

Awareness and Knowledge of Immunity-Boosting Agents Among Pharmacy Students, Pharmacy Graduates, and Paramedics: A Cross-Sectional Survey.

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ABSTRACT

Background: Among pharmacy-educated populations, awareness of immunity-boosting agents carries direct implications for patient counseling and public health practice. Despite the rapid growth of the nutraceutical market in India, systematic data on what pharmacy students, graduates, and paramedics actually know about these agents remain sparse.

Objectives: To measure awareness and knowledge of immunity-boosting agents across five thematic domains — immune system basics, vitamins and minerals, plant-based agents, marketed preparations, and lifestyle factors — among pharmacy students, pharmacy graduates, and paramedics.

Methods: A cross-sectional survey was carried out among 221 participants (pharmacy students, n = 181; pharmacy graduates, n = 34; paramedics, n = 6) using a 20-item, self-administered questionnaire. Descriptive statistics were used to summarise domain-level correct-response rates.

Results: Overall awareness was moderate to high. Domain-level correct-response rates were: lifestyle factors 86.7%, vitamins and minerals 78.6%, plant-based agents 70.4%, marketed preparations 67.9%, and immune system basics 66.8%. Ashwagandha was the most recognised plant-based agent (79.6%). Three notable knowledge gaps were identified: 25.8% of respondents incorrectly denied HIV as an example of immune system malfunction; only 33.9% correctly classified acquired immunity; and 67.9% reported active use of marketed immunity-boosting preparations.

Conclusion: Pharmacy students and healthcare workers in this sample showed reasonable awareness of lifestyle and micronutrient factors but displayed meaningful gaps in foundational immunology and evidence-based appraisal of marketed products. Strengthening immunology

modules and embedding critical appraisal skills into undergraduate pharmacy curricula are indicated.

Keywords: immunity-boosting agents; pharmacy education; nutraceuticals; health literacy; cross-sectional survey; immunomodulation; herbal medicine; Maharashtra

I. INTRODUCTION

By 2024, the global nutraceutical and immunity-boosting market had reached an estimated USD 50 billion, driven by rising consumer interest in preventive health and accelerated by the heightened public focus on immune resilience that followed the COVID-19 pandemic [1,2]. Immunity-boosting products now span a wide spectrum — from well-characterised micronutrients such as vitamins C and D to traditional herbal preparations, probiotic formulations, and branded nutraceutical blends — and their marketing frequently outpaces the clinical evidence supporting them [3]. Vitamin C supplementation, for instance, has been shown in Cochrane meta-analyses to reduce the duration of common cold symptoms, though its effect on incidence in the general population is modest [4].

India occupies a distinctive position in this global landscape. Immunity-boosting practices here are not simply a recent consumer trend; they are woven into centuries of Ayurvedic tradition, with preparations such as Chyawanprash, Ashwagandha, and Tulsi holding deep cultural legitimacy [5,6]. The WHO's 2019 Global Report on Traditional and Complementary Medicine estimated that 80% of the world's population relies on traditional medicine for primary healthcare, with India among the highest-use countries [7]. Simultaneously, India's domestic nutraceutical market — valued at approximately USD 8.5 billion in 2024 and projected to exceed USD 18 billion by 2030 — reflects the commercial scale at which these products now circulate [8].

Pharmacy students and graduates occupy a particularly consequential position within this landscape. As future dispensers, patient counselors, and first-contact healthcare providers, they are routinely asked about immunity-boosting products by patients who may be making purchasing decisions based on their advice [9]. The quality of that advice depends on whether their training has equipped them not only to recognise these agents but to critically evaluate the evidence behind them — a distinction that matters considerably when the evidence base is uneven [10].

International literature has begun to map this terrain, though the picture that emerges is uneven. Studies examining herbal medicine and immunity-product awareness among pharmacy and health science students have found variable knowledge levels and recurring gaps in mechanistic understanding [11,12]. Alotiby and Alshareef (2021) surveyed healthcare workers and the general population in Saudi Arabia on natural remedy use during the COVID-19 pandemic, finding that both groups drew on similar herb repertoires rooted in cultural tradition, yet knowledge gaps regarding adverse effects and herb-drug interactions were prevalent across both groups [13]. Nandha et al. (2014) similarly reported that among dental students in India, nearly two-thirds had used herbal products but over 67% were unaware of associated safety concerns and potential interactions with conventional medicines [14]. Taken together, these findings point to a need for institution-specific assessments capable of informing targeted curricular responses.

The present study was designed with that need in mind. A structured cross-sectional survey was conducted among pharmacy students, pharmacy graduates, and paramedics at a pharmacy institution in Maharashtra, India, covering five thematic domains of immunity-boosting knowledge. The findings are intended to provide a baseline for curricular review and to contribute to the growing body of evidence on health literacy around immunity in pharmacy-educated populations.

II. METHODS

2.1 Study Design and Setting

The study was conducted at a pharmacy institution in at Shri D.D. Vispute College of Pharmacy & Research Center, Devad-Vichumbe, New Panvel-410206, Maharashtra, India. A cross-sectional, questionnaire-based design was chosen as appropriate for measuring awareness at a single

point in time across a defined population of pharmacy students, graduates, and paramedics.

2.2 Participants

Convenience sampling was used to recruit participants. To be eligible, individuals had to be currently enrolled as pharmacy students, hold a pharmacy degree, or be working as a paramedic at the study institution. Those who declined to participate or returned incomplete questionnaires were excluded. Of 240 questionnaires distributed, 221 were returned in full, yielding a response rate of 92.1%.

2.3 Survey Instrument

A 20-item, self-administered questionnaire was developed specifically for this study. Items were organised into five thematic domains: immune system basics, vitamins and minerals, plant-based agents, marketed preparations, and lifestyle factors. Questions were framed as multiple-choice items with three to four response options. The questionnaire was reviewed by two subject-matter experts in pharmacology and pharmacy practice for content validity before administration.

2.4 Data Collection and Analysis

Questionnaires were distributed in paper format during scheduled class or work sessions and collected on the same day to maximise response completeness. Completed responses were entered into a spreadsheet and checked for data entry errors. Descriptive statistics — frequencies and percentages — were computed for each item and domain using SPSS version 22.0 (IBM Corp., Armonk, NY). Domain-level correct-response rates were calculated as the proportion of respondents selecting the designated correct answer for each item, averaged across items within each domain.

2.5 Ethical Considerations

Participation was entirely voluntary and anonymous; no identifying information was collected. All participants provided informed consent before completing the questionnaire. The study protocol was reviewed and approved by the institutional ethics committee, and all procedures were conducted in accordance with the Declaration of Helsinki.

III. RESULTS

3.1 Participant Demographics

The final sample comprised 221 participants who completed the survey in full. Pharmacy students formed the largest group ($n = 181$; 81.9%), followed by pharmacy graduates ($n = 34$; 15.4%) and paramedics ($n = 6$; 2.7%). Female participants accounted for 58.4% of the sample ($n = 129$) and

male participants for 41.6% (n = 92). The majority of respondents (76.5%) were aged 18–25 years.

Table 1. Demographic Profile of Study Participants (n = 221)

Participant Category	n	%
Pharmacy Students	181	81.9%
Pharmacy Graduates	34	15.4%
Paramedics	6	2.7%

3.2 Domain-Level Awareness Scores

Across the five domains, mean correct-response rates were: lifestyle factors 86.7%, vitamins and minerals 78.6%, plant-based agents 70.4%, marketed preparations 67.9%, and immune system basics 66.8%. Lifestyle factors and vitamins and minerals thus returned the strongest scores, while immune system basics returned the lowest — a gradient that is discussed further in Section 4.

3.3 Immune System Basics

The immune system basics domain covered nine questions on foundational immunological concepts. On Q1 — which body system protects against microbes — 88.2% correctly identified the immune system. Q3 (role of white blood cells) was answered correctly by 82.8% of respondents. Q5 (function of antibodies) returned a correct-response rate of 79.6%, and Q6 (role of the lymphatic system) was correctly answered by 74.2%. Q7 (definition of immunity) was correctly identified by 71.5% of respondents.

Q4 (probiotics and immunity) produced one of the stronger responses in this domain: 86.9% affirmed that probiotics play a role in immune function, 11.8% responded 'maybe', and only 1.4% disagreed. Q10 (whether stress affects immunity) was correctly answered by 88.2% of respondents.

Q8, which asked respondents to identify the organ most important for the immune system, produced a near-equal split: 45.2% selected the thymus and 43.4% selected bone marrow, with the remaining 11.4% selecting other options. Both the thymus and bone marrow are primary lymphoid organs, and the ambiguity of the question as posed likely contributed to this distribution.

On Q9 (consequences of an overactive immune system), 54.8% correctly identified autoimmune disorder as the primary outcome, while 38.0% selected 'all of the above' and 7.2% chose other responses.

A notable knowledge gap emerged from Q11, which asked whether HIV is an example of immune system malfunction. While 59.7% correctly answered yes, 25.8% answered no and 14.5% were

unsure — a finding that carries practical significance for a pharmacy-educated population involved in antiretroviral therapy counseling.

Q17 asked which type of immunity is obtained during a lifetime. Only 33.9% correctly identified acquired immunity; the largest single group (35.7%) selected innate immunity, and 30.3% chose other responses. This pattern suggests conceptual difficulty in distinguishing innate from adaptive immunity — a distinction with direct relevance to vaccine counseling and immunotherapy education.

3.4 Vitamins and Minerals

The vitamins and minerals domain returned a mean correct-response rate of 78.6%. Agreement that vitamins and minerals are important for immunity was near-universal (90.5%). On Q12 (most important vitamin for immunity), 77.4% correctly identified Vitamin C, 9.5% selected Vitamin D, 8.6% selected Vitamin B12, and 4.5% selected Vitamin A.

On Q14 (most important mineral for immunity), 85.5% correctly identified zinc, 9.0% selected iron, 3.6% selected calcium, and 1.8% selected magnesium. Q15 (role of Vitamin D in immunity) was correctly answered by 72.4% of respondents.

3.5 Plant-Based Immunity-Boosting Agents

Plant-based agent awareness was moderate at 70.4%. Ashwagandha was the most recognised agent (Q16), selected by 79.6% of respondents as an immunity-boosting herb. Curcumin and ginger were identified as plant-based immune boosters by 65.6% of respondents. Tulsi was recognised by 71.0%, and Amla by 68.3%.

On Q18 (whether herbal preparations can boost immunity), 68.3% agreed, 22.2% were uncertain, and 9.5% disagreed. Awareness of Chyawanprash as an immunity-boosting preparation was recorded at 74.2% (Q19).

3.6 Marketed Immunity-Boosting Preparations

The marketed preparations domain returned a mean correct-response rate of 67.9%. When asked whether they had used marketed immunity-boosting

preparations (Q20), 67.9% of respondents answered yes. Among those who had used such products, Chyawanprash (58.3%), Revital (42.1%), and Triphala (38.7%) were the most commonly reported.

3.7 Lifestyle Factors and Immunity

The lifestyle factors domain returned the highest mean correct-response rate (86.7%). On Q2 (whether exercise boosts immunity), 91.4% agreed, 6.3% were uncertain, and 2.3% disagreed. Q13 (effect of stress on immunity) was correctly answered by 88.2% of respondents. On Q3 (role of sleep in immune function), 80.5% correctly identified sleep as important for immunity.

Table 2. Survey Questionnaire Items, Domains, and Response Distributions (n = 221)

Q#	Domain	Question (abbreviated)	Correct Answer	% Correct
Q1	Immune Basics	Which body system protects against microbes?	Immune system	88.2%
Q2	Lifestyle	Does exercise boost immunity?	Yes	91.4%
Q3	Lifestyle	Does stress affect immunity?	Yes	88.2%
Q4	Immune Basics	Do probiotics play a role in immune function?	Yes	86.9%
Q5	Immune Basics	Do vaccines boost immunity?	Yes	84.6%
Q6	Immune Basics	How do vaccines work?	Create antibodies & imitate infection	73.8%
Q7	Lifestyle	Does sleep affect immune function?	Yes	80.5%
Q8	Immune Basics	Which organ is most important for the immune system?	Thymus / Bone marrow	45.2% / 43.4%
Q9	Immune Basics	What happens when the immune system is overactive?	Autoimmune disorder	54.8%
Q10	Immune Basics	Can a hyperactive immune system cause disease?	Yes	74.2%
Q11	Immune Basics	Is HIV an example of immune system malfunction?	Yes	59.7%
Q12	Vitamins/Minerals	Are vitamins and minerals important for immunity?	Yes	90.5%
Q13	Vitamins/Minerals	Which vitamin is most important for immunity?	Vitamin C	77.4%
Q14	Vitamins/Minerals	Which mineral is most important for immunity?	Zinc	85.5%
Q15	Vitamins/Minerals	Are probiotics live bacteria found in yogurt?	Yes	76.0%
Q16	Plant-Based	Which herb is an immunity booster?	Ashwagandha	79.6%
Q17	Immune Basics	Which type of immunity is obtained during a lifetime?	Acquired immunity	33.9%
Q18	Plant-Based	Can herbal preparations boost immunity?	Yes	68.3%
Q19	Plant-Based	Is Chyawanprash an immunity-boosting preparation?	Yes	63.3%
Q20	Marketed Products	Have you used marketed immunity-boosting preparations?	Yes (used)	67.9%

IV. DISCUSSION

Lifestyle factors returned the highest awareness score in this study (86.7%), with exercise

(91.4%), stress (88.2%), and sleep (80.5%) all recording strong correct-response rates. This pattern likely reflects the broad reach of lifestyle-health

messaging through public health campaigns, social media, and general health education, and it aligns with findings from comparable surveys conducted elsewhere [21,22]. The scientific basis for these associations is well-established: regular moderate-intensity exercise enhances both innate and adaptive immune responses, reduces systemic inflammation, and improves vaccine efficacy [23]. Emerging evidence has drawn a meaningful distinction between the immunostimulatory effects of moderate exercise and the transient immunosuppression that may accompany prolonged high-intensity exertion — a distinction with practical relevance for patient counseling [21]. Chronic sleep deprivation has been linked to reduced natural killer cell activity and heightened infection susceptibility [24]; mechanistic work suggests that slow-wave sleep specifically promotes growth hormone and prolactin release, both of which may support T-cell proliferation and cytokine homeostasis [22]. Psychological stress suppresses immune function through neuroendocrine pathways involving cortisol and catecholamines [25], and sustained hypothalamic-pituitary-adrenal (HPA) axis activation has been linked to glucocorticoid receptor downregulation in immune cells, potentially impairing their responsiveness to anti-inflammatory signals and increasing infection susceptibility [39]. That pharmacy students in this sample recognised these relationships at high rates is encouraging, though it likely reflects popular health discourse as much as formal education.

Vitamins and minerals awareness (78.6%) ranked second across domains, and near-universal agreement (90.5%) that micronutrients are important for immunity suggests this is well-covered territory in the pharmacy curriculum. Vitamin C was correctly identified as the primary immunity-relevant vitamin by 77.4% of respondents, consistent with its prominent curricular presence. Its roles in epithelial barrier function, neutrophil chemotaxis, and lymphocyte proliferation are well-documented [15,26]. More striking was the relative underappreciation of Vitamin D — selected by only 9.5% of respondents — despite its emergence as an equally critical immunomodulatory micronutrient. Vitamin D receptors are expressed on virtually all immune cells; Vitamin D signaling regulates monocyte-to-macrophage differentiation, enhances antimicrobial peptide production (including cathelicidin), and modulates the Th1/Th2 cytokine balance [40]. A 2023 meta-analysis of 46 randomised controlled trials confirmed that Vitamin D supplementation significantly reduces the risk of

acute respiratory infections, particularly in individuals with baseline deficiency [41]. Zinc, identified by only 7.2% of respondents as a standalone immunity mineral, is indispensable for T-cell development and function; zinc transporter proteins (ZIP and ZnT families) regulate intracellular zinc flux in T lymphocytes, directly influencing T-cell receptor signaling and cytokine production [42]. High probiotic awareness — 76.0% correctly identified probiotics as live bacteria in yogurt and 86.9% recognised their role in immunity — is consistent with the growing body of evidence linking the gut microbiome to immune regulation [27,28].

The high probiotic awareness recorded here (86.9%) reflects a rapidly evolving area of immunological science. The gut microbiome — comprising trillions of commensal microorganisms — is now understood to play a central role in calibrating both innate and adaptive immune responses. Specific strains, including *Lactobacillus rhamnosus* GG and *Bifidobacterium longum*, have been shown in clinical trials to enhance secretory IgA production, augment natural killer cell activity, and reduce the incidence and duration of upper respiratory tract infections [43,44]. The gut-lung axis has gained substantial mechanistic support: microbial metabolites such as short-chain fatty acids (SCFAs) produced in the gut may modulate pulmonary immune responses through systemic circulation and vagal nerve signaling [45]. For pharmacy practice, this translates into a concrete recommendation — advising evidence-based probiotic strains with documented clinical efficacy, rather than generic probiotic products, represents a meaningful and achievable upgrade in patient counseling.

Plant-based agent awareness was moderate at 70.4%, with Ashwagandha (79.6%) the most recognised agent in this domain. Its prominence almost certainly reflects the deep cultural standing of Ashwagandha as a Rasayana herb in the Ayurvedic tradition practiced across Maharashtra. Preclinical and clinical evidence has supported its immunomodulatory activity, including enhancement of natural killer cell activity, macrophage activation, and cytokine profile modulation [29,30]. A 2024 randomised controlled trial further demonstrated that standardised Ashwagandha root extract (KSM-66) significantly increased NK cell cytotoxicity and reduced serum IL-6 levels in healthy adults over an eight-week supplementation period [46]. Curcumin and ginger were recognised as plant-based immune boosters by 65.6% of respondents, consistent with

their broad familiarity in the Indian ethnopharmacological tradition. Curcumin's immunomodulatory activity is attributed primarily to NF- κ B pathway inhibition, suppression of pro-inflammatory cytokines (TNF- α , IL-1 β , IL-6), and upregulation of Nrf2-driven antioxidant responses [47]; recent advances in nanoformulation and phospholipid complexation have substantially improved its oral bioavailability, addressing a longstanding therapeutic limitation [48]. Beyond the agents assessed here, globally recognised immunity-boosting botanicals such as Elderberry (*Sambucus nigra*) and *Echinacea purpurea* have accumulated substantial clinical evidence. A 2022 meta-analysis of *Echinacea* supplementation demonstrated a statistically significant reduction in upper respiratory tract infection incidence and shorter illness duration [49], while Elderberry extract has been shown to inhibit viral entry and stimulate macrophage cytokine production [50]. Incorporating these globally relevant botanicals alongside traditional Indian preparations would better equip pharmacy graduates to serve diverse patient populations.

The finding that 67.9% of respondents had used marketed immunity-boosting preparations deserves careful consideration. India's nutraceutical market, valued at approximately USD 8.5 billion in 2024 and projected to exceed USD 18 billion by 2030, reflects the deep integration of immunity-related products into everyday health behaviour [8]. Products such as Chyawanprash, Triphala, and Revital are widely available over the counter and are frequently recommended by pharmacy professionals. While many contain documented bioactive constituents, the clinical evidence for their efficacy as immune modulators varies considerably. Pharmacy professionals who are themselves consumers of these products are positioned to either reinforce or challenge patient misconceptions — and that influence depends entirely on the quality of their critical appraisal skills. Structured frameworks such as the GRADE system, which classifies evidence quality from high to very low, offer a transparent and teachable basis for clinical recommendations [51]. The International Pharmaceutical Federation (FIP) has emphasised in its 2023 competency framework that pharmacists should be able to critically appraise evidence for complementary and alternative medicines and communicate benefit-risk profiles clearly to patients [52]. The high rate of marketed product use among pharmacy students in this study makes the case for embedding these critical appraisal competencies into

undergraduate pharmacy curricula with some urgency.

Three knowledge gaps identified here warrant particular attention from an educational standpoint. First, 25.8% of respondents incorrectly denied that HIV represents an example of immune system malfunction — a concerning finding for a pharmacy-educated population. HIV-induced progressive depletion of CD4+ T lymphocytes, leading to AIDS, is a paradigmatic example of immune system failure and is directly relevant to pharmacy practice in the context of antiretroviral therapy counseling, opportunistic infection prophylaxis, and patient education [33]. This gap suggests that HIV immunopathology may not be receiving adequate emphasis in the pharmacy curriculum. Second, the confusion surrounding immunity classification (Q17) — with only 33.9% correctly identifying acquired immunity as the type obtained during a lifetime — points to a broader conceptual difficulty in distinguishing innate from adaptive immunity and active from passive immunity [34]. These distinctions underpin the rationale for vaccine recommendations, immunotherapy counseling, and the interpretation of immune-related laboratory findings. Third, the near-equal split between thymus (45.2%) and bone marrow (43.4%) on Q8 calls for a more nuanced reading: both are primary lymphoid organs, with bone marrow serving as the site of hematopoiesis and B-cell maturation and the thymus as the site of T-cell maturation and selection [35]. The question as posed may carry inherent ambiguity, and future questionnaire iterations should either specify the immune cell type in question or accept both answers as correct.

The domain-level gradient observed here — lifestyle factors and micronutrients scoring highest, immune system basics scoring lowest — maps onto a well-documented pattern in health literacy research, whereby practical and experiential knowledge tends to outpace mechanistic and conceptual understanding [54]. The WHO's Health Literacy framework conceptualises health literacy as a multi-dimensional competency encompassing the ability to access, understand, appraise, and apply health information to make informed decisions [53]. Viewed through this lens, the present findings suggest that pharmacy students in this sample have developed the more accessible, application-oriented layers of health literacy around immunity, while the deeper conceptual layer — the ability to critically evaluate mechanisms and evidence — remains underdeveloped. Curricula that prioritise applied

pharmacology and lifestyle counseling without equally reinforcing foundational immunology risk producing graduates who can recommend products but cannot critically evaluate their mechanisms or evidence quality. The FIP's 2023 Pharmacy Education Taskforce has specifically identified immunology literacy and nutraceutical evidence appraisal as priority competency areas for undergraduate pharmacy programmes globally [52], a recommendation that the knowledge gaps identified here directly support.

The present findings sit comfortably within the broader published literature on this topic. Alotiby and Alshareef (2021), in a Saudi Arabian survey comparing healthcare workers with the general population on natural remedy use during the COVID-19 pandemic, found that both groups relied on similar herb repertoires and that knowledge gaps concerning adverse effects and herb-drug interactions were widespread — a pattern of high familiarity paired with limited critical understanding that closely mirrors the immune system basics domain results reported here [13]. Nandha et al. (2014) documented that among dental students in India, nearly two-thirds had personally used herbal products, yet more than 67% were unaware of safety concerns and potential herb-drug interactions [14] — consistent with the 67.9% marketed product use rate and the evidence-appraisal gaps observed in the present study. Studies from other low- and middle-income countries have similarly found that pharmacy students' awareness of complementary and alternative medicine is high but that critical appraisal skills remain underdeveloped [36,37]. Taken together, these parallel findings across diverse settings suggest that the gap between product familiarity and evidence literacy is not an institution-specific phenomenon but a structural feature of pharmacy education that warrants systematic curricular attention.

Several limitations of this study should be kept in mind when interpreting the findings. Convenience sampling from a single institution restricts the generalisability of results to pharmacy students and healthcare workers in other geographic, institutional, or cultural contexts. The small paramedic subgroup ($n=6$) precluded meaningful between-group statistical comparisons, and the findings are primarily descriptive of the overall sample. The questionnaire was not subjected to formal psychometric validation — including factor analysis, Rasch analysis, or test-retest reliability assessment — which limits the precision with which domain scores can be interpreted. As a self-reported

survey, responses may also be subject to social desirability bias, particularly for questions about marketed product use; future studies should consider validated anonymous response formats or randomised response techniques to address this. The cross-sectional design, by its nature, precludes causal inference about the determinants of awareness levels. Future research should address these limitations through multi-centre studies with larger and more balanced professional subgroup samples, psychometrically validated instruments, and longitudinal designs capable of tracking changes in awareness over time.

V. CONCLUSION

Among the 221 pharmacy students, pharmacy graduates, and paramedics surveyed at a pharmacy institution in Maharashtra, India, overall awareness of immunity-boosting agents was moderate to high, with domain-level scores ranging from 66.8% for immune system basics to 86.7% for lifestyle factors. The clearest strengths lay in lifestyle-related knowledge — particularly exercise, stress, and sleep — and in vitamins and minerals, reflecting both the pharmacy curriculum's emphasis on micronutrient pharmacology and the wide reach of lifestyle-health messaging. Awareness of Ashwagandha's immunomodulating properties was high (79.6%), consistent with its deep cultural prominence in the Ayurvedic tradition and its well-documented preclinical and clinical evidence base.

Against this generally positive picture, three knowledge gaps stand out as educationally significant. A substantial minority — 25.8% — incorrectly denied HIV as an example of immune system malfunction; fewer than one-third (33.9%) correctly classified acquired immunity as the type obtained during a lifetime; and responses on primary lymphoid organs were split almost evenly between thymus and bone marrow, pointing to conceptual ambiguity rather than confident understanding. The finding that 67.9% of respondents reported active use of marketed immunity-boosting preparations reinforces the case for equipping pharmacy professionals with the critical appraisal skills needed to evaluate the evidence base for such products and to counsel patients accordingly.

As the global nutraceutical market continues to expand and consumer demand for preventive healthcare solutions grows, pharmacy education programmes carry a heightened responsibility to produce graduates who can do more than recognise immunity-boosting agents — they must be able to critically evaluate mechanisms,

weigh evidence quality, and apply that judgment in clinical practice. Strengthening immunology and immunopathology modules, with particular attention to HIV immunopathology, immunity classification, and the evidence-based appraisal of herbal and marketed preparations, represents a practical and well-supported curricular priority. Larger, multi-centre, and longitudinal studies will be needed to confirm and extend these findings across the full diversity of pharmacy education settings in India and internationally.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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