Nutrition, Metabolism & Cardiovascular Diseases (xxxx) xxx, xxx

Available online at www.sciencedirect.com

Nutrition, Metabolism & Cardiovascular Diseases

journal homepage: www.elsevier.com/locate/nmcd

An intensive follow-up in subjects with cardiometabolic high-risk

Hernán A. Pérez [a,d], Akinwunmi O. Adeoye [b,c], Laura Aballay [c], Luis A. Armando [a], Néstor H. García [c,*]

[a] *Blossom DMO, Hipólito Irigoyen 31, Córdoba, X5000, Argentina*
[b] *Department of Biochemistry, Federal University Oye-Ekiti, Nigeria*
[c] *INICSA, Enrique Barros Pabellón Biología Celular, Ciudad Universitaria, X5000, Córdoba, Argentina*
[d] *Center for Advanced Imaging Research, Department of Diagnostic Radiology and Nuclear Medicine, Maryland University, Baltimore, MA, USA*

Received 12 October 2020; received in revised form 17 May 2021; accepted 15 June 2021
Handling Editor: J. Bella
Available online ■ ■ ■

KEYWORDS
Cardiovascular diseases;
Cardiometabolic risk;
Behavioral risk;
Chronic care model;
Stratification tools

Abstract *Background and aim:* Addressing chronic problems requires a model of care that promotes self-management of the disease and facilitates adherence to treatment. This project was designed to enhance patient's clinical and functional outcomes through a Comprehensive Model to be implemented in our health system and to evaluate the results.
Methods and results: Different population stratification tools were tested and designed to classify subjects according to different variables. We have developed a program to detect and screen cardiometabolic risk by integrating most of the Chronic Care Model recommendations through in-house developed management software (MoviHealth®). From the results, 1317 subjects were evaluated (27% of the whole population) during the first year of follow-up which significantly improved for all variables along the follow-up period. The blood pressure of the hypertensive population in 2010 and 2015 showed the importance of enrollment of subjects and the optimization of the blood pressure control. The result of HbA1c observed in 2010 decreased progressively to 7.1 $\pm$ 1.4% in 2015, and dyslipidemia levels improved gradually. The number of cardiovascular events requiring hospitalization decreased significantly (48%), from 1.9 events per 100 subjects in 2011 to 0.98 in 2015.
Conclusion: Our program has combined strategies for the prevention and control of non-communicable diseases, incorporating interventions to control risk factors and to reduce morbidity and mortality. It also had improvements in life quality, accessibility to health-care services, and the promotion of self-care.

Introduction

Non-communicable diseases, such as cardiovascular diseases, diabetes, cancer, and chronic obstructive pulmonary disease cause 60% of the world's deaths. About 16 million of these deaths are of people under 70 years. However, a large percentage of cardiovascular diseases and other non-communicable diseases are mostly preventable. Also, the total number of deaths, and especially those that occurred prematurely, can be reduced through reduction/prevention of behavioral risk factors such as unhealthy diet, tobacco use, physical inactivity, excessive salt intake, and harmful use of alcohol [1,2].

Unhealthy behaviors result in physiological/metabolic changes such as hypertension, diabetes, obesity, and dyslipidemia causing atherosclerosis and vascular events.

* Corresponding author. Fax: +54 351 576 0248.
E-mail address: garcia.nestor@conicet.gov.ar (N.H. García).

https://doi.org/10.1016/j.numecd.2021.06.011
0939-4753/

Please cite this article as: Pérez HA et al., An intensive follow-up in subjects with cardiometabolic high-risk, Nutrition, Metabolism & Cardiovascular Diseases, https://doi.org/10.1016/j.numecd.2021.06.011

Since the underlying pathological processes and risk factors are common to all the diseases mentioned before; a similar approach for their prevention and control would be appropriate and effective for the disease conditions. It has been reported that if the main non-communicable diseases risk factors are being eradicated, 80% of heart diseases, strokes, and diabetes type II could be avoided, as well as 40% of cancers [3]. To this purpose, there are cost-effective interventions designed for individuals and the population as a whole [4,5]. The best cost-effective, sustainable, and fundable strategy of promotion and primary care to confront this global epidemic should be based on social basis and risk factors [6,7].

Different strategies have been used in order to improve life quality and to reduce chronic pathology rates; but so far, they have proved to be quite ineffective because of poor education in preventive health care. Poor results observed in smoke–quitting and physical inactivity, as well as failure to control obesity, are explained by the difficulty of building an inter-sectoral response since the individual approach with no positive results over population's lifestyle has prevailed. The evidence indicates that the socio-economic environment contributes to about 50% of the population health level, while the health system contributes to 25% [8].

In addition, in Argentina there is no data specifying the incidence and control of chronic diseases despite the intensive strategies driven by several government institutions. Presently, health services are mainly focused on acute care problems and maternal and child populations, thus we designed a program based on the Chronic Care Model, driven by the Pan American Health Organization, as a viable option for reorienting health services to subjects with non-communicable diseases.

Our program intends to detect and screen cardiometabolic risk, integrating most of the Chronic Care Model recommendations through in-house developed management software (MoviHealth®). Self-care support is implemented through a mobile application, education (workshops and materials), outgoing calls, chat, and coach. Services were redesigned to introduce screening activities in occupational and residential environments. We also included pay-per-performance programs for health-professionals and incentives for subjects. Finally, we added a systematic measurement of subclinical atherosclerosis (Total Plaque Area (TPA)) and an electronic system for medical records integrated into the management system of chronic diseases (MoviHealth®) with decision-making support (Micromedex®). The Health Insurance Company Board has not only played a key role by implementing the program at the company's health center, but it has also developed political actions that were necessary to involve employers, unions, and civil facilities such as clubs, hotels, etc.

This project was designed to enhance a patient's clinical and functional outcomes through a Comprehensive Model to be implemented in our health system and to evaluate the results.

Methods

In this study, we present a description of the program's main variables behavior.

The program began in 2008 considering the classical care model for people with chronic diseases driven by the Pan American Health Organization [9]. The program was incorporated into the employer health insurance, Obra Social del Personal de Luz y Fuerza de Córdoba, as Chronic Diseases Care Service. The study was approved by the Ethics Committee and each participant signed an informed consent.

We performed this model's classical components by the progressive integration of the following activities:

1. Screening activities at industrial and residential environments for Framingham Risk Score (FRS) determination, stratification, and individual follow-up.
2. Pay-per-performance programs for health-professionals: professionals must accomplish quality criteria in recording clinical data to earn additional payments.
3. Incentives for subjects: patients whose control values were within the acceptable range (cholesterol <200 mg/dl, blood pressure (BP) < 130/70 mmHg and HbA1c <7%) received free-of-charge medication.
4. Management software for chronic conditions (Movi-Health ®) to control several care processes, including screening activities, risk categorization, subjects' citation, protocols, and follow-up procedures.
5. Medical records software (MoviHealth®) integrated with Management software for chronic conditions with accessory modules to support decision-making, including control and alerts for drug interactions (Ultimedex), providing access to recommendations (Micromedex Clinical Knowledge) and educational material for subjects (Micromedex Care Notes).
6. In 2010, we added another component to the program: determination of carotid subclinical atherosclerosis by TPA for subjects with high cardiovascular risk.
7. Subjects were provided with a mobile application for self-monitoring of body weight, BP, glycaemia, etc.
8. Educational activities for subjects including workshops, printed material about prevalent pathologies-associated conditions, and promotion of healthy habits.
9. Outgoing calls campaigns for scheduling citations and conducting telephone screening.
10. Via-chat support is provided by a health worker.
11. Weight reduction program for voluntary subjects who meet the admission criteria and follow–up including anthropometry, nutritional consultation, and physical activity.
12. Activities involving employers and unions, such as prevention and attention of addictions (alcoholism, smoking, etc.), and contributions to acquire proper medication.

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13. Special activities at sports clubs, hotels, etc., to stimulate physical and recreational activities.

The inclusion of a volunteer to the program started with the stratification of cardiometabolic risk by using the FRS score based on body mass index (BMI) [12]. Those subjects with a score ≤ 6% were assigned to control General Practitioner (GP), while those with scores> 6% were re-tested using the Framingham Post-test algorithm [13]. After this stratification with the Framingham Post-test algorithm, subjects with scores <20% were assigned to follow-up by GP while those with scores ≥ 20% were assigned to the cardiometabolic high risk group as the High-Risk Control Service thereafter. This service consists of a multidisciplinary team of physicians, nutritionists, educators, gym trainers, psychologists, and health workers.

Also, the follow-up of subjects meeting the "criteria" of controlled disease were awarded free-of-charge medication. These "criteria" were: HbA1c <7%, Total Cholesterol <200 mg/dl, BP < 130/70 mmHg, among others. Subjects with BMI >30 kg/m^2 were derived from the Body Weight Reduction Program. Finally, subjects were followed for correction of risk factors using the current recommendations of the Argentina Society of Internal Medicine.

Risk factor assessment

All individuals provided details of their demographics, medical history, and concomitant medication. A history of cigarette smoking was considered present if a subject was a current or former smoker. Subjects were considered to have diabetes, hypertension, or hyperlipidemia based on a self-reported diagnosis or previous use of oral hypoglycemic agents, insulin sensitizers, subcutaneous insulin, antihypertensive medication use, or lipid-lowering drugs. BP was assessed as the mean of three measurements performed on the left arm in the sitting position, after a 5-min period of rest, with the OMRON Hem705 sphygmomanometer [13]. Personal history of CVD was defined by prior myocardial infarction, coronary/peripheral revascularization, stroke, or any self-reports of chest pain, chest pressure, or chest tightness. Arrhythmias were not considered as part of the definition of premature cardiovascular disease.

Clinical risk scoring

The FRS sex-specific risk equations that substitute BMI for lipid profile (BMI-FRS) were used to predict the risk of developing CVD over the next 10 years [12]. A previously described [13] risk calculator for CVD was used that incorporates TPA measurements into BMI-FRS (Ptp-TPA) to produce 10-year risks for all-cause CVD.

Carotid total plaque area determination

In 2010, TPA was measured as described previously [13], with a high-resolution duplex ultrasound scanner. Plaque was defined as a local thickening of the intima >1 mm in thickness. Measurements were made in magnified longitudinal views of each plaque seen in the right and left common, internal, and external carotid arteries. The plane in which each plaque was measured was given by the view showing the largest extent of plaque. The image was then frozen and magnified, and the plaque was measured by tracing around the perimeter with a cursor on the screen (Fig. 1). The operator then moved on to the next plaque and repeated the process until all visible plaques were measured. The sum of cross-sectional areas of all plaques seen in both carotids, between the clavicle and the angle of the jaw, were taken as TPA and this value was used for the post-test analysis.

Statistical analysis

The descriptive analysis was expressed as mean and standard deviation (SD) in text and tables, and as mean and the standard error of the mean (SEM) in figures. The outcome measure used to evaluate the Program is the rate of occurrence of cardiovascular events (CVE): time to the first hospitalization for acute ischemic syndromes, coronary revascularization procedures, stroke, complications of diabetes (in diabetes), and heart failure. We compared the occurrence of events using models of survival (Log Rank test and Cox proportional hazards model). Values of $p < 0.05$ were considered statistically significant.

Results

Progressive incorporation of subjects to the program

The general characteristic of the study population is presented in Table 1 and Table 2. Chronic Care Program was intended for subjects of 18 years old or more. The progressive increasing number of volunteers who joined the Chronic Care Program grew gradually. During the first year of follow-up 27% of the whole population was evaluated. The number of subjects entering the program continued growing and by 2015 we evaluated 72% of the whole population (Table 3). Along the follow-up period, significant improvements were observed for all variables.

Progressive optimization of classical risk factors

Hypertension

Hypertensive subjects (Fig. 2) recruitment increased progressively from 2010 (29.1%) to 2014 (48.0%). This increase was also observed in the incidence of controlled high BP (SBP <140 mmHg): 48.1% in 2010 vs 77.4% in 2015. It was also observed that a proportional increase in subjects with SBP <130 mmHg: 24.1% in 2010 vs 48.3% in 2015. As expected, a decrease in the incidence of SBP >140 mmHg occurred: 51.9% in 2010 vs 22.6% in 2015.

This shows both the importance of enrollment of subjects and the optimization of BP control.

Diabetes mellitus

In 2010 (Fig. 3), 215 diabetic subjects (7.1% of the study population) entered the program, and this proportion

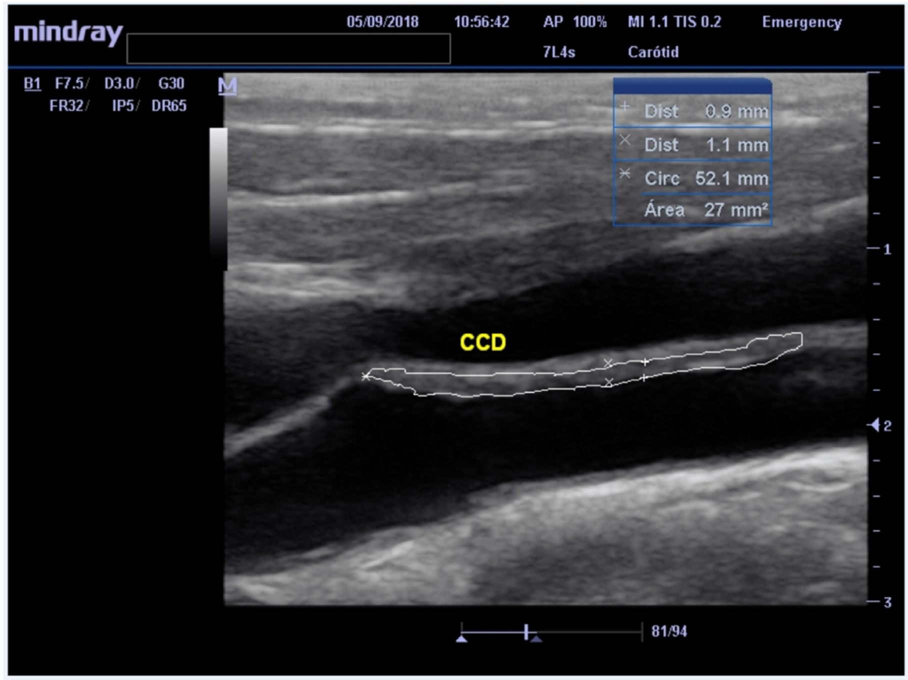

Figure 1 Measurement of carotid plaque area in a 55 years old woman. Each plaque was measured in a longitudinal view in the plane in which the plaque is maximal. The image was frozen and magnified on the screen, and a cursor was traced around the perimeter of the cross section. The microprocessor in the duplex scanner displays the cross-sectional area of the plaque. The plaque shown is in the right common carotid artery and measures 27 mm^2.

increased by 10.7% in 2014 and 9.7% in 2015. The HbA1c observed in 2010 was 8.4 ± 1.8%, and it decreased progressively to 7.1 ± 1.4% in 2015. In 2014 and 2015 96% and 76% of subjects had HbA1c <8%.

Cholesterol control

Bodyweight From the results of this study, it did not surprise the program's failure to achieve a decrease in body weight. In this case, in 2010 64.6% of subjects had a BMI <30 kg/m^2. This proportion remained stable until 2015 when it reached 65.3%. Only 34.7% of our population met obesity criteria.

Dyslipidemia The results showed that the control of dyslipidemia levels improved gradually. As shown in Fig. 4, in 2010 64% of subjects had total cholesterol <200 mg/dl, while in 2015 it increased to 69.7%. Regarding LDL cholesterol levels: in 2010, 66.1% of subjects had LDL <120 mg/dL vs 71.8% in 2015. The same optimal control

Table 1 Epidemiological data and Patient recruitment and follow-up.

	2008 (n = 1317)	2009 (n = 2320)	2010 (n = 3019)	2011 (n = 3806)	2012 (n = 3400)	2013 (n = 3425)	2014 (n = 3315)	2015 (n = 3657)
Men (%)	41.3	46.4	40.9	79.9	45.3	46.8	46.7	45.6
Age (years)	58 ± 14	48 ± 26	57 ± 19	56 ± 31	56 ± 17	54 ± 18	57 ± 18	58 ± 17
BMI (kg/m^2)	29.7 ± 5.6	29.1 ± 14.6	27.9 ± 4.1	29.5 ± 5.4	28.3 ± 5.1	28.5 ± 5.7	28.5 ± 5.4	28.2 ± 5.5
Smokers (%)	N/A	N/A	2.02	14.13	13.82	15.27	13.33	12.79
DM II (%)	15.8	16.7	7.1	6.2	9.0	9.6	10.7	9.7
HbA1c (%)	N/A	N/A	7.5 ± 2.0	7.1 ± 1.5*	7.1 ± 1.9*	6.3 ± 1.2*	6.1 ± 0.9*	6.9 ± 1.5*
Hypertension (%)	N/A	N/A	7.9	15.1	39.2	36.8	47.1	48.6
SBP_{HTA}	N/A	N/A	141 ± 17	138 ± 19*	135 ± 18*	134 ± 18*	130 ± 12*	132 ± 13*
DBP_{HTA}	N/A	N/A	80 ± 12	80 ± 12	78 ± 11*	78 ± 11*	74±8*	75±9*
LDL_{Chol} (mg/dl)	N/A	N/A	111 ± 40	109 ± 37	106 ± 40*	96 ± 36*	108 ± 34	99 ± 39*
TG (mg/dl)	N/A	N/A	154 ± 98	157 ± 96	163 ± 96*	167 ± 97*	156 ± 90	154 ± 89
$Fram_{BMI}$ (%)	N/A	N/A	21.2 ± 10.4	21.5 ± 9.6	18.1 ± 18.2	18.1 ± 18.9	22.2 ± 19.5	21.6 ± 19.7
FHx (%)	N/A	N/A	17.5	15.0	12.0	8.4	5.3	18.3
Participants (%)	27	47	64	74	67	69	67	72

BMI = body mass index, DM II = diabetes type II, HbA1c = Glycosylated haemoglobin, Smokers = Active Smokers, SBP_{HTA}, DBP_{HTA} = Systolic and diastolic blood pressure from hypertensive subjects, LDLChol = LDL cholesterol, TG = Triglycerides, FramBMI = Framingham score BMI based, FHx = family medical history of premature cardiovascular events, Participants, percentage of the whole population older than 18 years. *p < 0.005 vs 2010, Kruskal–Wallis One Way Analysis of Variance on Ranks (Dunn's Method).

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Table 2 Concomitant medication.

	2008 (n = 1317)	2009 (n = 2320)	2010 (n = 3019)	2011 (n = 3806)	2012 (n = 3400)	2013 (n = 3425)	2014 (n = 3315)	2015 (n = 3657)
Antiplatelet (%)	N/A	N/A	17.4	16.1	18.4	19.2	21.4	20.7
Statins (%)	N/A	N/A	38.0	71.1	64.1	53.3	61.9	52.1
BB (% HTA)	N/A	N/A	25.6	23.3	26.6	27.5	25.7	21.8
RASm (% HTA)	N/A	N/A	73.2	74.9	70.4	80.7	84.3	78.9
Diuretics (% HTA)	N/A	N/A	29.2	31.1	35.2	35.4	32.9	30.7
CCB (% HTA)	N/A	N/A	29.9	29.6	31.7	35.5	31.4	31.1

Antiplatelet drugs (aspirin, acenocumarol, clopidogrel), Statins (atorvastatin, rosuvastatin), were expressed as percentage from total population. RASm = Renin angiotensin system modulators (enalapril, benazepril, ramipril, lisinopril, losartan, valsartan, candesartan), BB = Beta-blockers (carvedilol, atenolol, nebivolol), were expressed as percentage from hypertensive population.

was observed in diabetic subjects, while in 2010 only 40% had LDL cholesterol <100 mg/dl, in 2015 subjects with optimal control cholesterol was nearly 70%. This is consistent with the improvement observed in the control of diabetes.

Atherosclerosis In order to determine the impact of the Chronic Care Program in atherosclerosis, subclinical carotid atherosclerosis was assessed by TPA. Three groups were identified: Regression group (35% of the population), Stable group (14% of the population), and Progression Group (51% of the population).

In the Regression group, atherosclerosis burden decreased from 139 ± 16 to 107 ± 14 mm^2, and the Ptp-TPA decreased from 58 ± 3 to 45 ± 3%. BP also decreased from 140 ± 3/81 ± 1 mmHg to 137 ± 2/77 ± 1 mmHg. LDL, HDL cholesterol, and triglycerides were not significantly different during the evaluation periods. In the Stable group, neither the atherosclerosis burden (78 ± 2 vs 81 ± 1 mm^2) nor the Ptp-TPA (45 ± 3 vs 42 ± 2%) changed significantly, but the BMI decreased from 29 ± 1 to 28 ± 1 kg/m^2. BP, LDL cholesterol, HDL, and triglycerides were not significantly different during the evaluation periods. However, in the Progression Group, TPA increased from 91 ± 7 to 145 ± 10 mm^2, reaching a worse post-test risk (50 ± 1 to 59 ± 3%, $p < 0.05$ t-test). BP did not change significantly during the evaluation period (143 ± 3/80 ± 2 vs 142 ± 3/78 ± 2 mmHg). LDL cholesterol was 100 ± 5 mg/dl, HbA1c 6.5 ± 0.2%, and the remaining variables were not different during the evaluation period.

Cardiovascular events

Information on CVE incidence was obtained retrospectively from the health insurance company records. In the period under examination (from 2011 to 2015), there were 331 subjects presenting 448 CVE. As shown in Table 4, the number of CVE decreased significantly, while the population at risk remained relatively constant. Consequently, the rate of CVE decreased by 48%, from 1.89 events per 100 subjects in 2011 to 0.98 in 2015 (Fig. 5). Restricting the analysis to people over 65 years old, we found an even greater reduction in CVE rate (60% for the entire period), from 5.85 every 100 subjects in 2011 to 2.35 in 2015. For subjects aged 65 or more, the reduction in the event rate observed was accompanied by an increase of the population at risk, which went from 1675 subjects in 2011 to 2000 in 2015 (Fig. 6).

Table 3 Epidemiological data – Chronic Care Program.

	2008	2009	2010	2011	2012	2013	2014	2015
Total population	4901	4892	4735	5119	5063	4930	4944	5082
Program population	1317	2320	3019	3806	3400	3425	3315	3657
Program %	27	47	64	74	67	69	67	72

Discussion

Our program provides important information, suggesting that intensification of the integral medical control, associated with a stimuli program per performance for the subjects as well as the physician was a useful tool to improve primary care assistance without the need of sophisticated tools.

Our program is characterized by a high rate of patient recruitment. This procedure was secured by using two strategies: a) through outgoing phone-calls campaigns automatically generated by the MoviHealth® software, which was based on the Framingham score– assigns minimum annual visits to each patient, and b) through the physician's ability to schedule the visit. Following this procedure, we managed to enter and follow 50% of the general population.

Additional strategies were used to maintain this medical control rate. Pay-per-performance programs for health-professionals, thus stimulating the quality of medical actions in the follow-up. This measure has been shown to improve the patient's outcome in several reports [14]. Another strategy was based on incentives for subjects: those who met the criteria of "controlled pathology" (hypertension, diabetes II, hypercholesterolemia) received free-of-charge medication. This not only encourages the patient to follow medical guidelines but also enhances compliance.

Hypertension is a risk factor for many CVE [15]. Although interventions to individuals at high-risk are necessary and important, policies aimed at the whole population had a greater impact as they prevent CVE in a large number of people considered non-hypertensive [5]. The last national report of the Ministry of Health

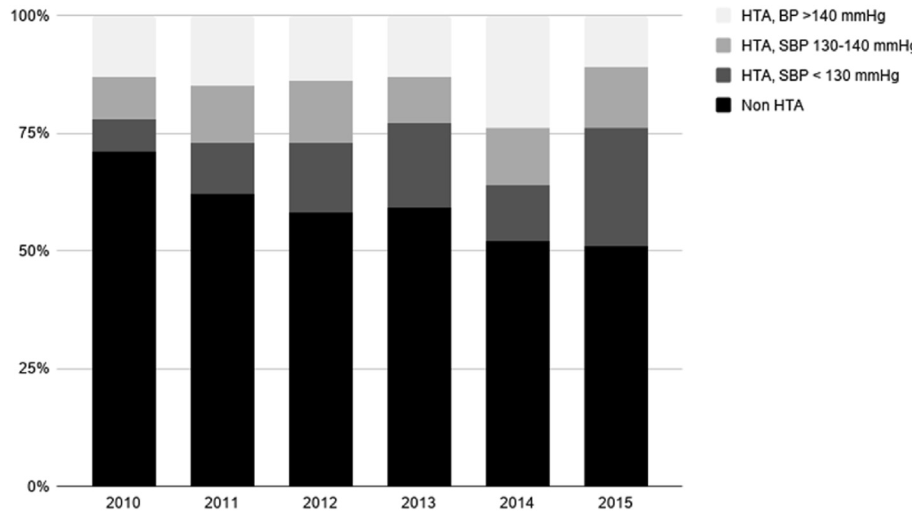

Figure 2 Improvement of blood pressure control. Each bar represents the total population per year. The percentage of hypertensive patients with SBP <130 mmHg increased along with the program progress.

(Argentina) regarding hypertension was based on surveys rather than measurements, which prevents us from making comparisons. In 2009, in subjects over 64 years old, it was reported a prevalence of 62.1%; 47.5% in subjects 50–63, and 28.4% in subjects 35–49. Only 38.9% of people with access to public medical care treatment receive treatment, while in subjects with private health insurance this percentage rises to 64.5%. Unfortunately, national reports do not allow evaluating the effectiveness to control hypertension.

In our sample, we observed an increasing number of subjects with controlled BP. In 2010, 48.1% of hypertensive subjects had SBP <140 mmHg, and 24.1% of these subjects <130 mmHg. In 2015, 77.4% had a SBP <140 mmHg and 48.3% < 130 mmHg. It was observed that the results obtained from this study are better than those previously reported by other investigators; for instance, in the United States, 32% had hypertension, from which only 54% are well-controlled [17,18]. In Australia, 32% of the population had hypertension and 32% of them are well-controlled [19]. Other developed countries show similar statistics on this subject.

It is worth noting that most of the subjects with SBP >140 mmHg and suspected hypertension rated a high score for Framingham, thus being included in the chronic monitoring group and remaining in the program with

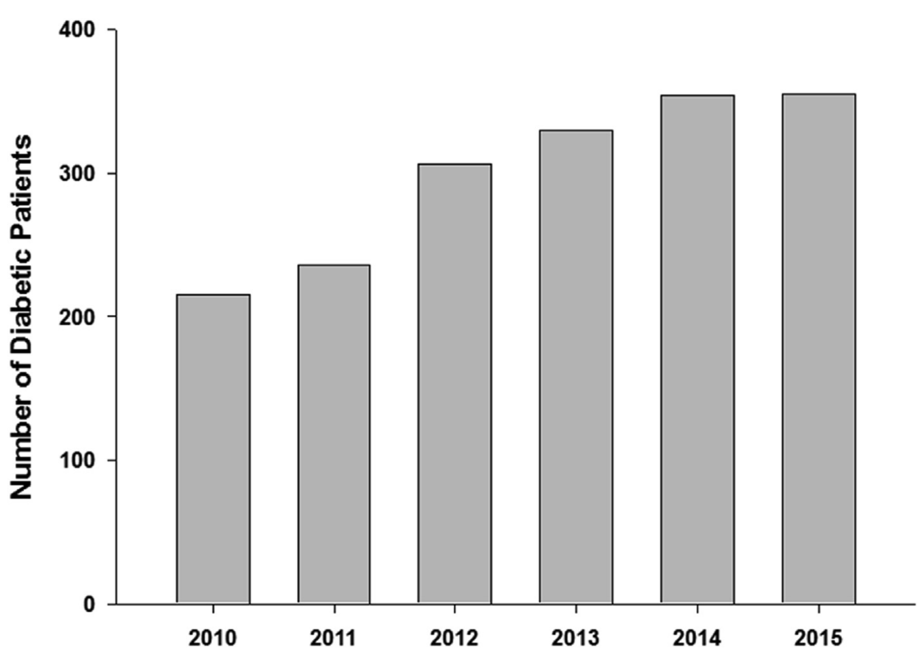

Figure 3 Incorporation of diabetic patients along the program time.

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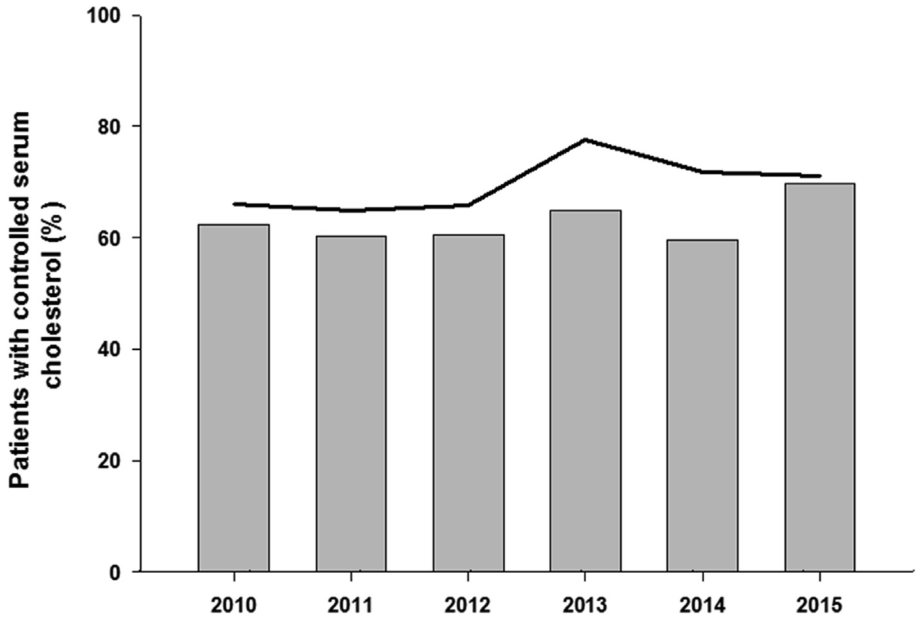

Figure 4 Bars represent the percentage of patients with serum cholesterol <200 mg/dl, while the upper line represents the percentage of patients with serum LDL cholesterol <120 mg/dl.

follow-up rates as mentioned above. This contrasts with other reports, where despite being effectively treated for hypertension, half of the subjects abandoned after the first year of diagnosis [20] and, of those remaining under medical supervision, only 50% took at least 80% of prescribed medications [21]. Consequently, due to the poor compliance, about 75% of hypertensive subjects failed to obtain optimal control of BP [22,23].

In 2000, the estimated number of diabetics' subjects in Argentina were 1,426,000 which is predicted to rise to 2,457,000 in 2030 [24]. In the last (2001) National Census in Argentina, the prevalence of diabetes exceeds 4% of the total population. Nevertheless, other sources estimated a prevalence of 6% [25] and even 9.6% [26] in Argentina. Considering age ranges: between 30 and 39 years old the incidence is <5%, 40–49: 10%, 50–59: 20%, 60–80 about 19% [26]. In 2010, our program entered 215 diagnosed diabetic subjects, 7.12% of the population, reaching 9.7% in 2015. These data indicated an effective individualization of diabetics and their incorporation into the program with due follow-up. This follow-up was also observed in HbA1c values (from 8.90% in 2010 to 7.90% in 2015).

Hypercholesterolemia is a key risk factor for developing stroke, cardiovascular and renal diseases. It is estimated that high cholesterol causes 2.6 million deaths (4.5% of total), and a loss of 29.7 million years of life disability-adjusted, which is 2.0% of total worldwide [27].

According to the Third National Survey for Risk Factors [31], the prevalence of hypercholesterolemia was 29.8%, of which 53.2% received treatment. Unfortunately, the report does not state the incidence of controlled subjects. In Argentina, the incidence of hypercholesterolemia was 29.1% in 2009, while in our program 62.4% of subjects had cholesterol <200 mg/dl and 66.1% LDL <120 mg/dl, suggesting very good compliance to non-pharmacological and pharmacological treatment. This optimization in the control of cholesterol levels (<200 mg/dl) increased over time, from 64.8% in 2013 to 69.7% in 2015 [31]. In the United States, the incidence of hypercholesterolemia is 33.5%; only 1 of 3 subjects is well-controlled, and only 50% is treated [32]. As earlier discussed, these results are quite different from ours.

In our country, the surveys on population, driven by the Ministry of Health, showed data resulting from calculations of BMI based on self-reported weights and heights; that is, numbers reported by the respondent instead of measured data. According to the results of the Third National Survey for Risk Factors [31], the prevalence of obesity in subjects over 35 years was 26.9%, while later in 2011, 24.2% was reported, showing a 12% increase.

In our study population, the prevalence of obesity was higher. It was 35.8% in 2011, and 37.1% in 2013. It is worth mentioning that our population was weighed and measured with calibrated scales instead of self-reported data, which could explain the observed difference when comparing these values with the Ministry of Health report. In our population, the obesity incidence slightly changed from 2010 to 2015: 35.4%–34.7%. No doubt the most difficult risk factor to modify is bodyweight [33].

Table 4 Number of cardiovascular events from 2011 to 2015.

Year	Patients (total population)			Patients $\geq$ 65 years old		
	Patients (n)	Events (n)	Events rate	Patients (n)	Events (n)	Events rate
2011	6853	130	1.89	1675	98	5.85
2012	6800	98	1.44	1734	79	4.55
2013	6733	83	1.23	1834	65	3.54
2014	6695	69	1.03	1916	52	2.71
2015	6893	68	0.99	2000	47	2.35

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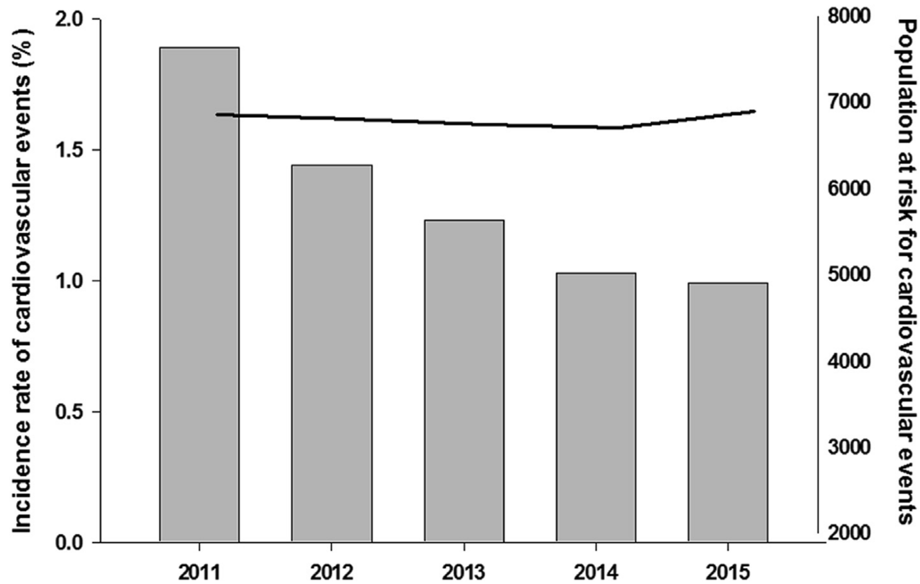

Figure 5 Bars represent the rate of cardiovascular events yearly, while the upper line represents the number of patients at risk for the development of a cardiovascular event.

The development of cardiovascular disease is due to the buildup of atherosclerotic plaques within the sub-intimal regions of arteries. The development of these plaques takes years and remains largely asymptomatic until a critical event. The three main strategies for preventing cardiovascular diseases include surveillance and monitoring, prevention, and reduction of risk factors, and improve management and health care through early detection and timely treatment which are the key components of any global or national strategy. The presence of carotid atherosclerosis is an old variable to indicate increased cardiovascular risk. In the last decade, with the development of technology to quantify atherosclerosis load, it has become possible to follow-up and assess the patient's evolution and to evaluate the on-going treatment over the basis of subclinical atherosclerosis.

In our population, despite having optimal control of dyslipidemia, HbA1c, and BP, this was not enough to achieve regression of the atherosclerosis area in most subjects (65%). This may happen due to other uncontrolled variables that could favor atherosclerosis progression such as periodontitis, unidentified chronic inflammation (high PCR from an unknown cause), hyperhomocysteinemia, metabolic syndrome and hypothyroidism, active smoking, overweight, lack of physical activity, etc. 35% of our subjects achieved regression and 11% remained stable, consequently 49% of subjects did not increase the atherosclerosis load.

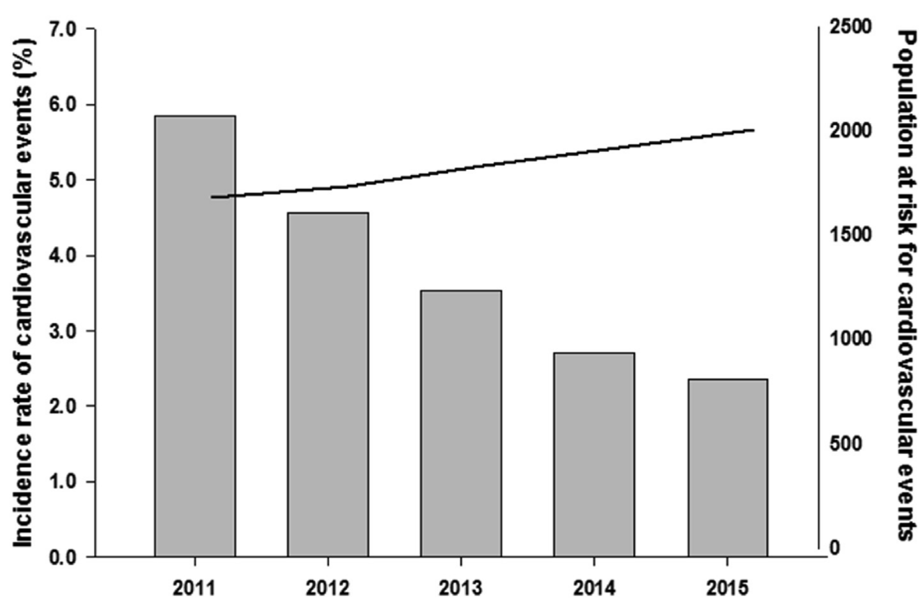

Figure 6 Bars represent the rate of cardiovascular events yearly in patients older than 65 years old, while the upper line represents the number of patients at risk for the development of a cardiovascular event.

Please cite this article as: Pérez HA et al., An intensive follow-up in subjects with cardiometabolic high-risk, Nutrition, Metabolism & Cardiovascular Diseases, https://doi.org/10.1016/j.numecd.2021.06.011

These values are substantially different from those reported by Spence et al. [10], who reported that 73.0% of the sample did not progress the atherosclerosis load. It is interesting to note that Dr. Spence's strategy was based on regression.

In this preliminary assessment, an important reduction of CVE was determined retrospectively throughout the evaluation period. This reduction is even greater if we only evaluate subjects 65 years old or above. In both cases, there was a 50% reduction of events from 2011 to 2015. The results of this retrospective study could be influenced by the successful control of classical risk factors such as BP, diabetes mellitus, dyslipidemia, medication compliance, self-monitoring, among others.

This program, of course, has limitations. First, this is a description of a non-randomized observational cohort, and causal relationships to outcomes cannot be proven. Second, only subjects from Cordoba were included, and the findings may not be generalizable to other populations (unlikely), including other ethnicities not evaluated here. Third, given the nature of the study, many critical parameters were not prospectively evaluated but despite these limitations, encouraging efficacy trends emerged.

Conclusion

Addressing chronic conditions following ICCC recommendations requires implementing and sustaining special activities and medium-to-long-term investments. There is sufficient evidence supporting that the application of intensive—monitoring schemes in high-risk populations is a cost-effective intervention. Our program has combined strategies for the prevention and control of NCDs, incorporating interventions to control risk factors and to reduce morbidity and mortality. It also had improvements on the quality of life, accessibility to health-care services, and promoting self-care. Based on the results of this descriptive study, we believe it is important to highlight the possibility of implementing measures for intensive monitoring of a large number of subjects at high risk, thus obtaining relevant changes in the control variables. While a suitable study for comparison has not been designed yet, the results showed a high rate of patient recruitment and retention, accompanied by a progressive control of Hypertension and significant improvements in HbA1c and dyslipidemia, with most of the subjects achieving their therapeutic goals. The reduction in CVE rate observed in the retrospective analysis may also be supported by the optimal control of risk factors. New specific studies should be performed to determine the value of these interventions. The progressive implementation of community-based activities and the redesign of health-care services, along with the proper management of information and the coordination of activities through management software, seem to be an effective way to develop such programs.

Conflicts of interest

None declared.

Acknowledgement

We would like to thank all the staff at Blossom DMO for technical support and the study participants for completing the study. This study was funded by Blossom DMO (Grant no. SO-2017).

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Please cite this article as: Pérez HA et al., An intensive follow-up in subjects with cardiometabolic high-risk, Nutrition, Metabolism & Cardiovascular Diseases, https://doi.org/10.1016/j.numecd.2021.06.011