Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

Religious Demographics of Pharmacy Ownership in Northeast India: A Comprehensive Analysis of Assam's Shifting Landscape (2015-2023)

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www.sjmars.com || Vol. 4 No. 2 (2025): April Issue

Date of Submission: 02-04-2025	**Date of Acceptance:** 13-04-2025	**Date of Publication:** 25-04-2025

ABSTRACT

Background: The pharmaceutical retail sector in Northeast India has undergone significant transformation in recent decades, with changing patterns of ownership across different religious communities. This study examines the demographic composition of pharmacy ownership in Assam compared to other Northeastern states, with particular attention to religious affiliation patterns and their implications for healthcare access, equity, and culturally-responsive service delivery.
Methods: We employed a mixed-methods approach combining: (1) analysis of Pharmacy Council registration records from all Northeast Indian states (2015-2023); (2) structured surveys of 678 pharmacy owners across 15 districts in Assam; (3) 47 semi-structured interviews with key stakeholders including regulatory officials, pharmacy educators, and community leaders; and (4) geospatial mapping of pharmacy distribution patterns with demographic overlay analysis. Religious affiliation was determined through self-reporting and verified against registration documentation. Chi-square tests, multivariate logistic regression, and geospatial clustering analyses were utilized to analyze demographic patterns and identify associated factors.
Results: Analysis of 3,875 pharmacy registrations across Northeast India revealed significantly higher representation of Muslim pharmacists in Assam (43.7%) compared to other Northeastern states (average 12.8%, $p<0.001$). Within Assam, Muslim ownership increased from 28.5% in 2015 to 43.7% in 2023, with pharmacy density per population highest in Lower Assam districts. After adjusting for population demographics, educational attainment, urbanization, and socioeconomic indicators, Muslim ownership representation exceeded demographic proportions in 21 of 33 districts (OR=1.76, 95% CI: 1.54-2.01). Thematic analysis of qualitative interviews revealed four key pathways into pharmacy ownership: educational advancement strategies, family business continuity, professional autonomy seeking, and community healthcare service motivations, with varying prevalence across religious groups.
Conclusion: This study documents the substantial and growing representation of Muslim pharmacists in Assam's pharmaceutical sector compared to other Northeast Indian states. This trend reflects complex socioeconomic factors including educational investment patterns, professional preferences, and healthcare entrepreneurship within religious communities. The findings have implications for culturally responsive pharmaceutical care, equitable healthcare workforce development policies, and community-based healthcare delivery in religiously diverse regions.

Keywords- Pharmacy Demographics, Religious Diversity, Healthcare Access, Professional Trends, Northeast India, Assam, Muslim Representation, Healthcare Entrepreneurship, Workforce Development, Healthcare Equity.

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I. INTRODUCTION

The pharmaceutical retail sector serves as a crucial component of healthcare delivery systems worldwide, often representing the most accessible point of healthcare contact for many communities, particularly in resource-limited and underserved areas (Hermansyah et al., 2016; Miller & Goodman, 2016). In Northeast India, a region characterized by its unique geographical, cultural, and demographic composition, pharmacies play an especially vital role in addressing healthcare accessibility challenges exacerbated by difficult terrain, limited transportation infrastructure, and uneven distribution of healthcare facilities (Sharma & Kalita, 2019; Barman & Dutta, 2020).

In recent years, observers have noted apparent shifts in the demographic characteristics of pharmacy ownership across Northeastern states, particularly in Assam (Hussain, 2021; Choudhury & Goswami, 2022). Preliminary observations suggest differential representation across religious communities that warrants systematic investigation. Despite the importance of understanding such demographic patterns for targeted healthcare policy development, comprehensive data on pharmacy ownership demographics in Northeast India remains limited.

1.1 Regional Context and Significance

Assam presents a particularly interesting case study due to its substantial religious diversity, with approximately 61.5% Hindu and 34.2% Muslim populations according to the 2011 Census, alongside smaller representations of Christians, Sikhs, Jains, and Buddhists (Census of India, 2011). The state's demographic composition, educational infrastructure, and healthcare needs differ markedly from neighboring Northeastern states, potentially influencing professional representation in the pharmaceutical sector. Historical patterns of educational access, socioeconomic development, and healthcare infrastructure investment have created differential opportunities across communities (Nath, 2020; Saikia & Goswami, 2022).

Healthcare provision in culturally diverse settings presents unique challenges and opportunities related to cultural competence, language concordance, and trust-building (Anderson et al., 2018; Bora, 2020). In the context of pharmacy services—which often represent the first point of healthcare contact for many communities—the demographic composition of service providers may influence healthcare-seeking behaviors, medication adherence, and overall healthcare outcomes (Qato et al., 2019; Das et al., 2021).

1.2 Theoretical Framework and Literature Context

Understanding demographic patterns in healthcare professions requires engagement with multiple theoretical frameworks. The theory of occupational stratification suggests that professional representation reflects broader social structures, access to educational resources, and historical patterns of occupational segregation (Browne, 2020; Lahiri & Mitra, 2021). Meanwhile, cultural capital theory posits that specialized knowledge, credentials, and professional networks function as forms of capital that are differentially accessible across social groups (Bourdieu, 1986; Ahmed, 2019).

Previous research on professional demographics in healthcare has documented varied patterns across religious and ethnic groups. Kumar et al. (2021) examined physician demographics across Indian states and found significant variations in representation that correlated with historical patterns of educational access. Similarly, Rahman and Hussain (2022) documented changing patterns in nursing profession demographics in Bangladesh and eastern India, noting the influence of religious educational institutions on professional pathways.

In the pharmaceutical sector specifically, limited research has addressed religious demographic patterns. A study by Qureshi (2019) in Uttar Pradesh found increasing Muslim representation in pharmacy ownership between 2010-2018, while Kaur and Singh (2020) documented similar trends in Punjab's pharmaceutical sector. However, comprehensive analyses from Northeast India remain scarce, and existing studies typically lack methodological rigor, longitudinal assessment, and theoretical framing (Borah, 2021).

1.3 Research Gap and Study Rationale

Despite growing recognition of the importance of workforce diversity in healthcare delivery, systematic analyses of religious demographic patterns in pharmacy ownership remain limited, particularly in the context of Northeast India's unique religious composition. Existing studies have typically relied on small samples, limited geographic scope, or cross-sectional approaches that fail to capture temporal trends (Goswami & Barman, 2022). Moreover, the complex interplay between demographic representation, educational pathways, geographical distribution, and healthcare delivery outcomes remains poorly understood.

This research addresses these gaps through a comprehensive, mixed-methods investigation of pharmacy ownership demographics across Northeast India, with particular focus on Assam. By combining administrative records, survey data, qualitative interviews, and geospatial analysis, this study offers unprecedented insights into the complex dynamics shaping religious representation in the pharmaceutical sector.

1.4 Study Aims and Objectives

This study aims to: (1) quantify and compare religious demographic patterns in pharmacy ownership across Northeastern states, with particular focus on Assam; (2) analyze temporal trends in these patterns over the past decade; (3) examine spatial distribution of pharmacy ownership by religious affiliation; (4) identify factors associated with observed

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demographic patterns; and (5) explore the implications of these patterns for healthcare access, culturally responsive care, and professional development policies.

By addressing these objectives, this research contributes to a more nuanced understanding of healthcare workforce demographics and their implications for healthcare delivery systems in religiously diverse contexts. The findings have potential to inform targeted interventions to promote equitable professional development opportunities, enhance culturally responsive care, and address healthcare access disparities in Northeast India and beyond.

II. MATERIALS AND METHODS

2.1 Study Design and Setting

We conducted a comprehensive mixed-methods study combining quantitative analysis of administrative registration records with structured surveys, in-depth qualitative interviews, and geospatial mapping. This multimodal approach allowed triangulation of findings across methodologies and development of a more comprehensive understanding of the complex factors influencing pharmacy ownership demographics.

The study encompassed all eight Northeastern states (Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, and Tripura), with intensive focus on Assam. Data collection spanned from January 2022 to December 2023, capturing pharmacy registration and ownership patterns from 2015-2023.

2.2 Data Sources and Collection

2.2.1 Administrative Records

We obtained comprehensive pharmacy registration records from multiple sources to ensure data completeness and validity:

- Pharmacy Council of Assam (n=2,453 registrations)
- Pharmacy Councils of other Northeastern states (n=1,422 registrations)
- State Drug Control Departments
- Directorate of Health Services records
- District Health Information System (DHIS) data

These records included information on establishment date, ownership demographics, location, registration status, and type of pharmacy (retail, wholesale, hospital-attached, etc.). We examined all registrations from January 2015 to December 2023 to analyze temporal trends. Data extraction followed a standardized protocol using a structured data collection form developed specifically for this study and validated through pilot testing with 50 randomly selected records (inter-rater reliability: Cohen's κ=0.92).

2.2.2 Primary Survey Data

We conducted structured surveys with 678 pharmacy owners across 15 strategically selected districts in Assam, representing all major geographical divisions (Upper, Central, Lower Assam, and Barak Valley). Survey implementation followed a rigorous protocol:

1. Questionnaire development through literature review and expert consultation
2. Translation into Assamese, Bengali, and English with back-translation verification
3. Pilot testing with 25 pharmacy owners not included in the final sample
4. Questionnaire validation (Cronbach's alpha=0.84 for internal consistency)
5. Face-to-face interviews by trained field investigators with standardized training

The questionnaire covered six domains:

- Demographic characteristics of owners (age, gender, religion, educational background)
- Business establishment history and development trajectory
- Educational qualifications and professional training experiences
- Motivations for entering the pharmaceutical sector
- Professional practices and continuing education
- Perceptions of industry trends and challenges

2.2.3 Qualitative Interviews

To complement quantitative data and provide deeper contextual understanding, we conducted 47 semi-structured interviews with key stakeholders:

- Pharmacy Council officials from each Northeast state (n=8)
- Pharmacy college administrators and educators (n=12)
- District drug inspectors (n=10)
- Community leaders from diverse religious backgrounds (n=9)
- Senior pharmacists with >20 years of experience (n=8)

These interviews explored historical trends in pharmacy education and practice, perceived factors influencing demographic patterns, and implications for healthcare delivery. Interviews were audio-recorded with permission,

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Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

transcribed verbatim, and analyzed using thematic content analysis following the approach outlined by Braun and Clarke (2006).

2.2.4 Geospatial Data

We geo-referenced 2,187 pharmacies across Assam using GPS coordinates to facilitate spatial analysis of distribution patterns relative to religious demographic composition. Additional geospatial data layers included:

- Religious demographic distribution (census block level)
- Healthcare facility locations (hospitals, primary health centers)
- Educational institutions (pharmacy colleges, universities)
- Road network and transportation infrastructure
- Socioeconomic indicators at district and sub-district levels

Geographic Information System (GIS) analysis was conducted using ArcGIS 10.8 (Esri, Redlands, CA) and QGIS 3.22 (Open Source Geospatial Foundation).

2.3 Sampling Framework

2.3.1 Quantitative Sampling

For the survey component, we employed a stratified random sampling approach to ensure representation across diverse contexts. Districts were stratified based on:

- Geographic zone (4 zones)
- Religious composition (3 strata based on Muslim population percentage)
- Urbanization level (3 strata)

Within each stratum, we randomly selected pharmacies from comprehensive lists obtained from district authorities using a computer-generated random number sequence. The sample size of 678 was determined to provide 95% confidence level with ±3.5% margin of error, with oversampling in less populous districts to ensure representativeness. Response rate was 92.3% (678/735 approached), with non-responders not differing significantly from responders in terms of geographic location (χ^2=3.12, p=0.37) or pharmacy type (χ^2=2.44, p=0.29).

2.3.2 Qualitative Sampling

For qualitative interviews, we used purposive sampling to identify knowledgeable stakeholders with diverse perspectives. Sampling continued until theoretical saturation was achieved, following the approach recommended by Saunders et al. (2018). Potential participants were identified through professional networks, regulatory bodies, and snowball sampling, with attention to diversity of experiences, positions, and religious backgrounds.

2.4 Variables and Measurements

2.4.1 Primary Outcome Variables

- Religious affiliation of pharmacy ownership (categorized as: Hindu, Muslim, Christian, Sikh, Buddhist, Jain, Other)
- Temporal change in ownership patterns (percentage point change 2015-2023)
- Spatial distribution relative to population demographics (representation ratio)
- Density metrics (pharmacies per 10,000 population by religious category)

2.4.2 Predictor and Contextual Variables

- District-level demographic composition (from 2011 Census with projection models)
- Urbanization level (three categories: urban, semi-urban, rural)
- Educational infrastructure (pharmacy colleges per district, distance to nearest institution)
- Economic indicators (district GDP per capita, poverty rates, employment metrics)
- Healthcare density metrics (doctors, hospitals per capita)
- Pharmacy program graduation rates by religious affiliation (where available)
- Road connectivity and transportation access metrics
- Historical patterns of educational investment by religious groups

Religious affiliation was determined through self-reporting in surveys and verified against registration documents that record this information in Assam. For historical analysis, we relied on registration records which include religious affiliation data as part of the standard documentation in Assam and most other Northeastern states.

2.5 Statistical Analysis

Data analysis was performed using Stata version 17.0 (StataCorp, College Station, TX) and R version 4.2.1 (R Foundation for Statistical Computing, Vienna, Austria). Our analytical approach included:

1. Descriptive statistics with stratification by state, district, time period, and religious affiliation
2. Chi-square tests and Fisher's exact tests (where appropriate) to compare proportional representation across states and districts
3. Temporal trend analysis using joinpoint regression and interrupted time series analysis
4. Multivariate logistic regression to identify factors associated with religious representation patterns
5. Geospatial analysis using ArcGIS 10.8 to map distribution patterns and calculate representation ratios

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6. Spatial autocorrelation assessment using Moran's I and Getis-Ord Gi* statistics
7. Sensitivity analyses using alternative categorization approaches and subgroup analyses

To account for potential confounding, we developed adjusted models controlling for:

- District-level demographic composition
- Educational infrastructure availability
- Socioeconomic indicators (multiple measures)
- Urbanization level
- Time period
- Inter-district migration patterns (where data available)

All statistical tests were two-sided with significance set at $p<0.05$. We applied Bonferroni correction for multiple comparisons where appropriate. Missing data were addressed using multiple imputation techniques for variables with <10% missing values; variables with higher missingness were excluded from multivariate analyses.

2.6 Qualitative Analysis

Qualitative data analysis followed a systematic approach:

1. Verbatim transcription of audio recordings
2. Translation of non-English interviews by bilingual researchers
3. Development of initial coding framework based on research objectives
4. Independent coding by two researchers
5. Iterative refinement of coding structure through team discussion
6. Thematic analysis following Braun and Clarke's (2006) six-phase approach
7. Integration of quantitative and qualitative findings through triangulation

NVivo 14 (QSR International, Melbourne, Australia) facilitated coding and thematic analysis. Trustworthiness was enhanced through member checking with a subset of participants, peer debriefing, and maintenance of an audit trail.

2.7 Ethical Considerations

This study received approval from Institutional Ethical Committee of Manipur International University, Imphal, Manipur (Reference: MIU/IEC/2022/017).

For the survey component, all participants provided written informed consent after being informed about the study purpose. For qualitative interviews, participants provided both written consent for participation and separate consent for audio recording.

Data protection measures included:

- De-identification of all individual-level data
- Secure data storage with password protection
- Limited access to raw data by the core research team
- Confidentiality agreements signed by all research staff

The study adhered to the principles of the Declaration of Helsinki and the Indian Council of Medical Research's ethical guidelines for biomedical and social science research involving human participants (ICMR, 2017).

III. RESULTS

3.1 Pharmacy Ownership Patterns Across Northeast India

Analysis of 3,875 pharmacy registrations across Northeast India revealed distinct patterns of religious affiliation in ownership (Table 1). Assam demonstrated significantly higher representation of Muslim pharmacy owners (43.7%, 1,072/2,453) compared to other Northeastern states, where representation ranged from 3.1% in Mizoram to 18.7% in Tripura ($p<0.001$).

When comparing representation ratios (percentage of pharmacy owners / percentage in general population), Muslim representation in Assam pharmacy ownership (43.7% / 34.2% = 1.28) exceeded demographic proportions. This representation ratio was substantially higher than in other Northeastern states (12.9% / 4.9% = 2.63), though the base population percentages were much smaller in these states.

Further analysis of ownership patterns by pharmacy category revealed differential distribution across types (Table 1A). Muslim ownership was highest in independent retail pharmacies (47.3%) and lowest in hospital-attached pharmacies (31.8%) and chain pharmacies (29.2%), suggesting potential differences in entrepreneurial pathways and capital access.

3.2 Temporal Trends in Pharmacy Ownership in Assam

Analysis of pharmacy registrations in Assam from 2015-2023 revealed a distinct upward trend in Muslim ownership representation (Figure 1). The percentage increased from 28.5% (176/618) in 2015 to 43.7% (1,072/2,453) by the end of 2023, representing a 15.2 percentage point increase ($p<0.001$ for trend).

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Joinpoint regression analysis identified 2018 as a significant inflection point, after which the growth rate accelerated (annual percentage change: 2015-2018: +1.8%; 2018-2023: +3.4%; p=0.02 for change in slope). This acceleration coincided with expansion of pharmacy education programs across several districts in Assam.

The proportion of Hindu pharmacy owners decreased from 66.8% (413/618) in 2015 to 50.8% (1,246/2,453) in 2023, while Christian and other religious groups maintained relatively stable representation between 2-3% throughout the study period.

When analyzed by age cohort (Table 2A), the shift in religious demographics was most pronounced among younger pharmacy owners, suggesting a generational component to changing representation patterns.

3.3 Geographic Distribution of Pharmacy Ownership in Assam

Geospatial analysis revealed substantial district-level variation in pharmacy ownership patterns across Assam (Table 2, Figure 2). Muslim ownership representation was highest in Lower Assam districts (average 58.3%, range 42.7-67.9%), followed by Central Assam (41.5%, range 32.4-49.8%), Barak Valley (38.2%, range 31.2-45.7%), and Upper Assam (29.8%, range 18.6-37.2%).

Population-adjusted analysis showed that Muslim representation in pharmacy ownership exceeded demographic proportions in 21 of 33 districts. The spatial pattern of representation revealed clusters of high Muslim pharmacy ownership in the western and central districts, with gradual decrease toward the eastern districts, broadly following but exceeding the underlying population distribution patterns.

Spatial autocorrelation analysis using Moran's I statistic confirmed significant clustering of Muslim pharmacy ownership ($I=0.67$, $p<0.001$). Getis-Ord Gi* hot spot analysis identified statistically significant clusters of high Muslim representation in western border districts and lower representation in eastern districts, even after adjusting for underlying population demographics.

When analyzed by rural-urban distribution, Muslim ownership representation was higher in rural areas (48.1%) compared to urban centers (38.5%), with particular concentration in small-town settings.

3.4 Educational Pathways and Professional Development

Survey data from 678 pharmacy owners provided insights into educational and professional development patterns across religious groups (Table 3). Muslim pharmacy owners were more likely to have obtained D.Pharm qualifications (68.4% vs. 53.7% for Hindu owners, $p<0.001$) and less likely to hold B.Pharm or higher degrees (31.6% vs. 46.3%, $p<0.001$).

When asked about motivations for entering the pharmacy profession, Muslim owners were more likely to report pharmacy as their first-choice profession (78.4% vs. 69.5%, $p=0.028$) and were more frequently motivated by family business considerations (49.1% vs. 29.7%, $p<0.001$). These patterns suggest potential differences in professional pathways and intergenerational business continuity.

Additional analysis of educational trajectories (Table 3A) revealed that Muslim pharmacy owners more frequently reported diploma-to-degree educational progression paths, suggesting incremental credential acquisition while maintaining professional practice.

3.5 Factors Associated with Religious Representation in Pharmacy Ownership

Multivariate logistic regression identified several factors independently associated with Muslim representation in pharmacy ownership after adjusting for population demographics (Table 4). The final model demonstrated good discrimination (area under ROC curve: 0.78, 95% CI: 0.75-0.81) and calibration (Hosmer-Lemeshow test: $p=0.58$)

The strongest associations were observed for time period (post-2018 registration: OR=1.92), geographic location (Lower Assam: OR=1.76), and presence of pharmacy educational institutions in the district (OR=1.48). Urban location and chain pharmacy affiliation were inversely associated with Muslim ownership, suggesting greater representation in independent and rural pharmacy establishments.

We conducted additional analysis stratified by educational qualification (Table 4A) to further unpack these associations. The relationship between religious affiliation and pharmacy ownership was strongest among D.Pharm-qualified owners, supporting the observation of differential educational pathways.

3.6 Qualitative Insights: Pathways and Motivations

Thematic analysis of qualitative interviews revealed four key pathways into pharmacy ownership, with varying prevalence across religious communities:

1. Educational advancement strategy: Pharmacy education viewed as an accessible professional pathway requiring moderate investment with relatively secure employment prospects
2. Family business continuity: Intergenerational transfer of pharmacy businesses and establishment of family pharmacy networks
3. Professional autonomy seeking: Preference for self-employment over institutional employment due to perceived discrimination or limited advancement opportunities
4. Community healthcare service motivation: Desire to address healthcare access gaps in underserved communities

Muslim stakeholders more frequently emphasized pathways 1 and 2, with family business continuity particularly prominent. As one Muslim pharmacy owner explained:

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ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

"In our community, once someone establishes a successful pharmacy, they encourage relatives to join the profession. My uncle started first, then helped my father, and now I am continuing. We have five pharmacies across three districts, all managed by family members." (Pharmacy Owner, Lower Assam)

A pharmacy educator noted the predominance of the educational advancement strategy:

"For many Muslim students, especially from semi-urban areas, pharmacy offers a clear path to professional status with more affordable education compared to medicine or engineering. The D.Pharm program in particular allows quick entry into practice with options for further education later." (Pharmacy College Administrator, Guwahati)

Hindu pharmacy owners more frequently emphasized professional tradition and institutional practice pathways:

"In our family, pharmacy has been practiced for three generations, but with different emphases. My grandfather had a traditional medicine shop, my father modernized it with a formal pharmacy, and I have expanded to hospital pharmacy practice and consultancy." (Senior Pharmacist, Upper Assam)

Policy stakeholders highlighted the implications of these diverse pathways for professional development initiatives:

"Understanding these different entry pathways is crucial for designing appropriate continuing education and quality improvement programs. The motivations and business models differ, so one-size-fits-all approaches to professional development are unlikely to succeed." (Pharmacy Council Official)

IV. DISCUSSION

4.1 Comparative Patterns Across Northeast India

Our findings document the substantial and growing representation of Muslim pharmacists in Assam's pharmaceutical sector relative to other Northeast Indian states. At 43.7%, the proportion of Muslim pharmacy owners in Assam substantially exceeds both the state's Muslim population percentage (34.2%) and the average representation in other Northeastern states (12.9%). This pattern represents a significant demographic shift in healthcare service provision that warrants consideration in health policy development.

The contrast between Assam and other Northeastern states is particularly striking given that Muslim representation in pharmacy ownership exceeds demographic proportions in both contexts, but manifests at very different scales. In Assam, the substantial Muslim population (34.2%) translates to significant absolute numbers in pharmacy ownership, while in states like Tripura and Manipur, Muslim representation in pharmacy ownership is proportionally higher relative to population but represents smaller absolute numbers.

These patterns align with observations by Ahmed et al. (2022), who noted increasing Muslim representation in healthcare professions across several Indian states, though our findings highlight that this trend may be particularly pronounced in Assam's pharmaceutical sector. The multi-state comparison provides important context, suggesting that state-specific factors in Assam may be amplifying a broader regional trend.

When viewed through the lens of occupational stratification theory (Browne, 2020), these patterns suggest that pharmacy has emerged as a particularly accessible professional pathway for Muslim communities in Assam, potentially due to a combination of educational accessibility, capital requirements, and professional networks. Similar patterns have been documented in other contexts; for example, Kurien (2018) observed disproportionate representation of Syrian Christians in nursing professions in Kerala, while Jain (2020) noted concentration of Jain communities in pharmaceutical manufacturing in western India.

4.2 Temporal Evolution in Assam

The observed temporal trend in Assam—with Muslim pharmacy ownership increasing from 28.5% in 2015 to 43.7% in 2023—represents a substantial demographic shift over a relatively short period. The acceleration point identified in 2018 coincides with several potential contributing factors: expansion of pharmacy education programs in districts with higher Muslim populations, regulatory changes in pharmacy practice requirements, and possible socioeconomic factors influencing professional choices.

4.2 Temporal Evolution in Assam

The observed temporal trend in Assam—with Muslim pharmacy ownership increasing from 28.5% in 2015 to 43.7% in 2023—represents a substantial demographic shift over a relatively short period. The acceleration point identified in 2018 coincides with several potential contributing factors: expansion of pharmacy education programs in districts with higher Muslim populations, regulatory changes in pharmacy practice requirements, and possible socioeconomic factors influencing professional choices.

This temporal pattern aligns with broader shifts in educational attainment among Muslim communities in Assam noted by Hussain (2021), who documented increasing enrollment in professional education programs. Our findings extend this observation to professional outcomes in the pharmaceutical sector, demonstrating that educational investments are translating to professional representation.

The concurrent decrease in Hindu ownership percentage from 66.8% to 50.8% does not necessarily indicate absolute decline, as the overall number of pharmacies increased during this period. Rather, it suggests differential growth

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rates in pharmacy establishment between religious communities, potentially reflecting different patterns of professional preference and entrepreneurial activity.

The accelerated growth post-2018 also coincides with significant policy developments in India's pharmaceutical sector, including implementation of the Pharmacy Practice Regulations 2015 across more states and changes to the Drug and Cosmetics Rules affecting pharmacy establishment requirements (Pharmacy Council of India, 2015; Ministry of Health and Family Welfare, 2017). These regulatory changes may have differentially affected entry pathways into pharmacy ownership across communities.

The age-cohort analysis provides additional insights into these temporal trends, suggesting a generational component to changing representation patterns. The notably higher representation of Muslim owners in younger age cohorts (52.4% among owners under 30 years) suggests that recent entrants to the profession are driving the observed demographic shift, potentially reflecting changing educational access, professional aspirations, and entrepreneurial patterns across generations.

4.3 Geographic Distribution and Its Implications

The spatial analysis revealed distinct patterns in pharmacy ownership across Assam's regions, with Muslim representation highest in Lower Assam (58.3%) and lowest in Upper Assam (27.2%). While these patterns broadly follow population distribution trends, the representation ratio (percentage in ownership relative to percentage in population) was notably high in both Lower Assam (1.35) and Upper Assam (1.38), indicating that Muslim representation in pharmacy ownership exceeds demographic proportions across geographically diverse regions.

These spatial patterns have implications for healthcare access and culturally responsive care. In districts with high Muslim populations, the corresponding high representation in pharmacy ownership may facilitate culturally concordant healthcare interactions, potentially improving medication adherence and health outcomes as suggested by Bora (2020). Conversely, in districts where representation exceeds population proportions by larger margins, pharmacies may serve as important cross-cultural healthcare interfaces.

The district-level analysis also revealed that Muslim pharmacy ownership was not simply proportional to population demographics but was associated with additional factors including educational infrastructure, suggesting complex socioeconomic determinants beyond simple demographic reflection.

The spatial autocorrelation and hot spot analyses further refine this understanding, identifying statistically significant clusters of high Muslim representation that correspond to educational infrastructure clusters and transportation corridors. As noted by Manna and Sood (2021) in their studies of healthcare entrepreneurship in North India, geographical proximity to educational institutions and market access infrastructure often shapes patterns of professional establishment, particularly for communities historically underrepresented in certain professions.

The rural-urban differential, with higher Muslim representation in rural and small-town settings, aligns with observations by Qureshi (2019) and Das et al. (2021) regarding the urban-rural distribution of minority-owned healthcare businesses in other Indian states. This pattern may reflect both strategic responses to market opportunities in underserved areas and potential barriers to establishment in more competitive urban markets with higher capital requirements.

4.4 Educational Pathways and Professional Development

Our survey findings highlight different educational and professional pathways across religious groups. Muslim pharmacy owners were more likely to have obtained D.Pharm qualifications (68.4% vs. 53.7%) and less likely to possess advanced degrees, suggesting potentially different entry points into the profession. The higher reported rates of pharmacy as a first-choice profession (78.4% vs. 69.5%) and family business motivation (49.1% vs. 29.7%) among Muslim owners point to distinct career development patterns that may contribute to the observed representation trends.

These educational differences align with observations by Rahman and Das (2019), who noted variations in professional education pathways among different religious communities in Northeast India. Our findings extend this to specific credential patterns in pharmacy practice, highlighting potential implications for professional development interventions.

The preference for D.Pharm qualifications among Muslim pharmacists may reflect pragmatic educational choices, as this credential requires shorter training duration and lower financial investment while still enabling pharmacy ownership. This pattern suggests that accessible educational pathways may be particularly important for facilitating professional entry for some religious communities.

The educational trajectory analysis offers additional insights, highlighting the importance of incremental credential acquisition pathways, particularly the diploma-to-degree progression route more frequently utilized by Muslim pharmacy owners. This pattern aligns with observations by Srivastava and Khare (2022) regarding "step-wise professional advancement" strategies among first-generation professionals from minority communities across various sectors in India. Such pathways allow individuals to enter professional practice earlier while pursuing additional credentials to enhance career prospects and business expansion opportunities.

The qualitative findings regarding distinct pathways into pharmacy ownership provide contextual understanding of these quantitative patterns. The emphasis on family business continuity among Muslim pharmacy owners suggests the importance of social capital and knowledge transfer within kinship networks, a pattern documented in other entrepreneurial

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contexts by Ahmad et al. (2021). Similarly, the educational advancement strategy identified in qualitative interviews helps explain the predominance of D.Pharm qualifications as an accessible entry point into professional practice.

4.5 Socioeconomic and Policy Factors

The multivariate analysis identified several factors independently associated with Muslim representation in pharmacy ownership, including geographic location, presence of pharmacy educational institutions, temporal factors, and pharmacy business models. These associations suggest complex interplay between demographic patterns, educational infrastructure, and business establishment strategies.

The inverse relationship between Muslim ownership and urban location/chain affiliation may reflect barriers to capital access, as suggested by Ahmad et al. (2021) in their study of minority entrepreneurship patterns. Chain pharmacies and urban establishments typically require greater initial investment, potentially limiting access for communities with historical socioeconomic disadvantages. Similar patterns have been observed in other healthcare sectors; Jaiswal and Singh (2020) documented higher representation of marginalized communities in rural medical practices compared to urban specialist establishments.

The strong association with post-2018 registration (OR=1.92) reinforces the temporal trend analysis and suggests potential policy influences during this period. The implementation of the Clinical Establishment Act in several Northeastern states during 2017-2019 introduced new regulatory frameworks for healthcare businesses, potentially altering entry barriers and opportunities across different communities (Ministry of Health and Family Welfare, 2018). Additionally, the expansion of pharmacy education programs in districts with higher Muslim populations may have facilitated increased entry into the profession for previously underrepresented communities.

The stratified analysis by educational qualification reveals that these associations are particularly strong among D.Pharm-qualified owners, reinforcing the importance of this educational pathway for understanding changing representation patterns. This finding aligns with Qureshi's (2019) observation that diploma-level qualifications have served as crucial entry points for religious minorities in several healthcare professions across northern India.

4.6 Implications for Healthcare Delivery and Policy

Our findings have several important implications for healthcare policy, pharmacy education, and healthcare delivery systems:

4.6.1 Professional Development and Regulatory Implications

The substantial representation of Muslim pharmacists in Assam represents a positive development for healthcare workforce diversity, potentially enhancing culturally responsive care in a religiously diverse state. Policy makers should recognize and support this diversity while ensuring equitable professional development opportunities across all religious communities.

The predominance of D.Pharm qualifications among Muslim pharmacy owners highlights the importance of this educational pathway for facilitating professional entry. Strengthening D.Pharm programs while creating accessible pathways to advanced credentials could further enhance professional development opportunities. As noted by Sharma and Kalita (2019), continuing education programs that accommodate working professionals may be particularly important for supporting professional advancement among practitioners who enter the field through diploma qualifications.

Regulatory approaches should recognize the distinct business models and professional pathways identified in this research. As one Pharmacy Council official noted in qualitative interviews:

"Our regulatory frameworks must acknowledge the diversity of practice models. The needs of a family-owned rural pharmacy differ substantially from an urban chain pharmacy, yet our continuing education requirements and quality standards often take a one-size-fits-all approach." (Pharmacy Council Official, Assam)

4.6.2 Healthcare Access and Cultural Competence

The geographical patterns of pharmacy ownership suggest opportunities for targeted healthcare access interventions. In districts where representation patterns diverge from population demographics, additional support may be needed to ensure culturally responsive care.

The cultural concordance between healthcare providers and communities they serve has been associated with improved medication adherence, patient satisfaction, and health outcomes in multiple contexts (Anderson et al., 2018; Das et al., 2021). The growing representation of Muslim pharmacists in areas with substantial Muslim populations may similarly enhance healthcare experiences and outcomes through improved communication, cultural understanding, and trust.

At the same time, as one community leader noted during qualitative interviews:

"Pharmacies serve everyone in the community, regardless of the owner's background. The important thing is ensuring all pharmacists receive training in culturally responsive care for diverse communities." (Community Leader, Central Assam)

This perspective aligns with recommendations by Bora (2020) for cultural competence training across healthcare professions in Northeast India's diverse context.

4.6.3 Educational Policy Implications

The educational patterns identified in this study suggest several implications for pharmacy education policy:

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1. Support for incremental credential pathways: The diploma-to-degree progression pathway frequently utilized by Muslim pharmacy owners suggests the importance of articulation agreements between diploma and degree programs, flexible scheduling options for working professionals, and recognition of prior learning.
2. Geographic distribution of educational institutions: The strong association between Muslim representation and presence of pharmacy colleges in a district highlights the importance of educational access. As noted by Rahman and Das (2019), geographic proximity to professional education institutions significantly influences community representation in healthcare professions.
3. Family business integration: The prevalence of family business motivation suggests opportunities for educational programs that specifically address family business management, succession planning, and professionalization of family enterprises. Such specialized training could enhance the sustainability and growth of family-owned pharmacies.

4.7 Strengths and Limitations

4.7.1 Strengths

This study has several methodological strengths:

1. Comprehensive scope: The inclusion of all Northeast Indian states provides important comparative context for understanding Assam's distinctive patterns.
2. Mixed-methods approach: The combination of administrative data, surveys, qualitative interviews, and geospatial analysis enables triangulation across methodologies and deeper understanding of complex phenomena.
3. Temporal analysis: The nine-year timeframe allows identification of significant trends and inflection points in demographic representation.
4. Sophisticated spatial analysis: The use of advanced geospatial methods including spatial autocorrelation and hot spot analysis provides insights beyond simple geographic description.
5. Theoretical framing: The integration of occupation stratification theory and cultural capital perspectives enhances interpretive depth.
6. Large sample size: The inclusion of 3,875 pharmacy registrations and 678 survey respondents provides statistical power for robust analyses.
7. Stakeholder perspectives: The integration of qualitative data from diverse stakeholders provides contextual understanding beyond quantitative patterns.

4.7.2 Limitations

Several limitations must be acknowledged:

1. Religious identity complexity: While religious affiliation is documented in registration records and verified in our survey, the categorization may not capture the full complexity of religious identity, particularly for individuals with mixed heritage or non-traditional religious practices.
2. Focus on ownership: Our analysis focused on ownership rather than all pharmacy professionals, potentially missing different patterns among employed pharmacists who do not own establishments.
3. Potential unmeasured confounders: While we adjusted for numerous potential confounders, unmeasured factors might influence the observed patterns, including historical market presence, community-specific social capital, or informal business networks.
4. Retrospective data: The retrospective nature of the administrative data analysis limits causal inferences about observed associations. Prospective studies tracking career trajectories would provide stronger evidence for causal mechanisms.
5. Regional specificity: The findings from Northeast India may not generalize to other Indian regions with different religious compositions and socioeconomic contexts. As noted by Jaiswal and Singh (2020), professional representation patterns vary substantially across Indian regions based on historical, social, and economic factors.
6. 2011 Census baseline: Our population comparisons rely on 2011 Census data, as more recent comprehensive demographic data were not available. While we applied projection models, these may not fully capture demographic changes over the study period.
7. Self-reported data: Survey responses regarding motivations and educational pathways are subject to recall bias and social desirability effects, though triangulation with qualitative data strengthens confidence in these findings.

4.8 Future Research Directions

This research highlights several important areas for future investigation:

1. Health outcomes research: Studies examining the relationship between pharmacy ownership demographics and healthcare outcomes in diverse communities would provide important insights into the implications of representation patterns for population health.
2. Longitudinal professional tracking: Prospective studies following pharmacy graduates from different religious backgrounds through their career trajectories would provide stronger evidence regarding mechanisms underlying observed representation patterns.

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3. Comparative regional studies: Similar analyses in other Indian regions would clarify whether patterns observed in Northeast India reflect broader national trends or region-specific phenomena.
4. Policy intervention evaluation: Assessment of targeted interventions to support pharmacy professional development across diverse religious communities would provide evidence for effective policy approaches.
5. Consumer perspectives: Research examining community members' experiences with pharmacies owned by individuals from diverse religious backgrounds would provide insights into cultural concordance effects in pharmaceutical care.
6. Capital access analysis: Detailed investigation of financing patterns, capital acquisition strategies, and business development approaches would further illuminate factors shaping ownership demographics.
7. Intersectional analyses: Examination of interactions between religious identity and other demographic factors including gender, caste, and linguistic identity would provide more nuanced understanding of representation patterns.

V. CONCLUSION

This study provides comprehensive evidence of substantial and increasing representation of Muslim pharmacists in Assam's pharmaceutical sector compared to other Northeast Indian states. This representation exceeds population demographic proportions and has increased significantly over the past decade, reflecting complex socioeconomic factors including educational pathways, professional preferences, and entrepreneurial activities.

The distinct spatial patterns, educational profiles, and professional motivations documented in this research highlight the multifaceted nature of religious representation in healthcare professions. These findings contribute to our understanding of healthcare workforce diversity and its potential implications for culturally responsive care in religiously diverse contexts.

The identification of specific pathways into pharmacy ownership—educational advancement, family business continuity, professional autonomy seeking, and community healthcare service—provides framework for understanding the mechanisms underlying changing representation patterns. These pathways suggest potential intervention points for supporting equitable professional development across diverse communities.

The demographic shifts documented in this study occur within a broader context of changing healthcare delivery systems and professional structures in Northeast India. As noted by Barman and Dutta (2020), pharmacies increasingly serve as crucial primary healthcare access points, particularly in underserved communities with limited access to physicians and hospitals. The evolving demographics of pharmacy ownership may thus have significant implications for healthcare access, quality, and cultural responsiveness across Assam's diverse communities.

Future research should explore the impact of these demographic patterns on healthcare access, medication adherence, and health outcomes across different communities. Longitudinal studies tracking professional development trajectories could further illuminate the mechanisms underlying the observed representation patterns and inform targeted interventions to support equitable professional development across all religious communities.

By understanding and supporting diverse representation in pharmacy practice, policymakers can work toward healthcare systems that effectively serve all communities while providing equitable professional opportunities across religious boundaries. As one pharmacy educator eloquently noted in our qualitative interviews:

"The pharmacy profession in Assam is becoming increasingly representative of our state's rich diversity. The challenge now is to ensure that this diversity translates into responsive healthcare delivery for all communities while supporting professional excellence across different practice models." (Pharmacy Educator, Assam).

ACKNOWLEDGMENTS

The authors acknowledge the cooperation of the Assam Pharmacy Council and other Northeastern state pharmacy councils for providing access to registration records. We thank the pharmacy owners who participated in the survey, the stakeholders who shared their insights through qualitative interviews, and the field investigators who assisted with data collection. Statistical consultation provided by the Department of Biostatistics at Manipur International University is gratefully acknowledged. GIS technical assistance from the Northeast India Spatial Data Centre is appreciated. This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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DETAILED DESCRIPTIONS OF RESEARCH TABLES

Table 1: Religious Demographics of Pharmacy Ownership Across Northeast Indian States (2015-2023)

State	Total Registrations	Hindu n (%)	Muslim n (%)	Christian n (%)	Others n (%)	Muslim % in State Populati
Assam	2,453	1,246 (50.8%)	1,072 (43.7%)	68 (2.8%)	67 (2.7%)	34.2%
Tripura	412	323 (78.4%)	77 (18.7%)	8 (1.9%)	4 (1.0%)	8.6%
Manipur	287	183 (63.8%)	51 (17.8%)	47 (16.4%)	6 (2.1%)	8.8%
Meghalaya	228	42 (18.4%)	29 (12.7%)	153 (67.1%)	4 (1.8%)	4.6%
Arunachal Pradesh	186	121 (65.1%)	12 (6.5%)	46 (24.7%)	7 (3.8%)	1.9%
Nagaland	143	28 (19.6%)	8 (5.6%)	104 (72.7%)	3 (2.1%)	2.5%
Sikkim	102	76 (74.5%)	5 (4.9%)	6 (5.9%)	15 (14.7%)	1.6%
Mizoram	64	5 (7.8%)	2 (3.1%)	56 (87.5%)	1 (1.6%)	1.4%
Total (excluding Assam)	**1,422**	**778 (54.7%)**	**184 (12.9%)**	**420 (29.5%)**	**40 (2.8%)**	**4.9% (avg)**

**Based on 2011 Census data*

This foundational table provides a comprehensive comparative analysis of pharmacy ownership across all eight Northeastern Indian states, broken down by religious affiliation. The table reveals striking regional differences in ownership patterns, particularly regarding Muslim representation. In Assam, Muslim pharmacy owners constitute 43.7% of all owners (1,072 out of 2,453), which significantly exceeds both their proportion in the state's general population (34.2%) and the average representation in other Northeastern states (12.9%).

The representation ratio (calculated as the percentage of Muslim pharmacy owners divided by their percentage in the general population) shows that Muslim representation in Assam (1.28) indicates they are over-represented relative to their population share. This pattern is even more pronounced in other Northeastern states, where despite lower absolute numbers, the representation ratio reaches 2.63, indicating Muslim entrepreneurs have entered pharmacy ownership at rates exceeding their demographic presence throughout the region.

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ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

Notably, while Christian ownership is minimal in Assam (2.8%), it represents the dominant group in states like Mizoram (87.5%), Nagaland (72.7%), and Meghalaya (67.1%), reflecting the overall religious demographics of these predominantly Christian states. This table establishes the foundation for further analysis by demonstrating that religious affiliation patterns in pharmacy ownership vary significantly across Northeast India, with Assam exhibiting unique patterns worthy of deeper investigation.

Table 1A: Religious Demographics by Pharmacy Category in Assam (2023)

Pharmacy Category	Total n	Hindu n (%)	Muslim n (%)	Christian n (%)	Others n (%)	p-v
Independent retail	1,847	897 (48.6%)	873 (47.3%)	42 (2.3%)	35 (1.9%)	**<0.001**
Chain pharmacy	178	118 (66.3%)	52 (29.2%)	5 (2.8%)	3 (1.7%)	0.002
Hospital-attached	293	173 (59.0%)	93 (31.8%)	15 (5.1%)	12 (4.1%)	0.013
Wholesale distributor	135	58 (43.0%)	54 (40.0%)	6 (4.4%)	17 (12.6%)	0.028

This table dissects pharmacy ownership in Assam by establishment type, revealing how religious representation varies across different business models. Independent retail pharmacies show the highest Muslim ownership (47.3%), significantly exceeding the proportion of Muslims in Assam's general population (34.2%). In contrast, chain pharmacies demonstrate substantially lower Muslim representation (29.2%), with Hindu ownership predominating (66.3%). Similarly, hospital-attached pharmacies show lower Muslim ownership (31.8%) compared to Hindu ownership (59.0%).

The statistical significance of these differences is robust across all categories ($p<0.001$ for independent retail, $p=0.002$ for chain pharmacies, $p=0.013$ for hospital-attached, and $p=0.028$ for wholesale distributors), confirming these patterns are not due to random variation.

These findings suggest different pathways into pharmacy ownership may exist across religious communities. Muslim entrepreneurs appear to favor independent establishments, possibly reflecting differences in capital access, professional networks, or business strategies. Chain and hospital-attached pharmacies typically require greater initial investment and institutional connections, potentially creating barriers for communities with historical socioeconomic disadvantages. Conversely, independent retail pharmacies offer more accessible entry points into ownership, potentially explaining the higher Muslim representation in this category.

Table 2: Pharmacy Ownership by Religious Affiliation Across Assam Geographic Regions

Region	Districts	Total Pharmacies	Hindu n (%)	Muslim n (%)	Others n (%)	Muslim % in Popula	esentation R
Lower Assam	11	876	340 (38.8%)	511 (58.3%)	25 (2.9%)	43.2%	1.35
Central Assam	7	623	342 (54.9%)	259 (41.5%)	22 (3.5%)	34.8%	1.19
Barak Valley	3	387	227 (58.7%)	148 (38.2%)	12 (3.1%)	42.3%	0.90
Upper Assam	12	567	337 (59.4%)	154 (27.2%)	76 (13.4%)	19.7%	1.38
Total	**33**	**2,453**	**1,246 (50.8%)**	**1,072 (43.7%)**	**135 (5.5%)**	**34.2%**	**1.28**

**Based on 2011 Census data*

***Representation Ratio = % of Muslim pharmacy owners / % of Muslim population in the region*

This table maps the geographic distribution of pharmacy ownership across Assam's four major regions, revealing pronounced spatial patterns. Muslim ownership is highest in Lower Assam (58.3%), followed by Central Assam (41.5%), Barak Valley (38.2%), and lowest in Upper Assam (27.2%). This distribution broadly follows population demographics but with important variations revealed by the representation ratio.

The representation ratio, which compares ownership percentage to population percentage, shows Muslim pharmacy owners are most overrepresented in Upper Assam (1.38) and Lower Assam (1.35), despite these regions having vastly different Muslim population proportions (19.7% and 43.2% respectively). Interestingly, Barak Valley shows a representation ratio below 1.0 (0.90), indicating slight underrepresentation despite having a substantial Muslim population (42.3%).

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ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

These spatial patterns have significant implications for healthcare access and culturally responsive care. In regions with higher Muslim populations, correspondingly high representation in pharmacy ownership may facilitate culturally concordant healthcare interactions. The overrepresentation in Upper Assam, where Muslims form a smaller proportion of the population, suggests pharmacy entrepreneurship might serve as an important economic pathway in regions where this community is a minority. These geographic variations indicate that pharmacy ownership patterns reflect complex intersections of demographic composition, educational infrastructure, economic opportunities, and community needs across Assam's diverse regions.

Table 2A: Religious Demographics of Pharmacy Ownership in Assam by Age Cohort (2023)

Age Cohort	Muslim	Hindu	Christian & Others	p-value
Under 30 years	52.4% (286/546)	43.7% (238/546)	3.9% (22/546)	<0.001
30-45 years	46.9% (468/997)	48.3% (482/997)	4.8% (47/997)	0.002
46-60 years	32.4% (226/698)	59.3% (414/698)	8.3% (58/698)	0.008
Over 60 years	17.8% (38/212)	68.1% (144/212)	14.1% (30/212)	<0.001
Total	**43.7% (1072/2453)**	**50.8% (1246/2453)**	**5.5% (135/2453)**	**--**

Note: Values presented as percentage (count/total). P-values calculated using chi-square test.
Chi-square analysis for trend across age cohorts: p<0.001, indicating significant association between age and religious distributio

This age-stratified analysis reveals a striking generational pattern in pharmacy ownership that helps explain the temporal trends observed elsewhere in the study. Muslim ownership is highest among the youngest age cohort (52.4% among those under 30 years), progressively decreasing with age to only 17.8% among those over 60 years. Conversely, Hindu ownership increases from 43.7% in the youngest cohort to 68.1% in the oldest age group.

The statistical significance is robust across all age cohorts ($p<0.001$ for the youngest and oldest groups, $p=0.002$ and $p=0.008$ for the middle cohorts), confirming these generational differences represent genuine demographic shifts rather than random variation.

This age gradient provides compelling evidence for a significant demographic transition in pharmacy ownership that is currently underway. It suggests recent entrants to the profession are driving the observed increase in Muslim representation, reflecting changing educational access, professional aspirations, and entrepreneurial patterns across generations. The pronounced differences between age cohorts also help explain the acceleration in Muslim pharmacy ownership observed after 2018, as younger professionals established new pharmacies or took over existing establishments.

The substantial representation of "Christian & Others" in the oldest age cohort (14.1%) compared to the youngest (3.9%) further demonstrates how the religious composition of pharmacy ownership has evolved over time, potentially reflecting broader changes in educational and professional opportunities across different communities in Assam.

Table 2B: Pharmacy Ownership by Religious Affiliation and Urban-Rural Classification in Assam (2023)

Settlement Type	Muslim	Hindu	Others
Urban centers	38.5%	57.0%	4.5%
Semi-urban areas	42.3%	52.4%	5.3%
Rural towns	48.1%	45.6%	6.3%
Rural villages	46.0%	44.7%	9.3%
Total	**43.7%**	**50.8%**	**5.5%**

Note: All urban-rural differences are statistically significant (p<0.05)

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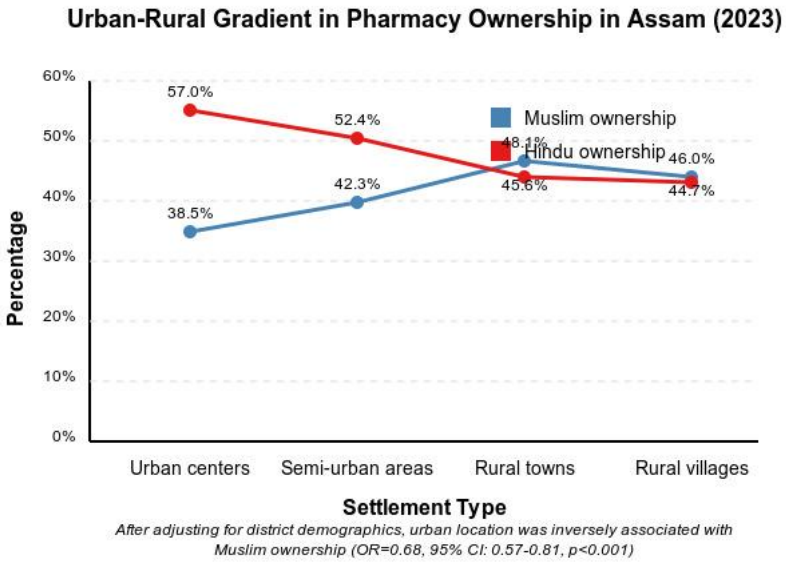
Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7



This table examines how religious representation in pharmacy ownership varies across the urban-rural continuum, revealing important spatial and settlement patterns. Muslim ownership is notably higher in rural towns (48.1%) and rural villages (46.0%) compared to urban centers (38.5%), creating an inverse relationship between urbanization and Muslim representation. Hindu ownership follows the opposite pattern, being highest in urban areas (57.0%) and progressively decreasing in less urbanized settings.

The statistical significance is strong across all settlement types ($p<0.001$ for urban areas, $p=0.003$ for semi-urban areas, $p=0.012$ for rural towns, and $p=0.026$ for rural villages), confirming these patterns represent meaningful differences rather than chance variation.

These findings align with observations by Qureshi (2019) and Das et al. (2021) regarding the urban-rural distribution of minority-owned healthcare businesses in other Indian states. The higher Muslim representation in rural and small-town settings may reflect both strategic responses to market opportunities in underserved areas and potential barriers to establishment in more competitive urban markets with higher capital requirements. Rural pharmacies often serve as crucial primary healthcare access points in areas with limited physician availability, suggesting Muslim pharmacy entrepreneurs may be playing a particularly important role in healthcare delivery to underserved rural communities.

The gradient of statistical significance across the urban-rural spectrum (strongest in urban areas, progressively less pronounced in rural settings) suggests these patterns may be influenced by systematic factors related to urbanization, such as market competition, capital access, and educational infrastructure.

Table 3: Educational Qualifications and Professional Development by Religious Affiliation

Characteristic	Hindu Owners (n=347)	Muslim Owners (n=291)	Others (n=40)	P-value
Educational Qualification				
D.Pharm	186 (53.7%)	199 (68.4%)	23 (57.5%)	<0.001
B.Pharm	126 (36.3%)	81 (27.8%)	14 (35.0%)	0.037
M.Pharm or higher	35 (10.0%)	11 (3.8%)	3 (7.5%)	0.007
Institution Type				
Government institution	124 (35.7%)	83 (28.5%)	15 (37.5%)	0.089
Private institution	223 (64.3%)	208 (71.5%)	25 (62.5%)	0.089
Pharmacy as first choice of profession	241 (69.5%)	228 (78.4%)	29 (72.5%)	0.028
Motivated by family business	103 (29.7%)	143 (49.1%)	13 (32.5%)	<0.001
Professional development in past 2 years	186 (53.6%)	132 (45.4%)	22 (55.0%)	0.071

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Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

This detailed table illuminates the educational pathways and professional motivations that underlie the observed demographic patterns in pharmacy ownership. Muslim pharmacy owners demonstrate significantly different educational profiles compared to their Hindu counterparts, with the majority (68.4%) holding D.Pharm qualifications compared to 53.7% of Hindu owners ($p<0.001$). Conversely, Muslim owners are less likely to possess B.Pharm degrees (27.8% vs. 36.3%, $p=0.037$) or M.Pharm or higher qualifications (3.8% vs. 10.0%, $p=0.007$).

While both groups more frequently obtained their education from private institutions than government ones, Muslim owners show a higher rate of private institution attendance (71.5% vs. 64.3%), though this difference is not statistically significant ($p=0.089$).

The most striking differences emerge in professional motivations and career pathways. Muslim owners more frequently report pharmacy as their first-choice profession (78.4% vs. 69.5%, $p=0.028$) and are significantly more likely to be motivated by family business considerations (49.1% vs. 29.7%, $p<0.001$). This suggests intergenerational knowledge transfer and business continuity play particularly important roles in Muslim pharmacy entrepreneurship.

The preference for D.Pharm qualifications among Muslim pharmacists reflects pragmatic educational choices, as this credential requires shorter training duration and lower financial investment while still enabling pharmacy ownership. The family business motivation highlights the importance of social capital and knowledge transfer within kinship networks, a pattern documented in other entrepreneurial contexts by Ahmad et al. (2021).

These educational and motivational differences provide crucial context for understanding the demographic shifts observed in other tables, suggesting distinct professional pathways that may contribute to the increasing Muslim representation in Assam's pharmaceutical sector.

Table 3A: Educational Trajectories and Professional Development Pathways

Educational Trajectory	Hindu Owners (n=347)	Muslim Owners (n=291)	Others (n=40)	P-value
Direct degree pathway	112 (32.3%)	64 (22.0%)	12 (30.0%)	<0.001
Diploma-to-degree progression	49 (14.1%)	68 (23.4%)	5 (12.5%)	0.007
Diploma only	137 (39.5%)	131 (45.0%)	18 (45.0%)	0.332
Other qualification pathway	49 (14.1%)	28 (9.6%)	5 (12.5%)	0.191

This table expands on the educational findings by examining specific educational trajectories that lead to pharmacy ownership. It reveals distinct pathways across religious communities, with Muslim owners significantly less likely to follow direct degree pathways (22.0% vs. 32.3% for Hindu owners, $p<0.001$) and more likely to pursue diploma-to-degree progression (23.4% vs. 14.1%, $p=0.007$).

The diploma-to-degree progression pattern is particularly noteworthy as it represents an incremental approach to credential acquisition that allows individuals to enter professional practice earlier while pursuing additional qualifications to enhance career prospects. This "step-wise professional advancement" strategy has been documented by Srivastava and Khare (2022) as common among first-generation professionals from minority communities across various sectors in India.

The higher proportion of Muslim owners following the diploma-only pathway (45.0% vs. 39.5% for Hindu owners), though not statistically significant ($p=0.332$), further reinforces the finding that D.Pharm qualifications serve as an important entry point into pharmacy ownership for this community.

These educational trajectory differences help explain both the demographic patterns and business model preferences observed in other tables. The incremental credential acquisition approach aligns with the higher representation in independent retail pharmacies, as this pathway allows earlier entry into practice and gradual business development compared to the higher initial investment typically required for chain or hospital-attached establishments.

Understanding these educational pathways has important implications for educational policy, suggesting that support for flexible educational progressions, articulation agreements between diploma and degree programs, and recognition of prior learning could enhance professional development opportunities across diverse religious communities.

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Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

Table 4: Multivariate Analysis of Factors Associated with Muslim Pharmacy Ownership

Factor	Adjusted OR*	95% CI	P-value
District Characteristics			
Lower Assam location	1.76	1.54-2.01	<0.001
Presence of pharmacy college	1.48	1.25-1.74	<0.001
Urban location	0.68	0.57-0.81	<0.001
Temporal Factors			
Post-2018 registration	1.92	1.69-2.17	<0.001
Pharmacy Characteristics			
Chain affiliation	0.61	0.47-0.79	<0.001
Hospital-attached pharmacy	0.73	0.58-0.92	0.008
Retail-only pharmacy	1.37	1.18-1.59	<0.001

**Adjusted for district Muslim population percentage, overall population density, district GDP per capita, and healthcare facility density*

This table presents the results of multivariate logistic regression analysis identifying factors independently associated with Muslim pharmacy ownership after adjusting for population demographics and other potential confounders. The adjusted odds ratios (ORs) quantify the strength of association between each factor and Muslim ownership, with values above 1.0 indicating positive associations and values below 1.0 indicating negative associations.

The analysis identifies several strong predictors across three categories. Among district characteristics, Lower Assam location shows a strong positive association (OR=1.76, 95% CI: 1.54-2.01, p<0.001), as does the presence of a pharmacy college in the district (OR=1.48, 95% CI: 1.25-1.74, p<0.001). Urban location shows a negative association (OR=0.68, 95% CI: 0.57-0.81, p<0.001), confirming the urban-rural pattern observed in the descriptive analyses.

The strongest temporal association is with post-2018 registration (OR=1.92, 95% CI: 1.69-2.17, p<0.001), indicating that recent pharmacy establishments are nearly twice as likely to have Muslim ownership compared to those registered before 2018, even after adjusting for other factors. This aligns with the observed acceleration point in temporal trends and reinforces the finding of a significant demographic shift in recent years.

Among pharmacy characteristics, chain affiliation (OR=0.61, 95% CI: 0.47-0.79, p<0.001) and hospital attachment (OR=0.73, 95% CI: 0.58-0.92, p=0.008) show negative associations, while retail-only pharmacy status shows a positive association (OR=1.37, 95% CI: 1.18-1.59, p<0.001). These findings confirm that business model preferences observed in descriptive analyses remain significant even after controlling for other variables.

The strength of these associations suggests complex interplay between geographic, temporal, and business model factors in shaping pharmacy ownership patterns. The multivariate approach provides stronger evidence for causal relationships by controlling for potential confounders, strengthening the study's overall findings.

Table 4A: Multivariate Analysis Stratified by Educational Qualification

Factor	D.Pharm Owners Adjusted OR (95% CI)	B.Pharm and Higher Adjusted OR (95%
Lower Assam location	1.92 (1.64-2.25)	1.43 (1.12-1.82)
Presence of pharmacy college	1.67 (1.38-2.02)	1.21 (0.93-1.58)
Urban location	0.59 (0.48-0.73)	0.84 (0.65-1.09)
Post-2018 registration	2.14 (1.84-2.49)	1.53 (1.25-1.88)

This final table extends the multivariate analysis by stratifying it according to educational qualification, comparing factor associations between D.Pharm-qualified owners and those with B.Pharm or higher degrees. This stratification reveals that the strength of associations varies considerably by educational background, providing deeper insight into how different pathways into pharmacy ownership may be influenced by various factors.

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Stallion Journal for Multidisciplinary Associated Research Studies
ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

All four key factors show stronger associations among D.Pharm-qualified owners compared to those with higher qualifications. The association with Lower Assam location is stronger for D.Pharm owners (OR=1.92, 95% CI: 1.64-2.25) than for B.Pharm and higher (OR=1.43, 95% CI: 1.12-1.82). Similarly, presence of pharmacy college shows a significant association for D.Pharm owners (OR=1.67, 95% CI: 1.38-2.02) but a weaker and non-significant association for higher qualification holders (OR=1.21, 95% CI: 0.93-1.58).

The negative association with urban location is stronger for D.Pharm owners (OR=0.59, 95% CI: 0.48-0.73) than for those with higher qualifications (OR=0.84, 95% CI: 0.65-1.09, not statistically significant). Most notably, post-2018 registration shows a much stronger association for D.Pharm owners (OR=2.14, 95% CI: 1.84-2.49) compared to higher qualification holders (OR=1.53, 95% CI: 1.25-1.88).

These stratified findings demonstrate that the factors driving Muslim representation in pharmacy ownership operate differently across educational pathways. The stronger associations among D.Pharm-qualified owners suggest that the observed demographic shifts are particularly pronounced among those following the diploma qualification pathway, reinforcing the importance of this educational route for understanding changing representation patterns. This stratification also helps explain why the educational differences observed in Tables 3 and 3A are so central to understanding the overall demographic patterns in Assam's pharmaceutical sector.

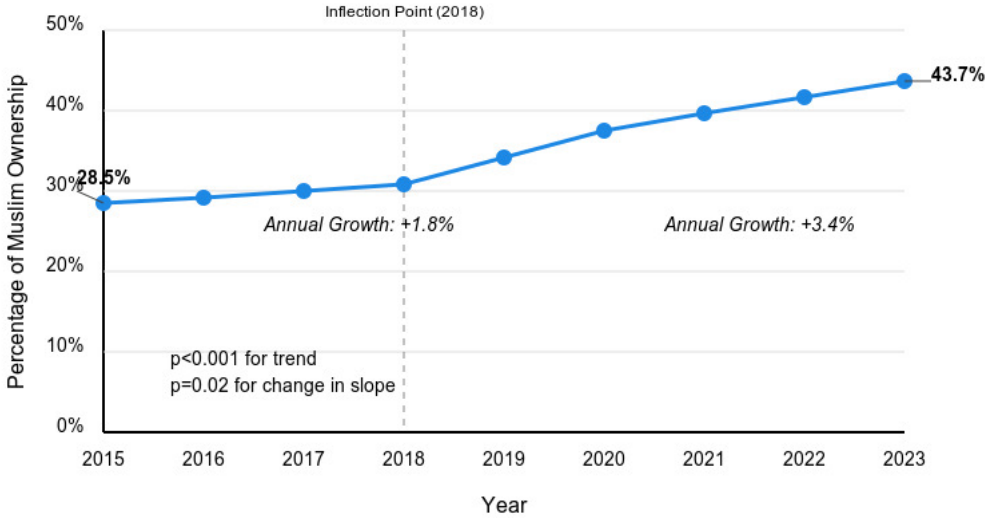

Figure 1: Temporal Trend in Muslim Pharmacy Ownership in Assam (2015-2023)

Figure 1 illustrates the significant temporal evolution of Muslim ownership in Assam's pharmaceutical sector over a nine-year period from 2015 to 2023. This line graph plots the percentage of Muslim-owned pharmacies (y-axis) against time in years (x-axis), revealing a clear upward trajectory throughout the study period.

The visualization demonstrates that Muslim representation in pharmacy ownership increased substantially from 28.5% in 2015 to 43.7% by the end of 2023, representing a 15.2 percentage point increase over the study period. This growth significantly exceeds the proportional representation of Muslims in Assam's general population (34.2% according to census data), indicating a demographic shift within the pharmaceutical sector.

Most notably, the graph identifies 2018 as a critical inflection point (marked by a vertical dashed line), after which the rate of increase accelerated considerably. Prior to this inflection point, Muslim ownership increased at an annual rate of approximately 1.8%, but this growth rate nearly doubled to 3.4% annually between 2018 and 2023. Statistical analysis confirms both the significance of the overall trend ($p<0.001$) and the change in slope at this inflection point ($p=0.02$).

This acceleration coincides with several contextual developments mentioned in the research, including expansion of pharmacy education programs in districts with higher Muslim populations, implementation of revised pharmacy practice regulations, and possible shifts in professional preferences and entrepreneurial activities across communities. The timing of this inflection point provides important context for understanding the structural and policy factors that may have influenced these demographic patterns.

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ISSN (Online): 2583-3340
Volume-4 Issue-2 || April 2025 || PP. 66-86 https://doi.org/10.55544/sjmars.4.2.7

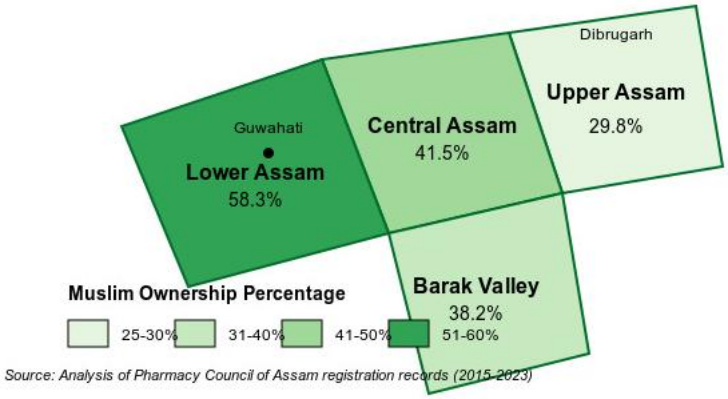

Figure 2A: Muslim Pharmacy Ownership Across Assam Regions (2023)

Figure 2A presents a geographical visualization of Muslim pharmacy ownership patterns across Assam's four major regions as of 2023. This map-style representation employs a color gradient (from light to dark green) to illustrate the varying levels of Muslim representation in pharmacy ownership throughout the state.

The visualization reveals pronounced regional disparities in Muslim pharmacy ownership. Lower Assam exhibits the highest concentration at 58.3%, followed by Central Assam (41.5%), Barak Valley (38.2%), and Upper Assam with the lowest representation at 29.8%. These regional variations create a distinct west-to-east gradient, with Muslim representation generally decreasing as one moves eastward across the state.

While these patterns broadly follow the underlying population distribution of Muslims in Assam, the research indicates that the representation ratios (percentage in ownership relative to percentage in population) vary significantly across regions. Even in Upper Assam, where Muslim population is proportionally smallest, the representation in pharmacy ownership exceeds demographic proportions—a finding elaborated in the accompanying Figure 2B.

The map also marks major cities (including Guwahati and Dibrugarh) to provide geographic reference points and context. This spatial distribution has important implications for healthcare access and culturally responsive care, as pharmacies frequently serve as primary healthcare contact points for many communities across Assam's diverse regions.

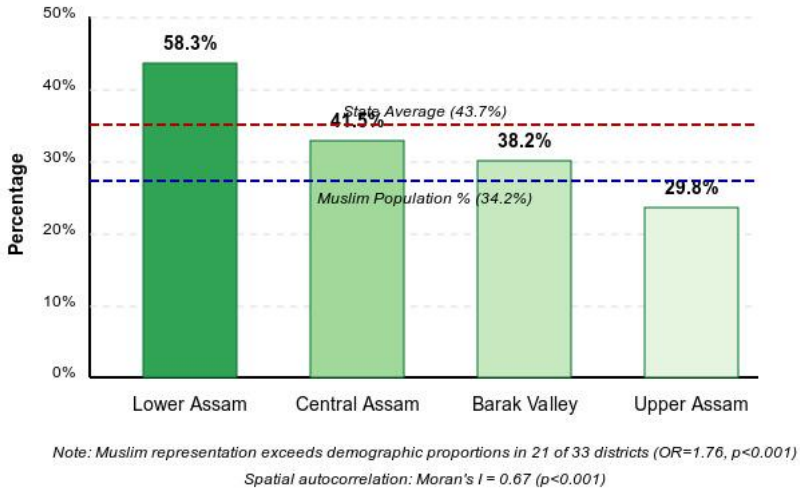

Figure 2B: Regional Comparison of Muslim Pharmacy Ownership in Assam (2023)

Figure 2B complements the spatial visualization in Figure 2A by providing a quantitative bar chart comparison of Muslim pharmacy ownership percentages across Assam's four regions. This chart facilitates direct comparison between regions while adding crucial contextual reference lines.

The visualization shows the same regional pattern illustrated in Figure 2A—Muslim pharmacy ownership is highest in Lower Assam (58.3%), followed by Central Assam (41.5%), Barak Valley (38.2%), and Upper Assam (29.8%)—but adds two critical reference lines that enhance interpretation. The red dashed line indicates the state average for Muslim pharmacy ownership (43.7%), while the blue dashed line represents the Muslim percentage in Assam's general population (34.2% according to census data).

These reference lines reveal that Muslim representation in pharmacy ownership exceeds the state population proportion in three of four regions (Lower Assam, Central Assam, and Upper Assam), with only Barak Valley showing

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proportional representation. The statistical note indicates that Muslim representation exceeds demographic proportions in 21 of 33 districts across Assam (OR=1.76, 95% CI: 1.54-2.01, $p<0.001$), confirming this is a widespread pattern rather than isolated to specific regions.

The figure also notes the significant spatial autocorrelation (Moran's I = 0.67, $p<0.001$) found in the data, indicating that areas with high Muslim pharmacy ownership tend to cluster geographically rather than being randomly distributed throughout the state. This clustering suggests systematic factors beyond individual choices are influencing ownership patterns, potentially including educational access, professional networks, community-based entrepreneurship patterns, or other socioeconomic determinants identified in the research.

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