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Evaluating Primary Healthcare Effectiveness Under Funding Attrition: A Dual-Perspective Comparative Study in Conflict-Affected Coastal Yemen

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Abstract

This study aimed to evaluate the effectiveness of primary health care program implementation in urban health centers in the city of Hodeidah, Republic of Yemen, through a comparative monitoring of “structural and operational” inputs and processes between 2024 and 2025 from the perspective of health and administrative staff, surveying “outcomes and health impact” from the beneficiaries’ perspective, and analyzing statistical differences attributable to demographic, functional, and service-related variables. The study adopted a descriptive, analytical, and comparative design using two standardized questionnaires administered to two independent populations: a sample of health and administrative staff (N = 190) using a comprehensive survey and stratified sampling method, and a sample of beneficiaries (N = 197) using a convenience sampling method. The results showed a statistically significant decline (t = 16.58, p = 0.000) in the overall assessment of structure and process for the year 2024, with the overall mean dropping from 3.40 (high level) to 2.61 (moderate level). The “Partnership and External Support” dimension led the regression trend with the largest time-based difference (− 1.10) as a result of the decline in international humanitarian funding in 2025, while the “Effectiveness of Medical Operations and Protocols” dimension showed the highest resilience, with an average of 2.90 in 2025. Beneficiaries’ assessment of outcomes achieved an overall average score of 3.28, with the “Quality of Interaction” and “Perceived Health Impact” dimensions topping the rankings with an identical and high average of 3.52, while the “Quality of Infrastructure and Facilities” dimension ranked last with an average of 3.00, affected by power outages and the coastal climate. Statistically significant differences were also found in favor of permanent residents compared to displaced persons (p = 0.002), and in favor of recipients of immunization and antenatal care services compared to general screening clinics and medication dispensing (p = 0.009). The study presents an analytical model that explains the dynamics of the disconnect between the effectiveness of integrated preventive programs and the inadequacy of drug supply chains in health systems experiencing funding shocks.

Key Findings

- We observed a severe operational shock that led to a highly statistically significant decline (t=16.58, p=0.000) in the structural and process inputs of primary care programs in Hodeidah between 2024 and 2025.
- The “Partnership and External Support” dimension was found to lead the decline trend with a time lag of (−1.10), reflecting the risks of fragile financial dependence on international relief organizations.
- It revealed exceptional cohesion and resilience in the “Effectiveness of Medical Operations and Protocols” dimension (2.90 in 2025) as a stable knowledge-based and ethical foundation among local staff in the face of financial deterioration.
- A service paradox was documented, characterized by high satisfaction with cumulative preventive programs (immunization and maternal care, with an average of 3.52) contrasted with low satisfaction with infrastructure (3.00) and shortages of essential medicines (2.58).
- A radical shift was observed in staff evaluations based on contract type; workers contracted by organizations shifted from peak satisfaction in 2024 to the depths of frustration and attrition in 2025 following the discontinuation of incentives (p=0.000).

1. Introduction and Theoretical Context of the Study

Health outcomes and results serve as the governing criterion and strategic determinant against which the efficiency of health systems, their resilience, and their capacity for humanitarian response are measured in the face of protracted crises and complex geopolitical shifts (Blanchet et al., 2017; Donabedian, 1988). Clinical and epidemiological indicators of recovery are complemented by the perceptions and experiences of direct beneficiaries, as the effectiveness of care is determined by the availability of a therapeutic environment that preserves dignity and ensures accessible and comprehensive care without imposing financial burdens on vulnerable groups that exceed their means (Starfield et al., 2005; WHO, 2020). Achieving these outcomes depends on the soundness of organizational and physical structures and the discipline of operational processes implementing primary health care programs; it is impossible to generate sustainable preventive and curative outcomes in isolation from stable human resources, the readiness of supply chains and vaccines, adherence to standard clinical guidelines, and flexible funding capable of absorbing shocks (Jameel et al., 2025; Kruk et al., 2018).

Healthcare challenges are exacerbated in developing countries grappling with armed conflict and economic collapse, as is the case in the Republic of Yemen; field reports and international surveys indicate that nearly half of health facilities are fully or partially out of service as a result of infrastructure targeting, the suspension of central operating budgets, the suspension of regular salaries for public employees, and the brain drain of medical professionals—all coinciding with widespread outbreaks of diseases such as cholera, malaria, dengue fever, and acute malnutrition (Al-Adhroey et al., 2024; Qirbi & Ismail, 2017; World Bank, 2023). This tragedy is particularly evident in the city of Hodeidah, a densely populated urban center on the Red Sea coast that has taken in hundreds of thousands of forcibly displaced people, and is characterized by an extremely hot and humid coastal climate that accelerates the deterioration of medical equipment and the spread of tropical vectors, in addition to the complete collapse of the

public electricity grid and the poor condition of sanitation systems (Al Waziza et al., 2023; Alselwi & Suhail, 2024).

These harsh conditions have led primary care facilities in Hodeidah to rely on grants and humanitarian aid provided by UN and international organizations—such as the World Health Organization, UNICEF, and the United Nations Population Fund—to cover operating expenses, fuel, cash incentives, and vaccine cold chains; However, this reliance faced a critical disruption between 2024 and 2025 (Yemen Health Cluster, 2024, 2025). While 2024 saw a broad funding response to contain the cholera outbreak and malnutrition, early 2025 witnessed a sharp decline in international humanitarian funding ceilings for Yemen—by more than 50 percent—which caused a severe operational shock within urban health facilities, resulting in the suspension of incentives, the depletion of essential medicines, and the suspension of training and maintenance programs (UN OCHA, 2025; WHO EMR, 2025).

The problem addressed in this study is the widening structural and practical gap between the standard criteria that should be met in primary health care inputs and processes and the reality of field practice and the actual health outcomes achieved among service seekers at centers in the city of Hodeidah (Al

Waziza et al., 2023). The study traces the trends of this disparity between 2024 and 2025. This knowledge and research gap stems from the scarcity of comparative health studies in Yemen that evaluate programs through a direct temporal comparison of two consecutive operational years that witnessed dramatic shifts in funding, along with the local literature's failure to apply dual evaluation models that integrate the service providers' perspective—for evaluating structural and process inputs—with the beneficiaries' perspective—for evaluating outcome and effectiveness outputs. Most previous efforts have focused either on general descriptive surveys or epidemiological studies of a single disease (Dureab et al., 2023; Mutahar et al., 2022).

Based on this methodological foundation, this study seeks to answer the main research question regarding the level of effectiveness in implementing primary health care programs in the Yemeni city of Hodeidah and the nature of the differences observed in their indicators between 2024 and 2025, from which subsidiary questions emerge that break down the levels of achievement across the structural and process dimensions (adequacy of human resources and staffing; availability of material resources and equipment; effectiveness of medical procedures and protocols; training and institutional development; and partnerships and external support) for the years 2024 and 2025 from the perspective of the working staff, as well as the levels of achievement of the outcome and effectiveness dimensions (service availability and accessibility, quality of infrastructure and facilities, quality of interaction and relationship with the service provider, comprehensiveness and integration of services, outcomes, and perceived health impact) from the beneficiaries' perspective, as well as examining the statistical significance of differences between the two years and testing for variations attributable to demographic, functional, and service-related variables in the two samples.

The study's objectives are integrated to assess structural and process inputs and compare them over time, investigate patients' experiences and health outcomes, and test statistical differences to identify sources of resilience and vulnerabilities in the

health system in Hodeidah. The study derives its theoretical significance from the adaptation of global management models to a conflict-affected coastal environment and from enriching the health literature with an accurate database, while its practical significance lies in providing the Ministry of Health and humanitarian organizations with field-based evidence to guide resource allocation, formulate policies for retaining staff, and ensure clean energy and secure supply chains.

The research hypotheses were formulated to test for the absence of statistically significant differences at a significance level ($\alpha \leq 0.05$) between the means of employees' evaluations of the degree to which structural and process dimensions were achieved between 2024 and 2025 CE as the first main hypothesis (, H01), which branches into five sub-hypotheses, and to test for the absence of significant differences in employees' evaluations for the year 2024 attributable to demographic and job-related variables as the second hypothesis (H02), and repeating the same test for the year 2025 as the third hypothesis (H03), in addition to testing for the absence of significant differences in beneficiaries' evaluations of outcomes and effectiveness attributable to their demographic characteristics and service delivery patterns as the fourth hypothesis (H04).

2. Theoretical Framework and Critical Literature Review

Conceptual Models Explaining the Quality and Resilience of Primary Health Care The conceptual framework of this study is based on a theoretical synthesis of the "Donabedian Model" (Structure–Process–Outcome), the "Starfield Primary Care Model," and the concept of "Health Systems Resilience" (Blanchet et al., 2017; Donabedian, 1980, 2005; Starfield, 1998). Donabedian defines structure as the stable physical, organizational, financial, and human characteristics of the health system, while process represents the sequence of clinical and administrative practices, interventions, and medical interactions carried out during service delivery, and outcomes constitute positive changes in the patient's health status and perceived satisfaction (Donabedian, 1988, 2003). The theory assumes an inevitable causal flow: providing appropriate structures enhances the quality of clinical processes, which necessarily leads to improved health outcomes (Mun, 2023; Setyaningrum et al., 2024).

However, applying these models to complex conflict and humanitarian crisis environments requires a conceptual refinement that addresses the "resource stability" assumption prevalent in classical models; the health system in Yemen is characterized by fluidity, uncertainty, and the erosion of central budgets (Al Waziza et al., 2023; Haldane et al., 2021). Therefore, the current study integrated structure and process into a composite independent variable measured from the perspective of health and administrative personnel across five dimensions: adequacy of human resources and staffing; availability of material resources and equipment; effectiveness of medical processes and protocols; training and institutional development; and an additional, distinctive dimension: partnership and external support (Orok et al., 2024; Shortell & Kaluzny, 2006).

In contrast, Starfield et al. (2005) ground the effectiveness of primary care in four central functions: first point of contact, longitudinal continuity, comprehensiveness, and referral coordination. These pillars are integrated with the Service Quality Gap Model (SERVQUAL) developed by Parasuraman and colleagues (Parasuraman et al., 1988) and the patient-centered care framework (IOM, 2001; Rathert et al., 2013), and the value-based healthcare approach (Porter, 2010) to form the five dimensions of the dependent variable: service availability and accessibility; quality of infrastructure and facilities; quality of interaction and relationship with the service provider; comprehensiveness and integration of services; and perceived health outcomes and impact (da Silva et al., 2024; Gharaee et al., 2024).

Systematic Review of Previous Studies

The literature on the evaluation of primary care services varied according to geographical contexts and methodological approaches, presenting mixed evidence regarding the coherence of health systems and challenges in supply chains. At the local and regional levels, a study by Al Waziza and colleagues (Al Waziza et al., 2023) on the health system in Al-Hudaydah Governorate revealed that the workforce suffers from a severe structural shortage; with physicians and specialists accounting for no more than 5% of the total health workforce, and a near-total reliance on international organizations for incentives, fuel, and supplies, which has left facilities lacking the capacity for self-sustainability. A study by Alselwi and Suhail (2024), which conducted a comparative analysis of cases and evidence in Hodeidah, confirmed significant shortcomings in the coverage of preventive nutrition programs for infants due to a lack of equipment

and disruptions in supply chains. In a Yemeni rural context, a study by Dureab and colleagues (Dureab et al., 2023) showed that community health volunteers achieve high satisfaction rates exceeding 75% in awareness and family planning programs; however, their continued service is threatened by the interruption of financial incentives and medical supplies. Similarly, a field study in Yemen by Al-Assadi (2026) documented that domestic transportation costs and the scarcity of free medications represent the greatest barriers to vulnerable groups' access to care.

At the regional and international levels, a study by Jassim and Khalifa (2018) in Baghdad revealed a low availability of specialty medications and female staff at health centers, despite high adherence to routine immunization protocols. In a longitudinal evaluative study across 96 health centers, Orok and colleagues (Orok et al., 2024) demonstrated that the stability of cold chains, drug supply, and direct financial support accounted for more than 41% of the improvement in the uptake of care packages, and that fluctuations in grants lead to rapid operational setbacks. Da Silva and colleagues (da Silva et al., 2024) developed a standardized measure based on the Donabedian and Starfield pillars, confirming a close positive correlation between clinical process discipline and improved health outcomes. On the other hand, Capeletti and Santos (Capeletti et al., 2024) employed an envelopment analysis and the Malmquist comparative index, concluding that measuring primary care efficiency using abstract physical inputs yields misleading indicators unless accompanied by an examination of clinical processes and recovery outcomes.

An analytical review of the literature reveals broad theoretical consensus on the centrality of the Donabedian model in framing care indicators; however, most previous studies have been characterized by a one-dimensional perspective, either focusing solely on service providers (de Oliveira et al., 2024) or surveying beneficiaries' perspectives in isolation from an examination of the facility's operational capabilities (Gharaee et al., 2024). Most previous surveys were also characterized by their static, cross-sectional nature, capturing the reality of care at a single, isolated point in time, thereby depriving decision-makers of an understanding of the dynamics of transformation and regression when economic shocks occur (Capeletti et al., 2024).

The knowledge gap addressed by the current study lies in providing a dual-component assessment that simultaneously combines monitoring the reality of the structure and processes through the workforce with measuring outcomes and effectiveness through end beneficiaries, within a comparative framework that tracks on-the-ground changes between two consecutive years (2024 and 2025), during which the city of Hodeidah experienced a severe decline in humanitarian funding, thereby providing authentic statistical evidence regarding the resilience and robustness of the health system in conflict-affected settings (Blanchet et al., 2017; WHO EMR, 2025).

3. Research Methodology and Statistical Results

3.1 Design and Psychometric Properties of the Measurement Instruments

The study adopted a descriptive-analytical-comparative methodology, as it is best suited for comparing institutional performance over time and interpreting statistical differences attributable to demographic, functional, and service-related characteristics (Creswell & Creswell, 2018; Sekaran & Bougie, 2016). The study was conducted in urban primary health care centers affiliated with the Office of Public Health and Population in the city of Hodeidah, distributed across the districts of Al-Hawq, Al-Mina, and Al-Hali. The field instruments were applied to two independent populations: health and administrative staff, and patients visiting the facilities.

The sample of health and administrative staff was selected using a combination of exhaustive enumeration and facilitated sampling with proportional stratified random sampling to ensure representation of all specialties. The researcher collected N=190 completed questionnaires suitable for statistical analysis, a sample size with statistical power exceeding 95% at a significance level of α=0.05 (Krejcie & Morgan, 1970). The sample of service recipients was selected using a facilitated random field sampling method from patients visiting the centers during official working hours; the valid sample size was N=197 patients and service recipients.

Two standardized questionnaires were developed based on the literature by Donabedian and Starfield and the World Health Organization's facility assessment surveys (Donabedian, 2005; WHO, 2020):

· Health and Administrative Staff Questionnaire for Assessing Structure and Process: This included demographic and occupational data, followed by 40 items distributed across 5 dimensions. It was designed as a dual-time assessment that measures the status of each item for the same facility in 2024 and then in 2025, using a 5-point Likert scale.

· Beneficiary Questionnaire to Assess Outcomes and Effectiveness: This included demographic and service-related data, followed by 44 items distributed across five main dimensions measuring accessibility, infrastructure, interaction with the practitioner, comprehensiveness of services, and perceived health outcomes and impact.

The study adopted a five-point verbal interpretation scale for arithmetic means: Very Low (1.00–1.79), Low (1.80–2.59), Moderate (2.60–3.39), High (3.40–4.19), and Very

High (4.20–5.00). The study met the criteria for face validity by presenting the two instruments to a specialized review committee of six university professors, with an agreement rate exceeding 85%, and for internal consistency, where the correlations
between items and dimensions ranged from 0.514 to 0.864 at a significance level *of p*

< 0.01. The dimensions were also strongly correlated with the total score, with correlation coefficients ranging from 0.741 to 0.912.

The Instrumen t and Standardiz ed Scales	Subdimension s Composing the Instrument	Numb er of Items	Cronbac h's alpha (α)	Half-Split Coefficie nt (Spearm an-Brown)	Skewne ss	Kurtosi s
	1. Adequacy of					
	Organizational	8	0.892	0.864	-0.342	0.218
	Structure and				(2024)	(2024)
	Staffing					
	2. Availability					
Employee Survey (Structure and Process)	of Material Resources and	8	0.914	0.887	-0.412	0.285
	Equipment				(2025)	(2025)
	3. Effectiveness of Procedures and Protocols	9	0.905	0.879	--	--
	4. Training and					
	Organizational	8	0.886	0.852	--	--
	Development					
	5. Partnerships					
	and External	7	0.871	0.843	--	--
	Support					
Overall Score for the Employee Questionn aire	**Full Structure and Process Scale**	**40**	**0.974**	**0.948**	**Within the normati ve range**	**Within the normati ve range**
	1. Service					
Beneficiary Survey (Results and Effectivene ss)	Availability and	10	0.884	0.851	-0.415	0.364
	Accessibility					
	2. Quality of Infrastructure and Utilities	9	0.869	0.838	--	--
	3. Quality of Interaction and	10	0.897	0.872	--	--
	Service					
	Provider					
	4. Comprehensive ness and Integration of Services	8	0.854	0.826	--	--	--
	5. Results and Perceived Health Impact	7	0.878	0.849	--	--	--
Overall Score on the Beneficiar y Questionn aire	**Complete Outcome and Effectiveness Scale**	**44**	**0.943**	**0.916**	**Within the normati ve range**	**Within the normati ve range**	**Moderat ely normal distributi on**

The indicators in the table above confirm that the study instruments exhibit standard reliability levels exceeding the psychometric acceptance threshold (0.70), with overall reliability of 0.974 for staff and 0.943 for beneficiaries (Nunnally & Bernstein, 1994). Furthermore, the skewness and kurtosis indices fell within the acceptable range [−1.0,

+1.0], and the Kolmogorov–Smirnov (K-S) significance exceeded the 0.05 threshold, thereby permitting the application of parametric parametric tests (Tabachnick & Fidell, 2019).

Demographic and Occupational Variables	Variable Categories (Employee Sample, N=190)	Frequency	Percentage (%)	Demographic and Service Variables	Variable Categories (Sample of Beneficiaries N=197)	Frequency	P ta (%
Gender	Male	73	38.4%	Gender	Male	52	2
	Female	117	61.6%		Female	145	7
	General Practitioner	18	9.5%		Under 25	48	2
	/ Specialist				years old		
	Nurse / Nursing	74	38.9%	Age	25 to 40 years	114	5
	Technician			Group	old		
	Healthcare worker	45	23.7%		Over 40 years	35	1
					old		
Job Title					Illiterate / Can read and		
	Laboratory/Pharmacy/Radiology Technician	35	18.4%		write but has no formal	62	3
				Educational Level	education		
	Administrative / Supervisory Staff	18	9.5%		Elementary/Secondary Education	93	4
	Intermediate				College		
	Diploma (2–3 years)	98	51.6%		education or higher	42	2
Educational Qualification	Bachelor's degree	82	43.2%	Housing and Residency Status	Permanent resident of the neighborhood /city	129	6
	Graduate Studies (Master's/Doctorate)	10	5.2%		Displaced from other areas	68	3

Years of experien ce	Less than 5 years	41	21.6%	Monthly household d income	Below the poverty line (<50,000 riyals)	91	46.2%
	5 to 10 years	79	41.6%		Limited (50,000–100,000 riyals)	83	42.1%
	More than 10 years	70	36.8%		Medium (>100,000 Yemeni riyals)	23	11.7%
Type of Contract and Employ ment Status	Permanent civil servant (Ministry staff)	68	35.8%	Current Type of Service	Immunization of Children and Women	56	28.4%
	Contractor supported by organizations	89	46.8%		Prenatal Care and Family Planning	51	25.9%
	Health volunteer / locally hired contractor	33	17.4%		Clinics for examinations and dispensing of medications	46	23.4%
Training courses (two years)	Did not take any courses	28	14.7%		Therapeutic Nutrition (Malnutrition)	29	14.7%
	One to two cycles	94	49.5%		Emergency and First Aid	15	7.6%
	3 or more training courses	68	35.8%	Number of visits to the center	First visit	31	15.7%
					Occasional (2–3 times)	88	44.7%
					Regular visitor (>3 times)	78	39.6%

The demographic distribution in the table above reveals a structural imbalance in the skill mix of the workforce; general practitioners account for only 9.5% of the workforce, while nursing and midwifery staff dominate with a combined share of 62.6%, and the vast majority of workers (64.2%) consist of contractors hired by organizations or volunteers who lack job security, reflecting the fragility of the workforce and its immediate vulnerability to funding fluctuations (Al Waziza et al., 2023). Conversely, women make up the majority of beneficiaries at 73.6%, as the centers' services focus on maternal and child health, while internally displaced persons account for 34.5%, while 88.3% of households live below the poverty line or have extremely limited income, confirming that beneficiaries belong to the most vulnerable and needy social groups (Alselwi & Suhail, 2024; Jameel et al., 2025).

3.2 Comparative Statistical Analysis of Structural and Process Inputs (2024 vs. 2025)

The measurement results for the structural and process variables revealed radical shifts between 2024 and 2025 across all dimensions and items, as shown in the data in the following table:

Dimension of the	Year 2024: Arith	2024: Stan dard	2024: Rank	2025: Arith	2025: Stan dard	2025: Rank	Difference Betw	Calculated t-	Significance Level	Direction of Differ

Indepe ndent Variabl e (Struct ure and Process)	metic Mean	Devi ation	and Level	metic Mean	Devi ation	and Level	een the Two Avera ges	value (t
Adequa cy of Organiz ational Structur e and Staffing	3.30	0.68	4 (Mod erate)	2.56	0.64	4 (Low)	-0.74	12.85
Availabi lity of Material Resourc es and Equipm ent	3.35	0.65	3 (Aver age)	2.62	0.62	3 (Aver age)	-0.73	13.42
Operati onal Efficien cy and Protocol s	3.44	0.62	2 (High)	2.90	0.61	1 (Med ium)	-0.54	9.78
Training and Instituti onal Develop ment	3.25	0.67	5 (Aver age)	2.41	0.63	5 (Low)	-0.84	14.65
Partners hip and External Support	3.65	0.69	1 (High)	2.55	0.68	4b (Low)	-1.10	18.24
Overall Score for Structu re and Process Variabl es	**3.40**	**0.58**	**-- (High)**	**2.61**	**0.55**	**-- (Aver age)**	**-0.79**	**16.58**

The results of the t-test for paired samples in the table above indicate rejection of the first main null hypothesis (H01) and all its alternative hypotheses at a highly significant level (p=0.000); 2024 achieved overall superiority across all operational indicators. The “Partnership and External Support” dimension led the regression with the highest t-value (−1.10) and the highest t-statistic (t=18.24), as it fell from the top position among

the 2024 dimensions—with a mean of 3.65—to a low mean of 2.55 in 2025. This was reflected in a decline in the sub-item “Regularity of periodic drug supply” to 2.22 in 2025, down from 3.52 in the previous year.

In contrast, the “Effectiveness of Medical Procedures and Protocols” dimension demonstrated remarkable resilience in the field; it rose from second place in 2024 (3.44) to first place in 2025 with an average of 2.90, recording the smallest decrease (−0.54, t=9.78); The subscale related to “Adherence to Approved Standard Treatment Protocols, such as the Integrated Management of Childhood Illnesses (IMCI) Guidelines” remained at the top of the dimension’s subscales with an average of 3.88 in 2024 and 3.32 in 2025, followed by infection control measures and safe waste sorting in safety bins (3.25 in 2025), while the item “availability of equipped ambulances” remained at the bottom of the assessment with a low average of 1.95 in 2025.

In the “Human Resources and Employment” dimension, the sub-dimension “Contribution of Operational Incentives and Rewards to Staff Retention” recorded the largest internal decline, falling from 3.42 in 2024 to 2.05 in 2025, while the sub-dimension “Availability of Qualified Female Staff” remained at the top of the dimension in both years, with averages of 3.84 and 3.10, respectively. As for the “Material Resources” dimension, the sub-dimension “Efficiency of solar-powered vaccine cold chains” ranked first (3.92 and then 3.18), followed by “Alternative energy systems and generators” (3.75 and 2.95, respectively), while the sub-dimension “Uninterrupted Availability of Essential Medicines” plummeted to the lowest ranking with an average of 2.18 in 2025. The “Training and Development” dimension recorded the lowest overall average among all dimensions in 2025 (2.41), as

organizations' contribution to training funding declined from 3.82 to 2.75, and the "Measuring the Impact of Training in the Field" sub-dimension ranked last with an average of 2.15.

3.3 Statistical Analysis of Outcomes and Effectiveness from the Beneficiaries' Perspective

An analysis of the responses from the beneficiary sample (N=197) to the five dimensions comprising the dependent variable revealed a significant disparity illustrating the gap between clinical performance and material readiness:

Dimension of the Dependent Variable (Outcomes and Effectiveness)	**Weighted Arithmeti c Mean**	**Standar d Deviatio n**	**Rank**	**Verbal Level**	**Top-Ranked Paragraphs by Dimension (Mean and Standard Deviation)**	**Paragraphs with the lowest scores on the dimension (mean and standard deviation)**
Service Availability and Accessibility	3.13	0.64	4	Average	Proximity to the center and ease of transportatio n (3.82±0.85)	After-hours emergency care (2.45±1
Quality of infrastructure and facilities	3.00	0.65	5	Average	Maintenance of Examination Rooms for	Efficiency of air conditioning and ventilation
					Privacy (3.55±0.89)	systems (2.52±1.08)
Quality of Interaction and Service Provider	3.52	0.61	1 (repeated)	High	Availability of female staff in private settings (4.05±0.76)	Ease of access to channels for complaints and suggestions (2.65±1.05)
Comprehensivenes s and integration of services	3.21	0.62	3	Average	Regularity of vaccinations for children and women (4.02±0.78)	Full dispensing of essential medicines (2.58 ± 1.05)
Results and Perceived Health Impact	3.52	0.63	1	High	Protection of the center's services for families from the pandemic (3.92±0.79)	Perceived improvemen t in service by 2025 (2.85±0.98)
Overall average of outcomes and effectiveness	**3.28**	**0.54**	**--**	**Averag e**	**Overall Mean of the Dependent Variable from the Beneficiaries ' Perspective (N=197)**	

The table above shows that the assessment of outcomes is divided into two distinct patterns: a high-positive pattern characterized by clinical human interaction and perceived preventive outcomes, both with an identical average of 3.52, with the item "availability of female staff" ranking highest at an average of 4.05 (the highest in the entire questionnaire), followed by protection of the family from epidemics with an average of 3.92, the doctor's attentive listening (3.85), and patients' confidence in practitioners' competence (3.75). In contrast, shortcomings were concentrated in the physical environment and supply chains; the infrastructure dimension ranked at the bottom of the list with an average of 3.00, influenced by the poor efficiency of air conditioning in hot waiting rooms (2.52) and substandard restrooms (2.65), along with bottlenecks in medication dispensing at the pharmacy (2.58), long wait times (2.58), and the lack of after-hours emergency services (2.45).

3.4 Results of Hypothesis Testing for Demographic, Functional, and Service Differences

To detect statistically significant differences between groups, independent samples t-*tests*, one-way analysis of variance (ANOVA), and post-hoc comparisons were applied. The statistical conclusions are as follows:

Tested null hypothesis and variable	Statistical Test Method	Calculated Statistic Value	Significance Level (p-value)	Statistical Conclusion	Source and Direction of Statistical Differences and Practical Significance
Differences Among Employees for the Year 2024 (H02)					
Gender (H02.1)	Independent Samples t-test	t=0.542	0.588	Null Hypothesis	There are no significant differences between males (3.37) and females (3.42).
Job Title (H02.2)	One-Way ANOVA	F=2.684	0.033	Rejection of the null hypothesis	A significant difference in favor of administrative and supervisory staff (3.68) compared to technical staff (3.24).
Educational Qualification (H02.3)	One-Way ANOVA	F=1.331	0.267	Null Hypothesis	There are no statistically significant differences among the educational qualification categories.
Years of Experience (H02.4)	One-Way ANOVA	F=3.882	0.022	Rejection of the null hypothesis	A significant effect in favor of longer experience (>10 years: 3.52) compared to newcomers (3.25).
Contract Type and Correlation (H02.5)	One-Way ANOVA	F=7.876	0.001	Rejection of the null hypothesis	A significant difference in favor of organizational contractors (3.55) compared to volunteers (3.12).
Number of training sessions (H02.6)	One-Way ANOVA	F=4.989	0.008	Rejection of the null hypothesis	A higher score for those who completed ≥3 courses (3.54) compared to those who did not undergo training (3.18).
Differences Among Employees for the Year 2025 (H03)					
Gender (H03.1)	Independent Samples t-test	t=0.615	0.540	Null Hypothesis	There are no significant differences between males (2.58) and females (2.63).
Job Title (H03.2)	One-Way ANOVA	F=1.482	0.209	Null Hypothesis	The differences were not significant, and the impact of the financial crisis affected all staff members.
Educational Qualification (H03.3)	One-Way ANOVA	F=0.745	0.476	Null Hypothesis	There are no statistically significant differences attributable to educational qualification.

Years of Experience (H03.4)	One-Way ANOVA	F=1.824	0.164	Null Hypothesis	There are no statistically significant differences attributable to professional experience.
Contract Type and Correlation (H03.5)	One-Way ANOVA	F=11.458	0.000	Rejection of the null hypothesis	A significant difference in favor of permanent employees (2.82) compared to contract workers (2.38).
Number of training sessions (H03.6)	One-Way ANOVA	F=2.154	0.119	Null Hypothesis	The differences disappeared as a result of the near-total suspension of field training programs.
Differences among beneficiaries (H04)					
Gender of beneficiaries (H04.1)	Independent Samples t-test	t=0.658	0.511	Null Hypothesis	There are no significant differences between males (3.24) and females (3.29).
Age Group (H04.2)	One-Way ANOVA	F=0.854	0.427	Null Hypothesis	There are no statistically significant differences attributable to the age groups of the beneficiaries.
Educational Level (H04.3)	One-Way ANOVA	F=3.215	0.042	Rejection of the null hypothesis	A significant difference in favor of those with the lowest level of education (illiterate) compared to those with a bachelor's degree.
Marital Status (H04.4)	One-Way ANOVA	F=0.485	0.616	Null Hypothesis	There are no statistically significant differences attributable to the beneficiaries' marital status.
Housing and Residency Status (H04.5)	Independent Samples t-test	t=3.125	0.002	Rejection of the null hypothesis	A significant difference in favor of permanent residents (3.36) compared to forcibly displaced persons (3.11).
Monthly household income (H04.6)	One-Way ANOVA	F=4.812	0.009	Rejection of the null hypothesis	Significant in favor of higher income (>100,000: 3.48) compared to below the poverty line (3.14).
Current Service Type (H04.7)	One-Way ANOVA	F=3.482	0.009	Rejection of the null hypothesis	Significant in favor of immunization recipients (3.46) and prenatal care (3.41) compared to general screening (3.08).
Frequency of visits to the center (H04.8)	One-Way ANOVA	F=3.518	0.032	Rejection of the null hypothesis	A significant difference in favor of repeat visitors (>3 times: 3.38) compared to first-time visitors (3.12).

4. Discussion of the Results in Light of the Literature and Explanatory Models

4.1 Interpretation of the Temporal Decline and the Human Funding Shock

The statistical results of the t-test (t=16.58,p=0.000) demonstrated a widespread deterioration in structural and operational inputs between 2024 and 2025, which can be contextually explained by the sudden funding shock that struck Yemen's health response plan in early 2025 (UN OCHA, 2025; Yemen Health Cluster, 2025). After 2024 saw exceptional financial inflows to combat the cholera outbreak and secure incentives for staff and fuel, the nearly 50% reduction in international donor pledges in 2025 resulted in a decrease of more than 60% in the number of centers supported by incentives and supplies in the city of Hodeidah (WHO EMR, 2025). This finding is consistent with the documentation by Al Waziza and colleagues (Al Waziza et al., 2023) that the health system in Hodeidah is characterized by absolute structural dependence on external support, making it vulnerable to operational paralysis at any decline in grants, and aligns with the findings of Orok and colleagues (Orok et al., 2024), who demonstrated that the interruption of direct funding generates immediate setbacks in the uptake of essential care packages in developing countries.

Furthermore, the fact that the "partnership and external support" dimension leads the downward trend with the highest time lag (−1.10) demonstrates that international partnerships in protracted conflict settings shift from an enabling, supportive role to that of the exclusive operator and financier of the facility (Dureab et al., 2023). When these partnerships declined, pharmaceutical supply chains collapsed (average of 2.22 in 2025) and fuel allocations and generator maintenance ceased, confirming the findings of the literature on health system resilience that the absence of sustainable funding and reliance on short-term relief interventions undermine the structural stability of facilities (Blanchet et al., 2017; Kruk et al., 2015).

4.2 Resilience of Clinical Operations and the Entrenchment of Human and Ethical Capital

In contrast to the financial collapse, the most distinctive phenomenon was the stability of the "Effectiveness of Medical Procedures and Protocols" dimension and its ranking first in 2025 (2.90) with the smallest decline (−0.54, t=9.78), while adherence to the Integrated Management of Childhood Illnesses (IMCI) guidelines remained at the top with an average of 3.32. Concurrently, the dimension "Quality of Interaction and

Relationship with the Service Provider" ranked first in the beneficiary assessment with an average of 3.52, and the availability of female staff topped the scale with an average of 4.05.

This consistency can be explained by the fact that clinical standards and professional ethics represent integrated knowledge and behavioral principles that have become firmly established among local staff through years of training, practice, and prior field inspections, making them resistant to rapid decline once external financial support is withdrawn (da Silva et al., 2024; Stewart, 1995). Doctors, nurses, and midwives in Hodeidah's neighborhoods felt a heightened ethical and humanitarian responsibility toward poor and displaced patients; they compensated for material shortages with active listening, empathy, respect for privacy, and strict adherence to infection control and triage measures (Mun, 2023; Mutahar et al., 2022). These findings confirm the validity of the assumptions of the Institute of Medicine (IOM, 2001) and Starfield's pillars (Starfield et al., 2005) that human connection and patient-centered clinical communication constitute the last line of defense protecting the health system from complete functional collapse during protracted crises.

4.3 The Dual-Performance Paradox: The Success of Cumulative Prevention Versus Medication Supply Shortages

The findings revealed a profound structural and operational paradox in the experience of beneficiaries in Hodeidah; the "health outcomes and perceived impact" dimension received a high rating (3.52) thanks to community awareness of the life-saving role of immunization programs, therapeutic feeding, and hydration stations in protecting thousands of children and women from certain death during outbreaks of cholera, measles, and severe malnutrition; the "family protection from epidemics" subscale scored 3.92 and the "vaccination adherence" subscale scored 4.02 (Alselwi & Suhail, 2024; UNICEF, 2024).

However, this cumulative preventive success was undermined by severe therapeutic and logistical shortcomings; specifically, the "Infrastructure and Facilities" dimension ranked last (3.00) due to the failure of air conditioning systems to function effectively in Hodeidah's harsh coastal climate, power outages, and the limited capacity of alternative solar power (2.52), as well as the shortage of essential medications in center pharmacies (2.58), the suspension of emergency services in the afternoon (2.45), and long waiting times (2.58). This paradox is consistent with the findings of Jassim and Khalifa (2018) and de Oliveira et al. (2024); while the centers succeed in implementing integrated preventive interventions supported in-kind by organizations (such as vaccine vials and ready-to-use nutritional supplements), while failing to provide comprehensive and continuous primary care due to pharmacies' inability to supply antibiotics and medications for chronic diseases. This forces poor patients to purchase them on the commercial market at prices beyond their means, thereby rendering free medical consultations therapeutically ineffective.

4.4 Dynamics of Disparities: The Contract Shock and Challenges of Justice for the Displaced and the Poor

The statistical shift in the contract type and employment status variables for the worker sample constituted the most significant and profound finding in the comparative

analysis; In 2024, the differences were significantly skewed (F=7.876, p=0.001) in favor of contract workers supported by organizations (3.55) at the expense of formal employees and volunteers, thanks to the regularity of cash incentives. In 2025, however, a radical and statistically significant reversal occurred (F=11.458, p=0.000), with the differences shifting in favor of permanent staff (2.82), while the evaluation of contract staff plummeted to the lowest level, with an average of 2.38.

This shift can be explained by the theory of anticipatory shock and loss of gains; temporary contract workers (who, together with volunteers, represent 64.2% of the workforce) were the first direct victims of the decline in grants, as their incentives were abruptly cut off and they lost their sole source of income without any pension coverage or job security, leading to acute occupational frustration and a brain drain. In contrast, permanent employees maintained relative stability due to their ties to the state's permanent administrative structure and the cumulative institutional safety net (Dureab et al., 2023).

At the beneficiary level, the results demonstrated a gap in equity and equal access; permanent residents rated effectiveness higher (p=0.002) than those forcibly displaced, and households with adequate income outperformed those below the poverty line (p=0.009), and recipients of immunizations and prenatal care rated effectiveness higher than those visiting general clinics (p=0.009). These differences are attributed to the fact that displaced and the poorest families live in camps and on the outskirts of the city, and bear transportation burdens and costs that prevent them from arriving early, Furthermore, the depletion of free medications at the pharmacy is a devastating blow to the poor, who cannot afford to purchase them elsewhere, whereas the better-off can absorb the shock and buy medication from private pharmacies while maintaining a positive assessment of the quality of medical examinations and clinical advice (Al-Assadi, 2026; Jameel et al., 2025).

5. Conclusions

The study demonstrated that the primary health care system in the city of Hodeidah suffers from structural fragility and unsustainable funding dependence; the decline in international humanitarian grants by nearly 50% in 2025 led to a comprehensive operational shock that was statistically significant ($t = 16.58, p = 0.000$) that affected all structural and operational dimensions, demonstrating the local system's inability to absorb financial shocks with its own resources.

Conversely, human and ethical capital, along with adherence to standard clinical protocols, served as the critical safety valve that protected the health system from complete functional collapse; the medical operations dimension exhibited the highest levels of resilience in 2025 (2.90), and clinical human interaction topped the beneficiary evaluations (3.52). On the ground, a paradox of dual performance emerged: the success of integrated, UN-supported preventive programs (immunization and prenatal care, with an average of 3.52) contrasted with the failure of general treatment pathways, the shortage of essential medicines (2.58), and the absence of after-hours emergency services (2.45).

The results also showed that the electricity crisis, compounded by the extremely hot and humid coastal climate, constitutes a health and environmental determinant no less serious than drug shortages; the lack of air conditioning in overcrowded waiting rooms made infrastructure the weakest link in the community's assessment (3.00). The indicators concluded by confirming the existence of gaps in health equity, as displaced persons and the poorest families face compounded barriers to access due to the costs of internal transportation and out-of-pocket expenses, along with operational risks stemming from reliance on a temporary and contract workforce (64.2%), whose rating plummeted sharply following the discontinuation of incentives in 2025 ($p = 0.000$).

6. Recommendations

6.1 Recommendations for the Ministry of Public Health and Population and the Health Office in Al-Hudaydah Governorate

Addressing these gaps requires the establishment of a sustainable financing mechanism known as the Local Health Sustainability Fund in Al-Hudaydah Governorate, funded by revenues from fees and taxes levied on economic activities and ports, as well as community and private-sector contributions, to ensure regular monthly financial incentives for doctors, nurses, and midwives, thereby reducing dependence on the volatility of international grants and preventing professional attrition. We also recommend adopting a binding phased plan to integrate contracted medical and nursing personnel into the state's official civil service, while restructuring the geographic distribution of personnel to ensure the presence of a general practitioner or family medicine specialist and a qualified midwife in every urban health center during both morning and evening shifts.

Urgent investment in renewable energy stands out as a top priority to equip all facilities with high-capacity industrial hybrid solar power systems and lithium batteries that ensure the continuous operation of waiting room air conditioners, vaccine refrigerators, and laboratories throughout the summer, 24 hours a day. This is complemented by the digitization of pharmaceutical supply chains and the integration of urban center pharmacies with the Central Health Office's warehouses via a real-time electronic system that monitors inventory and identifies early reorder points to prevent shortages of essential medications and infusion solutions. We also recommend equipping the three urban directorates (Al-Hawk, Al-Mina, and Al-Hali) with ambulances that are fully equipped and dedicated exclusively to transporting emergency cases and women in labor experiencing complications free of charge to the Al-Thawra General Hospital Authority, and activating the joint coordination operations rooms.

6.2 Recommendations for International Organizations, UN Agencies, and Donors The operational reality requires a reformulation of international funding policies for Yemen, shifting from short-term emergency relief projects to sustainable institutional development investments within the framework of the humanitarian-development nexus, by allocating no less than 45% of grants to the rehabilitation of hard infrastructure, sewage networks, and support for solar energy systems and water cooling stations. Resilient backup pharmaceutical supply chains must be established to ensure the continued supply of essential medicine packages to facilities even during periods of declining general grants, and to avoid sudden cuts to operational incentives, while requiring partners to notify local administrations of any funding reductions at least six months in advance to enable the implementation of alternative response plans.

We also recommend restructuring training and development programs to be based on surveys of the actual clinical and administrative needs of facilities in Hodeidah, including mandatory training tracks for staff on clinical communication and emergency management skills, and linking training to supportive supervision mechanisms that measure direct on-the-ground impact. Promoting social equity requires funding dedicated programs to facilitate access for displaced persons in camps and on the outskirts of Hodeidah to primary care centers by providing free transportation vouchers and supporting mobile medical teams to deliver care packages and vaccinations to their gathering sites.

6.3 Recommendations for the Administrations of Primary Health Care Centers in the City of Hodeidah

We recommend that center administrations implement a triage system and a numbered digital ticket system in reception areas to reduce waiting times, and schedule prenatal checkups and routine vaccinations at staggered intervals to prevent morning overcrowding and alleviate stress on staff. An internal assessment should also be conducted to equip examination rooms with privacy screens and secure partitions that ensure patient privacy, while completely separating the waiting areas for men from those for women and children and providing sufficient, clean seating.

We recommend that clinic administrations activate complaint and suggestion boxes and hotlines, form quality committees to periodically review feedback, and involve representatives from the local community and neighborhoods in the clinic's advisory committees to reinforce the principles of accountability and transparency. We also recommend establishing a local emergency fund at each center to cover the costs of rapid preventive maintenance for testing equipment, laboratories, and air conditioners, while tightening oversight of cleaning companies to ensure that facilities and restrooms are disinfected regularly.

7. Research Parameters and Future Prospects

The research parameters included limiting the geographic scope to urban health centers in the city of Hodeidah and relying on a comparison between the years 2024 and 2025, which opens up promising research prospects for future studies, including:

- A comparative study of the effectiveness of primary health care program implementation between urban and rural centers in Al-Hudaydah Governorate in light of distributive justice of resources.
- An evaluation of the productive and operational efficiency of primary care facilities in the Republic of Yemen using Data Envelopment Analysis (DEA) and the quality-adjusted Malmquist productivity index.
- Determinants of access to reproductive health and child care services among displaced women in camps on the western coast: an exploratory qualitative study.
- The Impact of Automating Primary Health Records and Implementing Electronic Disease Surveillance Platforms (eDEWS/DHIS2) on the Efficiency of Clinical Decision-Making and Outbreak Control in Fragile Settings.
- The Correlational Relationship Between Psychological Stress and Job Burnout Resulting from Salary Delays and Rates of Clinical Errors Among Nursing and Emergency Medical Staff in Yemen.

8. Ethical and Administrative Aspects

This study received official scientific and ethical approval from the Research Ethics Committee at the September 21 University of Medical and Applied Sciences, and administrative facilitation letters were issued to the Office of Public Health and Population in Al-Hudaydah Governorate to facilitate fieldwork and the administration of assessment tools in the targeted urban centers. Strict adherence was maintained to the ethical guidelines set forth in the Declaration of Helsinki on Medical Research Ethics; all participants in both the staff and beneficiary samples were informed of the objectives and nature of the research, and their informed, voluntary, and verbal consent was obtained prior to completing the questionnaires. Complete data confidentiality was ensured, and no personally identifiable information or names of participants were collected; every participant was granted the full right to withdraw or refuse to answer at any stage without any adverse consequences for their employment or service status. The researchers declare that there are no potential conflicts of interest—whether financial, institutional, or personal—related to the conduct of this study, the analysis of its results, the interpretation of its findings, or their publication in scientific journals. Furthermore, this research was conducted as a purely academic endeavor without receiving any financial funding or monetary support from any internal or external donor. The researchers— —extend their deepest appreciation and gratitude to the leadership and staff of the Office of Public Health and Population in Al-Hudaydah Governorate, the facility directors, and the medical, nursing, and administrative staff, as well as all participants and beneficiaries who contributed through their sincere cooperation to the completion of this research and provided field evidence under the exceptional circumstances in the city of Al-Hudaydah.

Declarations

Author Contribution

M.M.A. conceived and designed the study, developed the methodology, conducted the field data collection and statistical analysis, interpreted the results, wrote the original draft, and reviewed and edited the final manuscript. The author read and approved the final manuscript.

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Data Availability

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

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