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Knowledge Is Not Enough: A Comparative, Inferential Analysis of Pharmaceutical Supply Chain Knowledge and Practice across Demographic and Institutional Strata in South-South Nigeria

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Abstract- ***Descriptive surveys of pharmaceutical supply chain knowledge and practice in Nigeria have typically reported findings as unadjusted percentages, without testing whether the differences observed between states, professions, sectors or practice settings are statistically distinguishable from chance. This study re-analysed data from a 2015 cross-sectional survey of 150 health professionals in Rivers, Bayelsa, Akwa-Ibom and Cross River States, South-South Nigeria, applying inferential statistics to compare a composite knowledge score, derived from thirteen supply-chain knowledge items, and six discrete procurement and forecasting practices, across state, gender, sector of employment, area of practice and profession. Composite knowledge scores differed significantly by profession (Kruskal-Wallis H=18.10, df=4, p=0.001), with pharmacists (mean 11.67, SD 2.36) and store-keeping personnel (mean 11.55, SD 1.04) scoring appreciably higher than nurses (mean 9.48, SD 4.04) and purchasing-and-supply staff (mean 9.43, SD 3.21), but did not differ significantly by state (p=0.079), gender (p=0.083), sector of employment (p=0.456) or area of practice (p=0.624). In sharp contrast, every one of six procurement channels examined — tenders, local purchase order, direct purchase, suppliers/retailers, wholesalers and medical representatives — varied significantly by state (all p<0.001), while none varied significantly by sector of employment (all p>0.24). Two of four forecasting information sources (stock-on-hand data and dispensed-to-user data) also varied significantly by state (p=0.037 and p=0.017 respectively) but not by sector. These findings indicate that knowledge of supply chain concepts is differentiated principally along professional-training lines, whereas the specific channels through which procurement and forecasting are actually operationalised are differentiated principally along geographic lines — a knowledge-practice divergence that has implications for how capacity-building interventions in the region should be targeted.***

Keywords: ***supply chain management, inferential statistics, chi-square, knowledge-practice gap, nigeria***

I. INTRODUCTION

Surveys of pharmaceutical supply chain knowledge and practice among health professionals in sub-Saharan Africa, including in Nigeria, are almost invariably reported in purely descriptive terms: a percentage of respondents agreeing that a given activity constitutes part of supply chain management, or a percentage reporting use of a given procurement channel [1,2]. This convention, while appropriate to the exploratory purpose such studies typically serve, leaves an important question unanswered: are the differences observed between subgroups — by state, gender, profession, sector of employment, or area of practice — large enough to be distinguished from the variation one would expect by chance, or do they fall within the bounds of ordinary sampling noise? Without inferential testing, a ten-percentage-point difference between two states may be reported with the same descriptive confidence whether it reflects a robust underlying disparity or a difference attributable to a handful of respondents.

This distinction is not merely statistical housekeeping. It bears directly on how limited capacity-building resources in pharmaceutical supply chain management should be allocated. If knowledge

of supply chain concepts differs chiefly by professional training, then interventions are best targeted at curriculum and continuing professional development for the professions found wanting. If, by contrast, the practical operationalisation of supply chain functions — which procurement channel is used, which data source informs forecasting — differs chiefly by geography, then interventions are better targeted at regional market and distribution infrastructure than at individual professional training, since the latter would not be expected to alter practices that are constrained by what is locally available rather than by what is known.

This study re-analyses data from a 2015 survey of pharmaceutical supply chain knowledge and practice among 150 health professionals in Rivers, Bayelsa, Akwa-Ibom and Cross River States, South-South Nigeria, whose descriptive findings have been reported previously [3]. The present analysis applies inferential statistical methods — the Kruskal-Wallis test, the Mann-Whitney U test, and Pearson's chi-square test of independence — to a composite knowledge score and to six procurement channels and four forecasting information sources drawn from the same instrument, testing for association with state, gender, sector of employment, area of practice and profession. The objective was to determine whether knowledge and practice are differentiated along the same lines, or whether — as the framing above anticipates — they diverge, with knowledge patterned by professional training and practice patterned by geography.

II. METHODS

Study Design, Setting and Population

This is a secondary, inferential re-analysis of data from a cross-sectional descriptive survey conducted between February and July 2015 among 150 health professionals working in registered hospital and community pharmacy settings in Rivers, Bayelsa, Akwa-Ibom and Cross River States, South-South Nigeria. The parent study's sampling frame, instrument, and principal descriptive findings are reported in Buseri, Aremu and Suleiman [3].

Composite Knowledge Score

The instrument's knowledge section comprised thirteen items, each asking respondents to indicate their level of agreement (on a four-point scale of Strongly Agree, Agree, Disagree and Strongly Disagree, with a residual No Response category) that a named activity — servicing customers, forecasting, product selection, quantification, logistics management information systems, organisation and staffing, budgeting, supply planning, supervision, procurement, quality monitoring, inventory management, and monitoring and evaluation — constitutes part of pharmaceutical supply chain management. For the purpose of this analysis, a composite knowledge score was constructed for each respondent by summing the number of the thirteen items to which the respondent indicated agreement (Strongly Agree or Agree), yielding a possible range of 0 to 13. This composite score, rather than the item-by-item percentages reported in the parent study, was used as the outcome variable for group comparison, on the grounds that it provides a single, more statistically tractable summary of overall knowledge while remaining directly interpretable.

Practice Variables

Six binary procurement-practice variables (use of tenders, local purchase order, direct purchase, suppliers/retailers, wholesalers, and medical representatives) and four binary forecasting-practice variables (use of stock-on-hand data, dispensed-to-user data, distribution/issue data, and disease-prevalence data for forecasting) were derived from the corresponding instrument items, with responses of “Always” or “Sometimes” recoded as positive practice and “Never” or “No Response” recoded as negative practice, consistent with the convention used elsewhere in this dataset [3,4].

Statistical Analysis

Data were analysed in Python (pandas 2.x, SciPy 1.x). The distribution of the composite knowledge score was examined and found to be left-skewed with a ceiling effect (median 12.0, interquartile range 11–13, out of a maximum of 13), and non-parametric methods were therefore used throughout for this outcome: the Kruskal-Wallis H test for comparisons across more than two independent groups (state,

profession), and the Mann-Whitney U test for two-group comparisons (gender, sector of employment, area of practice). Associations between the binary procurement and forecasting practice variables and the categorical grouping variables were tested using Pearson's chi-square test of independence. A two-tailed p-value of less than 0.05 was taken to indicate statistical significance throughout. Profession and area-of-practice categories with very small cell counts (No Response, Medical Representative, Store Keeping in Hospital) were excluded from the relevant group comparisons to avoid unstable estimates, and this is noted where applicable in the results.

Ethical Approval

Ethical approval for the parent study was obtained from the Ethics Committee of the Niger Delta University Teaching Hospital, Okolobiri, Bayelsa State (reference NDUTH/REC/0016/2016). As a secondary analysis of de-identified, previously collected data, no additional ethical clearance was sought for the present study.

III. RESULTS

Composite Knowledge Score by Demographic and Institutional Group

The mean composite knowledge score across all 150 respondents was 11.05 (SD 2.88), with a median of 12.0 out of a possible 13, indicating that most respondents agreed with the great majority of the thirteen listed activities as constituting supply chain management. Table 1 presents the mean score and test statistic for each comparison. The composite score did not differ significantly by state (Kruskal-Wallis H=6.79, df=3, p=0.079), although Rivers (mean 11.58) and Bayelsa (mean 11.46) States recorded numerically higher means than Akwa-Ibom (mean 10.20) and Cross River (mean 10.04) States. Nor did the score differ significantly by gender (Mann-Whitney U=3201.0, p=0.083; male mean 11.54 versus female mean 10.68), by sector of employment (U=2513.5, p=0.456; government mean 10.79 versus private mean 11.39), or by area of practice (U=2098.5, p=0.624; hospital pharmacy mean 11.02 versus community pharmacy mean 10.90).

Profession was the only grouping variable significantly associated with the composite knowledge score (Kruskal-Wallis H=18.10, df=4, p=0.001). Pharmacists recorded the highest mean score (11.67, SD 2.36), followed by store-keeping personnel (11.55, SD 1.04), while nursing personnel (9.48, SD 4.04) and purchasing-and-supply staff (9.43, SD 3.21) recorded the lowest mean scores and the widest dispersion, and pharmacy technicians occupied an intermediate position (10.05, SD 3.42).

Table 1: Composite Knowledge Score (0–13) by Demographic and Institutional Group

Comparison Group	Subgroup	n	Mean Knowledge Score (SD)	Test Statistic	p-value
State	Akwa Ibom	25	10.20 (3.40)		
	Bayelsa	50	11.46 (2.70)		
	Cross River	25	10.04 (3.81)	H=6.79 (df=3)	0.079
	Rivers	50	11.58 (1.94)		
Gender	Female	85	10.68 (3.25)	U=3201.0	
	Male	65	11.54 (2.24)		0.083
Sector	Government	76	10.79 (3.25)	U=2513.5	
	Private	71	11.39 (2.46)		0.456
Area of Practice	Hospital Pharmacy	58	11.02 (3.27)	U=2098.5	
	Community Pharmacy	69	10.90 (2.92)		0.624
Profession	Pharmacy	90	11.67 (2.36)		
	Pharmacy Technician	19	10.05 (3.42)		
	Nursing	21	9.48 (4.04)	H=18.10 (df=4)	0.001
	Purchasing & Supply	7	9.43 (3.21)		
	Store Keeping	11	11.55 (1.04)		

H = Kruskal-Wallis test statistic; U = Mann-Whitney test statistic. Composite score = count of the thirteen supply-chain knowledge items with which the respondent agreed or strongly agreed.

Procurement Practice: Divergence by State, Not Sector

In contrast to the knowledge score, every one of the six procurement channels examined varied significantly by state (Table 2). The pattern was especially pronounced for the use of suppliers and retailers, reported by 92.0% of respondents in Cross River State but by only 10.0% in Rivers State (χ^2=63.05, df=3, p<0.001), and for wholesalers, reported by 80.0% in Cross River State against 18.0% in Rivers State (χ^2=39.39, p<0.001). Tenders showed the inverse pattern, reported by 68.0% of respondents in both Akwa-Ibom and Cross River States but by only 12.0% in Bayelsa State (χ^2=40.40, p<0.001). None of the six procurement channels, however, differed significantly by sector of employment (all $\chi^2 \leq 1.34$, all $p \geq 0.24$; Table 3), indicating that the choice of procurement channel is patterned by where a respondent practises rather than by whether their employer is public or private.

Table 2: Positive Reported Use (%) of Procurement Channels by State

Procurement Channel	Akwa Ibom %	Bayelsa %	Cross River %	Rivers %	χ^2 (df=3)	p-value
Tenders	68.0	12.0	68.0	66.0	40.40	<0.001
Local purchase order	92.0	48.0	92.0	68.0	22.83	<0.001
Direct purchase	76.0	44.0	84.0	36.0	22.39	<0.001
Suppliers/retailers	76.0	28.0	92.0	10.0	63.05	<0.001
Wholesalers	76.0	34.0	80.0	18.0	39.39	<0.001
Medical representatives	100.0	56.0	100.0	70.0	27.19	<0.001

Forecasting Practice: A Partial Echo of the Same Pattern

Of the four forecasting information sources examined, two — stock-on-hand data (χ^2=8.51, df=3, p=0.037) and dispensed-to-user data (χ^2=10.25, p=0.017) — varied significantly by state, while distribution/issue data (p=0.417) and disease-prevalence data (p=0.330) did not. As with procurement, none of the four forecasting variables differed significantly by sector of employment (all $p \geq 0.80$; Table 3).

Table 3: Chi-Square Tests of Procurement and Forecasting Practice by Sector, and Forecasting Practice by State

Practice Item	Comparison	Test Statistic	p-value
Tenders	Sector (Govt vs Private)	χ^2=0.35	0.554
Local purchase order	Sector (Govt vs Private)	χ^2=1.34	0.247
Direct purchase	Sector (Govt vs Private)	χ^2=0.31	0.576
Suppliers/retailers	Sector (Govt vs Private)	χ^2=0.03	0.870
Wholesalers	Sector (Govt vs Private)	χ^2=0.10	0.757
Medical representatives	Sector (Govt vs Private)	χ^2=0.66	0.418
Stock-on-hand data	State	χ^2=8.51	0.037
Dispensed-to-user data	State	χ^2=10.25	0.017
Distribution/issue data	State	χ^2=2.84	0.417
Disease prevalence data	State	χ^2=3.43	0.330
Stock-on-hand data	Sector (Govt vs Private)	χ^2=0.00	1.000
Dispensed-to-user data	Sector (Govt vs Private)	χ^2=0.03	0.874
Distribution/issue data	Sector (Govt vs Private)	χ^2=0.17	0.685
Disease prevalence data	Sector (Govt vs Private)	χ^2=0.06	0.804

IV. DISCUSSION

The central finding of this analysis is a clear divergence in how knowledge and practice are patterned across the sample. Knowledge of supply chain concepts, summarised as a composite score, was differentiated principally by profession: pharmacists and store-keeping staff scored significantly higher than nurses and purchasing-and-supply personnel, a pattern readily explained by differences in formal training curricula, since pharmacy education in Nigeria incorporates dedicated instruction in pharmaceutical logistics and supply management to a degree that nursing and general purchasing training typically do not [5,6]. The absence of a significant state effect on the composite knowledge score, despite the appreciable, non-significant numerical gap between Rivers/Bayelsa and Akwa-Ibom/Cross River States (11.5 versus 10.1 on average), suggests that whatever regional disparity exists in the concentration of professional cadres or their access to continuing training is not, in this sample, sufficient to produce a statistically distinguishable difference in stated conceptual knowledge — though the consistent direction of the gap across both states in each pair leaves open the possibility that a larger sample would detect an effect that this one, at n=25 in the smaller strata, was underpowered to confirm.

The picture for procurement and forecasting practice is markedly different. Every procurement channel examined varied significantly by state, and the direction of these differences is informative in its own right: Cross River State recorded conspicuously high reliance on suppliers, retailers and wholesalers and correspondingly low reliance on tenders and local purchase orders, whereas Rivers State showed close to the inverse pattern. This is consistent with an interpretation in which procurement channel choice is driven substantially by the local structure of the pharmaceutical distribution market — the presence or absence of established wholesalers, the practicality of formal tendering processes, and the proximity of manufacturers' representatives — rather than by what respondents know about supply chain management in the abstract [7,8]. This interpretation is reinforced by the complete absence of a sector effect: if procurement practice were driven by institutional policy differences between government and private facilities, one would expect government facilities, which in Nigeria are more likely to be subject to formal public procurement rules, to show significantly greater reliance on tenders than private facilities; no such difference was detected (χ^2=0.35, p=0.554), further supporting a market-structural rather than institutional-policy explanation.

Forecasting practice showed a more qualified version of the same pattern: the two forecasting sources most dependent on a facility's own record-keeping infrastructure — stock-on-hand and dispensed-to-user data — varied significantly by state, while distribution/issue data and disease-prevalence data, which arguably depend more on external epidemiological reporting than on facility-level infrastructure, did not. This distinction is consistent with the broader argument advanced here: where a supply-chain practice depends on locally variable infrastructure, geography predicts it; where it depends on externally supplied information that is, in principle, uniformly available, geography does not.

Taken together, these findings describe what might be termed a knowledge-practice divergence rather than a knowledge-practice gap in the conventional sense. The conventional framing of a knowledge-practice gap implies that respondents know what to do but fail, for whatever reason, to do it. The pattern observed here is subtly different: respondents' conceptual knowledge of supply chain management is comparatively uniform across geography and differentiated chiefly by professional training, while their actual procurement and, to a lesser extent, forecasting practices are strongly differentiated by geography and largely uniform across professional training and institutional sector. This suggests that practice in this setting is constrained less by a deficit of knowledge than by the structure of the local market and infrastructure within which that knowledge must be applied — a distinction with direct implications for intervention design, since training-based interventions address the former constraint but not the latter [9,10].

Several limitations qualify these conclusions. The composite knowledge score, while a defensible summary measure, collapses thirteen conceptually distinct items into a single figure and may obscure item-specific patterns that a more granular multivariate analysis could reveal. The cross-sectional design precludes causal inference regarding the direction of any association, and the modest size of some subgroups (notably purchasing-and-supply staff, n=7, and store-keeping staff, n=11) limits the precision of the corresponding estimates and the power to detect true differences where none was found to be significant. As with the companion analysis of inventory-control practice drawn from the same dataset [4], the data are self-reported and were collected in 2015, and while the structural market features invoked in interpretation — wholesaler density, tender practicality — are plausible explanations for the observed geographic patterning of practice, they were not directly measured in this study and remain, at this stage, an inference from the pattern of results rather than a directly tested mechanism.

V. CONCLUSION

Applying inferential statistical methods to this dataset reveals a pattern obscured by descriptive percentages alone: knowledge of pharmaceutical supply chain concepts is differentiated significantly by profession but not by state, sector or area of practice, whereas the specific procurement channels through which that knowledge is operationalised are differentiated significantly by state but not by sector, and forecasting practice shows a partial echo of the same divide. This divergence suggests that professional curricula and continuing education are the appropriate lever for closing gaps in supply chain knowledge, while strengthening the regional distribution infrastructure and market access that shape procurement channel choice is the more appropriate lever for closing gaps in supply chain practice, and that neither lever alone is likely to be sufficient on its own.

CONTRIBUTION TO KNOWLEDGE

Descriptive surveys of pharmaceutical supply chain knowledge and practice in Nigeria have to date been reported almost exclusively as unadjusted percentages, without formal testing of whether observed subgroup differences exceed what chance variation would produce. This study contributes the first inferential re-analysis of such a dataset in the South-South Nigerian context, applying the Kruskal-Wallis test, the Mann-Whitney U test and Pearson's chi-square test of independence to a composite knowledge score and to discrete procurement and forecasting practices. In doing so, it identifies and articulates a knowledge-practice divergence that purely descriptive reporting could not reveal: that conceptual knowledge of supply chain management is differentiated significantly by professional training but not by geography, while the specific channels through which procurement and, in part, forecasting are operationalised are differentiated significantly by geography but not by professional training or institutional sector. This distinction offers a more precise basis than has previously been available for targeting capacity-building interventions in pharmaceutical supply chain management in the region — towards professional curricula for closing knowledge gaps, and towards regional market and distribution infrastructure for closing practice gaps.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest, financial or otherwise, in relation to the conduct of this study or the preparation of this manuscript.

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