Lactose Intolerance in Saudi Arabia: A Systematic Review of Prevalence and Patterns

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ABSTRACT

Lactose Intolerance (LI) is an underdiagnosed yet prevalent medical condition in Saudi Arabia with serious public health implications. This systematic review analyzes current literature on LI prevalence, demographic patterns, clinical associations, and regional disparities, particularly in the context of the Saudi population. Results highlight methodological disparities while reporting prevalence rates ranging from 7.3% physician-confirmed values to 45.3% biochemically confirmed which underscores variations in diagnostic protocols. Demographic trends reveal increased LI awareness, particularly in female and younger populations (11-30 years), however, symptom reporting across the findings was inconsistent. Regional differences existed in genetically influenced LI distribution in regions where the prevalence of lactase persistence was dominated such as urban regions like Riyadh. Nutritional deficiencies like vitamin D and calcium are also correlating to dairy avoidance which not only escalates health risks like bone-related deformities. Given the increased dairy consumption, challenges such as underreporting of symptoms and misdiagnosis were persistent which is further complicated by confusion among LI and milk allergy symptoms within patients and healthcare providers alike. There was a research gap identified in the findings of inadequate urban-rural comparisons and pediatric data along with poor LI education in medical curricula. The study recommends the inclusion of adapting standardized diagnostic tools, improving genetic research, and integrating LI awareness into public health campaigns. It is important to address these challenges while emphasizing preventive healthcare and nutritional fortification for the improvement of LI management and reduced interrelated comorbidities across the Kingdom.

Keywords: Lactose Intolerance, Saudi Arabia, Public Health, Prevalence, Diagnostic Errors, Lactase.

INTRODUCTION

Lactose intolerance (LI) is classified as a medical condition recognized by the symptoms caused due to lactose malabsorption which indicates an absence or reduced efficiency of lactase or its diminished synthesis[1]. Due to lactase deficiency, unabsorbed lactose present within the intestinal tract may exert symptoms of lactose intolerance in susceptible individuals. The biological mechanism involves insufficient lactase enzyme levels not allowing lactose to be hydrolyzed into glucose and galactose in the small intestine, increasing osmotic load which elevates the intestinal water content, which not only secretes fluid and electrolytes but also causes dilation and speeding up transit of small intestine. Lactose upon reaching the colon is fermented by the colonic microbiome which results in the generation of short-chain fatty acids and gasses. This event leads to gastrointestinal symptoms comprising abdominal pain, bloating, flatulence, diarrhea, nausea, and borborygmi (intestinal rumbling sounds)[2,3]. The severity of lactose intolerance symptoms is subjective and varies such as depending on the amount of lactose ingested, the amount of lactase present within intestinal mucosa or intestinal flora, gastrointestinal motility, and an individual's sensitivity toward the symptoms[4].

Lactose Intolerance is typically characterized by three types: Primary lactose intolerance is driven by the developmentally regulated change in the lactase gene expression also known as adult-type lactase deficiency, Secondary lactase deficiency incorporates a medical condition exacerbated by intestinal damage which is secondary to various infections, food allergy, celiac disease, small bowel bacterial overgrowth, Crohn's disease etc. and the third type is congenital lactase deficiency (CLD) which a rare autosomal disease due to absence od reduced enzymatic activity from birth[5]. About 57% of the global population suffers from lactose intolerance[6]. However, this distribution is uneven globally and is expected to rise by 65%[7]. The LI burden in the USA is 50%, 70% in Asia, and almost 100% in African nations. While this distribution in the United States affects 15% whites, 53% Mexican-Americans, and 80% Afro-Americans. Whereas European prevalence rates are about 28% variability exists within the continent with fluctuation from 2% in Scandinavia to 70% in Southern Italy[8]. West Africans and Arab Descent are the most vulnerable to lactose intolerance[9]

There is an increased risk of Lactose intolerance within Middle-Eastern countries and Arab countries, for instance in a study in Kuwait, 82.1% of the sample population reported positive lactose intolerance, and 65 reported cases of severe lactose intolerance with all of them reported significant symptom experiences[10]. While in a larger cohort of the Saudi population involving 1189 participants indicated self-reporting of LI with symptoms representation from ages 11 and 30. Additionally, 68.2% of participants were daily airy consumers among those 36.5% expressed abdominal disturbances and gases, 22.8% abdominal pain, and 12.1% diarrhea after consuming dairy[11]. However, LI remains understudied within Saudi population contexts. Studies show

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traditionally dairy consumption plays very little to no role in dietary patterns which was also persistent mostly in the rural population. Interestingly, the increased access to a variety of dairy products due to urbanization and modernization is emphasizing awareness and potential benefits in Saudi Arabia[12]. This increased availability of processed dairy products containing lactose is susceptible to introducing lactose exposure in the population, complicating symptoms within lactose-intolerant individuals. Nutritional deficiencies due to inadequate dairy intake such as a study from boys to girls and from men to women, all of them have substantiated Vitamin D deficiency which strongly suggests fortification of dairy products is required[13]. In addition to these factors, misdiagnoses or underdiagnoses of LI is another challenging dimension in Saudi Arabia where a study reported high daily diary consumption in the population but only 13.8% were diagnosed accurately[14].

There is a wider research gap in Saudi studies with fragmented diagnostic methods used for LI diagnosis where Self-reported LI prevalence shows method-dependent variability against (Hydrogen Breath Test) HBT-confirmed rates. Furthermore, inconsistent approaches and symptom overlaps with IBS and poor awareness regarding diagnosis and symptom management are recurring issues[11,15]. Saudi studies for the prevalence of the LI population often underrepresent pediatric and urban-rural comparisons such as within various regional health studies different health conditions are discussed for these populations but do not involve LI[16,17].

This systematic literature review seeks to present a comprehensive synthesis of the current literature available on Lactose Intolerance (LI) in Saudi Arabia, focusing on understanding prevalence patterns, demographic factors, and clinical associations. Furthermore, this review explores reliable estimates of LI burden across the regions of the Saudi Kingdom while demonstrating at-risk subpopulations. Moreover, this study investigates the interconnection between LI and other medical conditions involving nutritional deficiencies and chronic gastrointestinal conditions which will help inform healthcare and public health policymakers to cater to the diverse Saudi population.

METHODOLOGY

Study Design: This study employs a systematic literature review design to synthesize existing literature on lactose intolerance (LI) in Saudi Arabia, focusing on prevalence patterns, demographic factors, and clinical associations. Adhering to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, the study ensures a rigorous and transparent process for selecting, evaluating, and synthesizing relevant research. The review includes peer-reviewed articles (clinical studies, cross-sectional cohorts) published in 2010 and 2024, targeting studies on LI prevalence, diagnostic methods, symptom management, and regional variations within Saudi Arabia.

Search Strategy: Academic databases, including PubMed, Google Scholar, and Saudi Digital Libraries, were utilized to search for relevant literature (Table 1). Keyword combinations related to lactose intolerance, prevalence, and Saudi Arabia were employed to refine the search. Key terms included: "Lactose Intolerance," "LI Prevalence," "Saudi Arabia," "Lactase Deficiency," "Dairy Consumption," "Hydrogen Breath Test," "Self-reported LI," "Urban-Rural Disparities," and "Pediatric LI." Boolean operators (AND, OR) were applied to narrow results to studies directly addressing LI in the Saudi context. Additional filters were used to exclude studies outside the specified timeframe or irrelevant to the research objectives. The search also incorporated references from selected articles to ensure comprehensive coverage of the topic.

Inclusion Criteria: The inclusion of studies involved publications published between 2010 and 2024, ensuring the relevance to the current LI landscape with diverse methodologies such as Peer-reviewed publications, clinical studies, cross-sectional cohorts, or theses. Studies discussing LI prevalence, diagnostic approaches, demographic factors, or clinical associations were given importance and lastly, full-text availability of English or Saudi language along with its translations were also ensured.

Exclusion Criteria: Studies were excluded if they were published before 2010, were in languages other than English or Arabic, lacked

Table 1. Defined Search Strategy

Database	Search terms	Boolean Operators
PubMed	(“Lactose Intolerance” OR “LI prevalence” OR “Lactase Deficiency” OR “Hypolactasia”) AND (“Saudi Arabi” OR “Middle East” OR “GCC”) (“Dairy Malabsorption” OR “Milk Allergy”) AND (“Saudi population” OR “Arab descent”) (“Gastrointestinal Symptoms” OR “Bloating” OR “Diarrhea”) AND (“Hydrogen Breath Test” OR “HBT”)	AND, OR
Google Scholar	(“Dairy Consumption Patterns” OR “Milk Intolerance”) AND (“Saudi Arabia” OR “Urban-Rural Disparities”) (“Self-reported LI” OR “System Perception”) AND (“Pediatric LI” OR “Adult LI”) (“Nutritional deficiencies” OR “Vitamin D Deficiency”) AND (“Saudi Health Surveys”) OR “Kingdom of Saudi Arabia”)	AND, OR
Saudi Digital Libraries	(“LI Diagnosis” OR “Lactose Tolerance Test”) AND (“Saudi Regions” OR “Jazan” OR “Riyadh”) (“Secondary Lactase Deficiency” OR “Congenital LI”) AND (“Saudi Clinical Studies OR “KSA Hospital Data”) (“Public Health Policies” OR “Dairy Fortification”) AND (“Saudi Ministry of Health” OR “Vision 2030 Nutrition”)	AND, OR

Table 2. Protocol for Study Selection

Criteria	Inclusion	Exclusion
Population	Studies focusing on individuals in Saudi Arabia with lactose intolerance	Studies outside of Saudi Arabia or unrelated to lactose intolerance
Phenomenon	LI prevalence, diagnostic methods, demographic factors, clinical associations	Studies not addressing LI or its clinical/nutritional impacts.
Publication Type	Peer-reviewed articles, Clinical studies, cross-sectional cohorts, theses	Editorials, Opinion pieces, or non-academic content
Time Frame	2010–2024	Publications before 2010 unless seminal works
Language	English and Arabic (translated if needed)	Non-translatable content

data relevant to Saudi Arabia or LI, and were non-peer-reviewed such as editorials, opinion pieces, or non-academic reports (Table 2). To ensure the methodological and academic quality of synthesis, studies demonstrating low methodological rigor were also excluded.

Study Selection: Studies were selected with strict adherence to PRISMA guidelines for ensuring systematic transparency. Initial academic database searches across PubMed, Google Scholar, and Saudi Digital Libraries with the help of keywords like *"Lactose Intolerance", "Saudi Arabia", and "Hydrogen Breath Test"* yielded 400 studies. Duplicates were removed and 200 studies were screened for title and abstract, with the exclusion of 180 studies for irrelevance. 20 studies were then checked for eligibility and full-text availability, while excluding 14 more studies lacking data and required focus. Finally, 06 studies were selected for the qualitative synthesis, ensuring alignment with the study's objective. Figure 1 illustrates the PRISMA flowchart depicting the screening process.

Quality Assessment: Design-specific quality assessment tools were employed to ensure the methodology and rigor of the included studies and minimize bias (Table 3). JBI checklists were utilized for evaluating cross-sectional studies focusing on sample representativeness and measurement accuracy. Assessment of group comparability and outcome reliability of Comparative studies were carried out. Observational Studies were ranked using the Newcastle-Ottawa Scale underlining the outcome and exposure measurement. Additionally, Genetic studies employed STREGA guidelines for reporting variations and population stratification. Discrepancies were resolved through mediation of two independent reviewers.

Data Analysis: A thematic analysis approach was carried out for the identification of recurring and emerging themes across studies providing insights into regional and demographic variations persisting among LI prevalence, clinical differences related to confirmed LI values, clinical correlations with nutritional deficiencies or comorbid conditions, and the public health disparities.

RESULTS

Study Characteristics

Diverse methodologies were a feature of selected studies (n = 6) for the investigation of lactose intolerance (LI) in Saudi Arabia, while particularly focusing on prevalence, demographic patterns, and clinical associations. A cross-sectional study design was utilized for the majority of the studies (n = 4) including self-reported surveys, biochemical tests, or hydrogen breath tests (HBT) for diagnosis. Sample sizes varied

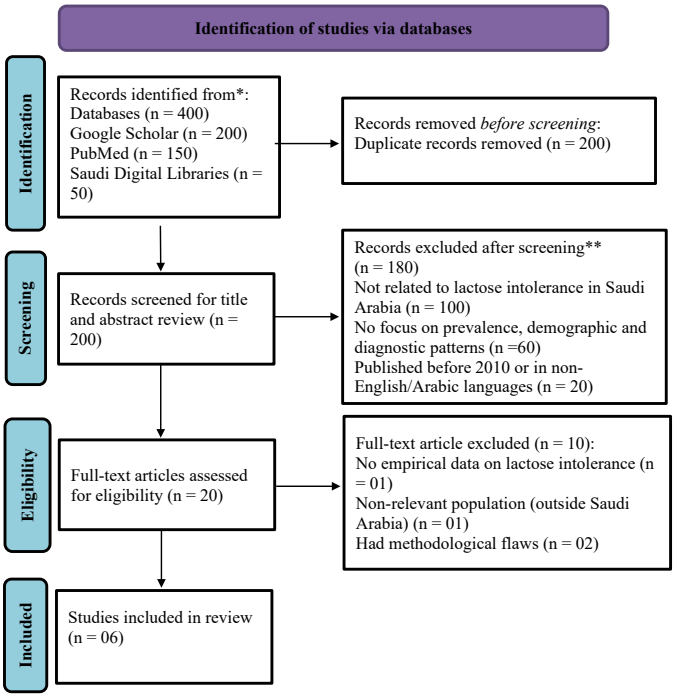

Figure 1. Identification of studies via databases

Table 3. Quality Assessment of Included Studies

Study (Year)	Design	Tool Used	Key Criteria Assessed	Strength	Limitation	Overall Rating
Aleyeidi et al. (2024)	Cross-sectional	JBI Checklist for Cross-Sectional Studies	Sample representativeness, measurement validity, confounding control, statistical methods	High response rate, clear symptom reporting	Self-reported data (potential bias)	Moderate-High
Bakry et al. (2023)	Comparative	JBI Checklist for Comparative Studies	Group comparability, exposure measurement, outcome assessment	Standardized survey, large sample size	No clinical confirmation of LI	Moderate
Alzahrani et al. (2022)	Cross-sectional	JBI Checklist for Cross-Sectional Studies	Sample representativeness, diagnostic validity (HBT), confounding factors	Used HBT for diagnosis, regional diversity	Limited adjustment for confounders (e.g., diet)	High
Kambal et al. (2024)	Cross-sectional	JBI Checklist for Cross-Sectional Studies	Awareness assessment, symptom reporting, regional focus (Jazan)	Community-based sampling, clear objectives	Self-reported LI (no HBT validation)	Moderate
Suayb et al. (2023)	Cross-sectional	JBI Checklist for Cross-Sectional Studies	Sample representativeness, diagnostic validity (biochemical testing), symptom reporting	Used biochemical testing for diagnosis, high prevalence reported (45.3%)	Potential selection bias, limited demographic diversity	Moderate-High
Imtiaz et al. (2007)	Genetic Association	STREGA checklist	Variant definition (LCT gene), population stratification, replication	Molecular confirmation of lactase persistence	Small sample size, and limited Saudi diversity.	Moderate

from 1189 participants[11] to fewer regional cohorts such as[15]. There was significant variance between prevalence rates, from 7.3% (physician-confirmed) to 45.3% (biochemically confirmed) which is an indication of methodological disparities. Additionally, studies also underscored demographic trends such as increased LI awareness in females and younger populations (11-30 years), however, symptom reporting was a persistent challenge. There is regional variation in terms of genetic adaptations was also highlighted (e.g., T/G-13915) variant regarding lactase persistence. Another aspect noted in the studies is the nutritional deficiencies such as Vitamin D and Calcium persistence due to decreased dairy consumption, while public awareness was reported to be significantly low. Several limitations were also noted such as reliance on self-reported data, small sample sizes, and gaps in rural-urban comparison (Table 4).

Thematic Analysis

Theme 1. Prevalence and Demographic Patterns of Lactose Intolerance in Saudi Arabia

It is imperative for Saudi Arabia's public health interventions that there is a thorough understanding of the prevalence of lactose intolerance (LI). There is a vast disparity between the prevalence rates among the studies, utilization of diagnostic criteria and tools, varying methodologies, and the populations studied. Suayb et al. (2023) reported one of the highest LI prevalence at 45.3% while using biochemical testing as a diagnostic tool[14]. Contrarily, Aleyeidi et al. (2024) observed a decreased physician-attested prevalence of 7.3%, while the positive screening correlated through the use of non-clinical tools among 14.7% of participants, this is reflective of increased underdiagnosis within general Saudi populations (18). Alzahrani et al. (2022) demonstrated 8.7% self-reported cases[11] whereas Kambal et al. (2024) reported in the Jazan population, a 13.8% diagnosed prevalence, both of these findings highlight the disparities persisting among methodologies across regions[15]. Studies also highlighted demographic inconsistencies such as predominant gender differences. Aleyeidi et al. (2024) reported only 9.7% of males had positive screening whereas females had higher values consisting of 15.4% of the population, this is also in agreement with Kambal et al. (2024) who denoted that female demographics are more aware about LI than males[15,18]. This is in contrast to Suayb et al. (2023) findings who observed increased biochemical positivity within the male population (30.3%) which might be attributed to metabolic or behavioral factors like dairy consumption[14]. These disparities emphasize the urgency of standardized diagnostic strategies.

Furthermore, Age has also been seen to be influencing LI prevalence across studies. With an earliest and common onset reported within the range of 11-30 years[11,15], younger participants were found to be more inclined toward better LI awareness. This awareness could be explained by their increased exposure to digital platforms providing the latest health information. This awareness was also due to increased educational levels such as higher knowledge of LI was demonstrated across studies in University graduates[11,15], however, this awareness didn't contribute significantly to the understanding of LI even in medical students[19], here 99.75% showed a significantly poor understanding of LI. This is reflective of the systemic gaps existing within medical academic curricula which not preparing adequate future healthcare professionals.

Theme 2: Regional Burden of Lactose Intolerance in Saudi Arabia

National data are scarce on the LI burden, whereas regional studies present the LI burden on Saudi Arabia to be heterogeneous. Studies like Kambal et al. (2024), with their focus on the Jazan region, reported a 13.8% rate of diagnosis whereas Aleyeidi et al. (2024) sample the population of Riyadh while demonstrating a 14.7% prevalence of likely undiagnosed population[15,18]. While Alzahrani et al (2022) wider sample was not region-specific, it particularly contributed 8.7% of self-reported cases which is suggestive of an increased variability existing between urban and more rurally inclined populations[11]. There is another interesting aspect highlighted in the genetic studies where the identified variants such as the T/G-13915 which is an important genetic marker for lactase persistence across Saudi regions while presented in 76.9% of the samples[20]. The prevalence of Lactase persistence and lower LI prevalence are more common in metropolitan regions such as Riyadh could be explained by the higher frequency of this allele in the urban populations and might be helpful in the explanation of some regional differences.

The regional differences are also exacerbated due to the environmental and dietary elements. In the instance of daily dairy consumption, there were disparities in symptom reporting while the consumption was reported high (64.7-68.2%) across studies. There was a lower incidence of reporting gas or distension due (18%) contrary to the higher consumption[15], whereas similar symptoms reported by Alzahrani et al. (2022) had a frequency of 36.5%[11]. This variability is predominantly influenced by regional differences with several factors such as dairy types consumed, dietary habits, or gut microbiota profiles. However, there is a concerning research gap between the urban versus rural prevalence rates which was evident as no study reported these differences. Provided the genetic and dietary variations, it is of utmost importance to focus future research on the stratification of data within regional or genetic dimensions to create a thorough understanding of the geographical burden of LI within Saudi Arabia.

Theme 3: Clinical and Nutritional Associations of Lactose Intolerance

Gastrointestinal discomfort associated with Lactose Intolerance is not the only clinical significance as it extends further. Within studies, the critical aspect is increased underdiagnosis of LI patients, which not

Table 4. Study Characteristics Table

Study (Year)	Design	Sample Size	Population	Diagnostic Methods	Key Findings	Limitation
Aleyeidi et al. (2024)	Cross-sectional	Not specified	General population (Riyadh)	Screening tool (47% sensitivity)	14.7% likely undiagnosed LI; higher in females (15.4%)	Self-reported data, potential bias
Bakry et al. (2023)	Comparative	Not specified	Medical students	Survey-based assessment	Poor LI knowledge (99.75%)	No clinical confirmation of LI
Alzahrani et al. (2022)	Cross-sectional	1189	General population	Self-report, HBT	8.7% self-reported LI; 36.5% abdominal symptoms	Limited adjustment for confounders
Kambal et al. (2024)	Cross-sectional	Not specified	Jazan region	Self-report, awareness survey	13.8% diagnosed LI; low awareness of complications	No HBT validation
Suayb et al. (2023)	Cross-sectional	Not specified	General population	Biochemical testing	45.3% LI prevalence; weak link to constipation	Potential selection bias
Imtiaz et al. (2007)	Genetic association	Neonatal samples	Urban population	Genetic testing (LCT gene)	T/G-13915 variant dominant (76.9%)	Small sample size, limited diversity

only limits the management of the symptoms but also the associated health challenges. Nutritional deficiencies are an emerging concern particularly related to deficiencies of Vitamin D and calcium, majorly due to dairy avoidance. Given the emergence, the majority of the Jazan population (92.6%) was unaware of complications like osteoporosis[15]. While gastrointestinal challenges are very common, they also tend to be reported very scarcely. Alzahrani et al. (2022) demonstrated abdominal distension (36.5%), pain (22.8%), and diarrhea (12.1%) to be the commonly reported symptoms[11], while there was no significant association observed between LI and these symptoms in the study by Suayb et al. (2023), except a very well link established with constipation ($p = 0.03$)[14]. These disparities may be a result of utilizing different diagnostic tools or perceptions of symptoms within the particular population.

Additionally, the associations between chronic conditions such as irritable bowel syndrome (IBS) and Inflammatory Bowel Disease (IBD) are unsupported within Saudi cohorts. Studies like Suayb et al. (2023) explicitly reported finding no correlation between LI and chronic conditions which is in disagreement with international research[21]. However, there was a modest but statistically significant influence of weight loss reported (19.2% of LI-positive individuals; $p = 0.047$) which underscores broader health outcomes[14]. The reporting of decreased diagnostic knowledge of LI among medical students[19] also exacerbates the likelihood of misdiagnoses or overdiagnosis within clinical practice. A striking feature was the persistence of misconceptions regarding LI within studies such as Alyeidi et al. (2024) reporting that 36.5% of the sample population misidentified rashes and shortness of breath to be symptoms of LI which are commonly confused with milk allergies[18]. Likewise, 48.8% of participants in the Jazan study highlighted the misidentification existing between milk allergy and LI to be the same conditions[15].

Theme 4: Implications for Public Health and Healthcare Policy

The findings are reflective of critical implications for public health strategy along with healthcare policy in Saudi Arabia. The vast disparities between knowledge and educational gaps should be addressed on priority. As underlined in Aleyeidi et al (2024) and Bakry et al. (2023) there is a lack of basic knowledge even among health professionals and medical students[18,19] which not only adds to the complexity of patients care but for diagnosis too. There is an increased emergence of requiring LI inclusion within medical and nutritional education curricula. Additionally, Diagnosing LI remains a major challenge, with screening tools providing moderate sensitivity and Aleyeidi et al. (2024) instrument reporting 47% sensitivity which might involve a higher chance of being false negatives[18]. Conversely, Imtiaz et al. (2007) favored genetic testing over traditional methods with the presence of T/G-13915 gene being predominant within Saudi populations[20], it could prove as an alternative to traditional invasive diagnostic procedures like lactose tolerance test along with streamlining the diagnosis protocols and lower the burden of undiagnosed LI cases.

DISCUSSION

This systematic literature review provides a comprehensive synthesis of the prevalence, demographic patterns, clinical associations, and public health implications related to lactose intolerance (LI) in Saudi Arabia. Findings revealed the methodological disparities in adding to the complexity of LI prevalence in Saudi Arabia which is mostly reliant on self-reported data leading to undermining the existing burden in comparison to genetic or biochemical testing. These findings are in agreement with broader literature trends which highlight LI prevalence to be challenging throughout due to variance in the diagnostic criteria[22]. This is further strengthened in the study of Bayless et al. (2017) who established that globally self-reported cases of LI are lower in comparison with hydrogen breath test (HBT)--confirmed cases, further highlighting the need for standardized diagnostic criteria. HBT sensitivity against self-reported LI prevalence is tested in various studies, highlighting 37.7% of reported cases to be positive[23] which is in contrast with the 8.7% of self-reported cases presented in the findings. The higher prevalence due to employing biochemical methods within Saudi studies might underscore the reliance on subjective testing may pose a hindrance for actual LI scales. Additionally, prevalence estimates are further complicated due to genetic factors. While the lactase persistence gene was dominant in the Saudi urban population, regional variation regarding genetics may help understand the challenges. Studies are suggestive of coastal regions reporting lower LI prevalence levels due to the presence of lactase-persistent alleles within those regions[24], which indicates that similar geographical patterns are persistent in Saudi Arabia as well. This highlights the potential of genetic testing along with dietary surveys for verification of the suggested relationships.

Disparities in the awareness levels were also identified in the findings, particularly among females and younger populations[11-30] years which reflects global trends. These findings are supported by broader literature which reports women to be more actively reporting LI symptoms which is attributed to their increased inclination towards health-seeking behaviors[9,23]. However, the findings also provide some contradictory factors specific to the Saudi population such as increased biochemical positivity persistent in males which are explained due to cultural differences in consuming dairy products or overall metabolic responses. This is demonstrated in studies that despite reported LI symptoms in males, they consume processed dairy products effectively which may largely be due to LI management strategies[25].

Furthermore, there's scarcity in the exploration of regional disparities in the Saudi population, including the urban-rural differences. This is in agreement with research on dietary patterns and nutritional profiles which underscores the inclination of the urban population to consume ultra-processed foods whereas rural populations consume diets that adhere to traditional patterns. The consistently growing phenomenon of dietary westernization in urban settings adds to the LI prevalence burden against the continuously growing dairy consumption and genetic admixture from wider urban setting populations[26]. This aligns with the rapid urbanization patterns in Saudi Arabia to influence the prevalence of LI, however, the scarcity of data is a critical research gap. Another interesting finding where increased dairy consumption was established despite the symptoms being reported, highlights the significance of cultural dietary habits in overriding the discomfort which is supported in research of regions such as Egypt, where despite significant LI prevalence, dairy is still considered and consumed as a staple food[27].

Findings also highlighted the association of LI with nutritional deficiencies such as lack of Vitamin D and calcium exacerbated due to avoidance of dairy. These findings are consistent with studies that report LI individuals to have lower blood Vitamin D levels in comparison to lactase-persistent counterparts[28]. Saudi values reported in findings are reflective of global concerns such as studies linking LI to an increased risk of osteoporosis or lowered bone health due to inadequate Calcium levels as a result of dairy avoidance[29]. These deficiencies can be addressed by performing fortification of non-dairy foods[29] which can help individuals avoid dairy consumption due to health conditions like LI. Another important limitation denoted in the findings was the limited to no evidence of linkage between LI and IBS or IBD within Saudi cohorts which is contrasting to Western studies that report 40% of IBS patients having Comorbid LI conditions[21].

These discrepancies reflect diagnostic overlaps or cultural differences persisting during symptom interpretation. Studies reported a high prevalence of LI among IBS patients and healthy controls alike, however only a fraction of LI patients met the criteria of IBS which is likely due to the regional variations in gut microbiota[30]. Additionally, the consistent issue in the findings was misdiagnosis which stems from the confusion present between LI and milk allergy, particularly evident in Saudi studies. This is also supported by studies establishing that LI diagnosis is often confused by both patients and healthcare providers with cow milk allergy (CMA)[31] which underscores the need for better clinical education.

The findings of this review emphasize the standardized LI diagnostic strategies in addition to education. There is a pressing need for the context of Saudi Arabia and leveraging Vision 2030's health infrastructure for the development of strategies to mitigate misdiagnosis and lack of education and awareness of LI among the general population. Medical curriculum should also be reformed along with genetic testing as alternatives to invasive tests. Furthermore, food fortification is also an important alternative to Saudi dairy avoidance or overconsumption.

Study Limitations: The prevalence estimates may be skewed due to reliance on self-reported data and variability with diagnostic methods. The generalizability of the findings is limited due to the very low representation of rural populations. The scarcity of national data and the huge literature gap regarding LI research limits the comprehensive understanding of LI patterns, particularly regarding Saudi contexts.

Future Recommendations: It is crucial to employ standardized diagnostic protocols for the improvement of LI detection accuracy and sensitivity. Educational reforms particularly in medical fields and public awareness are of critical importance to differentiate LI symptomatology from milk allergy symptoms and overall, LI management. Nationwide studies raising awareness of LI along with exploring urban-rural disparities are required.

CONCLUSION

This systematic review underscores the significant LI burden in Saudi Arabia in addition to being understudied, it also highlights challenges existing within prevalence estimates due to methodological inconsistencies, regional variations, and demographic factors. The findings further emphasize the disparities facing underdiagnosis, misdiagnosis, and lack of awareness especially among healthcare professionals which limits overall LI management. Additionally, critical nutritional deficiencies are also identified associated with dairy avoidance which calls for urgency of standardized diagnostic protocols, public health education, and dietary interventions that will help mitigate LI-related health disparities in the Saudi population.

Authorship Contribution: As the corresponding author Waleed Mohammad Al-Huzaim from conceptualization, study design, data acquisition, analysis and interpretation, manuscript drafting, critical revision, to final approval oversaw all stages of the research and ensured integrity.

Alanoud Salman Bin Suayb, Atheer Talal Aldalbhi, Htoun Fahad Al-Rajeh, Khawlah Safar Alshahrani, Maha Sulaiman Albarrak, Noora Omar Altmimi contributed to study design, data collection, analysis, manuscript drafting, critical revision, and final approval. All authors fulfilled ICMJE criteria for authorship.

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Competing Interest: None

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