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Research Article

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Determinants of Integrated Pharmaceutical Logistics System Performance in Ethiopian Public Health Facilities at Harari Regional State, Ethiopia

Beyene Dereje[1*], Alemayehu Megersa[1], Zenebe Keno[2], Abdi Mohammed[3]

[1]*Department of Pharmacology, School of Medicine, College of Health and Medical Science, Dire Dawa University, Dire Dawa, Ethiopia*

[2]*Pharmacy Department, Hiwot Fana Specialized University Hospital, College of Medicine and Health Science, Haramaya University, Harar, Ethiopia*

[3]*Department of Pharmacology, School of Pharmacy, College of Health and Medical Science, Haramaya University, Harar, Ethiopia*

[*]Corresponding Author
Beyene Dereje, Department of Pharmacology, School of Medicine, College of Health and Medical Science, Dire Dawa University, Dire Dawa, Ethiopia.

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Abstract

The well-functioning pharmaceutical logistics system to deliver medicines, vaccines and other health products are critical to the provision of health services. The study aims to determine the association and magnitude of determinant factors with performance of integrated pharmaceuticals logistics system among public health facilities in Harari Regional State of Ethiopia. The study used cross-sectional descriptive study and explanatory research designs and structured questionnaire were adapted from Logistics Indicator Assessment Tool (LIAT) to collect data. Descriptive statistics was used to describe the public health facility performance data and binary logistics regression was done by using SPSS version 27. Data were complemented with documentary analysis, description of internal processes and logistics registrations. Findings from this study indicate that management ownership level of the system with β value 3.961, [AOR -19.373 in 95% CI (3.765, 116.271), P = 0.001], and health facility staff skill level with β of value 2.109, [AOR - 8.241, 95% CI (3.703, 81.336), P = 0.005], have positive associations with integrated pharmaceuticals logistics system performance. But, the health facility service volume has no significant association with the performance of integrated pharmaceutical logistics system. The hypothesis proposed were accepted for both health facility staff's skills and management ownership of the system while the hypothesis proposed for health facility service volume is rejected as it has no significant effect on the performance. The study found that the health facility staff skill and management ownership have significant effect on integrated pharmaceutical logistics system implementation. The major factors for health professional under optimal skill were poor management support, staff insufficiency, and a poor skill transfer mechanism.

Keywords: Health Logistics, IPLS, Management Ownership, Staff Skill, Service Volume

Background

Well-functioning pharmaceutical logistics system to deliver medicines, vaccines and other health products are critical to the provision of health services. Any good health system necessitates supply chains that can guarantee consistent availability of affordable, high-quality medicines, vaccines and health products at all health service delivery points [1,2]. Health is an important indicator of the status of development of a society and country, and medicines are the cornerstone and integral part of every health care system [3,4]. Health care is unthinkable without the availability of necessary medicines. They not only save lives and promote health, but prevent epidemics and diseases too [5,6]. Accessibility to medicines is a fundamental human right, and its effectiveness is substantially affected by the functioning of the logistics system [7–9].

Ethiopia's pharmaceutical supply chain management system has historically struggled with a number of issues, including lack of availability, high costs, inadequate storage, poor stock management, and illogical usage [10–13]. The reasons for inadequate access to and availability of medications were complex, and some of the causes included irrational drug usage, unsustainable finance models, and inefficient health care supply chain systems to get drugs to the final consumers [14–18]. To address these challenges, the Ethiopian Federal Ministry of Health launched a comprehen-

sive supply chain strategic planning process, and the former Pharmaceutical Fund and Supply Agency (PFSA), now known as the Ethiopian Pharmaceutical Supply Service (EPSS), began implementing the Integrated Pharmaceutical Logistics System (IPLS) in early 2009 in order to carry out its pharmaceutical supply mandate in an efficient and effective manner [19–21].

The Ethiopian Pharmaceutical Supply Service (EPSS) is responsible for supply chain management of public health commodities in Ethiopia. The agency has 19 branch warehouses that serve more than 3,800 health facilities that in turn serve 120 million people in nine regional states and two administrative states [22,23]. The term IPLS refers to the single pharmaceutical reporting and distribution system based on the EPSS's overall mandate and scope which includes both Program and revolving drug fund (RDF) products. To be successful, the system must ensure that the right products are available in the right quantity, of the right quality, at the right place, at the right time, and at the right price. The following basic logistics functions are included in IPLS at the facility level: logistics management information system, inventory control system, and pharmaceutical storage. Currently IPLS is the main method used by all public health facilities to obtain necessary medications in Ethiopia [14,24–26]. Regular monitoring reports reveal that IPLS is enhancing data logging and reporting, storage and distribution systems, and the accessibility of necessary supplies at service delivery points [14,25,27].

The provision of healthcare services requires the constant availability of medical supplies and related drugs that are both of the necessary quality and quantity and are also safe, inexpensive, and effective [14,28,29]. Minor disturbances in the pharmaceutical supply chain can lead to catastrophic outcomes. Pharmaceutical product distribution must balance cost-cutting with rigorous adherence to service standards, all while accounting for risks associated with uncertainty [16,30,31]. When there are medicine shortages, hospitals are forced to postpone treatments and depend on less effective and more expensive replacements [32–35].

According to a research on drug pricing, availability, and affordability in 36 developing and middle-income countries, mean availability in the public sector ranged from 38.2% in Sub-Saharan Africa to 57.7% in Latin America and the Caribbean for a basket of key medicines. It is also indicated in underdeveloped nations, the most prevalent indicator of supply chain effectiveness is stock-out rate: the proportion of sites that are out of a certain item on the day the survey is conducted [36,37]. According to a Ministry of Health assessment of the pharmaceutical sector in Ethiopia, disorganized forecasting, redundant procurement, non-need-based donation and procurement, substandard storage and distribution facilities, and a high pharmaceutical wastage rate of more than 8% are all challenges in public pharmaceutical supply chain management [10,20,38,39].

The determinants for the performance of pharmaceutical logistics systems difficulties such as medicine stock outs, unavailability of particular drugs, poor storage conditions, insufficient stock management, and wastage rates for public health institutions have to be documented to show progress and develop strategic plans [40]. Despite the fact that IPLS was improving information recording and reporting, storage and distribution systems, and the availability of essential commodities at service delivery points, no studies had been conducted on the overall determinants and their association against Integrated Pharmaceutical Logistics System (IPLS) in study area [8,41–44]. Therefore, the purpose of this study was to analyze the association and magnitude between determinant factors with performance of pharmaceuticals logistics system of among Public health facilities of Harari Regional State, East Ethiopia.

Research Methodology

Study Setting and Period: Harari Region covers an area of 334 km2 with a total population of Quarter Million. It is administratively sub-divided into 9 numbered Woreda. According to 2021 health and health related indicator; there are 2 public hospitals, 4 Private hospitals, more than 26 clinics and 8 heath centers. Currently above 25 pharmacies and 31 drug stores are also in the city. Public Health Facilities includes one specialized comprehensive hospital, one general hospital and eight heath centers. Health facilities provide promotive, preventive, curative and rehabilitative outpatient care including basic laboratory and pharmacy services with the capacity range of 5 to 640 beds for emergency and delivery services in Harari region [45]. The study was done from April 4 to June 7, 2022.

Research Approach: Both qualitative and quantitative approaches were used to analyze the association and magnitude of determinant factors on performance of the integrated pharmaceutical logistics system management in Public Health Facilities of Harari Regional, Ethiopia. The study was conducted at the Service Deliver Point (SDP) level: Public Hospitals and Health Centers.

Research Design: Both cross-sectional descriptive study and explanatory research deigns were employed with inferential statistics of binary logistics regression to analyze the association and magnitude of determinant factors on performance of the integrated pharmaceutical logistics system.

Source and Type of Data: The sources of data for the study were health facility records, facility management, pharmacy staffs and dispensing units' focal persons working in the selected health facilities. The primary data was collected by observation, physical inventory, assessment of facility records, and structured interviews. In addition, secondary data was collected from documents, formats and reports of Public Health Facilities of Integrated Pharmaceutical Logistics System.

Target Population, Sample Size and Techniques: Target population was all Public health facilities in Harari region. Krejcie and

Morgan formula of "Determining Sample Size for Research Activities" #30, pp. 607-610) was used for sample calculation with Confidence of Interval of 95%, Population Proportion of 0.50, and Margin of Error of 5.0% and Chi-Square of 95% CI [46].

$$n = \frac{x^2 * N * P * (1-P)}{((ME^2 * (N-1)) + (x^2 * P * (1-P))} = 216$$

The sample was taken proportionally from all Public health facilities of the region from total participants of 540. Hence, 216/540*100 = 40% sample was taken from each health facility.

Methods of Data Collection, Design, Validity and Reliability: Data was collected by using researcher administered-structured questionnaire, document review and structured observation methods. Bin cards, receiving voucher (model 19), issuing vouchers (model 22) and ordering forms (IFRR, RRF) was used for all Logistics activities documentation of pharmaceuticals. Tracer Drugs for IPLS was selected from FMOH tracer drug list. Semi structure questionnaire set in Yes or No type of questions was used to collect primary data from the facilities. To ensure validity of study questionnaires, a pilot study was conducted, and Cronbach's Alpha was used to measure reliability. The reliability of questionnaire tested by Cronbach's alpha for each part indicates all of questionnaire parts are in acceptable reliability range which is above 0.700, hence above the acceptable range.

Methods of Data Analysis: Binary Logistics Regressions was used for the analysis of data obtained from questionnaire survey of the logistics system and Narrative data analysis was used for qualitative data. The quantitative data was entered and analyzed using SPSS Version 27 and the result are presented in the form of tables and graphs.

Model Specification: The Binary logistics regression was used to determine the association and magnitude of the determinant on the performance of pharmaceutical logistics. The study takes the determinant factor as independent variable and the performance of pharmaceutical logistics system as dependent variable. Wald test of binary logistics regression was used for model specification and binary assumptions.

Model Equation: $- \ln\left(\frac{P}{1-P}\right) = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$; where:

- β_o indicates the constant Interceptor (alpha)
- X_1 is Health Facility Staff Educational Background
- X_2 is Health Facility Staff Skill Level
- X_3 is Health Facility Management Ownership and
- β_1, β_2 and β_3 are regression coefficients

Conceptual Framework of the study: The determinants for Integrated Pharmaceutical Logistics System (IPLS) in public health facilities was adapted from USAID DELIVER PROJECT [47,48].

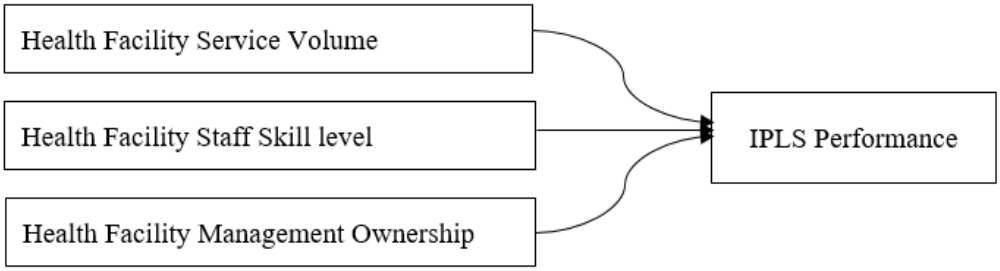

Figure 1: Conceptual Framework for determinants of IPLS performance [47,48]

Results

Sociodemographic characteristics of participants: In the study total of 216 staffs working on pharmaceuticals logistics system directly and indirectly that were interviewed; the responses rate was 207 (95.83%) which is representative enough to reflect reliable result for the study. Hence, studies agrees that respondent rate above 80% means less sampling bias and effective [49-51]. From the total of 207 study participants 123 (59.42%) were males and 84 (40.58%) were females. Professionally majority of study participants whom working on integrated pharmaceutical logistics system were Nurses 81 (39.13%), Pharmacy 64 (30.92%) and Medical Laboratory 23 (11.11%) (Table 1).

Table 1: Sociodemographic characteristics of study participants (N = 207)

Characteristics	N	Percentage	IPLS Performance			
			≥ 80%		< 80%	
			N	%	N	%
Sex						
Male	123	59.42%	78	63.41%	45	36.59%

Female	84	40.58%	38	45.24%	46	54.76%
Profession						
Pharmacy	64	30.92%	53	82.81%	11	17.19%
Nurse	81	39.13%	41	50.62%	40	49.38%
Midwifery	18	8.70%	8	44.44%	10	55.56%
Medical Doctor	6	2.90%	2	33.33%	4	66.67%
Psychiatry	11	5.31%	4	36.36%	7	63.64%
Health Officer	4	1.93%	1	25.00%	3	75.00%
Medical Laboratory	23	11.11%	7	30.43%	16	69.57%
Total	207		116		91	

N – Study Sample/Population

The performance of IPLS above 80% was 78 (63.41%) among males and 38 (45.24%) among females. Majority of Pharmacy professionals 78 (63.41%) performance was above the standard IPLS performance of 80%. From total study population of 116 (53.46%) performance was above 80% and 91 (46.54%) were performed below 80% IPLS implementation (Table 1).

Health Facility Staff Skill Level: The participants' response on whether their skill affects the performance indicates that, 85.7% responded as it affects the process. The skill measures show, 114 (55.07%) health facilities staffs were trained IPLS, 56 (27.05%) of them trained DSM, 53 (25.60%) of them trained DTC, 90 (43.48%) of professionals were trained APTS, 18 (8.70%) of them trained HCMIS and all health facilities main pharmaceutical store is managed by trained professionals. The staffs whom trained on IPLS, DSM and DTC have IPLS performance of ≥80% were 71.93%, 83.93% and 67.92% respectively (Table 2).

Table 2: Trainings related health facility staff's skill with IPLS performance (N = 207)

Trainings taken by Professionals	N	%	IPLS Performance (≥80%)		IPLS Performance (<80%)	
			N	%	N	%
IPLS Training						
Trained	114	55.07%	82	71.93%	32	28.07%
Not trained	93	44.93%	34	36.56%	59	63.44%
DSM Training						
Trained	56	27.05%	47	83.93%	9	16.07%
Not Trained	151	72.95%	69	45.70%	82	54.30%
DTC Training						
Trained	53	25.60%	36	67.92%	17	32.08%
Not trained	154	74.40%	97	62.99%	57	37.01%
HCMIS (Dagu) Training						
Trained	18	8.70%	16	88.89%	2	11.11%
Not trained	189	91.30%	98	51.85%	91	48.15%
APTS Training						
Trained	90	43.48%	57	63.33%	33	36.67%
Not trained	117	56.52%	52	44.44%	65	55.56%

DTC – Drug and Therapeutic Committee, DSM – Drug Supply Management, APTS – Auditable Pharmaceutical Transaction Service, HCMIS – Health Commodity Management Information System, N – Sample Size

The effect of the predictor components tested by using Wald test of binary logistics regression indicated that IPLS training level (P = 0.001), DTC training level (P = 0.000) and HCMIS training (P = 0.005) have significant effect on health facility staff skill level and also found it has significant effect on the performance. The β value for IPLS training level is 6.104, DTC training level with β value of 5.792 and HCMIS training level have β value of 3.037 for acceptable professional skill have positive association with performance.

The association of component predictors for indicators in the study determined by the confidence intervals value in the corresponding odd ratio of 4.784, 95% CI (4.459, 96.512) for IPLS, 11.089, 95% CI (4.122, 162.206) for DTC and 3.501, 95% CI (2.872, 73.603) for HCMIS training (Table 3).

Table 3: Binary Logistics Regression of Health Facility Staff Skill level

	B	SE	Wald	Df.	Sig.	AOR	95% C.I. for EXP(B)	
							Lower	Upper
IPLS	6.104	.528	10.525	1	.001	4.784	4.459	96.512
DSM	4.243	1.568	2.022	1	.105	.803	.069	1.302
DTC	5.792	1.502	7.801	1	.000	11.089	4.122	162.206
HCMIS	3.037	.573	1.852	1	.001	3.501	2.827	73.603
APTS	5.904	.668	4.351	1	.401	3.651	.915	1.045
Constant	-8.977	1.004	1.234	1	.196	.993		

IPLS - Integrated Pharmaceutical Logistics System, DSM – Drug Supply Management, DTC - Drug and Therapeutics Committee, HCMIS - Health Commodity Management Information System, APTS - Auditable Pharmaceutical Transaction Service

Health Facility Service Volume Level: Health Facility service volume level was assessed by 16 questions that are related to pharmaceutical logistics system adapted from Federal Ministry of Health criterion and LIAT details. The study covered 2 hospitals and 8 health centers with all of them are currently practicing Health Commodity Management System Facility Edition currently renamed Dagu which is used for electronic transaction and reporting system of pharmaceutical logistics system. Regarding the health service volume factor query, most of the respondents 61(72.61%) was responded that service volume would have relation with the performance. From health facilities with high service volume and patient load; 75% of them perform IPLS ≥ 80% and facilities with low patient load have 50% of pharmaceutical logistics performance.

The effect of the component or predictor variable tested by using Wald test of binary logistics regression, indicated that only patient load found be significant effect to the performance of health facility service with pharmaceutical logistics system 1.815, 95% CI (3.500, 81.920) (p=0.000). The magnitude of the association explained by the corresponding odd ratio of the table and the odd ratio of patient load in health facility service volume indicated 4.400 acceptable patient load hints 4 times more likely to perform IPLS better than with those with unacceptable level. The β value of patient load tells as the patient load increases by one unit the health facility service volume level increases by 1.815 when other components kept constant (Table 4).

Table 4: Binary Logistics regression of Health Facility Service Volume Level

	B	SE	Wald	Df.	Sig.	AOR	95% C.I. for EXP(B)	
							Lower	Upper
Facility type	-0.037	0.820	0.073	1	0.107	1.603	0.044	0.608
Patient load	1.815	1.938	0.612	1	0.000	4.400	3.500	81.920
Service type	1.885	0.863	4.775	1	0.211	1.509	0.089	1.126
Constant	-1.916	1.308	1.234	1	0.668	0.516		

B – Regression coefficient, SE – Standard error, Df. – Degree of freedom, AOR – Adjusted odd ratio

Health Facility Management Ownership Level: Respondents were asked on management system ownership importance on performance of integrated pharmaceutical logistics system and 100% were replied as it is a key for performance improvement. The management ownership level of the facilities measured on various aspects found 60.00% facilities with good and 40.00% with poor management ownership. The 83.33% of health facilities with good management support performed IPLS ≥ 80% while from the poor management ownership health facilities only 25% performed IPLS ≥ 80% (Table 5).

Table 5: Management ownership related to IPLS implementation (N = 207)

IPLS ownership related activities	Yes	No
Availability of regular DTC meeting related to IPLS	42.51%	57.49%
Regular higher management support on IPLS implementation	57.49%	42.51%
System implementation measured by balanced score card (BSC)	21.26%	78.74%
Regular IPLS review meeting by Regional Health Bureau (RHB)	87.44%	12.56%
Enough budget for pharmacy profession recruitment	19.81%	80.19%
Management receives reports regularly from pharmacy on IPLS	51.21%	48.79%
Management give IPLS implementation feedbacks on time	37.20%	62.80%

N - Sample Size, DTC – Drug and therapeutic committee

The effect of the predictor components was tested by using Wald test of binary logistics regression indicated regular feedback for reports with β value of 2.455, 95% CI (3.444, 79.003), (P = 0.002), regular DTC meeting with β value of 2.455, 95% CI (4.906, 106.549), (P = 0.000), BSC measurement of staff performance β value of 2.455, 95% CI (2.220, 90.001), (P =0.001) and BPR implementation β value of 2.455, 95% CI (2.341, 82.093), (P = 0.004) have association with management ownership of the system and found it has significant effect on the performance. The magnitude of the association explained by the adjusted odd ratio indicated acceptable regular feedback for reports is 11.641, regular DTC meeting is 26.140, BSC measurement of staff performance is 12.105 and BPR implementation is 16.845 times more likely to have good management ownership of pharmaceutical logistics system (Table 6).

Table 6: Binary Regression of Management Ownership of the System

	B	SE	Wald	Df.	Sig.	AOR	95% C.I. for EXP(B)	
							Lower	Upper
Feedback	2.455	1.457	2.837	1	0.002	11.641	3.444	79.003
Budget	1.739	1.403	1.536	1	0.215	5.690	0.098	1.004
Meeting	3.263	1.499	4.741	1	0.000	26.140	4.906	106.549
BSC	2.494	1.558	2.561	1	0.001	12.105	2.220	90.001
BPR	2.824	1.461	3.739	1	0.004	16.845	2.341	82.093
Constant	-6.611	1.988	11.057	1	0.001	0.001		

BSC – Balanced Score Card, BPR – Business Process Re-engineering, AOR – Adjusted odd ratio

Binary Logistics Regression of Combined Determinants: The combined analysis model fitness test was performed to confirm the suitability and found analysis model containing all predictors was statistically significant, C2 (4, N=207) = 83.291, P = 0.001, indicated that the model was able to distinguishes between the facilities with the problem of pharmaceutical Logistics system performance. Hosmer and Lemeshow test also supported the model in which limited the significance should be >0.05 found 0.502 for pharmaceutical logistics performance. The model as a whole also explained between 55.3% (Cox and Snell R square) and 76.6% (Nagelkerke R square) of the variance in performance of Pharmaceutical logistics system, and correctly classified 90.2% cases.

From the model equation the logit of the independent variables determined using the formula:

$$\ln\left(\frac{P}{1-P}\right) = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + e$$

The following equation was obtained from binary logistics regression. β_o = -2.016, indicates the constant interceptor (alpha); β_1 = 2.109, indicates skills level of health facility staffs (X_1), β_2 = -0.895 is the health facilities service volume level (X_2), β_3 = 3.961 is the management system ownership level (X_3).

Then the equation is: $\ln\left(\frac{P}{1-P}\right) = -2.016 + 2.109X_1 - 0.895X_2 + 3.961X_3 + e$ (Table 7).

Table 7: Binary Logistics Regression of the combined determinants

	B	SE	Wald	Df.	Sig.	AOR	95% C.I. for EXP(B)	
							Lower	Upper
HFSS	2.109	1.797	7.864	1	0.005	8.241	3.703	81.34
HFSV	-0.895	1.735	7.864	1	0.677	0.469	0.061	1.302
MOTS	3.961	0.530	10.850	1	0.001	19.373	3.765	116.271
Constant	-2.016	0.487	4.015	1	0.000	0.079		

HFSS - Health facility staff skill, HFSV - Health facility service volume, MOTS - Management ownership of the system

Discussion

The study analyzes the three determinants detail association and magnitude on performance of integrated pharmaceutical logistics system. The study found that the management ownership of the system and the health facility staff's skill on the system implementation were positively associated to performance of the effectiveness of pharmaceuticals logistics system while health facility service volume is not significantly associated to the performance. Even though management ownership of the system is encouraging it needs orientation on the system, better commitment of managements to support the system and need more attention on pharmaceutical supplies issues.

The major factors on management support and inability to get the required professionals and poor skill transfer mechanism were the factors for professional's lower performing skill. Based on the findings the investigators draw that the poor performance of the pharmaceuticals logistics system is strongly linked to management ownership of the system and health facility staff's skill, so that there is a strong and positive relationship of management ownership on the system and the performance of pharmaceuticals logistics system.

From the three results of the determinants; three conclusions were formulated as follows before significance level determination and model fitness tests. First, the skill of health facility staffs level increase by one unit, the performance of integrated pharmaceuticals logistics system increases by 2.109 when other independent variables of the study kept constant. Secondly, the service volume level of health facility increases by one unit, the performance of integrated pharmaceuticals logistics system decreases by 0.519 when other independent variables of the study kept constant. Thirdly, the management ownership of health facility level increase by one unit, the performance of integrated pharmaceuticals logistics system increases by 3.6961 when other independent variables of study kept constant.

There was a positive and significant relationship of the skill of health facility staffs working in the Pharmaceuticals storage, Pharmaceuticals Dispensary and other Dispensing Units (DUs) in the Hospital and Health Center which are receiving pharmaceuticals from main pharmaceutical storage room and uses for patient care and follow up, but no positive relationship of the Health Facility service volume (high or Low) with the pharmaceuticals logistics system performance. Management ownership and the skill of professionals are the two important determinant factors on performance of pharmaceuticals logistics system performance in the study area. The overall health facilities pharmaceuticals logistics system performance is moderate with 60% of health facilities performed ≥80% of performance with the mean performance of 61.91%. The three hypotheses proposed to determine the effect of determinants on the integrated pharmaceutical logistics system was described by their association and magnitudes as follows:

Ha$_1$: Health facility staffs skill have positive effect on performance of the integrated pharmaceuticals logistics system with β value of 2.109, sign value of 0.005, odd ratio of 8.241 and CI 95% (3.703, 81.336).

Ha$_2$: Management ownership of the IPLS system have positive effect on performance of integrated pharmaceuticals logistics system with β value of 3.961, P = 0.003, odd ratio of 19.373 and CI 95% (3.765, 116.271).

Ha$_3$: The health facility service volume had no significant positive association on performance of integrated pharmaceutical logistics system.

Thus, the investigators accepted the alternate hypothesis of health facility staff's skill level and management ownership of the IPLS system and unable to support the hypothesis with evidences of significant finding on health facility service volume, thus the proposed hypothesis is rejected.

Conclusion

The study found that the health facility staff skill and management ownership have significant effect on integrated pharmaceutical logistics system implementation. The major factors for health professional under optimal skill were poor management support, staff insufficiency, and a poor skill transfer mechanism.

Abbreviations

APTS: Auditable pharmaceuticals transaction system, DSM: Drug Supply Management, DTC: Drugs and Therapeutic committee, DU: Dispensing Unit, EML: Essential Medicine List, HCMIS: Health Commodity Management Information System, IPLS: Inte-

grated Pharmaceuticals Logistics System, RHB: Regional Health Bureau, WHO: World Health Organization

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

On reasonable request, the data used and analyzed during this study can be obtained from the corresponding author.

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