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ORIGINAL RESEARCH

Point-of-Care Testing for Anemia, Diabetes, and Hypertension: A Pharmacy-Based Model in Lima, Peru

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Abstract

BACKGROUND Prevention and control of chronic diseases is a high priority for many low- and middle-income countries. This study evaluated the feasibility and acceptability of training pharmacy workers to provide point-of-care testing for 3 chronic diseases—hypertension, diabetes, and anemia—to improve disease detection and awareness through private pharmacies.

METHODS We developed a multiphase training curriculum for pharmacists and pharmacy technicians to build capacity for identification of risk factors, patient education, point-of-care testing, and referral for abnormal results. We conducted a pre-post evaluation with participants and evaluated results using Student *t* test for proportions. We conducted point-of-care testing with pharmacy clients and evaluated acceptability by patient characteristics (age, gender, and type of patient) using multiple logistic regression.

RESULTS In total, 72 pharmacy workers (66%) completed the full training curriculum. Pretest scores indicated that pharmacists had more knowledge and skills in chronic disease risk factors, patient education, and testing than pharmacy technicians. All participants improved their knowledge and skills after the training, and post-test scores indicated that pharmacy technicians achieved the same level of competency as pharmacists ($P < .01$). Additionally, 698 clients received at least 1 test during the study; 53% completed the acceptability survey. Nearly 100% thought the pharmacy could provide faster results, faster and better attention, and better access to basic screening for hypertension, diabetes, and anemia than a traditional health center. Fast service was very important: 41% ranked faster results and 30% ranked faster attention as the most important factor for receiving diagnostic testing in the pharmacy.

DISCUSSION We found that it is both feasible for pharmacies and acceptable to clients to train pharmacy workers to provide point-of-care testing for anemia, diabetes, and hypertension. This innovative approach holds potential to increase early detection of risk factors and bolster disease prevention and management efforts in Peru and other low- and middle-income settings.

KEY WORDS point-of-care testing, POC test, rapid test, anemia, diabetes, hypertension, pharmacies, Peru

The authors declare no conflict of interest.

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INTRODUCTION

Prevention and control of chronic diseases, such as diabetes, anemia, and hypertension, has become an increasingly high priority for low- and middle-income countries (LMICs).[1,2] In Peru, these chronic illnesses represent a growing portion of the disease burden.[3–7] In addition to effects on morbidity and mortality, chronic diseases may negatively affect the social and economic health of Peruvian communities.[7–9] As such, the Peruvian government, researchers, and policymakers are beginning to look toward innovative health care delivery models that provide a comprehensive approach for chronic disease prevention, detection, and management.[10–12] One potential model that we evaluate in this paper is the provision of care, through pharmacies and drugstores, specifically targeted at hypertension, diabetes, and anemia.

Hypertension is one of the most prevalent risk factors for noncommunicable diseases in Peru, afflicting 12%-30% of the population.[3,4,13–15] If left uncontrolled, hypertension can lead to more serious cardiovascular events, such as heart disease.[16] Glucose abnormalities and diabetes also represent a significant portion of the disease burden in Peru, with prevalence ranging from 2%-20%, depending on the population.[4,5] Anemia affects 1.62 billion people globally and can cause delayed mental and physical development, fatigue, decreased work productivity, and increased risk of mortality.[6] Pregnant women and children younger than age 5 years have the highest prevalence of anemia because of increased iron requirements; pregnant women are also at highest risk for anemia-related mortality.[17] In Peru, 40.4% of women of fertile age and 42.7% of pregnant women suffer anemia (defined as <11 g/dL for these groups).[6]

Unfortunately, as in many LMICs, individual awareness, treatment, and control of chronic diseases remain low in Peru. Among those suffering from hypertension, less than half are aware that they have the condition and even fewer are treated.[14,18] Among diabetic individuals, the level of suboptimal glycemic control has been estimated to be 78% across Latin America and 97% in Peru.[19] Finally, 39% of children younger than 5 years and 21% of women of fertile age who are diagnosed with anemia in Peru receive no treatment.[20]

The World Health Organization has promoted better integration and use of community pharmacies to address the gap in diagnosis and treatment of chronic diseases.[21] In Peru, pharmacies and drugstores (also known as *boticas*) play a large role in the health care system, often serving as the first point of care for people seeking medical advice or attention. Of the 54.3% of people who needed medical attention and actually received it in the last year, 61% went to a pharmacy, whereas only 39% went to a public health care facility.[22] Additionally, the average demand for services in the last 8 years increased by 2.9% for pharmacies but decreased by 1.1% for public health care centers.[22]

Previous studies have determined that pharmacies can be leveraged to successfully implement public health programs in Peru. One study found that pharmacy workers can be trained to provide health promotion services related to sexually transmitted diseases, their symptoms, detection of cases, and appropriate referral to clinicians to improve disease management.[23] In another recent qualitative study evaluating patient preferences for maternal health point-of-care (POC) testing, individuals indicated that pharmacies would be acceptable delivery sites for diagnostic testing.[24] Additionally, governmental strategies are currently being implemented in collaboration with private pharmacies to improve access to medications for publicly insured individuals.[25]

Building off these prior successes, our study assessed the potential for using pharmacies as critical access points for diagnosis, health promotion, and treatment of chronic diseases. Nurses, clinicians, and other health care providers traditionally perform diagnostic testing in Peru, but this task is within the jurisdiction of pharmacy workers' licensures and could be provided in the pharmacy, along with referral for abnormal results, disease prevention education, and medication adherence counseling. To that end, we implemented and evaluated a chronic disease management pilot program integrating rapid diagnostic equipment and POC testing for hypertension, diabetes, and anemia into pharmacies to improve screening, diagnosis, and control of these diseases.

OBJECTIVES AND HYPOTHESIS

Our main study objective was to assess the feasibility and acceptability of training pharmacy workers to provide POC testing for anemia, diabetes, and hypertension in private pharmacies. The target population was 2-fold: (1) pharmacists and pharmacy technicians to be trained in POC testing and interpretation; and (2) pharmacy clients with particular focus on those at highest risk for developing anemia, diabetes, and hypertension: adult women of

Annals of Global Health, VOL. 83, NO. 2, 2017
March–April 2017: 394–404

reproductive age (18-49 years), pregnant adult women, and elderly individuals (>65 years of age).[26–29] We hypothesized that it would be feasible to train pharmacists and pharmacy workers to provide POC testing to clients. We also anticipated that this type of innovative diagnostic model would both be acceptable and lead to increased awareness about disease prevention among clients.

METHODS AND MATERIALS

We conducted this study in 2 phases: phase 1, training, and phase 2, implementation and evaluation. In phase 1, we trained pharmacists and pharmacy technicians ("pharmacy workers") to use POC testing for anemia, diabetes, and hypertension and evaluated the impact on technician knowledge and skills. In phase 2, we first implemented the POC program in 4 urban pharmacies in Lima; we then conducted surveys in 2 of the pharmacies to evaluate patient acceptability of pharmacy-based POC testing.

Three POC tests were used in this study: (1) DiaSpect POC Hemoglobin Analyzer (EKF Diagnostics, San Antonio, TX) was used to test for anemia; (2) Prestige Facil (Trividia Health, Fort Lauderdale, FL) was used to measure glucose for diabetes screening; and (3) Ri-champion N (Riester, Jungingen, Germany) a digital tensometer, was used to test for hypertension.

Phase I: Training Pharmacy Workers to Provide POC Testing. For phase I, we designed and implemented a comprehensive training curriculum to teach pharmacy workers how to provide pharmacy-based disease prevention and management services to clients with anemia, diabetes, and hypertension. The training was conducted in partnership with a commercial chain of pharmacies that provided the infrastructure for our study. We prioritized working with pharmacies that already had established relationships with medical clinics, so that individuals could be immediately referred if any abnormalities were detected or if any questions arose that were beyond the scope of the pharmacy workers' training. We invited all workers from the pharmacies to participate in the training.

The training program involved 3 components: (1) preliminary in-class training sessions to educate pharmacy workers about anemia, hypertension, and diabetes; (2) a practicum component to practice skills in the pharmacies; and (3) in-class training sessions to teach pharmacy workers to conduct POC testing and provide medical referrals as needed.

Training in basic knowledge of diseases and patient management skills. The first in-class training sessions aimed to give pharmacy workers basic knowledge about prevention and control of the diseases and practical skills to better communicate with clients, such as empathic communication and motivational interview techniques. For this portion of the curriculum, we created a training manual for the pharmacy workers and provided materials to assist with client counseling and education. We conducted the training in 4 weekly sessions of 4 hours each with groups of 25 to 28 pharmacy workers. At each seminar, trainers used a syllabus and didactic teaching methods for the first portion, followed by interactive discussion, exercises, and role-playing. We conducted evaluations before and after the training to assess changes in practical skills (eg, communication with clients) and knowledge about the prevalence and risk factors for diabetes, hypertension, and anemia. Trainees also completed a short survey about perceptions of the training received.

Practicum training in pharmacies. For the second training component, participants completed a practicum working in their pharmacy with clients to apply the skills and knowledge gained in the seminars. The pharmacy workers were given a form to record and rate their encounters with clients. Trainers visited the workers at each pharmacy to give them training certificates from phase I, provide additional materials, and discuss their experiences talking with clients about each disease. This interaction reinforced information learned in the preliminary didactic training session and allowed trainers to evaluate trainees in the field and answer questions.

Training pharmacy workers in point-of-care testing. The third component of training focused on POC testing. This component of the curriculum included 2 additional weekly interactive 4-hour training sessions to teach pharmacy workers to screen for hypertension, diabetes, and anemia using the rapid diagnostic test kits. Trainees were also taught how to record test results using cellphones and to refer individuals for additional care as needed. To screen for hypertension, trainees learned how to take blood pressure measurements using an electronic blood pressure cuff. For diabetes, they learned how to take blood samples using a finger

stick and process a glucose strip using an electronic reader that evaluates glucose levels. For anemia, they learned to take blood samples and use a POC test to evaluate hemoglobin. We also provided information about biohazards, such as appropriate disposal of used materials and trash, use of gloves, and consequences of not following safety recommendations.

Because of the limited availability of equipment (the study only had access to 4 POC tests sets) the POC training component was conducted with a subsection of pharmacy workers who completed the preliminary training sessions and practicum. Thirteen pharmacy workers were invited, based on training and practicum evaluations, to complete the POC training. Participants received certificates upon completion of the course.

Phase II: Implementing Point-of-Care Testing in the Pharmacies. After training completion, we implemented a 2-month POC pilot program in 4 pharmacies providing rapid diagnostics for hypertension, diabetes, and anemia to individuals seeking care. Those who received POC testing were asked to complete a brief survey to understand their perceptions of pharmacy-based POC services.

Based on the amount of equipment we had (4 POC tests sets), we selected 4 individuals to carry out the POC program in their own *boticas* out of the 13 pharmacy workers who completed the full POC training program. Although it might seem to be a small number of trainees, there were enough to prove the feasibility of the implementation. Pharmacy workers were selected based on demonstrated knowledge of the POC test kits, ability to identify need for referral, biohazard and safety practices, and training evaluation scores. All of the selected workers were pharmacists. To facilitate implementation, we provided each pharmacy worker with the equipment and materials necessary to implement the tests, including POC test kits, digital tensometer, cellphone, biosecurity bags and boxes, cotton, ethylic alcohol, lancets, informative brochures to share with clients, and educational materials about the diseases. We also provided pharmacy workers with an electronic counseling tool, available for use with clients on computers located at the pharmacies or on a tablet. At the end of the 2-month POC program, the 4 workers answered a survey about their experiences providing testing in the pharmacies.

Individuals were offered POC testing as they entered the pharmacy (Fig 1). Pharmacy workers offered information about each disease and rapid diagnostic testing to clients based on individual characteristics (age and gender) and risk profiles. Anemia testing was offered most often to women, and pregnancy was considered a risk factor for anemia. For hypertension and diabetes testing, recruitment was targeted at elderly individuals (>65 years old), smokers, and people with family history of the diseases. If individuals agreed to be screened, the trained pharmacy workers conducted the POC tests and provided interpretation of results. Tests were offered at no cost.

Individuals with abnormal results were referred to a clinician for additional services. Test results were considered abnormal and indicative of potential disease based on standard medical criteria. For anemia, we considered hemoglobin levels abnormal if they were <11 g/dL for pregnant women, 12 g/dL for nonpregnant women, and 13 g/dL for men.[10] For diabetes, abnormal glucose levels were defined as ≥200 mg/dL; however, for clients taking nutritional or dietary fats, we considered levels ≥120 mg/dL to be abnormal.[11] We used systolic and diastolic arterial pressure to test for potential hypertension, and we considered abnormal levels to be >139/90 mm

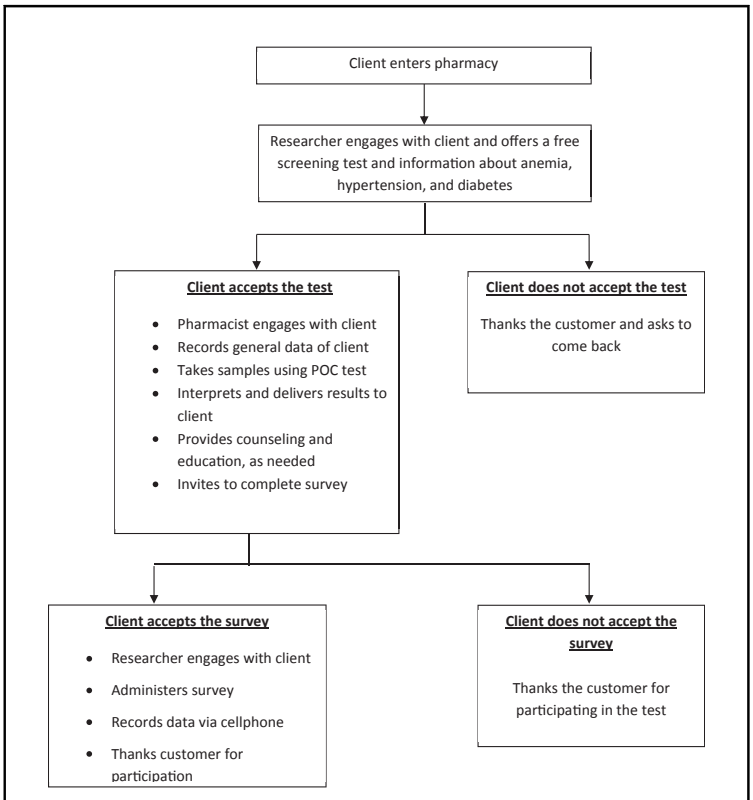

Figure 1. Flow chart of point-of-care recruitment and testing in the pharmacy. Abbreviation: POC, point of care.

Annals of Global Health, VOL. 83, NO. 2, 2017
March–April 2017: 394–404

Hg.[12] After testing, we asked those who received a POC test to complete a brief survey.

Data Analysis. We analyzed the impact of the training program and curriculum using a Student *t* test to evaluate within-individual differences in knowledge and skills pre- and post-training. We also compared levels of change pre- and post-training between pharmacists and pharmacy technicians. We used descriptive statistics and multivariable logistic regression to evaluate client acceptability of pharmacy-based POC testing by characteristics (continuous variable for age; categorical variables for gender and pharmacy location).

Ethics. This study received ethics approval from the Universidad Peruana Cayetano Heredia Institutional Review Board. All the participants gave oral informed consent to participate in the training and skills evaluation (pharmacy workers), screening test (clients), and survey (clients) before participation.

RESULTS

Phase I Results: Training Pharmacy Workers to Provide POC Testing. Table 1 illustrates the results of the preliminary training program (basic knowledge and patient management skills). Initially, 109 pharmacy workers participated in the training program; however, only 72 (66%) completed all 4 sessions. Of those completing all 4 sessions, 65% were pharmacists and 35% were pharmacy technicians. Pharmacists were younger on average than pharmacy technicians, with mean ages of 37 (±7.9) and 29 (±7.7) years old, respectively. Pharmacists and technicians had similar years of experience (approximately 33 months) in their respective roles.

At baseline, pharmacists had statistically significantly more knowledge and skills about the diseases and patient management than pharmacy technicians, based on an evaluation ranking these skills from 0-20 points ($P < .01$). Pharmacists scored an average of 12.1 points (±1.8) on the pretest and technicians scored an average of 10.9 (±1.7). All trainees indicated an increase in knowledge and skills after completing the training curriculum with post-test scores of 17.6 (±1.7) for pharmacists and 16.8 (±1.9) for pharmacy technicians. The between-group post-test comparison indicated that pharmacists and pharmacy technicians were similarly equipped after the training in their knowledge of diseases and skills communicating with clients ($P = .06$), although this finding was not statistically significant. After the training, 97% of pharmacy workers reported in a brief survey that they were satisfied with the training curriculum and usefulness of information received.

Phase II Results: Implementing Point-of-Care Testing in Pharmacies. Table 2 shows the characteristics of participants who received POC testing. In total, 698 individuals received at least 1 screening test during the 2-month POC pilot. Of these, 687 received a test for anemia, 473 for diabetes, and 665 for hypertension. Participants had a mean age of 44 years old (±16.2) and were primarily nonpregnant females (69%), and most were tested at the *botica* located in Ventanilla (51%). When comparing individuals receiving testing for each of the 3 disease groups, we found no significant differences among individual characteristics. Nearly two-thirds (62%) of individuals screened had abnormal results from at least 1 diagnostic test. Those with abnormal results were slightly older (46 years old, ±16.2), more likely to be nonpregnant women compared with men (OR = 1.3; 95% confidence interval [CI]: 1.0, 1.9), and more likely to be screened at Ventanilla compared with Comas (OR = 1.8; 95% CI: 1.0, 3.0).

Nearly 50% of individuals screened for anemia had abnormal hemoglobin results, the highest proportion of abnormal results of any disease group. Of those, the mean age was 45 years old (±16.5). Multivariable logistic regression indicates that nonpregnant women had 2 times the odds of receiving an abnormal test result for hemoglobin compared with men (95% CI: 1.4-2.8), when controlling for age and pharmacy location. In addition, individuals at the Ventanilla pharmacy location had 2.5 times the odds of having abnormal results (95% CI: 1.4-2.8) compared with our reference location of Comas, when controlling for age and gender.

Approximately 8% of individuals screened for diabetes had abnormal results. Of those, the mean age was 53 years old (±13.3). Nonpregnant women had the highest prevalence of abnormal results. Additionally, the San Juan de Lurigancho pharmacy location conducted the highest volume of glucose screens and had the highest proportion of abnormal results (12.5%). However, these findings were not statistically significantly associated with abnormal glucose levels.

Among those screened for hypertension, 23% had abnormal blood pressure. Of those, the mean age was 52 years old (±16.6). Individuals with 1 additional year of age had 1.04 times the odds of abnormal blood pressure when controlling for gender and study location; however, statistical

significance was marginal (95% CI: 1.03-1.05). In contrast to anemia and diabetes screening, a higher proportion of men (37%) had abnormal blood pressure compared with women (7% of pregnant women; 19% of nonpregnant women). The Ventanilla location performed the most (53%) hypertension screens. However, the San Juan de Lurigancho location had the highest prevalence of abnormal results (36%). Gender and study location were not statistically significantly associated with abnormal findings for hypertension.

Patient Acceptability of Pharmacy-Based Point-of-Care Testing. In total, 371 individuals (53% of those tested) completed surveys regarding the POC test they received. The majority (72%) of survey respondents was nonpregnant women, 27% were men, and 2% were pregnant women. More than half of respondents had either a prescription from a physician (9%) or a risk factor for 1 of the 3 diseases under study (45%). Another 46% had neither a prescription nor an obvious risk factor for disease but chose to complete a POC test.

More than 50% of respondents indicated that they had received similar tests in traditional health care facilities. Of those, 189 (51%) had received a glucose test, 231 (62%) had received a hemoglobin test, and 243 (65%) had received blood pressure screening; they had paid an average of $0.88-$4.23 (S/.2.5-12 Peruvian Nuevos Soles) for these services previously.[30] Approximately 70% thought this was an appropriate price for testing in the future. Clients also identified reasons they might seek POC testing in a pharmacy rather than a traditional health center in the future (Table 3). Nearly 100% thought that the pharmacy could provide faster results, faster and better attention, and better access to basic screening for hypertension, diabetes, and anemia than a traditional health center. However, only 38% thought that a pharmacy would provide POC testing at better prices. These results were consistent across individuals of differing gender, diagnostic status, and disease risk factors.

When asked to rank characteristics of future pharmacy-based POC testing, most individuals (71%) reported that attributes associated with reduced time seeking care were most important to them: 41% of individuals valued faster results the most, and 30% valued faster attention the most. Only 6% identified prices and 4% identified better access as the most important factor in their decision to use a pharmacy-based program over a traditional health facility (Fig 2).

Table 1. Characteristics of the Pharmacy Workers Trained in Point-of-Care Tests

	All Trainees	Pharmacists	Pharmacy Technicians
	N (%)	N (%)	N (%)
Total	72 (100)	47 (65.3)	25 (34.7)
Age*	34.2 (±8.6)	36.9 (±7.9)	29.3 (±7.7)
Working experience in pharmacy, months*	33.3 (±25.3)	32.9 (±23.9)	33.8 (±28.3)
Evaluation results: scale (0-20)			
Pretest*	11.7 (±1.9)	12.1 (±1.8)	10.9 (±1.7)
Post-test*	17.3 (±1.8)	17.6 (±1.7)	16.8 (±1.9)
Differences between groups†			
Pretest	$P < .01$		
Post-test	$P = .06$		

* Mean (standard deviation [SD]).
† Student *t* test for equal variances.

DISCUSSION

Our study aimed to increase detection and awareness of chronic diseases in Peru by training pharmacy workers to screen individuals for anemia, diabetes, and hypertension—3 diseases of increasing priority in Peru and globally as a result of growing prevalence.[4,6,7] Our findings indicate it is possible to train both pharmacists and pharmacy technicians to conduct rapid diagnostic tests in private pharmacies in Lima, Peru. Pharmacists had higher baseline levels of knowledge and competence than technicians before training. After training, both groups improved their knowledge and skills of POC testing and referral for abnormal results. Competency levels were similar between groups after training, suggesting that technicians can be trained to provide the same high level of rapid diagnostic testing and referral as pharmacists, despite having fewer years of formal educational training.

Previous studies have reported the benefits of including pharmacy workers in detection of diseases in low-resource settings globally where access to the traditional health system can be challenging.[31-36] Most studies evaluating POC testing in pharmacies in low-resource settings have focused on communicable diseases, such as malaria and human immunodeficiency virus.[35,37-39] However, a recent article on POC testing in high-income settings suggests pharmacy-based testing for chronic diseases can improve health outcomes while reducing societal costs.[40] Our study suggests that pharmacy-based POC testing for chronic disease is feasible and

Annals of Global Health, VOL. 83, NO. 2, 2017
March–April 2017: 394–404

Table 2. Characteristics of Individuals Receiving Rapid Diagnostic Tests in Pharmacies for Anemia, Diabetes, and Hypertension Screening by Test Results and Possible Risk Factors

Patient Characteristics	Number of Tests Completed in *Botica*	Tests with Abnormal Results		Odds Ratio	95% Confidence Interval	
	Total	N	% of Total Tests	Ref = 1.00	Lower	Upper
All Tests	N = 698	431	61.7			
Age*	43.8 (±16.2)	46.0 (±16.3)		1.02	1.01	1.03
Gender†						
Male	204 (29.2)	117	57.4	1.00		
Female, pregnant	16 (2.3)	7	43.8	0.6	0.2	1.6
Female, not pregnant	478 (68.5)	307	64.2	1.3	1.0	1.9
Pharmacy Location†						
Comas	64 (9.2)	32	50.0	1.00		
Independencia	82 (11.8)	48	58.5	1.4	0.7	2.7
San Juan de Lurigancho	198 (28.4)	125	63.1	1.7	1.0	3.0
Ventanilla	354 (50.7)	226	63.8	1.8	1.0	3.0
Anemia testing (hemoglobin)	N = 687	334	48.6			
Age*	43.6 (±16.1)	45.2 (±16.5)		1.01	1.00	1.02
Gender†						
Male	200 (29.1)	74	37.0	1.00		
Female, pregnant	16 (2.3)	6	37.5	1.0	0.4	2.8
Female, not pregnant	471 (68.6)	254	53.9	2.0	1.4	2.8
Pharmacy location†						
Comas	64 (9.3)	22	34.4	1.00		
Independencia	78 (11.4)	33	42.3	1.4	0.7	2.8
San Juan de Lurigancho	192 (28.9)	79	41.1	1.3	0.7	2.4
Ventanilla	353 (51.4)	200	56.7	2.5	1.4	4.4
Diabetes testing (glucose)	N = 473	36	7.6			
Age*	44.5 (±15.9)	53.4 (±13.3)		1.04	1.01	1.06
Gender†						
Male	141 (29.8)	9	6.4	1.00		
Female, pregnant	12 (2.5)	-	-	-	-	-
Female, not pregnant	320 (67.7)	27	8.4	1.4	0.6	2.9
Pharmacy location†						
Comas	64 (13.5)	2	3.1	1.00		
Independencia	81 (17.1)	5	6.2	2.0	0.4	10.9
San Juan de Lurigancho	192 (40.6)	24	12.5	4.4	1.0	19.3
Ventanilla	136 (28.8)	5	3.7	1.2	0.2	6.3
Hypertension testing (blood pressure)	N = 665	153	23.0			
Age*	43.9 (±16.2)	51.9 (±16.6)		1.04	1.03	1.05
Gender†						
Male	174 (29.2)	64	36.8	1.00		
Female, pregnant	15 (2.3)	1	6.7	0.2	0.0	1.1
Female, not pregnant	456 (68.5)	88	19.3	0.5	0.3	0.7
Pharmacy location†						
Comas	63 (9.5)	14	22.2	1.00		
Independencia	60 (9.0)	17	28.3	1.4	0.6	3.1
San Juan de Lurigancho	188 (28.3)	67	35.6	1.9	0.9	3.8
Ventanilla	354 (53.2)	55	15.5	0.6	0.3	1.2

* Mean (standard deviation [SD]).
† N (%).

Table 3. Potential Attributes of a *Botica*-Based Point-of-Care Testing Program Valued by Patients by Patient Characteristics

Potential Attributes*	All Patients N (%) N = 371	Buyer Type			Gender		
		Regular N = 170	Prescription† N = 33	At-Risk Individuals‡ N = 168	Male N = 99	Female, Not Pregnant N = 266	Female, Pregnant N = 6
Faster results	370 (99.7)	170 (100)	33 (100)	167 (99.4)	99 (100)	265 (99.6)	6 (100)
Faster attention	368 (99.2)	169 (99.4)	32 (97)	167 (99.4)	97 (98)	265 (99.6)	6 (100)
Better attention	366 (98.7)	167 (98.2)	33 (100)	166 (98.8)	99 (100)	261 (98.1)	6 (100)
Better prices	142 (38.3)	64 (37.6)	13 (39.4)	65 (38.7)	41 (41.4)	99 (37.2)	2 (33.3)
Closer/more access	371 (100)	170 (100)	33 (100)	168 (100)	99 (100)	266 (100)	6 (100)
None of the above	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)

* Participants were allowed to select more than 1 attribute.
† Number (%) of individuals that had a prescription for anemia, diabetes, or hypertension medications.
‡ At-risk individuals include those with self-reported risk factors for anemia, diabetes, and hypertension: pregnant women and individuals who are ≥40 years old, smokers, overweight, or have family history of disease.

could support disease detection and prevention among populations in LMICs.

A key consideration for implementation of pharmacy-based POC testing on a larger scale in low-resource settings is potentially high pharmacy worker turnover.[35] However, a previous study providing screening for sexually transmitted disease through pharmacies in Peru addressed turnover issues with systematic on-site training and increased attention to academic and occupational professionalism.[35] Additionally, a recent study identified several barriers to diabetes management in Peru, including information availability that can impede care coordination, financial barriers, and human resources/training barriers.[41] Our study found that pharmacy workers can be successfully trained to identify chronic disease risk and refer patients to the traditional health system for additional care, which could alleviate some of the training barriers identified. Information systems, care coordination between pharmacy workers and clinicians, and financial sustainability were beyond the scope of this study but could be evaluated in future work on pharmacy-based care.

Our study also assessed client acceptability of diagnostic testing in the pharmacy. Almost 100% of clients selected faster results, faster attention, better attention, and better access as a potential advantage of the pharmacy model. However, only 38% selected better prices. This may have been a reflection of the fact that POC testing was offered to study participants at no cost, which may not be the case in a nonstudy environment. Most individuals (71%) reported that attributes associated with reduced time seeking care were the most important to them. This is concordant with both the theoretical advantages of a pharmacy-based health care model[40,42] and health systems challenges ongoing in Peru and other LMICs.[43]

There are some limitations to this study. Pharmacy workers were trained to provide education on chronic disease, which could improve patient outcomes such as medication adherence.[44] However, we did not evaluate individual acceptance or perceived importance of education received by pharmacy workers. Future work should evaluate patient preferences for chronic disease education in the pharmacy and measure impact on disease prevention, management, and medication adherence. Additionally, although pharmacy clients reported amounts paid previously for POC testing outside of the pharmacy, we did not rigorously evaluate patient willingness-to-pay for or cost-effectiveness of services, nor did we collect information about income levels or insurance status.

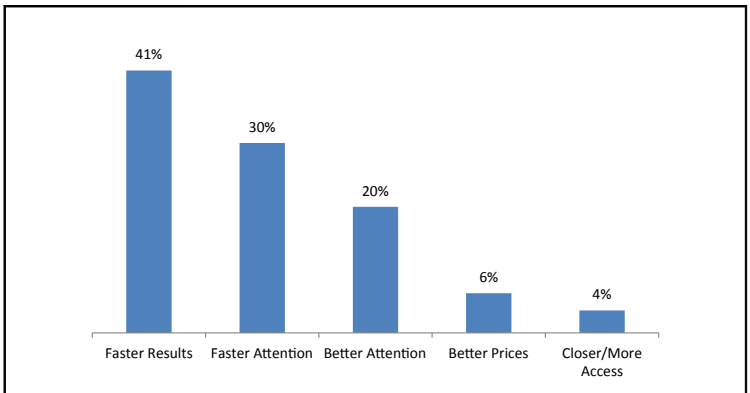

Figure 2. Attributes ranked as "most important" to individuals receiving point-of-care testing in the pharmacy.

Annals of Global Health, VOL. 83, NO. 2, 2017
March–April 2017: 394–404

These are fundamental factors in determining the sustainability of a pharmacy-based POC testing model for both pharmacies and customers, and should be considered in the future. Finally, only 53% of those who received testing completed the acceptability survey, which could limit generalizability of our patient findings.

However, this study developed, implemented, and evaluated a rigorous training curriculum for pharmacy workers to conduct POC testing for chronic disease. To our knowledge, this is the first study to expand POC testing for noncommunicable diseases in the pharmacy in Peru. Both pharmacists and pharmacy technicians scored highly on post-training evaluations, indicating that pharmacy workers of all levels may be potential agents for increasing access to diagnostic testing in Peru and other similar LMICs.

Additionally, this is the first study to assess the feasibility and acceptability of training pharmacy workers in an LMIC to conduct rapid diagnostic testing for multiple chronic diseases and could be used as a model for pharmacy-based public health training programs. Studies in the literature have evaluated the feasibility using community pharmacists to monitor blood pressure for hypertension patients in Canada,[45] explored pharmacist-client communication during blood pressure services in Portugal,[46] and assessed client preferences for pharmacy-based specialized asthma services in Australia.[47] A few studies have assessed patient acceptability of pharmacy-based services for hypertension in LMICs and found that, in general, pharmacy clients are supportive of pharmacy-based services.[48-50] Additionally, a meta-analysis estimated the potential impact of general pharmacy-based services for asthma, diabetes, and hypertension in LMICs and found that these programs could improve clinical outcomes and quality of life while reducing costs.[51] However, findings from these studies may not translate to POC rapid diagnostic testing in LMICs.

Implementation and scale-up of a pharmacy-based chronic disease screening program could increase a health system's capacity for disease detection by alleviating some of the task burden of doctors and nurses while reducing barriers to care for individuals and offering additional opportunities for patient health education. We find that it is both feasible and acceptable to provide POC testing for anemia, diabetes, and hypertension through private pharmacies. This study provides a manual for implementing POC testing into pharmacies in similar settings and identifies advantages and challenges of using pharmacies as a POC delivery setting.

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Annals of Global Health, VOL. 83, NO. 2, 2017
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