

ORIGINAL ARTICLE

Transforming population health through strategic innovation: CARE medical's integrated model for chronic disease management in private healthcare

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ABSTRACT

Background: Chronic diseases represent a major burden, considering the associated cost, low quality of life, and high mortality rates. Thus, early screening and management are essential to reduce their burden. There is limited evidence on the implementation and scalability of integrated Population Health Management (PHM) models—particularly those combining risk stratification, telehealth, and community outreach—in Saudi Arabia's private healthcare sector.

Objectives: To investigate the effect of implementing an integrated population-based health program in the private sector of Saudi Arabia.

Methods: The study was conducted at CARE Medical Al Rawabi (CMR) in Saudi Arabia in 2024.

CMR employed a phased framework:

- Initiation and Preparation: Strategic goal-setting, resource allocation, stakeholder alignment.
- Execution: Clinical programs, outreach strategies, digital platforms.
- Evaluation: Ongoing measurement of clinical and operational outcomes.

Foundational pillars included feasibility through telehealth, partnerships, and scalability via adaptable care models for diverse chronic conditions.

Results: The accuracy of the risk stratification model was 85%. The cancer screening trend increased by 59% in the second half of the year. Hospital admission rates were reduced from 2.5% in Q1 to 1.7% in Q4. 68% of the patients had their HbA1c levels below 7%, while 70% of the patients had their BP levels < 140/90 mmHg. The program saved 2 million Saudi Arabian Riyals.

Conclusion: Through advanced data analytics, targeted preventive care programs, integrated digital health tools, and robust community outreach, CMR demonstrates improved health outcomes, reduced hospitalizations, and cost-effective chronic disease management. The CMR case demonstrates that private sector entities can lead in advancing national health priorities through innovative PHM models.

Keywords: Transforming, Strategic Innovation, Chronic Disease, Management, Private Healthcare.

Introduction

Chronic diseases (CD) represent a major burden, considering the associated cost, low quality of life, and the high mortality rates compared to other infectious diseases [1,2]. For instance, in 2021, CD resulted in 43 million deaths. Moreover, diabetes mellitus, cardiovascular diseases, cancer, and chronic respiratory

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disorders represent 80% of the causes of premature death worldwide [3]. In Saudi Arabia, CD accounts for 73 % of death rates [4], and their prevalence in Saudi Arabia has significantly increased over the past years [2]. This could be attributed to many factors, including the lifestyle and the prevalence of obesity, which is associated with the incidence of diabetes and hypertension [5]. Furthermore, CD are associated with significant costs arising from management in addition to the costs from disability and absenteeism [6]. Thus, early screening and management are essential to reduce their burden [3].

Several initiatives have been suggested to control the incidence and management of CD. For instance, the World Health Organization 2030 sustainable health agenda aims to reduce 33% of premature mortality rates through prevention and control of CD [3]. This could be achieved through an integrated approach that involves monitoring CD trends, reducing the associated risk factors, and involving multiple stakeholders from health, finance, and educational backgrounds. This approach aims at implementing interventions to prevent and control CD progression [3]. Furthermore, several studies evaluated the impact of integrating digital platforms to improve CD prevention and management [7,8].

The Saudi-Arabia Vision 2030 involves providing a comprehensive care system for CD, involving workforce, governance, and regulations, e-health, and private sector participation [9]. However, there is limited evidence on the applicability of these approaches in the private sector. This study presents the comprehensive approach undertaken by CARE Medical Al Rawabi (CMR), a private hospital in Saudi Arabia, to implement a scalable, patient-centered Population Health Management (PHM) program. CMR aims to improve health outcomes, reduce hospitalizations, and provide cost-effective chronic disease management. CMR was one of six hospitals selected for PHM pilot program. Even prior to this selection, CMR had launched key interventions targeting CD, including diabetes, obesity, and breast cancer.

Methods

Study design and setting

This is a quasi-experimental study with data collection in the pre- and post-intervention periods. The study was conducted at CMR, a private hospital in Saudi Arabia. The program was implemented in 2024 and was applied to adult patients with diabetes, hypertension, obesity, ischemic heart disease (IHD), or those at risk of cancer. The project was conducted as a quality improvement initiative within the healthcare organization. The institutional approval was obtained per local policy requirements, and patient consent was obtained for telehealth and outreach activities.

Intervention

We employed a four-phase framework that involved the initiation, preparation, execution, and evaluation phases. The main pillars included feasibility through telehealth, partnerships, and scalability via adaptable care models for chronic conditions.

The initiation phase: selecting the targeted conditions based on the Council of Health Insurance priorities and available resources, defining the criteria for population segmentation, and classifying targeted population segments into targeted streams.

The preparation phase: segmenting population; risk stratification of population within each segment into low, moderate, and high risk; commercial stratification of each segment; and outcome measurement. CMR integrated electronic Health Records (EHRs), predictive modeling, and real-time dashboards to identify and segment populations. The key tracked metrics included Body mass index (BMI), blood pressure (BP), mammogram results, and HbA1c levels. Population segmentation was disease-specific, targeting diabetes, hypertension, IHD, and cancer. Additionally, this phase involved the development of clinical guidelines, order sets, and technology integration (telehealth).

- The execution phase: implementing clinical programs, outreach strategies, and digital platforms (CARE mobile application and website). The CMR's preventive model included:
 - Diabetes: Quarterly HbA1c monitoring and diabetic foot screening.
 - Hypertension: Routine BP checks.
 - Obesity: Multidisciplinary care, supported by a Surgical Review Corporation-accredited bariatric center.
 - Cancer: Screenings for cervical, breast, and colon cancer. This was conducted using pap smears, mammograms, fecal occult blood tests, and colonoscopies. Collaborations with the Zahra Breast Cancer Association resulted in a 59% increase in screening rates.

The CARE mobile application provided various services, including patient teleconsultation, appointment scheduling, ambulance requests, management of medications, and lab and radiology reports. The outreach strategies involved multichannel communication through calls, SMS, and using digital platforms; involving trusted messengers in the community; tailored messaging; educational campaigns; incorporating feedback for improvement; offering incentives to encourage participation; addressing outreach barriers; partnership with existing community networks; monitoring outreach; and refining outreach methods.

The evaluation phase: ongoing measurement of clinical and operational outcomes. This is done through quarterly audits of clinical practice guidelines



Transforming population health through strategic innovation

compliance and clinical outcomes, semi-annual patient satisfaction surveys, and cost-effectiveness analysis.

Data collection and statistical analysis

We collected qualitative and quantitative data. The qualitative data involved feedback from stakeholders. Data were collected from CMR's EHRs, telehealth digital platform, mobile application, and community outreach databases. The clinical outcomes included the percentage of patients with HbA1c < 7 and hypertension control (BP < 140/90 mmHg). The operational indicators included the number of readmissions, virtual consultations, the number of diabetic foot screenings, and the number of patients undergoing cancer screening. Patient engagement variables included app usage. Data validation was performed quarterly by the Quality and Patient Safety team. The saved cost was directly calculated from the reduced emergency visits, hospitalization, and unnecessary lab tests. The quantitative data were summarized using descriptive statistics (frequency and percentage). Using Excel, bar

and pie charts were used to summarize the measured outcomes. Additionally, the line graph was used to summarize the trends in hospital admissions over time.

Results

Risk stratification and data analytics

Using predictive modeling and real-time dashboards, CMR's integrated EHR analytics platform stratified populations into low, medium, and high-risk groups. The beta-stage predictive model achieved 85% accuracy in forecasting complications. As shown in Figure 1, the low-risk group was enrolled in wellness programs to prevent the incidence of complications, while the medium-risk group received lifestyle modifications. As for the high-risk group, they received intensive care management due to the complexity of their cases.

As for the diabetes mellitus population segmentation, patients were classified into four levels. As shown in Figure 2, Level 1 included adult patients (aged 15-75)

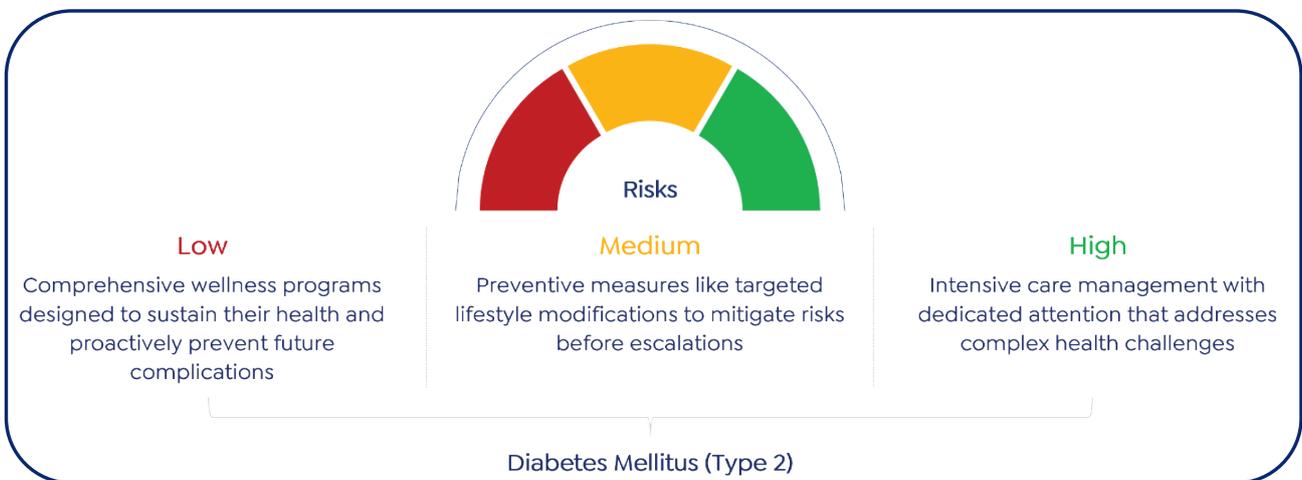


Figure 1. Risk stratification framework.

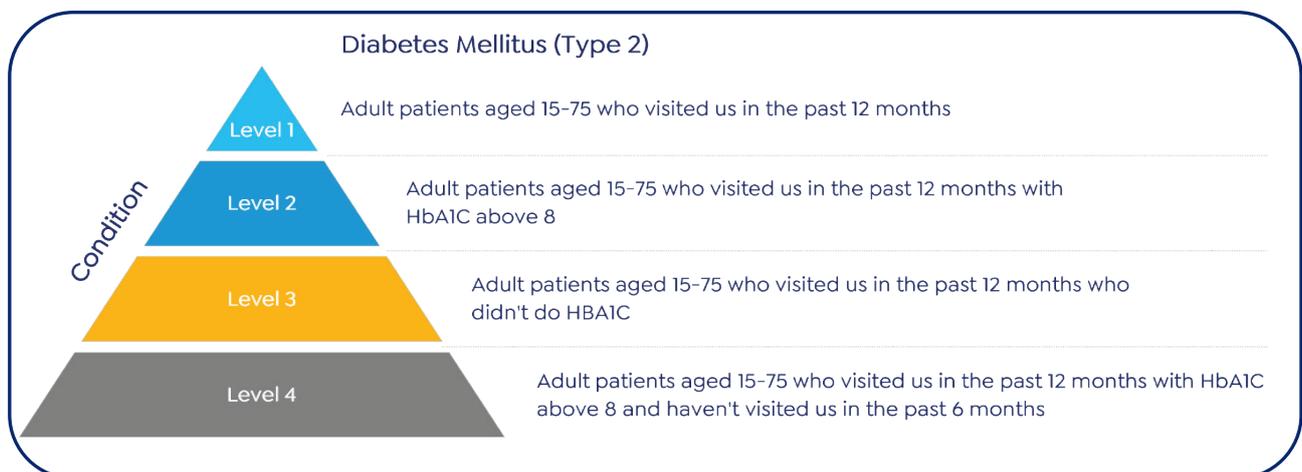


Figure 2. Diabetes mellitus population segmentation.



Transforming population health through strategic innovation

seen within the past 12 months. Meanwhile, level 2 included patients with HbA1c > 8%. Patients without recorded HbA1c testing and who visited the hospital in the last 12 months were classified as level 3, while those with HbA1c > 8% in the last 12 months without a clinical visit within the past 6 months were classified as level 4.

As for the hypertensive patients segmentation, patients were classified into four levels. As shown in Figure 3, Level 1 included adult patients aged ≥ 18 with hypertension seen within the past 12 months, while Level 2 included patients with recorded BP $\geq 140/90$ mmHg within the past 12 months. Patients without BP monitoring who visited the hospital in the last 12 months were classified as level 3, while those with BP $\geq 140/90$ mmHg in the last 12 months without a clinical visit within the past 6 months were classified as level 4.

Regarding the IHD population segmentation, patients were classified into three levels. As shown in Figure 4, Level 1 included adults (≥ 40 years) with IHD -related conditions (chronic IHD, chest pain, ACS, heart failure, atherosclerosis) seen within the past 12 months, while Level 2 included those with LDL cholesterol ≥ 2.5 mmol/L.

Adults (≥ 40 years) with LDL ≥ 2.5 mmol/l and no visits within the past 6 months were classified as level 3.

As for the segmentation of the obese population, patients were classified into three levels. As shown in Figure 5, Level 1 included adults (≥ 18 years) with BMI ≥ 30 seen within the past 12 months, while Level 2 included adults (≥ 18 years) with BMI ≥ 30 who underwent gastric sleeve surgery. Adults (≥ 18 years) with BMI ≥ 30 seen within the past 12 months who had not engaged with weight management services (Bariatric Surgery, Nutritionist/Dietician) were classified as level 3.

As for the segmentation of breast cancer screening, patients were classified into two levels. As shown in Figure 6, Level 1 included adult female patients (aged 35-70) seen within the past 12 months, while Level 2 included those seen within the past 12 months without a mammogram in the past 2 years.

Preventive care outcomes

Cancer screening

The data showed that the cancer screening trend increased by 59% in the second half of the year. As shown

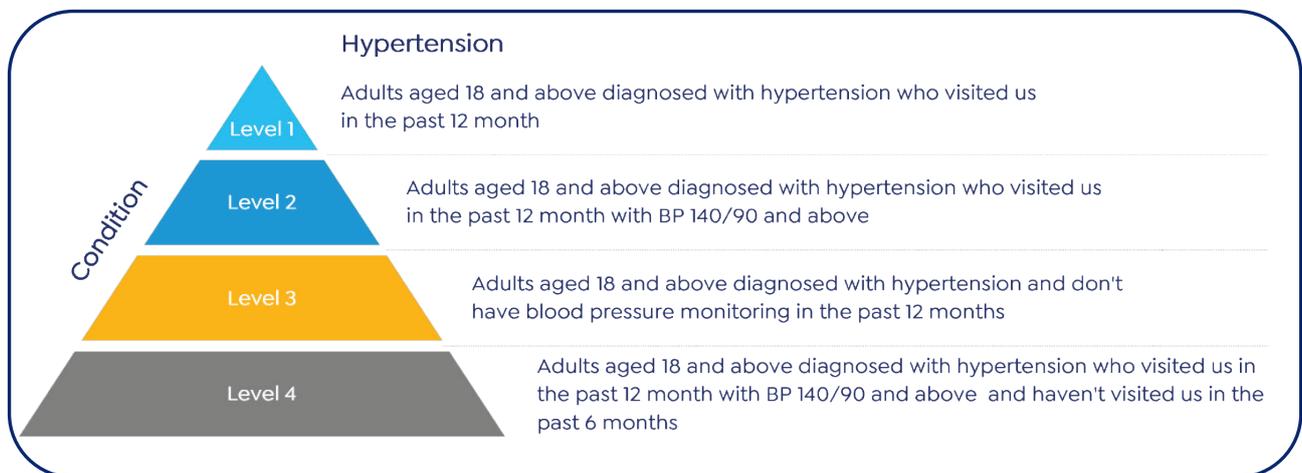


Figure 3. Hypertension population segmentation.

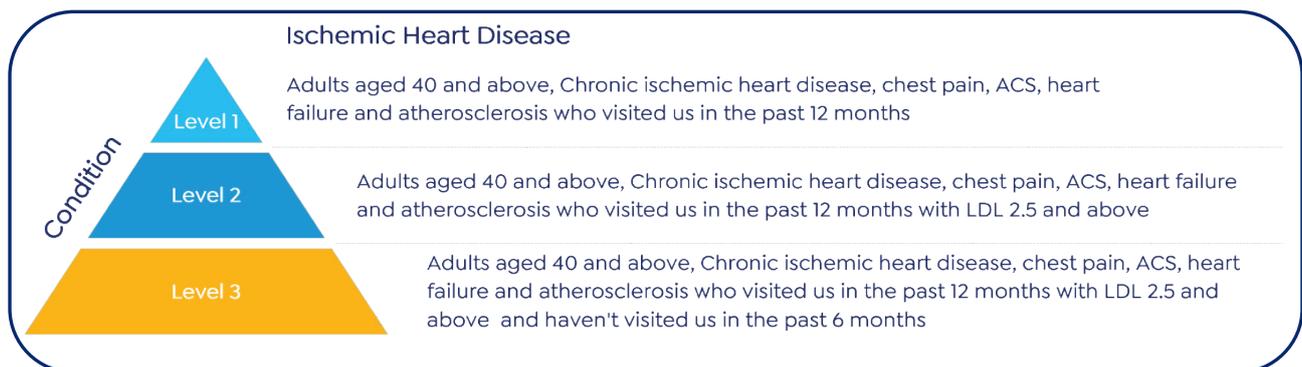


Figure 4. Ischemic heart disease population segmentation.



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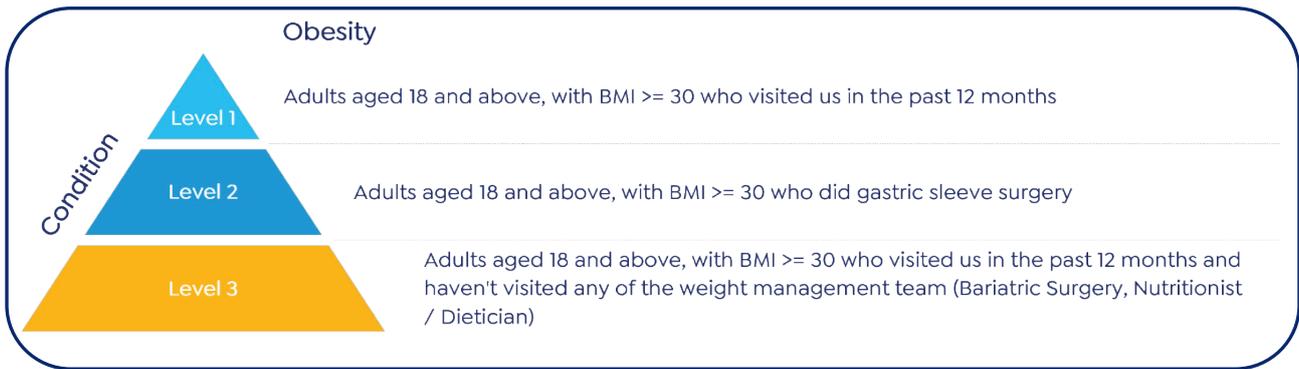


Figure 5. Obesity population segmentation.



Figure 6. Breast cancer screening segmentation.

in Figure 7A, the number of cancer screenings increased from 292 in Q1 to 516 in Q4. Similarly, mammogram testing increased by 59 % in the second half of the year. The number of mammograms ranged from 47 in Q1 to 100 in Q4 (Figure 7B). The rate of colonoscopy screening increased by 75% in the second half of the year, and the number of colonoscopies ranged from 49 in Q2 to 115 in Q4; while fecal occult blood testing increased by 65%, ranging from 87 in Q2 to 165 in Q4. Pap smear testing increased by 42%, ranging from 80 in Q2 to 136 in Q4 (Figure 7B).

Diabetes control and vascular referrals

The data showed that a significant proportion of patients had diabetic control following implementation of the program. As shown in Figure 8, 68% of the patients had HbA1c levels below 7% while 32% of them had HbA1c levels above 7%. The number of diabetic foot screenings was 16 in October, 12 in November, and 13 in December. Meanwhile, the number of patients with vascular complications and referrals was 10 in October and November, and reached 6 in December.

Hypertension control

The data showed that a significant proportion of patients had proper hypertension control following implementation of the program. 70% of the patients had their BP levels $<$ 140/90 mmHg, while 30% of them had their BP levels $>$ 140/90 mmHg.

Virtual consultation

The data showed that the number of virtual consultations has consistently increased throughout 2024 following the implementation of the PHM program. The number of virtual consultations was 500 in January, increased to 700 in June, and reached 850 in November.

Readmission rate

The data showed that the readmission rate within 30 days was reduced following the implementation of the PHM program. The readmission rate declined from 2.5% in Q1 to 1.7% in Q4.

Community events and engagement impact

The hospital has engaged thousands in 2024 by successfully hosting 17 community events and activities. These events included oral and dental health, winning with health, proper nutrition, World Asthma Day, Blood donation campaign, Global Handwashing Day, World Mental Health Day, Breast Cancer, Breastfeeding, Purple Saturday, and lung cancer.

Cost

The data showed that the implementation of the CARE medical integrated model improved adherence to clinical guidelines by 24%, increasing compliance from 60% to 84%. The reduction in unnecessary tests has led to an estimated 30% decrease in laboratory costs, saving around 2,000,000 Saudi Arabian Riyals (SAR).



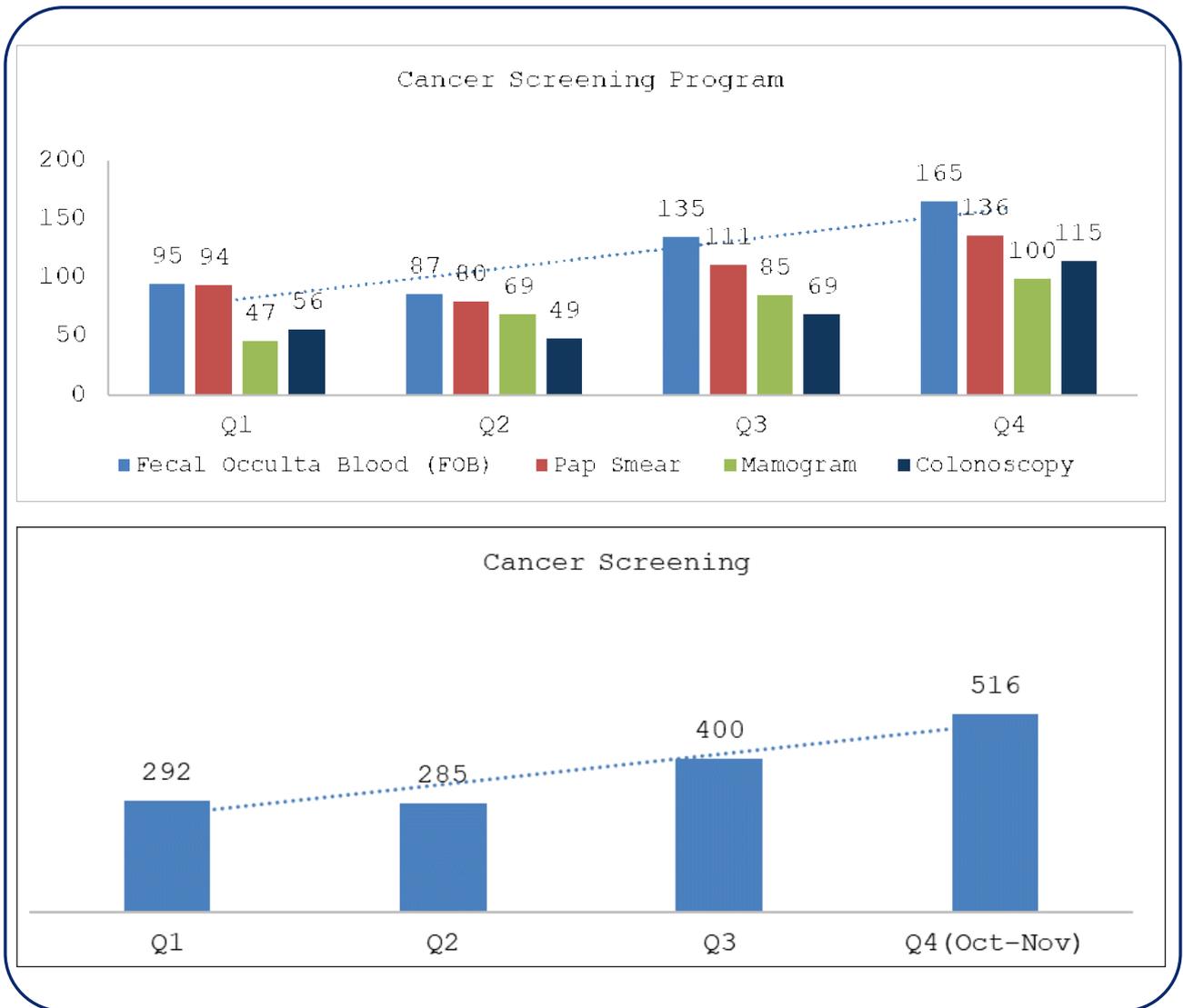


Figure 7. (A) Overall cancer screening trends (59% increase in the second half of the year). (B) Cancer screening trends according to the cancer type.

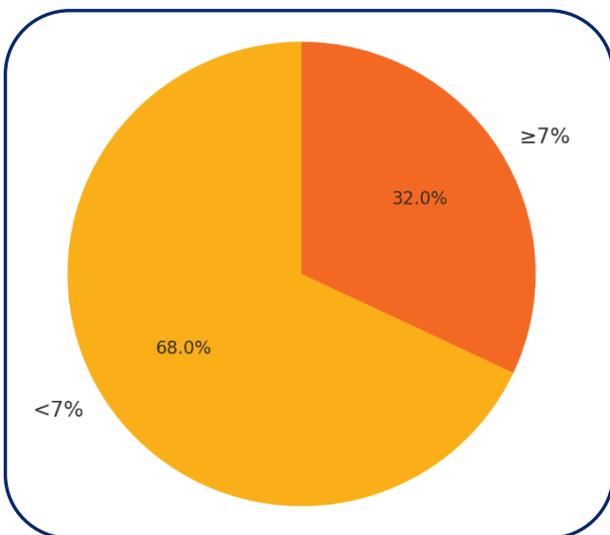


Figure 8. HbA1c control

Discussion

Aligning with Saudi Arabia Vision 2030, we investigated the outcomes of a population health program using an integrated model for chronic disease management in private healthcare. The program integrated outreach strategies, a risk stratification model, and digital platforms (mobile application, website). Our study demonstrated that the program resulted in efficient patient stratification, lower hospital admission rates, and reduced costs. It also increased the rates of hypertension and diabetes control.

Risk stratification tools integrate patients' health records and their outcomes to predict their prognosis. By categorizing patients into different segments, they enable adequate care delivery according to the severity of their condition [10]. We found that our risk



stratification model had an 85% accuracy and reduced readmission rates from 2.5% in the first quartile of 2024 to 1.7% in the fourth quartile of 2024. Similarly, Mateo-Abad et al. found that the implementation of the risk stratification system significantly reduced the rate of hospitalization [11].

Furthermore, the risk stratification model resulted in a cost reduction of about 2 million SAR, resulting from reduced emergency visits, hospitalizations, and unnecessary tests. Along with reduced readmission and hospitalization rates, we found that 70% of the patients had BP levels < 140/90 mmHg, and 68% of the patients had HbA1c levels below 7%. Consistent with that, the number of vascular referrals was reduced. This could be explained as improved glycemic control is associated with reduced vascular complications [12]. Furthermore, better glycemic control is associated with reduced lab tests, while patients with suboptimal diabetic control require more frequent HbA1c testing [13]. Similarly, Ashburner et al. found that the implementation of a population-based integrated program led to a significant improvement in DM and HTN control [14].

Our population health program involves awareness campaigns on the importance of cancer screening. The critical need for early detection is due to the dramatic rise in cancer incidence in Saudi Arabia, which has increased 26-fold in the past years [15]. This could be attributed to many factors, including obesity, sedentary lifestyle, and smoking [16]. It is estimated that more than a third of cancer-related mortalities could be avoided through early screening and providing adequate care [17]. Worldwide, breast cancer (BC) is the leading cause of mortality in females among other cancers [18], and is the most commonly occurring cancer among Saudi Arabian women [19], affecting about 30% of Saudi Arabian women [20]. Meanwhile, cervical cancer is ranked as the fourth leading cause of mortality in females worldwide [21]. This could be attributed to the low level of awareness and low screening rates. For instance, El Bcheraoui et al. found that 92% of females in Saudi Arabia did not get a mammogram [22]. Similarly, around 80% of Saudi Arabian women did not undergo cervical cancer screening [23]. Meanwhile, worldwide, the screening rates for cervical cancer are 36% and reach up to 88% in Europe [24].

In our study, we found that our integrated program led to an increase in the cervical cancer screening rates by 42%, and the overall screening rates of cancer by 59%. Also, our collaboration with the Zahra Breast Cancer Association increased BC screening rates by 59%. This is clinically relevant since the increased rates of BC screening by 10% are associated with increased detection of breast cancers smaller than 2 cm by 25% [25]. Nelson et al. found that BC screening is associated with lower BC mortality rates [26]. Moreover, colorectal cancer screening is important since it allows early detection and removal of precancerous lesions [27]. Thus, resulting in a reduced incidence of cancer and

its associated economic burden [28]. Following our intervention, the number of colonoscopies increased by 75%, while fecal occult blood screening increased by 65%.

Beyond cancer screening, addressing modifiable risks like obesity is critical as it is associated with numerous complications, including diabetes and hypertension [16]. Obesity is prevalent in around 20 to 39% of Saudi Arabians [29]. Moreover, DM and HTN are prevalent in 28% and 22.66% of the Saudi Arabians [30,31]. Thus, weight reduction is essential. For instance, each 15% reduction in weight is associated with a 19% reduction in the incidence of hypertension and a 37% reduction in the incidence of diabetes, saving around 181 million SAR over the duration of 120 months [32]. Through our nutritional and physical activity initiatives, 47% of the participants had weight reduction. Thus, our program could result in additional cost reductions beyond those from reduced readmissions and hospitalizations; however, this needs long-term assessment.

Patients with CD require frequent monitoring and consultation to control their conditions [33]. Teleconsultation could provide a similar experience compared to traditional consultation while saving time and reducing costs [34]. In our study, we found that the number of virtual consultations has reached 850 consultations per month. Similar to our findings, Zhang et al. found that teleconsultation resulted in a significant improvement in HbA1c and BP control [35]. On the other hand, some challenges could be noted with teleconsultations, including the inability to perform physical examinations, a lack of confidence in the doctor, and technical issues [36]. These challenges can be addressed by informing patients in advance that not all conditions can be managed through teleconsultations and that there may be a need for an in-person consultation [36].

Strengths and limitations

Our study has several strengths. First, to the best of our knowledge, this is the first study to describe the implementation of an integrated population health program in the private sector in Saudi Arabia. Thus, this project represents a blueprint for other private hospitals aiming to improve healthcare. The model integrated EHR and achieved a predictive accuracy of 85%. Moreover, it reflected the accuracy of the model based on patient outcomes, such as screening rates, hypertension, and diabetes control. The implementation of the program led to a significant reduction of costs (2 million SAR) resulting from hospital admissions and reduced unnecessary tests. Moreover, other cost reductions could result from the reduced incidence of CD.

Our study has some limitations. First, the program was implemented at a single care center in Saudi Arabia. Second, the period of implementation and follow-up was short since the project was only implemented



in 2024. Thus, we plan for long-term assessment, data monitoring, improvement, and stakeholder involvement. Although the program was implemented to improve CD, COPD patients were not involved. This could be attributed to the low prevalence and incidence of COPD in Saudi Arabia. For instance, in 2019, the prevalence of COPD was 2.05%, accounting for 1.65% of the overall mortality rates. Moreover, the mortality rates from COPD have been declining [37]. We calculated the cost directly from the reduced hospitalization and emergency visits. However, the cost of implementing the project was not calculated. Thus, a cost-effectiveness analysis might be essential before implementing the platform in other hospitals, especially the small ones with low resources. The PHM program involved using digital platforms and mobile applications. This may not be applicable in other countries with low income and high illiteracy rates.

Implications and sustainability plan

Our study has provided evidence of the efficiency of implementing an integrated population health program to improve the prevention and management of CD. The substantial cost savings (around 2 million Saudi Riyals) from hospitalization and readmission provided evidence on the effect of efficient risk stratification practices on improving the cost of healthcare while providing adequate patient care. The consistent rise in virtual consultations, reaching up to 850 per month, highlights its role in improving access and continuity of care within a PHM framework. This suggests telemedicine is a viable and increasingly preferred component of managing population health. Organizing diverse community events demonstrates a commitment to preventive health at the population level and is a contributing factor to increased awareness and screening rates. Additionally, the successful implementation of this model in a Saudi Arabian private hospital aligns with Saudi Arabia's Vision 2030 and provides a guide for other hospitals aiming to improve care quality.

Our sustainability plan involves providing continuous education and awareness, personalized communication through tailored messages based on patient needs, offering incentives and motivation to ensure continuous participation, using feedback to adapt strategies, data validation, and data quality audits to maintain platform performance and ensure data integrity evaluation, creating audits to ensure clinical practice guidelines compliance, and developing an integrated follow-up system with SMS, chatbots, calls, and educational materials. Thus, ensuring the platform's adequate performance, improving patient outcomes, and reducing costs.

Conclusion

Our study showed that the implementation of a population health program integrating telehealth, community outreach strategies, and risk stratification

models led to improvement in screening rates, reduced rates of hospitalizations, and reduced costs of healthcare in patients with CD. These results validate the feasibility of scalable PHM frameworks in resource-equipped settings.

List of abbreviations

CD	Chronic diseases
IHD	Ischemic heart disease

Conflicts of interest

The authors declare that they have no conflict of interest regarding the publication of this article.

Funding

None.

Ethical Approval

Ethical approval is not required at our institution to publish an anonymous case report.

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Transforming population health through strategic innovation

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