and short duration showed no change in outcome. It seems that poor baseline motivation, self-efficacy, and depressive symptoms need more attention in designing such programs [32]. In literature review 2, systematic reviews and meta-analysis evaluated the effectiveness of 15 and 16 studies based on "peer support on self-efficacy" and "self-efficacy-focused education." Although peer support did not induce any significant change in self-efficacy and quality of life, however, intervention with long duration (>6 months) had a better effect on patients improvement of quality of life [63] which is in line with findings of the present study. Meta-analysis of 10 selected studies from 16 interventions showed the beneficial impact of "self-efficacy-focused education" on glycemic control and quality of life in a patient with type 2 diabetes, but the lack of high-quality rating studies with good emotion/physiological strategies and complete outcome assessment makes it difficult to choose the best strategies [64].

In this systematic review, different methodological approaches for the development of self-efficacy and physical activity in diabetic patients had been summarized and discussed to facilitate the patients' and researchers' access to available studies and their outcomes. This review tried to show the importance of self-management programs in

controlling diabetes and emphasized the need for designing most effective methods in improving self-efficacy-focused education. However, this systematic review has several limitations worth mentioning. First, most of the studies were rated as moderate and weak quality with performance bias and detection bias (i.e., lack of double blind, standard randomization, and description of withdrawal). Secondly, the studies were heterogeneous. Study's characteristics, such as population (i.e., number, sex, race, age, education, and concomitant disease), inclusion and exclusion criteria, duration, design (i.e., RCT, prospective observational study, and cross-sectional study), and self-management improving methods were heterogeneous. The lack of enough studies with RCT design and limited number of participants in them make meta-analysis impossible. Moreover, the outcomes of the studies, especially with respect to behavioral outcomes, were also heterogonous because different scales had been employed for self-efficacy and self-management assessment, and different primary and secondary outcomes had been reported. Finally, we evaluated the available English reports (full text) of studies; therefore, potentially relevant reports in other language might have been missed. Taken together, the most important limitation of this study was insufficient high-quality RCTs with enough sample size, long-term education, and follow-up periods, which applied physiological/emotion arousal educational strategies and employed complete outcome assessments with standard scale. Therefore, we could not evaluate the validity and reliability of the instruments and the related outcomes. Regarding those limitations, it is difficult and even impossible to perform a meta-analysis study and combine the findings for achieving descriptive and practical conclusions. Therefore, the impact of self-efficacy-focused education programs including practicing the self-efficacy improvement skills, peer models, goal setting, positive feedback, and health provider persuasion methods on diabetes management is still under question.

5. Conclusion

A combination of traditional and virtual long-lasting self-care promoting (motivating) programs with good emotion/physiological strategies is needed to improve patients' self-efficacy for healthy habits like an active lifestyle. Family and social support play an essential role in establishing healthy behavioral changes in diabetic patients. Future high-quality RCT studies with larger sample size, self-efficacy-focused education-based strategies, long duration and follow-up, and standard outcome assessments are needed to evaluate the effectiveness of self-management strategies.

Data Availability

There is no raw data associated with this review article.

Conflicts of Interest

The authors declare no conflicts of interest in this study.

Authors' Contributions

Sajjad Hamidi was responsible for the database search, screening titles and abstracts, and data collection and extraction. Zahra Gholamnezhad was responsible for the conception and design of the study, screening the titles and abstracts, data extraction and quality assessment, and draft manuscript preparation and approved the final version of the manuscript. Narges Kasraie was responsible for the draft manuscript preparation and English native editing. Amirhossein Sahebkar advised the study and manuscript.

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Research Article

Bayes Conditional Probability-Based Causation Analysis between Gestational Diabetes Mellitus (GDM) and Pregnancy-Induced Hypertension (PIH): A Statistic Case Study in Harbin, China

Dan Diao,[1] Fang Diao,[1] Bin Xiao,[1] Ning Liu,[1] Dan Zheng,[1] Fengjuan Li,[1] and Xu Yang[2]

[1]*Red Cross Central Hospital (Harbin Obstetrics and Gynecology Hospital Affiliated with Harbin Medical University), Harbin 150001, China*
[2]*School of Civil Engineering, Harbin Institute of Technology, Harbin 150090, China*

Correspondence should be addressed to Xu Yang; yangxu_phdce@mail.com

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Both gestational diabetes mellitus (GDM) and pregnancy-induced hypertension (PIH) would influence the gestation significantly. However, the causation between these two symptoms remains speculative. 16,404 pregnant women were identified in Harbin, China, in this study. We investigated and evaluated the causal effect of GDM on PIH based on the Bayes conditional probability. The statistical results indicated that PIH might cause GDM, but not vice versa. Also, this case study demonstrated that the decrease temperature might also cause hypertension during pregnancy, and the prevalence rate of GDM increased with age. However, the prevalence of diabetes did not show a remarkable difference in varied areas and ages. This study could provide some essential information that will help to investigate the mechanism for GDM and PIH.

1. Introduction

Both gestational diabetes mellitus (GDM) and pregnancy-induced hypertension (PIH) would influence the gestation significantly. However, the causation between these two symptoms remains speculative.

It has been demonstrated that the individuals with diabetes mellitus (including type 1 and 2 diabetes mellitus) would be more likely diagnosed with hypertension than nondiabetics [1] The aortic arteriosclerosis of diabetics would accelerate remarkably [2], and their arterial compliance and elasticity decreased, which would directly cause systolic pressure increase [3]. Meanwhile, the damage of peripheral nerve caused by diabetes might induce microvascular dysfunction, which would also lead to an increase in systolic pressure [4–6].

All these discussions mentioned above were based on the influence of insulin resistance [7, 8]. In the early stage of insulin resistance, hyperinsulinemia would cause reabsorption of sodium by kidney tubules, which cause sympathetic activity frequently [9]. Then, the increased vasoconstriction led to the smooth muscle of small artery proliferation and anastomotic stenosis. The intracellular calcium concentration increased, and the sensitivity of the vasopressor increased. Finally, hypertension would be observed [10].

Otherwise, the mechanism of GDM is different from the other types of diabetes. GDM is a condition defined as any degree of glucose intolerance that starts or is first recognized during pregnancy, and it is characterized by recent hyperglycemia as a consequence of an association between insulin resistance and adequate insulin secretion [11–13]. The influence of GDM on hypertension or PIH has remained unclear.

Bayes conditional probability method provides a means of analyzing the causation between two events only based on prior knowledge of conditions that might be related to the event [14–19]. In this study, we attempt to investigate and evaluate the causal effect of GDM on PIH based on the Bayes decision rule. 16,404 pregnant women were included in this study. By implementing the Bayesian method for epidemiological research [20], the statistical results demonstrated that PIH might cause GDM, but not

Table 1: Statistical results distributed by month.

Month	Amount	Only GDM	$P(G)$	Only PIH	$P(P)$	Both	$P(PG)$	$P(P \mid G)$	$P(G \mid P)$
Jan	1311	245	18.69%	17	1.30%	9	0.69%	3.54%	34.62%
Feb	1480	248	16.76%	19	1.28%	9	0.61%	3.50%	32.14%
Mar	1554	247	15.89%	19	1.22%	15	0.97%	5.73%	44.12%
Apr	1436	271	18.87%	24	1.67%	11	0.77%	3.90%	31.43%
May	1381	202	14.63%	18	1.30%	8	0.58%	3.81%	30.77%
Jun	1458	202	13.85%	12	0.82%	5	0.34%	2.42%	29.41%
Jul	1447	196	13.55%	12	0.83%	10	0.69%	4.85%	45.45%
Aug	1360	198	14.56%	17	1.25%	14	1.03%	6.60%	45.16%
Sept	1307	194	14.84%	14	1.07%	9	0.69%	4.43%	39.13%
Oct	1245	170	13.65%	22	1.77%	5	0.40%	2.86%	18.52%
Nov	1181	183	15.50%	18	1.52%	9	0.76%	4.69%	33.33%
Dec	1244	184	14.79%	26	2.09%	10	0.80%	5.15%	27.78%
Total	16404	2540	15.48%	218	1.33%	114	0.69%	4.30%	34.34%

vice versa. This study could provide some essential information that will help to investigate the mechanism for GDM and PIH.

2. Materials and Methods

2.1. Bayes Conditional Probability. The events that were diagnosed with PIH and GDM were denoted as P and G, respectively. The events that were not diagnosed with PIH nor GDM were denoted as Q and H, respectively. The event that was diagnosed with both PIH and GDM was denoted as $G \cap P$. Then, the causal effect of GDM on PIH could be analyzed by calculating the probability of event P occurring given that G is true, i.e., $P(P \mid G)$. According to the Bayesian conditional probability, it could be given by [21]

$$P(P|G) = \frac{P(G|P) \cdot P(P)}{P(G)}, \tag{1}$$

where $P(G|P)$ could be obtained based on the conditional probability

$$P(G|P) = \frac{P(G \cap P)}{P(P)}. \tag{2}$$

$P(P)$, $P(G)$, and $P(GP)$ could be considered as prior probabilities. In this study, since these three prior probabilities all could be obtained by the statistic data, Equation (1) was equivalent to the probability of P under condition G:

$$P(P|G) = \frac{P(G \cap P)}{P(G)}. \tag{3}$$

The same procedure could be easily adapted to discuss the causal effect of PIH on GDM. This probability could be given by

$$P(G \mid P) = \frac{P(P \mid G) \cdot P(G)}{P(P)} = \frac{P(P \cap G)}{P(P)}. \tag{4}$$

2.2. Case Study on Pregnant Women. To identify cases, 16,404 pregnant women were included in an outpatient setting (hospital outpatient departments of Red Cross Central Hospital) in Harbin, China, between December 22, 2018, and December 28, 2020. All these pregnant women were considered as the total sample in this study. We included all outpatients with a documented diagnosis of pregnancy during about two years to improve diagnostic validity. The date of the first-time pregnancy diagnosis during the study period was assigned as their index date. These pregnant women were aged between 14 and 50.

It should be noticed that the medical testing standards would influence the diagnosis obviously. And the statistic data and the analysis results would then be affected. All the testing standards mentioned in this study followed the manners introduced in [22]. Specifically, the testing and diagnosis method mentioned would be introduced briefly as follow: the GDM would be confirmed according to the oral glucose tolerance test results starting from the 24th to 28th week of gestation. The PIH would be checked according to the blood pressure from the 20th week of gestation. Therefore, the statistical analysis discussion in this study mostly was based on pregnant women in the mid or late trimester of pregnancy.

Besides, the eclampsia would be determined by both hypertension and high urinary protein observed. In the diagnosis issued by the hospital outpatient departments of Red Cross Central Hospital, the eclampsia and PIH would be discussed separately. Thus, the PIH samples discussed in this study did not include those diagnosed with eclampsia.

Also, the ages of these pregnant women and their first diagnosis date were considered which might influence the

Table 2: Statistical results distributed by age.

Month	Amount	Only GDM	$P(G)$	Only PIH	$P(P)$	Both	$P(PG)$	$P(P \mid G)$	$P(G \mid P)$
14	1	0	0.00%	0	0.00%	0	0.00%	—	—
15	3	0	0.00%	0	0.00%	0	0.00%	—	—
16	7	0	0.00%	0	0.00%	0	0.00%	—	—
17	10	2	20.00%	0	0.00%	0	0.00%	0.00%	—
18	11	2	18.18%	0	0.00%	0	0.00%	0.00%	—
19	26	1	3.85%	1	3.85%	0	0.00%	0.00%	0.00%
20	43	2	4.65%	1	2.33%	0	0.00%	0.00%	0.00%
21	94	6	6.38%	2	2.13%	1	1.06%	14.29%	33.33%
22	142	5	3.52%	1	0.70%	0	0.00%	0.00%	0.00%
23	243	25	10.29%	2	0.82%	0	0.00%	0.00%	0.00%
24	353	33	9.35%	1	0.28%	1	0.28%	2.94%	50.00%
25	556	59	10.61%	13	2.34%	2	0.36%	3.28%	13.33%
26	869	103	11.85%	12	1.38%	7	0.81%	6.36%	36.84%
27	1178	140	11.88%	17	1.44%	5	0.42%	3.45%	22.73%
28	1489	200	13.43%	14	0.94%	6	0.40%	2.91%	30.00%
29	1695	240	14.16%	23	1.36%	12	0.71%	4.76%	34.29%
30	1671	226	13.52%	22	1.32%	6	0.36%	2.59%	21.43%
31	1656	248	14.98%	21	1.27%	8	0.48%	3.13%	27.59%
32	1512	274	18.12%	20	1.32%	12	0.79%	4.20%	37.50%
33	1145	207	18.08%	13	1.14%	10	0.87%	4.61%	43.48%
34	877	151	17.22%	19	2.17%	6	0.68%	3.82%	24.00%
35	690	148	21.45%	7	1.01%	7	1.01%	4.52%	50.00%
36	577	125	21.66%	5	0.87%	9	1.56%	6.72%	64.29%
37	472	91	19.28%	8	1.69%	5	1.06%	5.21%	38.46%
38	337	78	23.15%	7	2.08%	3	0.89%	3.70%	30.00%
39	279	62	22.22%	1	0.36%	4	1.43%	6.06%	80.00%
40	172	44	25.58%	2	1.16%	3	1.74%	6.38%	60.00%
41	108	21	19.44%	2	1.85%	2	1.85%	8.70%	50.00%
42	82	18	21.95%	2	2.44%	2	2.44%	10.00%	50.00%
43	48	13	27.08%	2	4.17%	1	2.08%	7.14%	33.33%
44	25	5	20.00%	0	0.00%	2	8.00%	28.57%	100.00%
45	12	4	33.33%	0	0.00%	0	0.00%	0.00%	—
46	8	2	25.00%	0	0.00%	0	0.00%	0.00%	—
47	4	2	50.00%	0	0.00%	0	0.00%	0.00%	—
48	5	2	40.00%	0	0.00%	0	0.00%	0.00%	—
49	3	1	33.33%	0	0.00%	0	0.00%	0.00%	—
50	1	0	0.00%	0	0.00%	0	0.00%	—	—
Total	16404	2540	15.48%	218	1.33%	114	0.69%	4.30%	34.34%

causation between GDM and PIH. These two factors would be studied and discussed as well.

3. Results

By applying Python programming as well as Excel, the data were analyzed, and the results obtained were illustrated as follows. Of these 16,404 pregnant women, 2,540 (15.48%) and 218 (1.33%) were diagnosed with the GDM and PIH, respectively. Meanwhile, 114 (0.69%) had both the GDM and PIH. The probability of P under condition G is $P(P \mid G) = 4.34\%$. Relatively, the probability the probability of G under condition P is $P(G \mid P) = 34.75\%$.

It should be noted there were very few patients aged less than 20 and more than 43. Therefore, estimates of the prevalence rate were imprecise, and these data were neglected in the following studies and discussions. Under the influence of the age (20-43), $P(G \mid P)$ and $P(P \mid G)$ fluctuated in the range of 0 to 14.29% and 0 to 80.00%, respectively. With respect to the influence of the month, $P(G \mid P)$ and $P(P \mid G)$ fluctuated

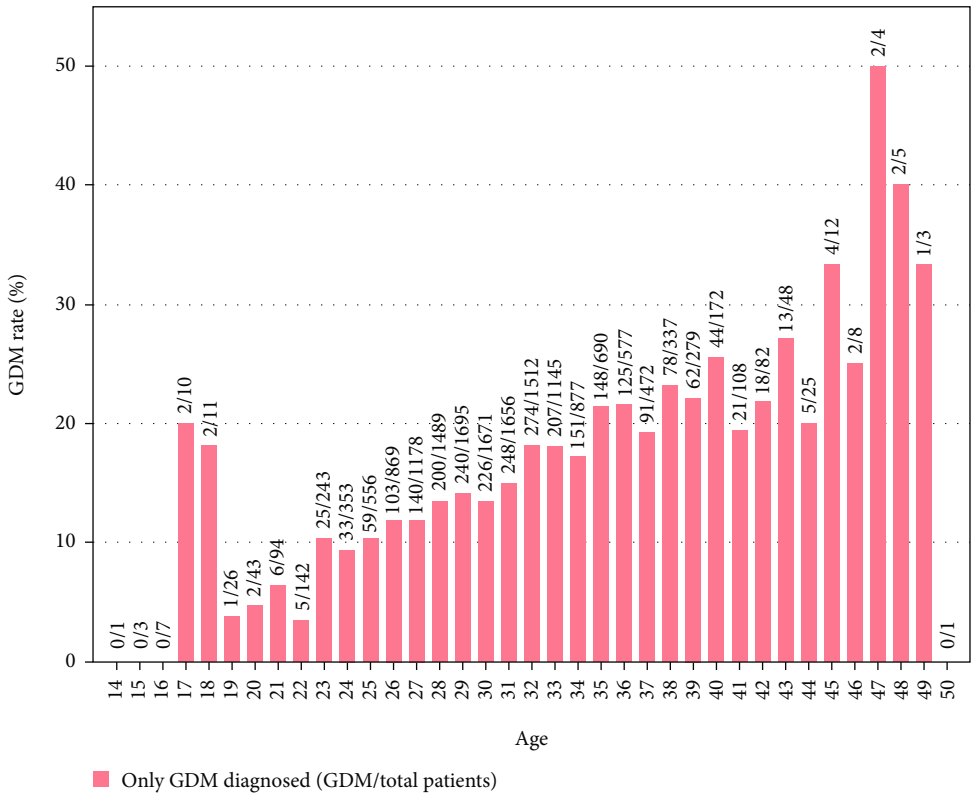

Figure 1: GDM rate distribution histogram with age.

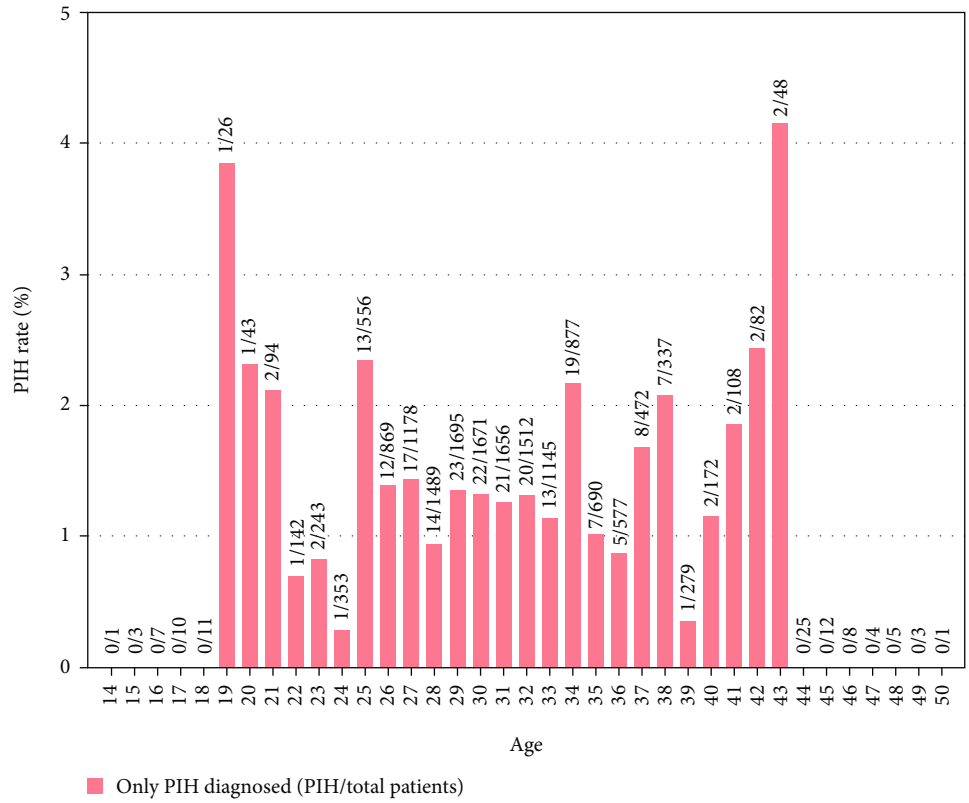

Figure 2: PIH rate distribution histogram with age.

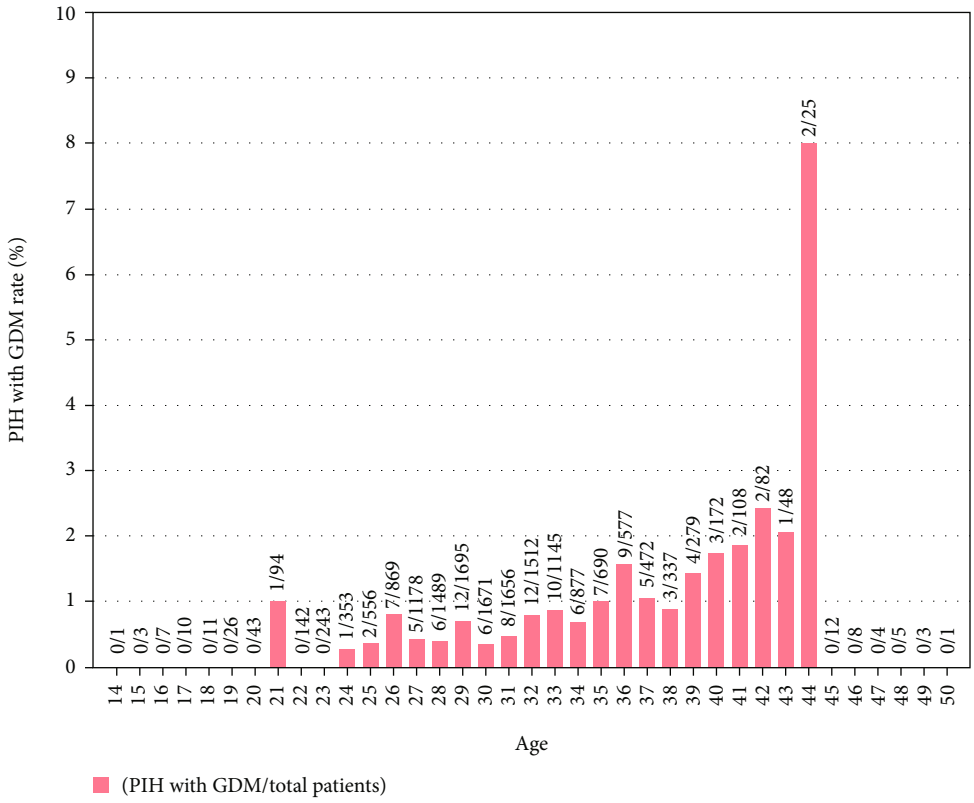

Figure 3: PIH rate distribution histogram with age.

in the range of 2.42% to 6.60% and 18.52% to 45.45%, respectively (more details could be found in Table 1 and 2).

Figures 1–3 represented the distribution of GDM, PIH, and both by age, respectively. Figure 4 represented the distribution of GDM, PIH, and both by month.

According to Figures 1–3, it could be observed that the GDM affects 10-25% of pregnancies and PIH affects 1-5%. Moreover, the prevalence rate of GDM increased with age. By contrast, it is not obvious how the patient's age influenced the PIH. In addition, the GDM and PIH were observed relatively less in June and July.

4. Discussion

It should be noted that both diabetes combined with pregnancy and GDM would cause blood glucose to increase in pregnancy [23]. The medical record provided by outpatient departments had discriminated against these two conditions. In this study, it could be considered that the patients diagnosed with GDM had normal blood glucose before the pregnancy. By the same logic, the patients diagnosed with PIH could be treated that had normal blood pressure before the pregnancy. Therefore, it could be said that the pregnancy caused the GDM and PIH to some degree. The increased blood glucose or diabetes caused by pregnancy could be considered as exposure and the PIH as an outcome, or vice versa. Based on these assumptions, the following discussions could be drawn:

Firstly, the relationship between GDM and PIH would be discussed. The probability of P under condition G ($P(P \mid G) = 4.34\%$) was obviously smaller than the probability of G under condition P ($P(G \mid P) = 34.75\%$). These two probabilities indicated that the PIH might cause the GDM, but the GDM was not likely to cause GDM in the view of statistics.

Secondly, the influence of region on the symptom would be discussed. The studies during 2013-2018 showed that the overall prevalence of GDM was 10-20% according to the IADPSG criteria [24–26]. Several types of research represented that the overall prevalence of PIH was less than 1% [27, 28]. In general, the prevalence of hypertension was higher in cold areas than others [29]. The statistical results induced in this case study identified in the northeast of China demonstrated that the decrease temperature might also cause hypertension during pregnancy. However, the prevalence of diabetes did not show a remarkable difference in varied areas.

Finally, the influence of age and month on GDM and PIH would be discussed. The age might be a notable factor on GDM [30]. Figure 1 and the statistical results represented in Table 1 and 2 demonstrated that older maternal age was significantly associated with risk of GDM. Besides, the lower prevalence of PIH drawn in Figure 3 also demonstrated the influence of temperature on hypertension during pregnancy.

In this study, the sample was analyzed only based on the statistic theory. The pathological mechanism would be discussed in our future works.

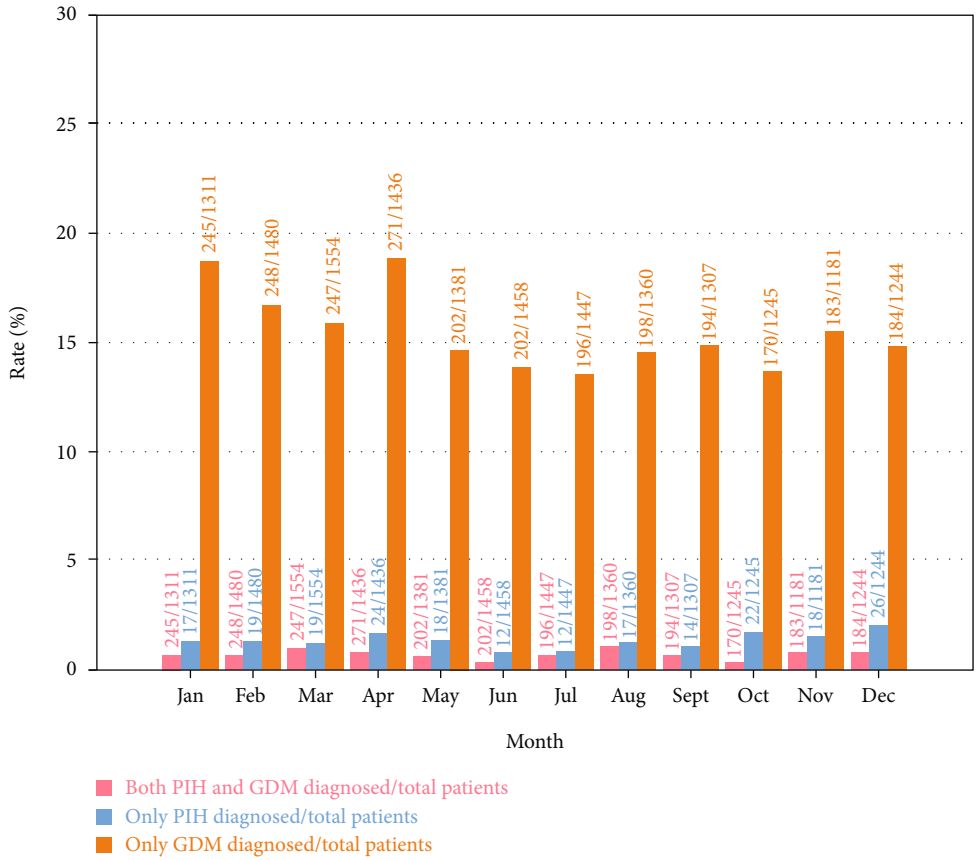

Figure 4: PIH, GDM, and both rate distribution histogram with month.

5. Conclusions

This study analyzed the causal relationship between the GDM and PIH based on the Bayes conditional probability. The following conclusions could be drawn:

(1) The smaller probability of P under condition G ($P(P \mid G) = 4.34\%$) and the larger probability of G under condition P ($P(G \mid P) = 34.75\%$) indicated that the PIH might cause the GDM. However, the GDM was not likely to cause PIH in the view of statistics

(2) The statistical results induced in this case study identified in the northeast of China demonstrated that the decrease temperature might also cause hypertension during pregnancy. However, the prevalence of diabetes did not show a remarkable difference in varied areas

(3) The statistic results indicated that older maternal age was significantly associated with the risk of GDM

This study contributes to the characterization of the prevalence rate of GDM and PIH, as well as the mechanism of these conditions during pregnancy.

Data Availability

No data were used to support this study.

Ethical Approval

We confirmed that all methods were carried out in accordance with relevant guidelines and regulations. We confirmed that all experimental protocols were approved by the institutional and licensing committee in Red Cross Central Hospital, Harbin, China.

Consent

We confirmed that informed consent was obtained from all subjects and the legal guardians of the subjects who below 16 years of age.

Disclosure

A preprint has previously been published [31].

Conflicts of Interest

We declare that there are no conflicts of interest.

Authors' Contributions

Diao Dan and Diao Fang contributed equally to this work.

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Research Article

Evaluation of Medical Care for Diabetic and Hypertensive Patients in Primary Care in Mexico: Observational Retrospective Study

Agustin Lara-Esqueda,[1] Sergio A. Zaizar-Fregoso,[1] Violeta M. Madrigal-Perez,[1] Mario Ramirez-Flores,[2] Daniel A. Montes-Galindo,[1] Margarita L. Martinez-Fierro,[3] Iram P. Rodriguez-Sanchez,[4] José Guzman-Esquivel,[5] Carmen Meza-Robles,[1] Gabriel Ceja-Espiritu,[2] Pablo A. Kuri-Morales,[6] Josuel Delgado-Enciso,[7] Armando Barriguete-Melendez,[8] Hector R. Galvan-Salazar,[1] Carlos E. Barajas-Saucedo,[2] Elvin Guillermo-Espinosa,[9] Agustin D. Lara-Basulto,[1] Jesus F. Gonzalez-Roldan,[10] and Ivan Delgado-Enciso[2]

[1]*Department of Research, Cancerology State Institute, Colima State Health Services, Colima 28085, Mexico*
[2]*Department of Molecular Medicine, School of Medicine, University of Colima, Colima 28040, Mexico*
[3]*Molecular Medicine Laboratory, Academic Unit of Human Medicine and Health Sciences, Zacatecas Autonomous University, Zacatecas 98160, Mexico*
[4]*Molecular and Structural Physiology Laboratory, School of Biological Sciences, Autonomous University of Nuevo León, Monterrey, Nuevo León 64460, Mexico*
[5]*Department of Research, Mexican Social Security Institute, Villa de Alvarez, Colima 28983, Mexico*
[6]*School of Medicine, Universidad Nacional Autonoma de Mexico, Ciudad de Mexico, 04510, Mexico*
[7]*Fundación para la Etica, Education e Investigación del Cáncer del Instituto Estatal de Cancerologia de Colima, Colima 28085, Mexico*
[8]*Universidad Anahuac Ciudad de Mexico, Mexico*
[9]*Colima State Health Services, Colima 28085, Mexico*
[10]*Subsecretaria de Prevención y Promoción de la Salud, Secretaria de Salud de Mexico, Ciudad de Mexico, 06600, Mexico*

Correspondence should be addressed to Ivan Delgado-Enciso; ivan_delgado_enciso@ucol.mx

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Introduction. The present study evaluated the quality of medical care for patients diagnosed with diabetes mellitus (DM), hypertension (HBP), and both pathologies (DM+HBP) within a public health system in Mexico. *Methods*. 45,498 patients were included from 2012 to 2015. All information was taken from the electronic medical record database. Each patient record was compared against the standard to test the quality of medical care. *Results*. Glycemia with hypertension goals reached 29.6% in DM+HBP, 48.6% in DM, and 53.2% in HBP. The goals of serum lipids were reached by 3% in DM+HBP, 5% in DM, and 0.2% in HBP. Glycemia, hypertension, and LDL cholesterol reached 0.04%. 15% of patients had an undiagnosed disease. Clinical follow-up examinations reached 20% for foot examination and clinical eye examination. Specialty referrals reached 1% in angiology or cardiology. *Conclusion*. Goals for glycemic and hypertension reached 50% in the overall population, while serum lipids, clinical follow-up examinations, and referral to a specialist were deficient. Patients who had both diseases had more consultations, better control for hypertension and lipids, but inferior glycemic control. Overall, quality care for DM and/or HBP has not been met according to the standards.

1. Introduction

Diabetes mellitus (DM) is characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Chronic hyperglycemia is associated with long-term damage, dysfunction, and organ failure, especially in the eyes, kidneys, nerves, heart, and blood vessels [1].

DM is a worldwide health problem where Mexico holds sixth place in prevalence globally, given that 15% of the adult population above 20 years of age had been diagnosed [2]. A national survey of the Mexican population showed that 54.5% of DM patients had visual acuity impairment, 9.9% had vision loss, 9.14% presented with foot ulcers, and 5.5% had undergone amputation of an extremity [3].

DM is also the leading cause of premature death within the Mexican population [4], holding the highest diabetes-specific mortality rate in Latin America, where 50% of the patients with DM died from cardiovascular events [5]. Moreover, the presence of DM increases the risk of developing hypertension (HBP) [6].

HBP prevalence within DM patients varies from 30% to 60% [7] and causes up to a 37-fold increase in mortality [8]. Comparing DM patients against non-DM patients, controlled hypertension has been demonstrated to improve risk [9].

Franklin et al. found that HBP was not diagnosed in 29% of DM patients, which had a higher risk (1.5 times) for presenting a cardiovascular event [10]. Consequently, HBP becomes another worldwide public health problem. In Mexico, 31% of the adult population above 20 years of age presents with HBP [11]. 45% of patients diagnosed with HBP died from a cardiac ischemic event, and 51% died from a cerebral ischemic event [12].

Long and Dagogo-Jack reported higher rates of cardiovascular death, myocardial infarction, angina pectoris, amputation, and stroke when patients with DM+HBP were compared against DM-only patients [13].

HBP and DM's economic impact is an enormous burden on society, with an estimated annual cost of $174 billion for DM care and $76.6 billion for HBP-related problems [13]. Both have a highly negative impact on the quality of life of patients, the family nucleus, and the country's economy [14]. Opportune diagnosis and treatment are relevant points for reducing associated complications and the probability of premature death [15].

Patients with DM+HBP have a higher risk of complications. Therefore, targeting multiple risk factors is essential to preventing and slowing the progression of these complications. Optimization of glycemic, lipid, and hypertension control has been demonstrated to improve patient outcomes [13].

The present study took DM+HBP patients as the pivot point to evaluate the quality of medical care given to them by comparing them against DM-only and HBP-only patients. The concept of quality of medical care is a problematic notion of defining. It is described herein as the compliance with actions and goals stated in the Mexican Clinical Practice Guidelines [16, 17] and the Official Mexican Standards [18, 19], which are based on the international guidelines of the American Diabetes Association (ADA) for diabetes [20] and the Eighth Joint National Committee (JNC 8) for hypertension [21].

2. Methods

2.1. Study Population. Data were obtained from the electronic health record (EHR) of Colima, known as SAECCOL (Spanish acronym), from January 2012 to December 2015. The SAECCOL was certified in the NOM-024-SSA3-2012, and its implementation and benefits have been previously described [22].

The present study was approved by the Research Ethics Committee of the Colima State Cancerology Institute, Colima State Health Services, Colima, Mexico. According to the World Medical Association Declaration of Helsinki and the General Guidelines for Health Research, it was carried out. The anonymity of the patients and healthcare personnel was guaranteed.

This study's inclusion criteria were to be diagnosed with diabetes and/or hypertension before December 2015 and stated in the EHR. No previous records before diagnosis were included. Therefore, patients without any of the two diseases were excluded.

Second, patients must be above 18 years old and have at least one record in the EHR. The study included 45,498 patients diagnosed with DM and/or HBP in the EHR within the study period. The population was divided into three categories: (a) diabetes mellitus only (DM), (b) hypertension only (HBP), and (c) diabetes mellitus plus hypertension (DM+HBP). All three categories were taken as stated in the EHR by a single categorical value, 0 for not having the diagnosis and 1 for diagnosis.

2.2. Healthcare Goals. The definition of the goals related to disease control and the procedures undergone by the patients were taken from the Mexican Clinical Practice Guidelines [16, 17] and the Official Mexican Standards [18, 19], which are based on international guidelines of the ADA for diabetes [20] and the JNC 8 for hypertension [21] (see Table 1).

Although international guidelines establish Hb1Ac as one of the goals, this method has not been adopted as a standard routine inside the Mexican public health system. Glucose was measured as preprandial with eight hours of fasting before the blood sample, and the target value was agreed upon lower than 126 mg/dl after guideline consulting. Postprandial glucose was measured two hours after 75 mg of oral glucose, and the target value was agreed upon lower than 200 mg/dl after guideline consulting. Clinical foot examination was identified as the performance of at least one clinical exam concerning deep and superficial lower limb sensitivity. Clinical eye examination was regarded as ophthalmoscopy performed in the primary care setting. Angiology, cardiology, internal medicine, and ophthalmology referrals were registered when the primary care physician referred the patient to the medical specialist, whether or not the patient went to that consultation.

Table 1: Control and management goals used in the present study.

Primary control points	Indicator
Systolic blood pressure	<140 mm Hg
Diastolic blood pressure	>65 and <90 mm Hg
Preprandial glycemia	<126 mg/dl
Postprandial glycemia	<200 mg/dl
Secondary control points	Indicator
Triglycerides	<150 mg/dl*
Cholesterol	<200 mg/dl*
LDL	<100 mg/dl*
HDL	≥50 mg/dl*
Management points	Indicator
Annual eye exam	Yes/no**
Annual foot exam	Yes/no**
Angiology referral	Yes/no**
Cardiology referral	Yes/no**
Internal medicine referral	Yes/no**
Ophthalmology referral	Yes/no**

*Mean values during the study period. **Action performed at least 1 time during the study period (2012-2015). LDL: low-density lipoprotein; HDL: high-density lipoprotein.

2.3. Data Processing. The anonymity of the patients and healthcare personnel was guaranteed. Data cleansing was carried out for each variable, eliminating extreme values that could be part of an erroneous capture. Missing values were substituted with 0 or any representative value that meant no action was performed for that measurement. The Mexican norms state that if an action is not registered in the clinical case record, it is treated as if it did not occur [23].

Finally, variables were grouped for each patient, synthesizing four years of records into a single register per patient, turning the analysis into a cross-sectional study. This measure had to be made given the overload of consults given in the primary level of medical attention.

Aggregation function utilized were (1) maximum function dichotomous variables, to obtain the value of 1 as the indicator of an action carried out during the study period, or the value of 0 if the action was not carried out during the four years; and (2) mean function for continuous variables, to reflect a single value throughout the study period. This aggregation strategy has been previously reported [24].

2.4. Data Analysis. Data are presented as the percentage of patients that met the goal for disease control and management. Control goals were categorized as "yes/no" for each patient, covering four years. The chi-squared test, odds ratio (OR), and 95% CI were employed to compare the different groups using the Crosstabs procedure. A $P < 0.05$ indicated a statistically significant difference. All statistical analyses were performed with SPSS version 20 software (IBM Corp., Armonk, NY, USA).

3. Results

The study population was made up of 45,498 patients, where a total of 41.01% had HBP, 30.09% had DM, and 28.90% had DM+HBP. Almost half of the consultations were given to the DM+HBP patients, despite them being the smallest group. The DM+HBP group had the highest amount of patients in pharmacological therapy (Table 2).

DM: diabetes mellitus; HBP: hypertension; SD: standard deviation; LDL: low-density lipoprotein; HDL: high-density lipoprotein.

Table 2 shows the percentages of patients that met established goals. The DM+HBP group had a lower amount of patients with glycemic control than the DM group, while they had higher hypertension control than the HBP group. Meanwhile, the DM+HBP group had almost 30% of their population in control for both.

Serum lipids got higher control in the DM+HBP group, while they also had higher control for the intersection of glycemic, hypertension, and LDL cholesterol. Also, this group had more population receiving clinical examinations and referrals to specialty consultation.

Table 3 compares the probability of reaching a goal between the groups. With simultaneous control of glycemia and hypertension, the DM+HBP group had 2.2-2.7-times less probability of achieving control than the DM and HBP groups. However, the DM+HBP group had more probability of reaching hypertension control than HBP, while also having less probability of reaching glycemic control than DM.

The DM+HBP patients had a 2-3-times greater probability of receiving pharmacologic therapy, nutritional education, serum lipids, clinical examination, and being referred to a specialist.

Patients in the DM group had a 20% less probability of achieving disease control than the patients in the HBP group while also having less probability of receiving pharmacologic therapy, nutritional guidance, and meeting the triglyceride goal. Also, the DM group patients had less probability of having foot and eye examinations than the HBP group patients.

Finally, the DM patients had more probability of being referred to an angiology, ophthalmology or internal medicine specialist and less probability of being referred to a cardiology specialist than the HBP patients. There were no differences in meeting the goal of cholesterol control between the patients in the DM group and those in the HBP group.

4. Discussion

Reaching a goal is the patient's shared responsibility through self-care and the physician through patient follow-up [13]. The coexistence of DM and HBP worsens clinical outcomes. Therefore, management should be comprised of a multifaceted approach [9].

A patient follow-up under standards, such as clinical foot and eye examinations and the periodic referral of patients to specialists, is an aspect that should be properly carried out before the implementation of other strategies.

The present study found that 45% of the diabetic and/or hypertensive patients reached control, but there were

Table 2: Percentage of patients reaching control and management goals.

Variables	Total $N = 45498$	DM+HBP $N = 13692$	DM $N = 13147$	HBP $N = 18659$
Per pathology	100%	28.90%	30.09%	41.01%
Consultations	100%	49.58%	16.82%	33.60%
Age (years ± SD)	56.6 ± 16.7	57.6 ± 18.3	51.6 ± 15.5	60.0 ± 14.4
Pharmacologic therapy	72.71%	86.75%	63.93%	68.59%
Glycemic controlled	66.25%	42.96%	48.60%	95.77%
Blood pressure controlled	69.03%	71.42%	88.99%	53.21%
Control of glycemia and blood pressure	44.78%	29.60%	48.60%	53.21%
Triglyceride goal	3.52%	5.40%	2.24%	3.03%
Cholesterol goal	5.27%	8.74%	3.92%	3.69%
LDL cholesterol goal	0.20%	0.44%	0.11%	0.10%
HDL cholesterol goal	0.13%	0.25%	0.09%	0.08%
Control of glycemia, blood pressure, and LDL cholesterol	0.04%	0.11%	0.03%	0.00%
Nutritional education	45.97%	60.76%	35.45%	42.53%
Clinical foot exam	22.29%	33.03%	16.36%	18.58%
Clinical eye exam	18.15%	27.18%	12.56%	15.47%
Angiology referral	0.84%	1.39%	0.80%	0.47%
Cardiology referral	1.63%	2.24%	0.22%	2.17%
Internal medicine referral	13.99%	23.31%	10.93%	9.30%
Ophthalmology referral	5.46%	9.50%	4.01%	3.51%

Table 3: Comparison between groups for reaching goals through odds ratio.

Variables	OR (95% CI) P value DM+HBP vs. DM*	DM+HBP vs. HBP*	DM vs. HBP*
Glycemic control	0.79 (0.75, 0.83) ≤ 0.001	—	—
Blood pressure control	—	2.19 (2.09, 2.30) ≤ 0.001	—
Glycemia and blood pressure control	0.44 (0.42, 0.47) ≤ 0.001	0.37 (0.35, 0.39) ≤ 0.001	0.83 (0.80, 0.87) ≤ 0.001
Pharmacologic therapy	3.69 (3.47, 3.92) ≤ 0.001	2.99 (2.82, 3.17) ≤ 0.001	0.81 (0.77, 0.85) ≤ 0.001
Nutritional guidance	2.82 (2.68, 2.96) ≤ 0.001	2.09 (2.00, 2.19) ≤ 0.001	0.74 (0.71, 0.78) ≤ 0.001
Triglyceride goal	2.49 (2.17, 2.85) ≤ 0.001	1.83 (1.64, 2.05) ≤ 0.001	0.74 (0.64, 0.85) ≤ 0.001
Cholesterol goal	2.34 (2.11, 2.61) ≤ 0.001	2.50 (2.27, 2.75) ≤ 0.001	1.07 (0.95, 1.20) 0.274
LDL goal	4.13 (2.31, 7.39) ≤ 0.001	4.56 (2.69, 7.72) ≤ 0.001	1.10 (0.55, 2.22) 0.781
HDL goal	2.72 (1.41, 5.26) 0.002	3.09 (1.68, 5.68) ≤ 0.001	1.14 (0.53, 2.43) 0.743
Foot exam	2.52 (2.38, 2.67) ≤ 0.001	2.16 (2.05, 2.27) ≤ 0.001	0.86 (0.81, 0.91) ≤ 0.001
Eye exam	2.60 (2.44, 2.77) ≤ 0.001	2.04 (1.93, 2.15) ≤ 0.001	0.78 (0.74, 0.84) ≤ 0.001
Angiology referral	1.75 (1.38, 2.22) ≤ 0.001	3.00 (2.33, 3.88) ≤ 0.001	1.72 (1.29, 2.29) ≤ 0.001
Cardiology referral	10.38 (7.08, 15.19) ≤ 0.001	1.04 (0.89, 1.20) 0.641	0.10 (0.07, 0.15) ≤ 0.001
Internal medicine referral	2.48 (2.32, 2.65) ≤ 0.001	2.97 (2.78, 3.16) ≤ 0.001	1.20 (1.11, 1.29) ≤ 0.001
Ophthalmology referral	2.51 (2.27, 2.79) ≤ 0.001	2.89 (2.62, 3.18) ≤ 0.001	1.15 (1.02, 1.29) 0.019

*Reference group (OR = 1.0). With no comparison between groups because they did not share the evaluation goal. DM: diabetes mellitus; HBP: hypertension; LDL: low-density lipoprotein; HDL: high-density lipoprotein.

significant differences between the groups analyzed. In comparison, patients in DM+HBP reached control by 30%. Strikingly, the DM+HBP patients had better hypertension control (71%) but inferior glycemic control (43%).

A decrease in the occurrence and progression of retinopathy, nephropathy, and neuropathy has been demonstrated with glycemic control [25]. Within Latin America, glycemic control has been reported in 43% of patients, while in the

United States, that proportion is 49% [26], and European studies reported 64% of patients in control [27]. In the present study, 48.6% of patients from the DM group reached glycemic control.

Regarding hypertension, the controlled disease was found in 56.8-58.7% of patients in other Mexican studies [3, 28]. Data collected in 2010 showed that the proportion of hypertension control was 50.4% in high-income countries, compared with 26.3% in low- and middle-income countries [11, 29]. In the present study, control is accomplished in 53% of the HBP group patients, similar to that reported for high-income countries.

Previous studies did not include patients with DM and HBP; this is a strength of the present study. We showed that there were differences between those groups of patients, at least in our study population.

The undiagnosed disease was 4% of HBP and 11% of DM, implying that at least 15% of the total population presented with both diseases and received treatment for only one of them.

Reported masked disease in 2000 was 29.3% for diabetic patients with masked HBP [9]. Having both diseases, but receiving treatment only for one, increases the damage to target organs and cardiovascular risk in those patients [9].

Serum lipid control is a less-studied theme. Only 3% of the patients had triglyceride control in our study population, and 5% had total cholesterol control. Moreover, control from LDL cholesterol and HDL cholesterol goals did not surpass 0.5% of the analyzed population.

Studies performed in the diabetic Mexican population reported LDL cholesterol control in 52% in 2003 and 12% in 2006 [30], while 57% had total cholesterol control [31]. In the United States, reports from LDL cholesterol control go from 40 to 63% in DM patients [26]. Variability in compliance with lipid control or other health goals even within Mexico may be due to substantial heterogeneity in healthcare quality assessments across Mexican healthcare subsystems. These differences across subsystems remained even after adjusting for socioeconomic, demographic, and health factors [31]. Despite regional variations, our population had the lowest control of serum lipids worldwide.

Nevertheless, our patients had glycemic control and hypertension control results similar to those reported for high-income countries; this could be due to an unequal therapeutic focus. More attention was given to controlling glycemia and hypertension than to serum lipid control.

These results suggest that therapeutic strategies for controlling lipid levels do not necessarily accompany glycemic control and hypertension control strategies. Healthcare quality was also measured through actions performed in the primary care setting, such as clinical examinations, along with a referral to specialists. Mexican studies showed that 8-25% of DM patients received an eye exam or were referred to an ophthalmologist, and 14-98% had a foot exam over one year [32].

Our analysis showed that only 1 out of every five patients had a foot or eye exam in the primary care setting within the study's 4-year time frame. During that same period, only 1% were referred to an angiologist or cardiologist, 5% to an ophthalmologist, and 14% to an internist. National and international guidelines indicate that a foot examination should be carried out at every consultation, and referrals should be once a year.

No previous reports evaluated healthcare quality in a population made up of patients with those three diagnoses. That division made it possible for us to analyze the differences between groups (see Table 3).

We found that the DM+HBP patients received more nutritional orientation and had a greater probability of being referred to than the single diagnosis groups. That could have influenced the greater control fulfillment with the hypertension goal but was incongruent with the inferior glycemic control observed in that group.

The DM+HBP patients had more than double the probability of having eye and foot examinations than the patients diagnosed only with DM or only with HBP. The DM+HBP patients had a 10-times greater probability of being referred to a cardiologist than the DM patients. The DM+HBP patients and the DM patients had a three- and 1.7-times greater probability than patients with HBP of being referred to an angiologist, respectively. In comparison, a more significant number of DM+HBP patients were referred to an angiologist than the DM patients. The DM+HBP patients were referred to an ophthalmologist 2.5 times more and to an internist 3 times more than the patients that were just diabetic or just hypertensive.

A direct comparison between the DM and HBP groups showed that the DM group also had less probability of having nutritional orientation, foot and eye examinations, and fewer cardiology referrals than the HBP group patients. In contrast, the DM group patients had a greater probability of being referred to angiology, internal medicine, and ophthalmology.

This data clarifies that the quality of chronic degenerative disease care within the same health system can vary, depending on the patients' diagnoses. We also observed that it was more common for a DM patient to have masked HBP than for an HBP patient to have masked DM.

We found low goal achievement in the primary care setting. Therefore, it is likely that complications are not detected opportunely and are diagnosed at advanced stages, reducing the patient's quality of life, increasing healthcare costs, and reducing patient life expectancy. It has been documented that diabetic patients have better control of their parameters when they are cared for by departments of specialized medicine in comparison with primary care physicians [33].

Strategies should be implemented in Mexico to improve this aspect of healthcare. It should be understood that the problem is not resolved by referring the patient to a specialist. The capacity of the specialized consultation must be calculated and the necessary adjustments made to meet the goals. Regarding the implemented strategies, simulating goal compliance by referring the patient to the specialist, even though the patient is never treated, or saturating the specialty consultation, to the detriment of quality care in both the programmed and emergency consultations, must be prevented.

Limitations for the present study included the time series analysis that was not possible to make given that time between subsequent consultations was not equally spaced

for all the patients. For example, it was not possible to know the time during follow-up in which the therapy goals were achieved. The authors did not manipulate these records in any manner; therefore, a collapse of data had to be done to perform statistical analysis. Another important limitation was that there were no records of referrals by primary care physicians to the nephrology service. This was due to peculiarities of the evaluated health system, where the primary care physician refers to the internal medicine service, without being able to refer the patient directly to a nephrology consultation. Kidney complications are very important in both diabetic and hypertensive patients and more so if the patient has both conditions.

Mexico is a country in development, and given that the population for this study was taken from a public health care system, HbA1c is not measured as the guidelines state; therefore, authors agreed to take glycemic control according to preprandial and postprandial measures.

5. Conclusions

Glycemia and hypertension control was achieved in 50% of the population, similar to that in reports from developed countries. Incongruously, serum lipid control was lower than that reported worldwide, suggesting that the control of secondary variables (such as lipids) was not always conducted with the same quality as that of the primary aims.

Foot and eye examinations were performed between 12 and 22% of patients, varying according to their diagnoses, while referrals to a specialist, such as an angiologist or cradologist, can be in less than 1% of patients.. The DM+HBP patients had a higher number of general medicine and specialty consultations, better control of HBP and serum lipids, and inferior glycemic control. The amount of undiagnosed disease reached 15%.

The care given to patients treated through the health systems must improve. Feasible health education strategies should be developed, and their application designed to not interfere with the quality of the programmed consultations.

Data Availability

The data belong to the Colima State Public Health Department and are only available to researchers that have applied for the data at the Administrative System of Clinical Records of Colima (SAECCOL, Spanish acronym), contact information: ivan_delgado_enciso@ucol.mx, contact person: Ivan Delgado.

Ethical Approval

The study protocol was approved by the ethics committee of the Colima State Cancerology Institute (Instituto Estatal de Cancerología de Colima) reference number CEI-CANCL100415-1, and permission to access nonpatient identifiable data was obtained from the Colima State Public Health Department.

Disclosure

The manuscript has been presented as a preprint at the following link: https://preprints.jmir.org/preprint/24720.

Conflicts of Interest

The authors declare that they have no competing interests.

Authors' Contributions

IDE, JFGR, and GCE conceived the study protocol and analysis plan and reviewed and edited the manuscript. SAZF, ALE, VMMP, DAMG, EGE, ABM, and CMR created the data collection tools and undertook the data collection. SAZF, MRF, HRGS, MLMF, HRGS, and CEBS analyzed the data. All authors contributed to the interpretation of the data. IPRS and ADLB contributed to the discussion and reviewed and edited the manuscript. PAKM and JGE drafted the article, and all authors contributed to the critical revision of the article. JDE is the guarantor of this work and, as such, takes responsibility for the integrity of the data and the accuracy of the data analysis. Agustin Lara-Esqueda and Sergio A. Zaizar-Fregoso contributed equally to this work.

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