

## Original Article

# An Intersectoral Approach to Hypertension Care: Solutions for Improving Blood Pressure Control in São Paulo, Brazil

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**BACKGROUND:** Hypertension is the leading risk factor for cardiovascular diseases (CVDs) and a major public health issue worldwide. In Brazil, it affects approximately 52.5% of the adult population. We describe the solutions package and the impact of a population health initiative in São Paulo city, following the CARDIO4Cities approach for the management of cardiovascular risk.

**METHODS:** Using a design thinking approach, interventions were developed with a coalition of local and international stakeholders to address needs of patients, healthcare professionals, and the health system. The resulting solution package was checked to comply with guidelines for non-communicable disease and hypertension management. Clinical impact was measured by extracting the hypertension cascade of care—monitored, diagnosis, treatment, and control—from medical records.

**RESULTS:** Under the leadership of the municipal health authorities, nine solutions were piloted and scaled across the city. Solutions conform with local and international best-practices. Between October 2017 and December 2021, 11,406 patient records were analyzed. Results showed a 40% increase in monitored patients (patients with at least one blood pressure, BP, measurement); reduced proportions of patients diagnosed among those with available BP measurements (72%–53%) and treated among diagnosed (93%–85%); and an improvement in controlled patients among those receiving treatment (16%–27%).

**CONCLUSIONS:** The solution package described in this study was correlated with increased BP control. The implementation methodology and results add to the body of real-world evidence supporting population health implementation science in Brazil and beyond.

**Keywords:** blood pressure; cardiovascular disease; design thinking; global health initiatives; hypertension; implementation strategy; population health.

## Graphical Abstract



Cardiovascular diseases (CVDs) are the leading cause of death and disability worldwide, accounting for 31% of global deaths.<sup>1</sup> Proven and cost-effective interventions and comprehensive guidance exists on how to implement global best-practices to improve health system performance and advance early detection, care delivery, and management of CVDs.<sup>2-4</sup> However, there is still high variation in improvements to lower the burden of disease globally<sup>5</sup> and in Brazil.<sup>6</sup>

In 2017, an urban population health initiative was launched with the objective to improve cardiovascular health by addressing its risk factors such as hypertension and building an implementation model that can be replicated for other cardiovascular risk factors globally.<sup>7</sup> The initiative was implemented in Dakar (Senegal), São Paulo (Brazil), and Ulaanbaatar (Mongolia). Each city followed the CARDIO4Cities approach, short for quality of Care, early Access, policy Reform, Data and digital technology, Intersectoral collaboration, and local Ownership.<sup>7</sup>

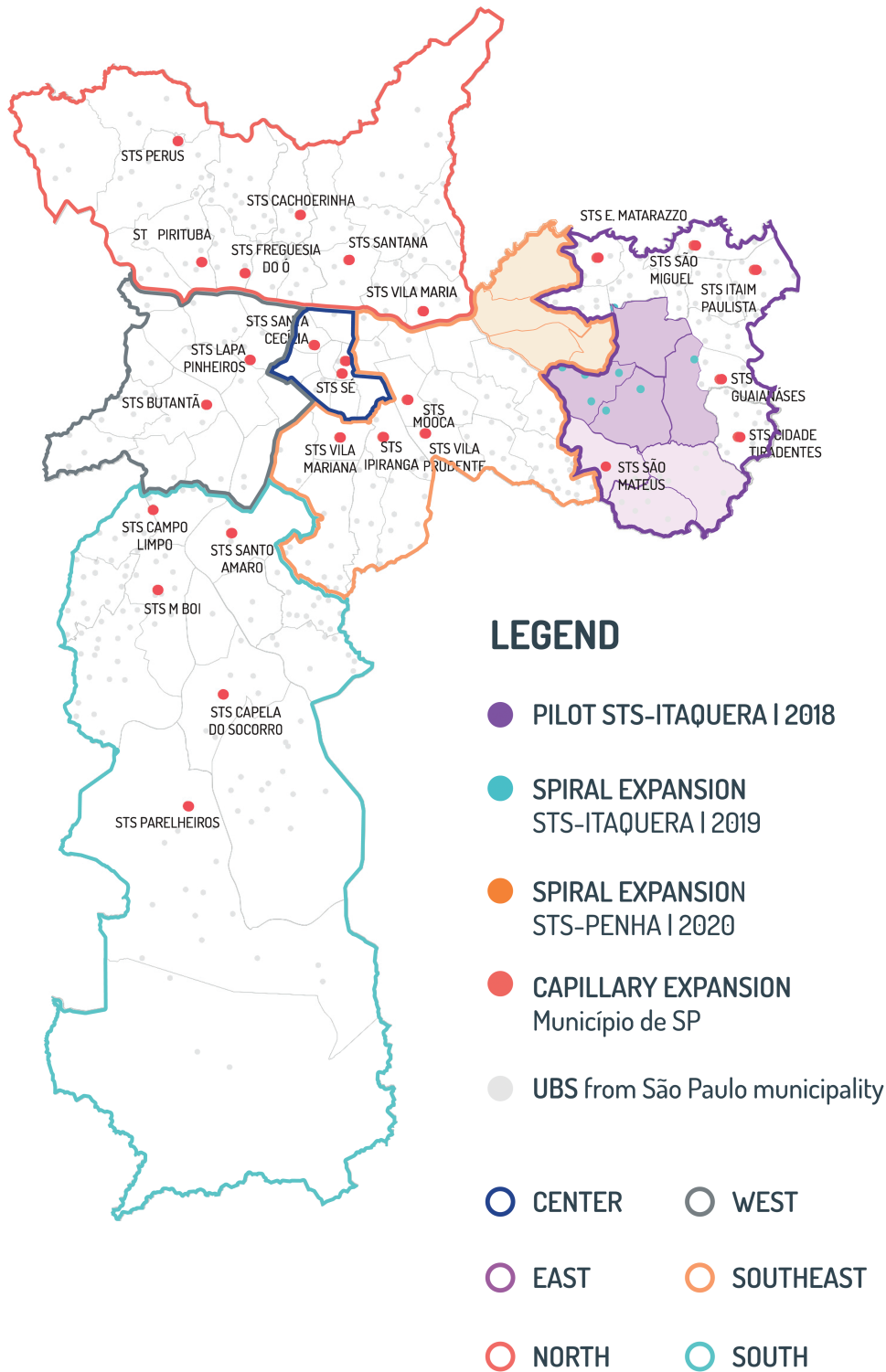
Previous studies reported a rise from 12.3% to 31.2% of hypertension control rates within 15 months of program implementation in São Paulo (Q3 2018–Q4 2019).<sup>8</sup> Subsequent studies estimated aversion of stroke and coronary heart disease (CHD) as well as the cost-effectiveness of the approach in São Paulo.<sup>9</sup> An analysis of the design thinking approach used in São Paulo describes the programs implementation process, including how local needs were mapped to global best-practices for cardiovascular risk reduction and transformed into interventions adjusted to the CARDIO4Cities approach.<sup>10</sup>

The purpose of this study is threefold: (i) To advance the understanding how global best-practices can be transformed in local health system implementation solutions, by describing the final implementation package of the initiative in São Paulo, (ii) to evaluate the implementation package's adherence to local and international guidelines, and (iii) to evaluate the impact of the solutions on clinical outcomes on the hypertension cascade of care by over an extended measurement period (Q4 2017–Q4 2021).

## METHODS

### CARDIO approach in São Paulo city

São Paulo in Brazil was selected in April 2017 as the target city for the initiative. The city was chosen based on high unmet cardiovascular health needs,<sup>11</sup> and the strong commitment of local authorities to improve cardiovascular health and to lead the initiative.<sup>12</sup> In São Paulo city, the initiative—locally known as “Cuidando do Seu Coração” (Caring for your Heart), was led by the São Paulo Health Department (SMS-SP). The SMS-SP selected two neighborhoods (Itaquera and Penha) to pilot, test, and evaluate interventions with the intention to scale-up a final implementation model to the municipality (32 neighborhoods in total) and include the activities in the line of care for chronic disease management. The activities were focused on the primary care network.<sup>10</sup> A total of 45 primary healthcare units (in Portuguese



**Figure 1.** Temporal and geographical expansion of the CARDIO approach in São Paulo city. Abbreviation: UBS, primary healthcare units (in Portuguese: Unidade Básica de Saúde).

Unidade Básica de Saúde—UBS) from Itaquera (24 UBS) and Penha (21 UBS) were included in the initiative over four phases of geographical expansion from 2017 to 2020 (Figure 1).

### Design of the study

The design thinking process was operationalized across the following phases of work: (i) Groundwork (initial alignment

on project goals, governance, and operations); (ii) Diagnosis (understanding hypertension care in São Paulo); (iii) Exploration (deep dive into key challenges); (iv) Co-creation (solutions development); (v) Pilot implementation (testing solutions at small-scale); and (vi) Scale-up (larger-scale implementation of proven solutions).<sup>10</sup> All phases were underpinned by three guiding principles: (a) Empathy—understanding and exploration of the citizens “and public servants” context; (b)

Co-creation—building inclusively with, and not for, the civil society; (c) Experimentation—test to learn by failing quickly and cheaply before scaling solutions.

The groundwork phase consisted of scoping possibilities to implement an urban population health initiative in São Paulo, i.e., understanding the existing policy environment, aligning health system priorities, and exploring possible institutional paths for implementation in the field. It focused on establishing adequate formal agreements that provided structure and governance, while assuring that ownership and full responsibility remained with the public authorities.

The diagnosis phase consisted of a situational analysis to understand the needs and perspectives of different players within the health system, including patients and healthcare professionals. Additionally, the analysis assessed key processes in the care, diagnosis, treatment, and control of non-communicable diseases (NCDs), with a focus on BP management.<sup>10</sup> This phase involved monitoring and understanding the daily routines of health system users, employees, the UBS team, managers, and other partners of the initiative. A range of tools were used, including online forms, conversation circles, and shadowing. The diversity of tools helped assess the challenges of the ecosystem in a broad and encompassing way.<sup>10</sup>

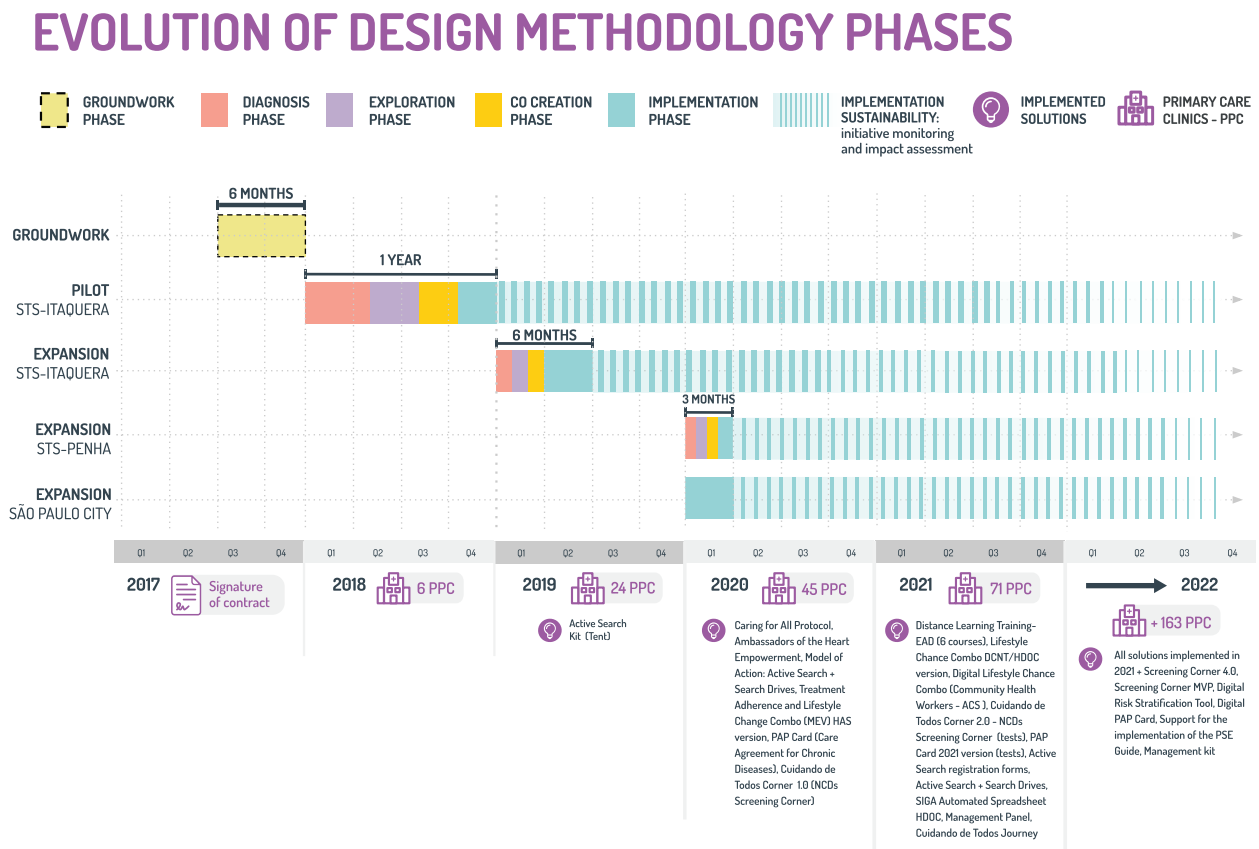
The exploratory phase focused on analyzing and discussing the findings of the previous phase and delineating concise learnings that were translated into broader problem statements with guiding questions and design principles.<sup>10</sup> In 2018, the core guiding

question of the initiative was defined as “How can we develop a replicable and sustainable model for the prevention and management of hypertension in urban environments underpinned by empathy, co-creation and experimentation?”.

In the co-creation phase, the guiding question and design principles were used to generate innovative ideas, concepts, and solution prototypes. This process involved the participation of all stakeholders previously engaged (e.g., healthcare system users, health professionals, health system managers, initiative partners). This stage resulted in a selection of possible solutions with the potential to address the identified challenges. The solution prototypes were transformed into concrete “pilot-ready” solutions using an iterative process<sup>10</sup> and mapped onto the six pillars of the CARDIO4Cities approach.

In the pilot implementation phase, the team tested the solutions on a small scale (six UBS in Itaquera). Key implementation learnings on desirability, feasibility, and viability as well as impact were collected and used to consecutively improve and finalize the solution package.

The following scale-up phase replicated the solution package under the supervision of the SMS-SP first to selected additional UBSs, then to the entirety of two neighborhoods (Itaquera and Penha), then to one selected clinic of all remaining health districts and neighborhoods, and eventually to the entire municipality. Figure 2 shows the design thinking phases and the corresponding timeline including design, pilot implementation, and scaling.



**Figure 2.** Evolution of design thinking methodology phases using the CARDIO approach initiative in São Paulo, Brazil, Brazil. Abbreviations: CWH, community health workers; HDCC, acronym for Hypertension, Diabetes, Obesity and Cholesterol (in Portuguese: Hipertensão, Diabetes, Obesidade e Colesterol); MVP, minimum viable product; NCD, Non-communicable disease; PAP, Agreed Self-care Plan (in Portuguese *Plano de Autocuidado Pactuado*); SIGA, healthcare data system from São Paulo city; STS, technical health supervisions (in Portuguese: *supervisões técnicas em saúde*).

## Outcomes and analysis

We analyze the outcomes on three levels. First, the final implementation solutions are described with objectives, methods, and results. Each solution was developed to serve a specific group of stakeholders from the healthcare infrastructure (patients, healthcare professionals, and health system) and to address elements on the cascade of care for hypertension across diagnosis, treatment, and control. The reported results of the solutions relate to their output (e.g., number of performed measurements, distributed materials, conducted trainings) and adherence to and satisfaction with the solutions collected through surveys and questionnaires.

Second, a descriptive assessment was performed to assess the adherence of the solutions to local and international guidelines for NCD/BP management. The guidelines and best-practices referenced included: the Sustainable Development Goals (SDGs),<sup>13</sup> the HEARTS package,<sup>14</sup> *Previne Brasil*,<sup>15</sup> Brazilian Ministry of Health technical note number 41/2020,<sup>16</sup> Municipal Government Goals 2021–2024 from São Paulo,<sup>17</sup> and the World Heart Federation Roadmap for Hypertension.<sup>18</sup>

Lastly, to evaluate the impact of the solutions on the clinical outcome, we used the cascade of care for hypertension, including diagnosis, treatment, and control with a methodology described previously.<sup>14</sup> Besides incorporating an extended measurement period (Q4 2017–Q4 2021), we also included an additional element in the cascade of care, the monitoring rate, defined as patients with at least one BP measurement. This indicator served as a proxy to evaluate changes in early detection and monitoring of CVD risk. Deidentified patient data were retrospectively extracted from medical records of adults (age  $\geq 18$  years) with a diagnosis of hypertension, who had visited the UBS at least once. Cumulative data were reported by quarter. The analysis for controlled patients was verified among treated patients with at least two visits in the same interval. The same approach was applied to other categories, such as controlled (the definitions of the cumulative cascade of care indicators are presented in [Supplementary Table 1](#)). If at the last visit a patient was classified as controlled and if he/she never returns for another visit, the information from the last visit will be considered in the controlled BP count in the following periods. The frequencies and percentages of the patients in each group were calculated using Python version 3.6.5. This study was approved by the National Commission for Research Ethics (in Portuguese, Comissão Nacional de Ética em Pesquisa, CONEP) in March 2020 (No. 5311415).

## RESULTS

As part of the design thinking strategy, seven co-creation workshops were held, with the participation of 268 people, including patients, health professionals, health system managers, and initiative partners. Gaps were identified across all phases of the care cascade, including opportunities to optimize health system management and standardize delivery of care, the need to expand early detection (screening and diagnosis) of patients with hypertension, and a joint management approach with patients focused on adherence to treatment and follow-up of controlled blood pressure levels.

**Implementation package of solutions** Nine solutions were included in the final package: The screening corner, the *Hearts Friends* health initiatives in schools, the PAP card (patient self-care pact card), the Caring for All Protocol, the Adherence Combo, remote trainings, a management panel, a management and governance

model, and a cardiovascular risk stratification tool. [Table 1](#) provides an overview of these solutions, including summaries, their main goals, objectives, and results associated with key performance indicators. A visual map of the solutions by target audience and across the cascade of care (diagnosis, treatment, control) is further presented in [Supplementary Table 2](#). By the end of 2021, all solutions were scaled-up across the public primary care services of São Paulo city and integrated into the official protocol for NCD and chronic care management in primary care for São Paulo city (Caring for All Protocol).

## Mapping and adherence of solutions to local and international guidelines

The solutions were developed based on both global and local best-practices. [Supplementary Table 3](#) maps the adherence of each of the initiative's solution to local and international guidelines. It demonstrates a conceptual overlap of all solutions with elements of international guidelines and recommendations. The objective to increase detection, subsequent treatment, control and continued support of individuals with NCDs/CVD risk, is addressed through the *Screening Corner*, the *Health initiatives in schools*, and different aspects in the *Management and Governance Model*, all aiming to reach the population at-risk. The use of digital tools is also widely suggested. In the initiative, digital and data elements are applied in the *Management Panel*, the *PAP Card*, or the *Risk Stratification Tool*. Lastly, the development of the simplified care protocol is a common theme across all global guidelines. This has been addressed by supporting the SMS-SP to develop the *Caring for All Protocol*.

## Impact of the solutions on the clinical outcomes of hypertension cascade of care

From the fourth quarter of 2017 to the fourth quarter of 2021, data from 11,406 patients were assessed. [Table 2](#) presents the cumulative results of the CARDIO approach in relation to the monitored, diagnosed, treated, and controlled patients.

Throughout implementation, the proportion of patients monitored increased by 40%. With the increase in the proportion of patients monitored, there was a reduction in the proportion of patients diagnosed with hypertension after starting the initiative, from 71.7% before the initiative (fourth quarter of 2017) to 52.8% at the last evaluation (fourth quarter of 2021). Following the reduction in the proportion of diagnosed patients there was also a lower proportion of hypertensive patients treated, from 92.5% to 85.0%. Among hypertensive patients under drug treatment (controlled), there was an increase from 16.2% to 32.5% up to the beginning of 2020. After onset of the COVID-19 pandemic in early 2020, this proportion was reduced, although the proportion of controlled individuals remained above the values of the pre-initiative period ([Table 2](#)).

## DISCUSSION

The CARDIO4Cities approach in São Paulo used health system-wide, joint design thinking to create novel, sustainable, and replicable solutions tailored to the local environment and needs around CVDs risk prevention and control.<sup>7,41</sup> Besides the observed favorable changes across the cascade of care, the implementation of this population health approach in a megacity such as São Paulo can provide a global reference for healthcare system stakeholders in Brazil and beyond. Of particular importance were the dedicated focus on the needs of the main beneficiaries (health

**Table 1.** Description and measured impact of the final solution package implemented and scaled-up in São Paulo city

Solution name and description	Main needs addressed by the solution	Objectives	Results
<p><b>Screening corner (<i>Cantinho cuidando de todos</i>)</b> Visually engaging, physical space in the reception area of the UBS to assess CVD risk of all incoming patients through active measurement and opportunistic screening of essential health data such as BP, weight, height, and calculated body mass index. All screening corners include: a bodyweight scale, a chair with an inclination suitable for seated BP measurement, a BP measurement device (one of 2 models: Automatic Blood Pressure Monitor Kiosk by MD or the Hyper Chair with Automatic Arm Blood Pressure Monitor Technology MAM BP3AC1-1PC by Medlebensohn) with visual indication for foot positioning during measurement, sheets for patients to record the measured BP value, and educational banners about CVD risk factors and self-care. Measurement devices may be operated by the patients themselves, or with the help of a medical professional (e.g., a nurse)</p>	<p>A gap exists between the number of hypertensive patients known by the UBS in relation to the estimated prevalence in the territory BP is not measured nor recorded regularly; thus, patients do not have any possibility to track their status Insufficient time for an extensive doctor-patient consultation incl. CVD risk assessment</p>	<p>To facilitate early detection of cardiovascular risk, identify undiagnosed patients and forward them into care and follow-up To track people with existing chronic non-communicable diseases at the UBS To promote and encourage self-care, prevention, and control of risk factors by providing screening possibilities and educational materials for patients Enable efficient utilization of waiting time and expedite pre-assessment to gain time for doctor-patient consultation</p>	<p>An average of 217 blood pressure measurements performed in Screening corner per month per UBS (during 3rd quarter of 2022) On average 28% of patients had at least one elevated BP measurement per month and UBS (during the 3rd quarter of 2022)</p>
<p><b>Health initiatives in schools—Heart Friends (<i>Saúde na escola—CEU Amigo de todos</i>)</b> Series of trainings in schools where student leaders and education professionals, supported by health professionals from a UBS, implemented activities focused on managing CVDs and their risk factors. Trainings followed a structured curriculum and disseminated information and conducted activities on prevention and management of CVDs and their risk factors to encourage the early adoption of healthy habits. This solution was integrated with the “Health at School Program,” an intersectoral effort of the Ministry of Health and Education on healthy eating, physical activity engagement, emotional, and mental health improvement</p>	<p>Population and at-risk groups are not addressed through channels beyond the health sector Established interdisciplinary policy are not executed adequately to reach impact potential</p>	<p>To support the implementation, and expand the reach, of the Health at School Program (PSE) to support its objectives related to CVDs. Conduct training and engagement of ambassadors, to encourage and expand new prevention practices to promote the fight against CVDs in schools, making the Unified Educational Centers (in Portuguese Centro Educacional Unificado—CEU), a reference in health promotion. The PSE is a federal public policy that aims, among others, to match activities of the SUS to activities of the public education networks, to impact students and their families, and optimize the use of available spaces, equipment and resources</p>	<p>On average, the people of the school community showed a 37% increase in the healthy habits index, calculated by comparing responses to the initial assessment questionnaire, applied in June 2020, to the final questionnaire, applied from December 2020 to February 2021</p>
<p><b>PAP card (<i>Cartão PAP</i>)</b> The “Agreed Self Care Plan” (Plano de Autocuidado Pactuado—PAP) card is a tracking tool for patient BP levels and for self-care measures that were agreed between the patient and health teams. The card is individualized and informs and educates the patient about their BP. It formalizes practical steps for patients to take care of their own health and allows the user to include notes about their medications, exams, and appointment schedules. Initially released as a paper version, the tool was digitalized in 2021 and integrated into e-saudeSP, the web-based government health platform</p>	<p>Low engagement of patients in their own health and lack of co-responsibility in disease management and treatment adherence Missing tools to support patient empowerment Absence of goals and action plan for physicians and patients</p>	<p>To encourage self-care through an easy to use and engaging a tool To make patient-initiated BP monitoring and tracking easy To formalize a self-care plan agreed between patients and the health team To facilitate, for health professionals, the visualizing of BP and the monitoring of patient's adherence to care</p>	<p>More than 33,600 PAP cards distributed (from November 2018 to November 2020) 100% of UBS professionals say they are “satisfied” or “very satisfied” (60% and “partially satisfied” (40%) with the tool (during 4th quarter of 2020)</p>

Table 1. Continued

Solution name and description	Main needs addressed by the solution	Objectives	Results
<p><b>Support in the implementation of the Caring for All Protocol (Cuidando de Todos)</b>                      The Caring for All Protocol was developed by SMS-SP, medical societies and other experts as the official protocol for the municipality. The protocol was approved as policy and the practical implementation was supported by the initiative through workshops and training with UBS professionals. The protocol consists of three documents: a clinical protocol focused on health professionals, a management protocol focused on health system decision-makers, and a simplified version of the clinical protocol to be used by physicians during consultations. The documents incorporate tools to improve clinical practice and health system management, such as treatment and management guidelines, official policies for patient care-pathways tracking, team task-sharing components, and evaluation of diagnosis and control of high BP as well as risk stratification guidance. The protocol was implemented through online and offline trainings, workshops and case-study discussions for multi-disciplinary teams (e.g., doctors, nurses, auxiliary nurses, community health care workers). Support the SMS-SP in the implementation of the protocol, providing materials, supporting trainings and capacity buildings, and promoting the dissemination of and engagement in its use</p>	<p>Missing standardization of treatment and follow-up processes                      Opportunities to improve application of best-practices                      Lack of a defined and structure process to distribute tasks and duties in the team</p>	<p>To develop updated, standardized, unified, evidence-based care guidelines for treatment of chronic disease and cardiovascular risk factors such as hypertension and diabetes in primary care                      To expand theoretical and practical knowledge of health professionals on the management processes, patient journey and team responsibilities when caring for patients with NCDs and CVD risk factors</p>	<p>A total of 4,305 protocols and supporting implementation tools were distributed for the UBS of the municipality (from November 2018 to November 2020)                      All UBS in the city received the protocol (470 UBS) (from November 2018 to November 2020)                      97% was the index of practical implementation of the protocol, calculated from the comparison between the number of UBS that indicated that they had implemented the Protocol and the total number of UBS in the city (according to the monitoring model stipulated by the SMS-SP) (from November 2018 to November 2020)</p>
<p><b>Adherence combo (Combo adesão)</b>                      Set of support tools (flip chart, bingo, conversation cards, dosage calendar, habit card, medication organizer bags, colored labels) for healthcare professionals to enhance patients' adherence. Tools are designed to be didactic, playful and engaging to support adherence to treatment and lifestyle changes. The set of support tools can be used in the UBS or in external activities, by any professional in the unit or people in the community engaged in dealing with CVD, such as the Community Health Workers (CHW). The adherence combo is also available in digital format on tablets used by the CHW in their daily activities</p>	<p>Poor understanding in patients of need for continued treatment and low engagement in care and adherence process                      No tools for health professionals available to work with patients on treatment adherence.</p>	<p>To train healthcare professionals to work on the topic of CVDs and CVD risk factors in a more playful and attractive way                      To increase the care team's knowledge about BP (for healthcare professionals and patients)                      To increase the number of people and diverse audiences sensitized through different approaches and languages for the care and prevention of CVDs</p>	<p>All 235 UBS that were part of the initiative by 2022 (after the expansion process to regions beyond Itaquera and Penha) received the Adhesion Combo tools (during the 3rd quarter of 2022)                      95% of healthcare professionals were satisfied with the support tools (during 4th quarter of 2020)</p>
<p><b>Remote trainings (Capacitação à distância)</b>                      Online trainings that support health professionals, teams and UBS managers in the implementation of actions to address CVD risk factors through technical and behavioral content. The course includes modules on patient care and CVDs management based on data and scientific evidence, efficiency and empowerment of the managerial role</p>	<p>Opportunity to optimize continued education of health teams, sharing of best-practices and standardization of care delivery                      Missing capacitation of some team members (e.g., community health workers) in CVD risk factors/NCDs</p>	<p>To contribute to the development of a continued education program and building the capacity for the implementation of the Caring for All Protocol for health managers and health professionals                      To train and implement a care management model for patients with CVDs and risk factors, in a sustainable and scalable way</p>	<p>45 managers trained (from November 2018 to November 2020)                      100% increase in the number of UBS managers reporting knowledge of the number of hypertensive patients with active registration in their units (evolution from 50% to 100% of managers with immediate availability of the number of hypertensive patients, n = 43 UBS, Itaquera and Penha, 2020)</p>

Table 1. Continued

Solution name and description	Main needs addressed by the solution	Objectives	Results
<p><b>Management Panel</b> Online dashboard that monitors the implementation of the Caring for All Protocol. The tool provides and visualizes data on protocol implementation (technical meetings, trainings, number of patients assisted in each stage of the Caring for All Protocol implementation path), the CVD risk line of care and its outputs and outcomes by UBS, Technical Health Supervision or Regional Health Coordination. It supports UBS managers, supervisors, and regional coordinators in day-to-day management and decision-making</p>	<p>Previously no availability of consolidated data reports and visualization to support health management decision-making Management mainly focused on prescription volume, not patient outcomes</p>	<p>To expand the qualification of the decision-making process To support UBS managers, supervisors, and regional coordinators in monitoring the implementation of the Caring for All Protocol</p>	<p>72 users per month (during 3rd quarter of 2022)</p>
<p><b>Management and Governance Model</b> Model that proposes a set of practices and processes to enhance and consolidate an efficient work routine for all management levels of the Municipal Health Department based on Caring for All Journey and the Protocol implementation path. The model includes (i) a mapping of actors, roles, and responsibilities including structural setup, time management, and team responsibilities to assure that strategic, tactical, and operational levels of the Health Department are aligned, (ii) suggestions on data management that allow an understanding of the epidemiological profile of the territory and measures the impact of the prevention and care actions, and (iii) suggestions for regular exchanges and effective communication across the different management levels and departments</p>	<p>Opportunities to optimize standardization of health system management Absence of defined goals to manage the care line for CVD risk and NCDs</p>	<p>To strengthen the Municipal Health Department, the Regional Health Coordination and Technical Health Supervisions roles, moving towards a sustainable and replicable management model for the entire municipality of São Paulo To consolidate a work routine in CVDs for all management levels of the Municipal Health Department To establish and spread theoretical and practical guidelines for the care and assistance of patients according to the line of care for CVDs To enable the achievement of goals related to CVDs of the Municipal Health Department and consolidate a common vision for a healthy city</p>	<p>Average of 77% of UBS participants in monthly management meetings with an improvement plan coming from the governance meeting (during 3rd quarter of 2022)</p>
<p><b>Risk Stratification Tool</b> Tool to support health professionals in assessing a patient's cardiovascular risk, evaluate their need for a medical consultation, and enable access to the most appropriate health care service line. The tool classifies a patient's cardiovascular risk (no, low, moderate, or high risk) as per the Caring for All Protocol by BP level, gender, age, family history of CVD, smoking, dyslipidemia, insulin resistance, obesity, target organ damage and the presence of Cerebrovascular Disease, Chronic Kidney Disease, Cardiovascular Disease and Diabetes Mellitus. In 2021, the tool was integrated into e-saudeSP, the web-based government health platform</p>	<p>Risk assessment is missing from patient records Prioritization of low, medium, high-risk patients is not done, inhibiting optimization of care processes</p>	<p>To assess the patient-level cardiovascular risks and optimize clinical decision-making To reorganize access to care to prioritize patients at higher risk of CVDs</p>	<p>12,821 patients underwent risk stratification (from October 2022 to December 2022)</p>

Abbreviations: BP, blood pressure; CEU, unified educational centers; NCD, non-communicable disease; PAP, agreed self-care plan; PEP, electronic patient medical record; SDG, sustainable development goals; SIGA, healthcare data system from São Paulo city; SMS-SP, São Paulo health department; UBS, primary healthcare units.



**Table 2.** Number and percentage of monitored, diagnosed, treated, and controlled patients during the implementation phase of the CARDIO approach in Penha and Itaquera, São Paulo

	2017				2018				2019				2020				2021			
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Total																				
n	2,199	3,836	5,316	6,229	7,394	8,420	9,200	9,821	10,314	10,677	10,815	10,983	11,118	11,220	11,330	11,390	11,406			
Monitored																				
n	892	1,820	2,814	3,601	4,634	5,744	6,592	7,264	7,846	8,322	8,526	8,741	8,906	9,050	9,180	9,269	9,300			
%	40.6	47.4	52.9	57.8	62.7	68.2	71.7	74.0	76.1	77.9	78.8	79.6	80.1	80.7	81.0	81.4	81.5			
Diagnosed																				
n	640	1,250	1,870	2,332	2,914	3,472	3,859	4,149	4,380	4,567	4,636	4,710	4,774	4,821	4,868	4,899	4,908			
%	71.7	68.7	66.5	64.8	62.9	60.4	58.5	57.1	55.8	54.9	54.4	53.9	53.6	53.3	53.0	52.9	52.8			
Treated																				
n	592	1,135	1,677	2,070	2,553	3,018	3,338	3,567	3,748	3,900	3,954	4,016	4,066	4,102	4,136	4,161	4,170			
%	92.5	90.8	89.7	88.8	87.6	86.9	86.5	86.0	85.6	85.4	85.3	85.3	85.2	85.1	85.0	84.9	85.0			
Controlled																				
n	96	289	458	601	771	963	1,006	1,077	1,198	1,268	1,120	1,021	1,073	1,145	1,081	1,089	1,106			
%	16.2	25.5	27.3	29.0	30.2	31.9	30.1	30.2	32.0	32.5	28.3	25.4	26.4	27.9	26.1	26.2	26.5			

Ground work: Q4 2017 and Q1 2018 (October 2017 to March of 2018); Diagnosis, exploration, co-creation, and pilot implementation—first year of the initiative: Q2 2018–Q1 2019 (April 2018–March 2019); Scale-up—second year of the initiative: Q2 2019–Q1 2020 (April 2019–March 2020); Scale-up—third year of the initiative: Q2 2020–Q4 2020 (April 2020–December 2020); Scale-up—fourth year of the initiative: Q1 2021–Q4 2021 (January 2021–December 2021). For monitored patients the proportion was calculated in relation to the total patients; For diagnosed patients, the proportion was calculated in relation to the monitored patients; For treated patients, the proportion was calculated in relation to the diagnosed patients; For controlled patients, the proportion was calculated in relation to the treated patients.

care professionals, patients, and the health system), the constant alignment with global best-practices, and the collaborative design thinking process which enabled the initiative to close the implementation gap. The solutions innovate through pragmatic simplicity which is essential to achieve the goal of a financially viable, scalable urban population health approach, integrated in the local health system and accepted by local communities.

The high prevalence of hypertension the Brazilian population indicates several lost opportunities in hypertension management across the continuum of care. Several of those gaps are known and the scientific knowledge to address those is available. But effective strategies that close the implementation gap to address cardiovascular risk factors on a population level are scarce. This study demonstrates a path from the identification of local needs of the health system, health professional and patients, via a design thinking approach to a final, simple package of solutions aligned with global recommendation that works in a local context. We demonstrate that the core solutions package of the CARDIO4Cities approach is aligned with local and international guidelines, such as the World Heart Federation Roadmap for Hypertension, the Global NCD Action Plan, HEARTS in America, and the Cardiovascular Prevention Guideline of the Brazilian Society of Cardiology.<sup>6,13,14,18</sup> The solution package has been successfully scaled across the city under the leadership and supervision of the health authorities, eventually including all health regions of the municipality and therefore demonstrating the potential for scale and replicability of the solutions. Our analysis of the impact of the CARDIO4Cities approach demonstrates increases in the proportion of monitored and controlled hypertensive patients, compared with the pre-initiative period. The improvements in patient outcomes demonstrate that the interventions in the primary care setting to control cardiovascular risk such as hypertension of the CARDIO4Cities approach, can ultimately reduce risk of cardiovascular events. These results align with previous studies that indicating successes of holistic approaches to address BP control rates.<sup>19–21</sup> While focusing particularly on the standardization and improvement of team-based care<sup>22</sup> and enabling patient access to care and management for chronic conditions.<sup>20,21</sup>

The study also demonstrates a reduction in the rates of diagnosed and treated patients. We hypothesize that this is attributable to the improvements in monitoring (from 40% to 80% during implementation of the CARDIO4Cities approach). We further hypothesize that initially, the patients with recorded BP measurements were of worse-than-average health (e.g., patients with previous cardiac events), prompting specific investigations into their blood pressure. This results in an overrepresentation of diagnosed hypertension, and of prescribed treatment in the patient group with available BP measurements, compared to the average among UBS patients at the beginning of CARDIO4Cities implementation. As blood pressure monitoring was systematically expanded to all UBS patients, the sample of patients included in our analysis became more representative of the overall primary care patient population, and diagnosis and treatment rates to approach their “true” average values.<sup>23</sup> It would be important to further investigate this hypothesis, e.g., by analyzing changes in characteristics of the patient population over time.

The COVID-19 pandemic put a significant burden on health-care. It also affected patient management in healthcare services, including primary care, limiting the access to healthcare facilities, reducing availability of preventive care and screening.<sup>24</sup> In this study, the proportion of patients with treated and controlled BP was impacted by the pandemic, but recovered a few months later, demonstrating the importance of integrated and sustainable health system strengthening activities, such as implemented in CARDIO4Cities.

## Limitations

The following limitations need to be acknowledged. CARDIO4Cities had to establish a process for data collection, by consolidating patient medical records from paper, posing difficulties for data extraction and the potential for inaccuracies. The initiative, as well as the data collection, were directly embedded into the existing health system and its ongoing operations. This meant that the data collection faced the common limitation of relying on secondary data based on non-digitalized

chart reviews, such as incomplete data, challenges in assessing data, lost or low-quality medical charts, and the disturbance of the usual workflow of a primary care unit. Data on the cascade of care was not routinely available in the beginning of the initiative. This refers to the initiative's dual goal: firstly, to measure the impact of various solutions and, secondly, to enhance data capacity and encourage data-driven decision-making among clinic managers and other decision-makers. This dual goal and the close collaboration with local authorities, did not allow for a rigorous experimental design (e.g., randomized control trial), and thus only cross-sectional comparisons can be drawn from the study. We analyzed data from a sample of UBSs, chosen on the advice of the City Health Authorities. The selection represents different management models of primary care provision in the city, but it is possible that the chosen UBSs were not representative. Due to the methodological setup, it was not possible to determine the unique contributions of any single solutions. From the beginning, the initiative planned a holistic intervention portfolio incorporated into the health system. Complex and multifaceted problems often require equally multifaceted solutions, so to effectively contribute to the complex public health issue in question, the project could not propose just one solution. Additionally, there was no political support to implement health system best-practices only in one area of the city while other city districts or clinics and thus the population would be deprived from access. In summary, we acknowledge that future replications of the CARDIO approach should investigate opportunities to be accompanied by a stricter experimental setup, to further strengthen the evidence while considering the feasibility of such population-wide initiative.

## CONCLUSION

The CARDIO4Cities approach as applied in São Paulo city demonstrates promising results in addressing the challenges of cardiovascular risk management, such as hypertension within the local primary healthcare system. By leveraging a health system-wide, joint design thinking implementation strategy, the initiative developed and implemented a multifaceted solution package that was adaptable to the local environment and needs. The successful implementation led to improvements in hypertension diagnosis, treatment, and control. This study provides valuable insights for healthcare stakeholders seeking to tackle complex public health issues like hypertension and CVDs. The CARDIO4Cities approach can serve as a model for future initiatives aiming to improve population health and the performance of health systems through innovative, sustainable, and replicable solutions.

## Supplementary Data

Supplementary materials are available at *American Journal of Hypertension* (<http://ajh.oxfordjournals.org>).

## Funding

The Novartis Foundation funded the urban population health initiative and the presented study.

## Acknowledgments

We specifically thank the municipal authorities from São Paulo, Brazil, for leading and owning this initiative; all health providers,

managers, nurses, doctors, community health agents and other health professionals who participated in the initiatives co-creation and roll out; and all patients who participated in the implementation. We are grateful to all local partners and stakeholders who contributed to the initiative, with a special thanks to the teams of Instituto Tellus and IQVIA in Brazil. We thank the Umame Foundation for the strategic partnership and co-funding of the initiative in São Paulo. This study received support from Novartis Foundation.

## Conflict of Interest

The Swiss Tropical and Public Health Institute, the Sociedade de Cardiologia do Estado de São Paulo, the Instituto Tellus and IQVIA are funded by the Novartis Foundation for contributing to the implementation and/ or evaluation of the urban population health initiative and the study described here. None of the authors has declared any additional conflict of interest.

## Author contributions

AA (Alvaro Avezum), LD, and LB participated in supervision, validation of results and the critical review of the manuscript. AB, LPL, AA, BA, and RVM worked on data curation, the analysis plan, methodology, validation of results, writing of the manuscript. MSP, DCM, JS participated in validation of results, methodology, review and editing of the manuscript. CJ supported the writing of the first draft, review and editing of the manuscript, and the validation of results. MS, YCB, and TR supported project administration, supervision, validation of results, review and editing of the manuscript. KM, AZA represent the government authorities involved in the approval, leadership, administration and supervision of the initiative and this research. JB supported conceptualization, funding acquisition, project administration, supervision, validation of results, methodology, writing of the first draft, review and editing of the manuscript. All authors have read and approved the final version of this paper and agreed to be accountable for all aspects of the work.

## Data availability statement

Data sharing of individual level data is not possible due to the restriction of local approvals and ethical committees. Data was collected from standard procedures in the primary healthcare system and is thus under the jurisdiction of the respective health authorities. Research protocols and indicator frameworks can be made available to any interested party up-on request to the corresponding author.

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