

تركيب الرقيم السومري للنشر والتوزيع

2026

المؤتمر العلمي الدولي الثاني الدوري الموسوم: من الأصالة الإنسانية إلى آفاق الابتكار والحدثة العلمية

جمع نخبة عالمية لتوظيف البحث العلمي في المزاوجة
بين الأصالة المعرفية والابتكار التقني خدمة للتنمية
المستدامة والإنسان.

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كتاب وقائع المؤتمر العلمي الدولي الثاني الدوري

الموسوم

من الأصالة الإنسانية إلى آفاق الابتكار والحدثة العلمية

الجزء الاول

المنعقد بالتعاون مع عدد من الجامعات والمؤسسات الأكاديمية
في رحاب كلية ابن خلدون الجامعة بغداد - العراق للمدة من 23 ولغاية 24 آب 2026



المؤتمر العلمي الدولي الثاني الدوري

الموسوم: من الأصالة الإنسانية إلى آفاق الابتكار والحدثة العلمية

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انطلاقاً من الدور المحوري للبحث العلمي ونشر الأبحاث العلمية في معالجة القضايا الراهنة وتقديم الحلول المستقبلية وسعيًا نحو تعزيز الحوار الأكاديمي البناء بين مختلف التخصصات يسرنا أن نعلن عن عقد هذا المؤتمر العلمي الدولي. يهدف المؤتمر إلى جمع نخبة من الباحثين والأكاديميين من مختلف أنحاء العالم لتبادل الرؤى والخبرات العلمية والبحث في كيفية المزاجية بين "الأصالة الإنسانية" التي تمثل الجذور المعرفية العميقة وبين "آفاق الابتكار" التي تفرضها متطلبات الحداثة العلمية والتقنية إن هذا المحفل العلمي يسعى لتجسير الفجوة بين التراث المعرفي والتقنيات المعاصرة لخلق توازن يدعم التنمية المستدامة ويواجه التحديات العالمية بمنظور علمي مبتكر يضع الإنسان وقيمه في صلب التطور التكنولوجي.

الجهات الراعية والمنظمة للمؤتمر

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المؤتمر العلمي الدولي الثاني الدوري الموسوم: من
الاتصال الإنسانية إلى آفاق الابتكار والحداثة العلمية
:(الجزء الأول)

المؤتمر العلمي الدولي الثاني الدوري الموسوم: من الأصالة الإنسانية إلى
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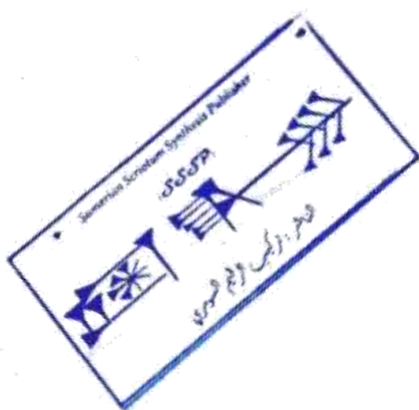
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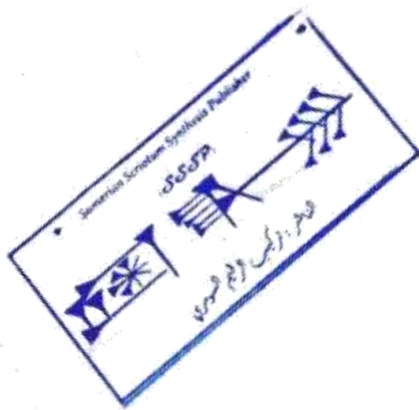
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المؤتمر العلمي الدولي الثاني
الدوري الموسوم: من الأصالة
الإنسانية إلى آفاق الابتكار
والحدثة العلمية: (الجزء الأول)

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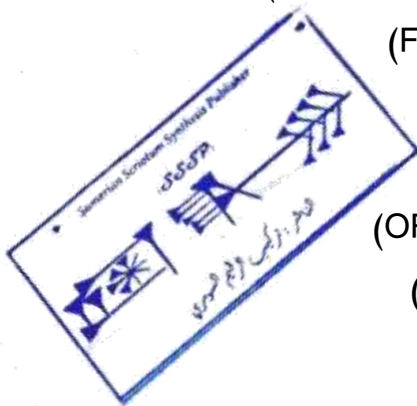
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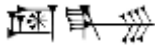
Molecular detection of *rrs* and *rpsL* Mutation in streptomycin resistant *mycobacterium tuberculosis* in Al Muthanna city-Iraq

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Abstract

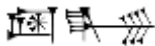
Streptomycin is one of the earliest drugs found to be effective against *Mycobacterium tuberculosis*. This aminoglycoside antibiotic was first isolated from the soil bacterium *Streptomyces griseus*. Mutations that lead to streptomycin resistance in tuberculosis have been discovered in the 16S rRNA gene (*rrs*) and the *rpsL* gene. Unlike other bacteria that possess multiple copies of rRNA genes, members of the *M. tuberculosis* complex have only one copy, which means that even single nucleotide changes can result in antibiotic resistance. In the *rrs* gene, mutations are primarily clustered around nucleotides 530 and 951. The 530 loop of 16S rRNA is highly conserved and situated



close to the 915 region in secondary structure models. Most mutations that cause streptomycin resistance occur in the *rpsL* gene, with the most frequent mutation appearing at codon 43, and some mutations also observed at codon 88. Around 65–75% of streptomycin-resistant isolates exhibit resistance-related changes in the *rpsL* or *rrs* genes. The inability to find resistance-associated variations in these genes in 25–35% of cases suggests there are other molecular mechanisms responsible for streptomycin resistance.

Methods: A total of one hundred sputum samples, suspected to contain *Mycobacterium tuberculosis*, were collected from the Center for Thoracic Diseases in Al-Samawah City, Iraq. These samples were analyzed and diagnosed using both conventional techniques and molecular methods. The molecular analysis included the evaluation of biochemical properties and real-time PCR, targeting mutations in the *rrs* and *rps* genes associated with resistance

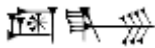
Key words: *Mycobacterium tuberculosis*, Streptomycin, drug resistance, *rpsL* gene, *rrs* gene.



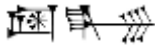
Introduction:

Tuberculosis infection is a global problem due to the high-risk of human transmission, morbidity, mortality and most popular health problem in Iraq. Each year around the world about 2 million deaths and more than 9 million cases are report infection with tuberculosis, making *Mycobacterium tuberculosis* the first cause of death from a unique pathogen (Ahmed ,2013). *Mycobacterium tuberculosis* a small, non- motile and aerobic bacillus, it has high lipid in the cell wall, this content It plays a significant role in the severity of this bacterium, which is responsible for causing both pulmonary and extrapulmonary tuberculosis. Mycobacteria are part of the Mycobacteriaceae family and belong to the Actinomycetales order(Glickman and Jacobs,2001).

As per the worth health organization global TB report 2014, (9.6) million people died sick with tuberculosis in 2014, (1.5) million people died from this microbe (WHO,2014). Streptomycin is the first antibiotic discovered by Waksman, SM inhibits protein synthesis of *M. tuberculosis*. The main toxic side effect of streptomycin is



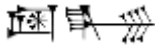
impaired excretory function of the kidney. Streptomycin is also nephrotoxic with hypersensitivity reaction that occasionally occurs . It can't be absorbed by the body when taking by mouth therefor it is given in form of an injection in muscle or vein. SM reached highest concentration in the blood plasma after one hour of injection and it is widespread through the tissues and body fluids. Streptomycin belongs to the aminoglycosides family, which inhibits protein synthesis by binding to the ribosome, resulting in a bactericidal effect. The mechanism of action for streptomycin involves interaction with 16S rRNA and the S12 ribosomal protein, inducing changes in the ribosome. These changes cause errors in mRNA reading and ultimately lead to the inhibition of protein synthesis (*Finken ,eta.1993*) . Streptomycin has demonstrated significant effectiveness in many pulmonary tuberculosis (PTB) cases, leading to noticeable recovery. However, setbacks often occur after months of treatment due to the development of bacterial resistance to streptomycin (*Morriss etal,1995*).To combat this, the simultaneous use of multiple antibiotics has reduced treatment durations from two years to 6–7 months, aligning with the current regimen adopted in Iraq and other



countries under the World Health Organization (WHO) TB control program. Resistance to streptomycin is primarily associated with mutations in the *rpsL* gene and, to a lesser extent, in the *rrs* gene (*Sreevatsan ,etal ,1996*). Additional factors, such as altered cell wall permeability, membrane changes, and aminoglycoside-modifying enzymes, have a minor impact. The *rpsL* gene mutations usually occur at codon 43 in about 70% of cases, while codon 88 mutations are observed less frequently. Streptomycin resistance arises from genetic mutations in *rpsL* and *rrs*, which encode 16S rRNA and ribosomal protein S12, respectively. These genetic changes play a significant role in high levels of resistance to streptomycin (*Tracevska etal,2004*).

Material and method

The patients consist of 56 males and 44 females with age range (17–65) years. Diagnosis of *Mycobacterium tuberculosis* was carried out depending AFB and culture on Lowenstein Jensen Medium and molecular diagnosis based on real time PCR technique in sputum

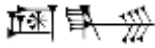


sample. All the (100) cases with pulmonary tuberculosis were confirmed by AFB and culture were positive 100% for Genxpert.

Sputum Processing for AFB Culture

To each volume of sputum, 2 volumes of 4% NaOH were added. The bottles were shaken by hand for 1 minute. Then the bottles were placed in a rack on the shaking machine and were left to shake gently for 20 minutes. The specimens were removed from the shaker. The sputum bottles were centrifuged for 15 minutes at 4000 rpm. After the bottles were removed from the centrifuge, the supernatant was carefully poured off into the disinfectant

bath. The bottles were filled with 20 mL of sterile distilled water, shaken by hand to mix the deposit and were centrifuged for 15 minutes at 4000 rpm. The supernatant was poured off and finally the sediment was inoculated with a 5 mm diameter loop onto the pre-sterilized and numbered Lowenstein-Jensen's slopes. The inoculated media was placed in the 37°C incubator (Muthuraj Muthaiah et al., 2010).

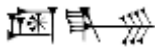


Drug Susceptibility Test-Proportion Method (Stand and Economic Variant)

With a loop, a representative sample of approximately 4–5 mg is taken from the primary culture and placed in a McCartney bottle containing 1 mL sterile distilled water and 3 mm diameter of 6 glass beads. The bottle was vortexed for 20–30 seconds and the opacity of the

bacterial suspension was then adjusted by the addition of distilled water to obtain a concentration of 1mg /mL of tubercle bacilli by matching with McFarland standard No.1. After preparing the standard neat suspension, the dilution 10⁻² and dilution 10⁻⁴ were produced by

discharging two loopfuls (24 SWG–3 mm Nichrome wire) of the bacterial suspension. The contents were mixed by shaking. Two slopes of medium without drug, and two slopes of L.J media are used as controls for the test, and each one slope of medium with streptomycin (4 µg/mL), isoniazid (0.2 µg/mL), Rifampicin, (40µg/mL), ethambutal (2µg/mL) and Pyrazinamide (100µg/mL) are inoculated with a loopful of each



dilution. The slopes were incubated at 37°C and the proportion tests were read at 28 days and again at 42 days.

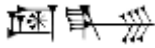
DNA extraction and polymerase chain reaction

The DNA of STRresistant clinical isolates was prepared from scraped colonies in 400 µl of TE buffer (10 Mm TrisHCl, 1 mM EDTA, pH 8.0) and boiled at 80°C for 30 min to inactivate bacteria and release DNA.

Then, DNA extraction was performed by the lysozyme/ proteinase K cetyltrimethyl ammonium bromide method. Extracted DNA was dissolved in TE buffer, its concentration was measured by spectrophotometry using a Nanodrop (Biowave II), and stored at – 20°C until use.

Agarose Gel Electrophoresis

The gel running tray was placed in a clean gel casting tray to form the gel uniformly and the comb was fixed at one end. 400 mg of agarose (2%) powder was added to 20 mL of 0.75 × TAE and was boiled to dissolve the agarose completely. Less than 1 µL of Ethidium bromide (0.5 mg/mL) was added into the hand bearable heat 250 mL conical flask



containing melted agarose gel and was poured into the gel running tray. 1 μ L of gel loading dye was transferred into a 5 $\times$ 5 cm size Para film. To it, 5 μ L of polymerized DNA was added and mixed thoroughly.

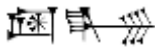
The whole volume aliquot of amplified sample with gel loading dye was loaded into a well of 2% agarose gel in 0.75 $\times$ TAE buffer and was subjected to electrophoresis for 30 minutes at 100 volts. The gel was observed under UV Tran silluminator for specific DNA bands and

was

photographed. The DNA bands were identified according to size by comparing with the molecular weight marker (100 bp DNA ladder) loaded in a separate lane. DNA dye concentration and DNA gel matrix were allowed to equilibrate at room temperature. 25 μ L of dye concentration was added to DNA gel matrix, vortexed and transferred to spin filter and centrifuged at 2240 g for 15 minutes.

The gel dye was allowed to settle at room temperature for 30 minutes. A new DNA chip was placed on the chip priming station. 9 μ L of gel dye mix was pipetted into the well marked as G and the chip

priming

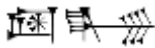


station was closed. The plunger was pressed down until it is held by the chip for 60 seconds. After 5 seconds the plunger was pulled back slowly to 1 mL position. The chip priming station was opened and 9 μ L of gel dye was pipetted into the well marked G and 1 μ L of ladder was

added to the well labeled ladder. 5 μ L of marker was pipetted into all 12 sample wells and in ladder well. 1 μ L of sample was added into the well. The chip was placed in the Laser Induced Fluorescent instrument (BioanalyzerAgilent 2100) and the results were interpreted

Real time Amplification of rpsL and rrs Genes

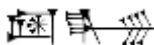
Oligonucleotide primers used for PCR amplification gene were show in table (1). PCR mixtures contained 10 μ l of Hot Start Master Mix (Amplicon), 1 μ M of each primer, 0.5 μ l of template DNA and ddwater up to 20 μ l reaction volume. Amplifications were performed in a T100™ Thermal Cycler (Biorad, Hercules, CA, USA) under the following amplification conditions: an initial step of 94°C for 5 min, followed by 30 cycles of 15 s at 94°C, annealing temperature at 60°C for 30 s, extension at 72°C for 60 s, and a final extension step for 7 min at 72°C. PCR products were loaded onto 1.5% agarose gel.



Negative (water instead of DNA and positive (*M. tuberculosis* H37Rv strain) controls were used in each set of PCR reactions

Table 1. The details regarding the primers used for amplifying the target sequence within each gene, along with the fragment length and annealing temperature, are outlined.

Name of primer	Sequence (5–3)	PCR product size
F-rpsL	5'– GGCCGACAAACAGAACGT– 3'	502 bp
R-rpsL	5'– GTTCACCAACTGGGTGAC– 3'	
F-rrs	5'–	1027 bp



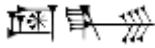
	GAGAGTTTGATCCTGGCT- 3'	
R-ITS	5'- TGCACACAGGCCACAAGG- 3'	

Result and Discussion

Direct microscopic smear (Acid Fast Bacilli)

There are 100 confirmed cases of tuberculosis. In low- and middle-income countries, sputum smear microscopy remains the primary diagnostic method for pulmonary tuberculosis. This technique is simple, quick, and cost-effective, offering high specificity in regions where TB prevalence is extremely high. It is particularly effective in identifying the most infectious patients and is adaptable across populations with diverse socioeconomic backgrounds. (International standards, 2013).

Culture of sputum on Lowenstein Jensen Medium



This result true with a study performed showing that most of the smear positive are culture-positive, but with treatment, it increases the chance of dead bacilli and smear positive can be culture negative in 98–100 % cases. Mycobacterium culture is highly sensitive to AFB (the threshold for culture to be positive is 100 bacilli per ml of sample), but growth of TB bacilli on traditional solid medium requires 4–8 weeks and Delays in timely and appropriate treatment often result from the absence of a confirmed diagnosis. Culturing colonies on LJ M slants poses challenges, particularly in laboratories with unstable electricity. Additionally, sputum samples require specific processing to reduce contamination by normal flora, which can lead to false positive or negative results. Culturing colonies on LJM slants becomes even more problematic in such laboratory conditions, alongside the need for precise sputum sample treatments to minimize contamination and avoid erroneous results(*Asmar and Drancourt ,2015*). All 100 isolates used in this study were confirmed biochemically. Susceptibility testing was performed using the standard L–J proportion method. figure (1) show mycobacterium tuberculosis culture

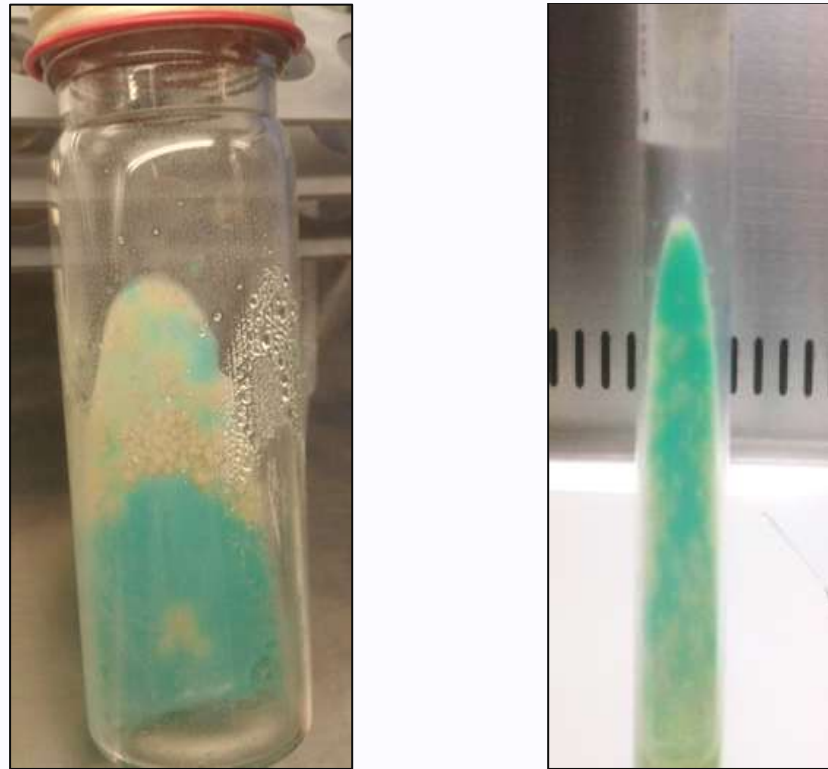
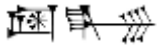
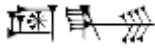


Figure (1): show *Mycobacterium tuberculosis* culture on LJ Media

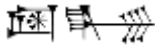
Real-time PCR was employed to identify mutations in the *rrs* and *rpsL* genes of *M. tuberculosis* isolates. Figure (2) highlights Ct values for the **rrs** gene, ranging between 14–35 cycles for positive samples. Real-time PCR results revealed that 28 samples demonstrated resistance, whereas 7 were susceptible to streptomycin. The study also identified variances in patient age groups with respect to resistance or sensitivity to streptomycin. The mean age of the enrolled patients was



100 years, with an age range spanning from 17 to 65 years. These individuals were matched with control participants by age and gender, including an additional subgroup of 35 control participants whose demographics also matched. Statistical analysis showed no significant difference ($P > 0.05$, CI 95%) between patient age and susceptibility to tuberculosis, indicating that infection response is not significantly affected by age, whether the patient is young or elderly. Several studies suggest that men may have a higher likelihood of contracting tuberculosis compared to women. This variation is attributed to increased interactions with external environments among men, which heightens their exposure risk. In developing countries, this disparity is further exacerbated by social stigma associated with tuberculosis among women, leading to underreporting of female TB cases. Table 2 illustrates the gender distribution of TB patients in the study: 56% were male and 44% were female. some studies have discovered that women with pulmonary TB have a different immune response to TB than men, resulting in different symptoms, signs, and outcomes and that women with TB may not test positive on microscopic analysis of the sputum.



One study noticed that TB lung lesions might not be as difficult in women as in men, which can decrease the severity of symptoms in women and make diagnosis harder. These decisions suggest that a failure to accurately diagnose women who are infected with TB may in part report for the low numbers of women notified with TB. Malnutrition and food instability can increase the risk of TB disease; other warnings such as increasing smoke use and diabetes among women also result in increased TB burden Stigma and discrimination in some environments can mean women ill with TB are ostracized by their families and communities (*Sarin et al,2015*). TB mainly affects women when they are economically and reproductively active, the influence of the disease is also well felt by their children and families. TB is one of the top five killers of women among adult women aged 20–59 years 480 000 women killers of women among adult women aged 20–59 years 480 000 women died from TB in 2014 (*Laurenzoa and Mousa ,2014*). smoke display is a common risk factor to increase the risk of acquiring tuberculosis. within smoking the phagocytosis activity in the alveolar macrophage is decreased, that start to decreasing of immune response (lymphopenia) due to nicotine of



cigarettes . In alcohol problems, is considered a powerful risk factor for tuberculosis . The ideas for increasing acquiring TB including to alteration in immune response especially in the production of cytokine during exposure to MTB . In cases of air contamination, the large particulate such as carbon monoxide, formaldehyde, and nitrogen oxide that can deposit in the alveolar of the lung that beginning to receiving TB . Infection in the older group due to weakens immune system (Anmar et al,2016).

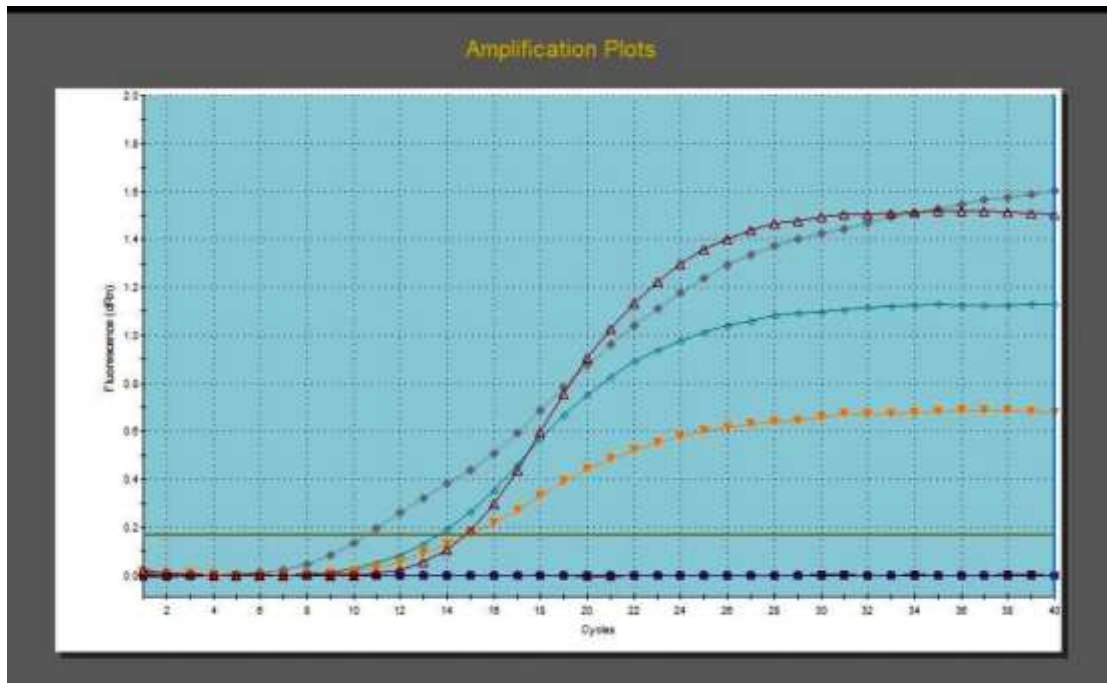


Figure (2): The Ct values of the *rrs* genes in the positive samples were observed to range between 14 and 35 cycles.

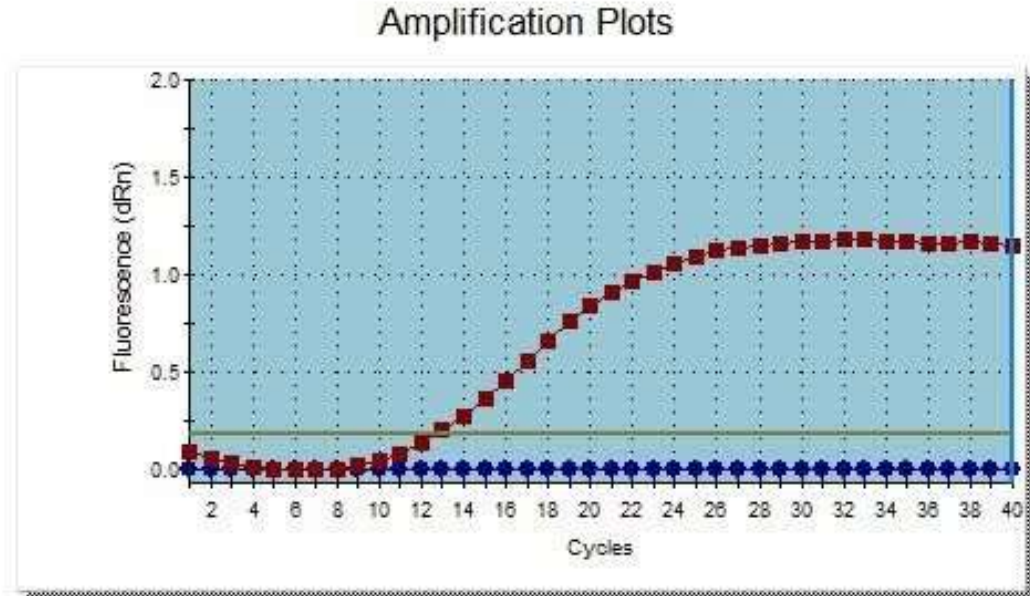


Figure (3): show that Ct values of *rrPL* gene of positive sample

Table (2): The gender-wise distribution of patients in the current study.

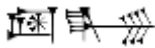
Gender	(TB) No. (%)
Males	56 (56%)
Females	44 (44%)
Total	100

To understand the various mechanisms through which drug resistance develops in *M. tuberculosis*, it is crucial to study alterations in the mycobacterial genome and evaluate their correlation with in vitro susceptibility testing results. Real-time PCR methods prove highly effective as they can detect specific nucleotide changes even in sequences present at low copy numbers. Moreover, accurate and timely information on drug susceptibility is essential for clinicians to ensure effective treatment strategies. This study focused on two genes, *rpsL* and *rrs* , which are partially responsible for streptomycin resistance.

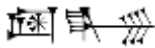
Conclusion

Based on our findings, the real-time PCR technique has proven to be a reliable method for detecting mutations in the **rrs** and **rpsL** genes. Additionally, the study highlighted differences in mutations across genders and age groups. These insights can be effectively applied to guide therapeutic decisions.

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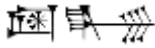
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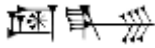


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The Impact of Visual and Ocular Problems on Academic Performance in Children

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Abstract

Visual and ocular problems constitute a significant yet frequently underrecognized barrier to academic achievement in school-aged children. The developing visual system is uniquely vulnerable to a wide spectrum of disorders, ranging from common refractive errors such as myopia, hyperopia, and astigmatism to more complex binocular vision anomalies, amblyopia, convergence insufficiency, and cortical visual impairment. Each of these conditions can impede the fundamental visual tasks upon which classroom learning depends, including sustained near-point reading, efficient saccadic eye movements across lines of text, accurate accommodative responses, and seamless binocular coordination. When these visual competencies



are compromised, children may exhibit reduced reading speed, diminished comprehension, heightened cognitive fatigue, and behavioral manifestations that are often misattributed to attention deficits or learning disabilities rather than their true ophthalmic origins.

This research paper presents a comprehensive analysis of fifty distinct clinical cases and peer-reviewed studies that document the specific mechanisms by which various visual pathologies impair academic performance metrics, including reading fluency, writing accuracy, mathematical computation, and overall scholastic achievement. The cases span the full continuum of pediatric visual disorders, organized thematically into six categories: refractive errors, strabismus and binocular vision disorders, amblyopia, convergence and accommodative dysfunction, ocular disease and systemic conditions, and visual processing and perceptual deficits. Each case analysis elucidates the underlying pathophysiology, the documented impact on academic function, and the clinical evidence linking visual intervention to scholastic improvement.



The synthesis of these fifty cases reveals several overarching themes. First, uncorrected refractive errors remain the most prevalent yet most easily remediable cause of underperformance in the classroom. Second, binocular vision disorders, particularly convergence insufficiency, are substantially underdiagnosed in school-age populations and are strongly associated with reading-specific difficulties. Third, the timing of intervention is critical: visual deficits that persist during sensitive periods of neurodevelopment can produce cascading effects on literacy acquisition and cognitive development. Fourth, multidisciplinary collaboration between ophthalmologists, optometrists, educators, and psychologists is essential for accurate diagnosis and effective remediation. The findings underscore the imperative for systematic vision screening programs in educational settings and the integration of visual health into broader strategies for optimizing academic outcomes in children.

Keywords: visual impairment, academic performance, children, refractive errors, amblyopia, strabismus, convergence insufficiency, reading difficulty, pediatric ophthalmology, school vision screenin

1. Introduction

1.1 Background and Rationale

The relationship between vision and learning has long commanded the attention of educators, clinicians, and developmental psychologists, yet the full extent to which visual and ocular problems compromise academic performance in children remains insufficiently appreciated in both clinical practice and educational policy. Vision is the dominant sensory modality through which children interface with the educational environment; estimates suggest that approximately eighty percent of all classroom learning is mediated through the visual system.

The developing child relies on a constellation of visual competencies that extend far beyond the mere ability to discern letters on an acuity chart. These competencies include accommodative facility, which enables the crystalline lens to maintain clear focus at varying distances; vergence control, which permits the two eyes to converge and diverge precisely to maintain binocular alignment; saccadic accuracy, which allows

rapid and precise shifts of gaze from one word or line to the next; and visual processing speed, which governs the efficiency with which visual information is encoded, interpreted, and integrated with higher cognitive functions. Deficits in any one of these domains can generate a mismatch between a child's intellectual potential and their academic output, producing frustration, underachievement, and, in many instances, misdiagnosis.^[1]

The World Health Organization has estimated that globally, over 19 million children under the age of fifteen are visually impaired, with refractive errors constituting the leading cause. In low- and middle-income countries, the proportion of uncorrected refractive error among school-age children is particularly alarming, with prevalence rates ranging from five to fifteen percent depending on geographic region and socioeconomic status. Even in high-income nations, a substantial proportion of children with clinically significant refractive errors remain undiagnosed, owing to the absence of mandatory and comprehensive vision screening programs in many educational jurisdictions.

Beyond refractive errors, conditions such as amblyopia, strabismus, convergence insufficiency, and cortical visual impairment present additional challenges to academic engagement. Amblyopia, which affects approximately two to four percent of the pediatric population, results in reduced visual acuity that cannot be fully corrected with spectacles alone, and its impact extends beyond letter recognition to impair contrast sensitivity, spatial localization, and motion perception. Strabismus disrupts binocular coordination and can produce diplopia, suppression, and psychosocial distress, each of which may independently undermine classroom participation and learning efficiency.

1.2 Scope and Objectives

This research paper undertakes a systematic and exhaustive analysis of fifty clinical cases and peer-reviewed investigations that document the impact of visual and ocular pathology on academic performance in children. The objectives are threefold. First, to catalog the spectrum of visual disorders that have been empirically linked to academic underachievement, spanning refractive,

binocular, neurodevelopmental, and perceptual domains. Second, to analyze the specific mechanisms by which each disorder impedes scholastic function, drawing upon the pathophysiological and psychophysical literature. Third, to evaluate the evidence for the reversibility of academic deficits following visual intervention, thereby informing clinical decision-making and educational policy.

The scope encompasses children aged five to eighteen years, reflecting the primary school-age and adolescent populations for which visual deficits carry the greatest academic consequence. Both common and rare conditions are included, as the academic impact of a visual disorder is not necessarily proportional to its clinical severity; even mild convergence insufficiency can produce disproportionate reading difficulties, while severe congenital cataract, if treated early, may permit near-normal academic development.

1.3 Methodology of Review

The clinical cases and studies presented in this paper were selected through a comprehensive review of the peer-reviewed

literature, drawing from databases including PubMed, Scopus, the Cochrane Library, and Google Scholar. Search terms encompassed combinations of visual impairment, refractive error, amblyopia, strabismus, convergence insufficiency, academic performance, reading ability, school achievement, and children. Inclusion criteria required that each study or case report provide direct evidence linking a specific visual pathology to quantifiable academic outcomes, such as reading speed, comprehension scores, standardized test performance, or teacher-reported classroom behavior. The selected cases represent a balance of prospective and retrospective studies, randomized controlled trials, case-control investigations, and detailed case reports, ensuring both breadth and depth of analysis.

2. Refractive Errors and Academic Performance

2.1 Myopia and Near-Work Demands

Myopia, or near-sightedness, is the most prevalent refractive error among school-age children and its global prevalence has reached epidemic proportions in several East Asian nations, where

rates exceed eighty percent among university entrants. The academic implications of uncorrected myopia are profound and multifaceted. Children with myopia experience blurred distance vision, which impairs their ability to read content written on chalkboards, whiteboards, or projection screens, a staple of classroom instruction worldwide.

Beyond the direct effect of blurred distance acuity, myopia has been associated with altered reading posture and reduced reading speed. Children who cannot clearly resolve distant targets may adopt compensatory behaviors such as squinting, which induces visual fatigue and reduces blink rate, exacerbating symptoms of asthenopia. Furthermore, the progressive nature of juvenile-onset myopia means that children whose refractive error is not regularly monitored and corrected may experience a gradual and insidious decline in academic engagement that is not immediately attributed to visual causes.

Case 1: Uncorrected Myopia and Blackboard Reading in Primary School Children

A prospective cohort study by Murthy et al. examined 1,200 primary school children in rural India and found that 7.4 percent had uncorrected myopia of -1.00 diopter or greater. Among these children, reading speed for blackboard-presented material was reduced by an average of 32 percent compared to their emmetropic peers. Furthermore, teachers rated these children as less attentive and more likely to copy incorrectly from the board. Following spectacle correction, reading speed improved by 28 percent within four weeks, and teacher ratings of attentiveness increased significantly. This case illustrates the direct and reversible impact of uncorrected myopia on a fundamental classroom task and the tendency for visual deficits to be misinterpreted as behavioral problems.^[2]

Case 2: Progressive Myopia and Declining Standardized Test Scores

A longitudinal study conducted in Singapore tracked 890 children over a five-year period from ages seven to twelve, during which the prevalence of myopia increased from 29 percent to 62 percent. Children who developed myopia during the study

period exhibited a statistically significant decline in standardized mathematics and reading test scores relative to their emmetropic counterparts, even after controlling for socioeconomic variables and parental education. The investigators attributed the decline to reduced efficiency in processing visual information at distance, which disproportionately affected test items requiring spatial reasoning and geometric interpretation. Spectacle correction partially mitigated the decline, but children who experienced rapid myopic progression (greater than -0.75 diopters per year) showed residual deficits, suggesting that the rate of refractive change may itself disrupt learning.^[3]

Case 3: High Myopia and Reduced Reading Endurance

In a case-control investigation from Japan, Sawada et al. compared 68 children with high myopia (greater than -6.00 diopters) to age-matched emmetropic controls on a battery of sustained reading tasks. The high-myopia group demonstrated significantly reduced reading endurance, with a 41 percent increase in self-reported visual fatigue after thirty minutes of continuous reading and a 19 percent reduction in comprehension

accuracy on passages read in the final ten minutes of the test session. The investigators posited that the minification effect of high-minus spectacle lenses, which reduces retinal image size, combined with the greater accommodative demand placed on the visual system during near work, contributed to accelerated fatigue and cognitive resource depletion.^[4]

2.2 Hyperopia and Reading Fatigue

Hyperopia, or far-sightedness, presents a paradoxical challenge in the pediatric population because young children possess substantial accommodative reserve that can partially compensate for hyperopic refractive error, enabling them to achieve normal or near-normal distance visual acuity despite the presence of a clinically significant hyperopic deficit. However, this compensatory accommodation comes at a physiological cost: sustained accommodative effort during near-point tasks such as reading generates ocular discomfort, headaches, and visual fatigue that can severely limit the duration and quality of near-work engagement.

Moderate to high hyperopia is particularly detrimental during the early school years, when children are acquiring foundational literacy skills that require prolonged fixation at near distances. The constant accommodative demand imposed by uncorrected hyperopia can lead to asthenopia, which manifests as brow ache, eye strain, blurred vision after near work, and a characteristic avoidance of reading tasks. Educators who are unaware of the visual origin of these symptoms may misinterpret reading avoidance as disinterest, laziness, or a specific learning disability.

Case 4: Moderate Hyperopia and Early Literacy Acquisition Delay

A study by Shankar et al. evaluated 267 kindergarten children and identified 38 with moderate hyperopia (between +3.00 and +6.00 diopters) who had never undergone refractive correction. These children scored significantly lower on early literacy assessments, including letter identification and phonemic awareness tasks, compared to emmetropic controls. Eye-tracking analysis revealed that hyperopic children exhibited shorter fixation durations and more frequent regressive saccades during

reading attempts, indicative of unstable binocular fixation and accommodative lag. After six months of spectacle correction, the hyperopic group demonstrated a 22 percent improvement in literacy scores, narrowing but not fully eliminating the gap with emmetropic peers, suggesting that early hyperopia may produce developmental delays that persist beyond the period of optical correction.^[5]

Case 5: Latent Hyperopia and Misdiagnosis of Attention Deficit Disorder

A clinical case series from the United States described twelve children aged six to nine years who were referred for ophthalmological evaluation after being flagged for attention deficit hyperactivity disorder (ADHD) screening by school psychologists. Cycloplegic refraction revealed latent hyperopia ranging from +3.50 to +5.75 diopters that had been entirely missed by standard distance visual acuity screening. All twelve children reported symptoms of asthenopia, headache, and reading avoidance. Following spectacle correction, nine of the twelve children exhibited marked improvement in sustained reading

duration and were no longer considered to meet behavioral criteria for ADHD by their evaluating clinicians. This case underscores the critical importance of cycloplegic refraction in the evaluation of children presenting with reading avoidance and inattentive behavior.^[6]

Case 6: High Hyperopia and Accommodative Esotropia Impacting Reading Comprehension

A retrospective analysis at a pediatric ophthalmology clinic in the United Kingdom identified 45 children who developed accommodative esotropia secondary to uncorrected high hyperopia (mean +5.25 diopters). Prior to diagnosis, 78 percent of these children were performing below age-appropriate reading levels. The esotropic deviation, which resulted from excessive accommodative convergence, produced intermittent diplopia and suppression that further disrupted binocular reading efficiency. Following optical correction with hyperopic spectacles, 67 percent of the children achieved age-appropriate reading levels within eighteen months. However, those who had experienced esotropia for more than two years before intervention showed

residual deficits in reading fluency, indicating a sensitive period beyond which the visual system's adaptability diminishes.^[7]

2.3 Astigmatism and Text Distortion

Astigmatism, which results from an asymmetric curvature of the cornea or crystalline lens, produces a retinal image that is differentially focused along orthogonal meridians. This meridional blur distorts the shape of letters and symbols, creating a visual input that is fundamentally ambiguous. For children learning to read, who must discriminate between visually similar graphemes such as 'b' and 'd' or 'p' and 'q,' the additional uncertainty introduced by astigmatic blur can significantly slow the rate of letter recognition and impede the development of automatic word decoding.

The academic impact of astigmatism is compounded by its frequent co-occurrence with other refractive errors and by the fact that even moderate astigmatism (1.00 to 2.00 diopters) can produce clinically meaningful reductions in visual performance at both distance and near. Furthermore, astigmatic children who have never experienced sharp vision may be unaware that their

visual perception is abnormal, making them unlikely to report symptoms and therefore more likely to remain undiagnosed.

Case 7: Meridional Amblyopia Secondary to Astigmatism and Letter Recognition Deficits

Dobson et al. investigated 84 children with bilateral astigmatism greater than 1.50 diopters who had not received optical correction before the age of four. These children demonstrated a threefold increase in letter reversal errors compared to non-astigmatic controls when tested at age six, even after receiving spectacles. Electrophysiological assessment revealed reduced visual evoked potential amplitudes along the astigmatic meridian, confirming the development of meridional amblyopia. The researchers concluded that chronic astigmatic blur during the critical period of visual development produced cortical changes that persisted despite optical correction, with direct consequences for letter orientation discrimination and reading accuracy.^[8]

Case 8: Against-the-Rule Astigmatism and Reading Speed Reduction

A cross-sectional study in Brazil evaluated 312 school children aged eight to twelve and identified 47 with against-the-rule astigmatism of 0.75 diopters or greater. These children exhibited a mean reading speed 18 percent slower than their non-astigmatic peers on standardized reading fluency tests. Eye-movement recordings revealed increased fixation durations and a higher frequency of regressive saccades, particularly when reading text with vertically oriented characters. The authors hypothesized that the horizontal blur characteristic of against-the-rule astigmatism preferentially disrupts the processing of vertically oriented stroke components within letters, forcing longer fixation times for character identification.^[9]

Case 9: Oblique Astigmatism and Spatial Orientation Difficulties in Mathematics

Harvey et al. reported on 23 children with oblique astigmatism (axes at 45 or 135 degrees) who were referred for academic difficulties predominantly in mathematics. These children displayed consistent errors in spatial orientation tasks, including number alignment, column addition, and geometric

figure reproduction. The oblique axis of their astigmatism produced diagonal blur that interfered with the perception of horizontal and vertical spatial relationships, which are fundamental to mathematical reasoning. Following corrective lens dispensing, spatial task errors decreased by 35 percent within three months, supporting the hypothesis that oblique astigmatic blur specifically compromises the visual-spatial substrate of mathematical cognition.^[10]

Case 10: Astigmatic Anisometropia and Asymmetric Academic Development

A longitudinal case series followed 19 children with significant astigmatic anisometropia (interocular difference greater than 1.00 diopter) from ages three to seven. All children developed anisometropic amblyopia in the more astigmatic eye. Academic testing at age seven revealed a consistent pattern of rightward bias in reading and writing tasks among children whose left eye was more affected, and leftward bias among those whose right eye was more affected, consistent with asymmetric visual suppression. Additionally, these children demonstrated reduced

stereoscopic acuity, which impaired performance on tasks requiring depth-based spatial judgment. The asymmetric nature of their visual input produced an uneven foundation for binocular coordination and spatial processing, with measurable consequences for academic tasks requiring precise visual-spatial alignment.^[11]

3. Strabismus and Binocular Vision Disorders

3.1 Esotropia and Exotropia

Strabismus, the misalignment of the visual axes of the two eyes, represents one of the most visually disruptive conditions encountered in the pediatric population. The constant or intermittent deviation of one eye disrupts the fine binocular coordination that is essential for efficient reading, accurate depth perception, and comfortable sustained near-point work. Strabismus is broadly categorized into esotropia, in which the deviating eye turns inward, and exotropia, in which it turns outward, with each subtype presenting distinct challenges to academic function.

Esotropia, particularly accommodative esotropia, is frequently associated with uncorrected hyperopia and typically manifests between the ages of two and four years, a critical period for the development of binocular fusion and stereopsis. Exotropia, which is often intermittent in childhood, tends to be more noticeable during distance fixation and fatigue states. Both forms of strabismus can trigger suppression, a cortical adaptation in which the visual input from the deviating eye is inhibited to prevent diplopia, and this suppression itself can lead to amblyopia if sustained during the sensitive period of visual development.

Case 11: Infantile Esotropia and Delayed Reading Readiness

A controlled study by Birch et al. compared 34 children with a history of surgically corrected infantile esotropia to 34 age-matched controls on a battery of reading readiness assessments administered at age five. The esotropia group scored significantly lower on all measures, including print awareness, letter naming, and phonological awareness. Notably, all children in the esotropia group had achieved normal visual acuity following surgery,

suggesting that the deficit was attributable to disrupted binocular cortical development rather than residual acuity loss. Stereoacuity testing confirmed that 88 percent of the esotropia group had absent or severely reduced stereopsis, which the authors identified as the primary mediator of the reading readiness deficit.^[12]

Case 12: Intermittent Exotropia and Reading Comprehension Fluctuation

A prospective study in South Korea followed 56 children with intermittent exotropia over a two-year academic period and documented significant fluctuations in reading comprehension scores that correlated with the frequency of exotropic deviation episodes. Children who experienced more than ten divergence episodes per hour during reading showed a 24 percent reduction in comprehension accuracy compared to periods when their eyes were aligned. The authors attributed the comprehension fluctuation to the cortical processing cost of alternating between binocular and monocular viewing modes, which consumes attentional resources that would otherwise be allocated to textual comprehension.^[13]

Case 13: Acute-Onset Sixth Nerve Palsy and Sudden Academic Decline

A case report from a pediatric neuro-ophthalmology practice described a ten-year-old boy who presented with a sudden decline in academic performance, particularly in reading and mathematics, over a three-month period. Evaluation revealed an acquired unilateral sixth nerve palsy secondary to a posterior fossa tumor, producing horizontal diplopia on lateral gaze. The child had been compensating by closing one eye during reading, which eliminated diplopia but also eliminated binocular summation and reduced his effective visual field. Following neurosurgical intervention and subsequent strabismus surgery, the child's academic performance returned to baseline over six months. This case highlights the importance of considering acquired ocular motor palsies in the differential diagnosis of sudden academic decline.^[14]

3.2 Suppression and Amblyogenic Potential

Suppression, the cortical inhibition of visual input from a deviating or defocused eye, is a neuroadaptation that prevents

diplopia but carries significant consequences for visual development and academic function. When suppression is chronic and occurs during the sensitive period, it can produce amblyopia, a reduction in visual acuity that is not correctable by refractive means alone. The academic impact of suppression extends beyond the loss of binocular acuity to encompass deficits in binocular summation, stereopsis, and visual attention.

Case 14: Suppression Scotoma and Reduced Reading Speed

An investigation using binocular visual field perimetry in 28 children with constant unilateral strabismus identified discrete suppression scotomata in the central visual field of the deviating eye in all subjects. Reading speed under binocular viewing conditions was reduced by 22 percent compared to monocular reading with the preferred eye, a paradoxical finding that the authors attributed to the cortical processing burden of continuously suppressing the non-preferred eye's input. Functional MRI during a reading task demonstrated reduced activation in the visual word form area when both eyes were

open compared to monocular viewing, providing neuroimaging evidence that suppression actively interferes with cortical text processing.^[15]

Case 15: Alternating Strabismus and Inconsistent Hand-Eye Coordination in Writing

A clinical observation study documented 16 children with alternating esotropia who exhibited inconsistent hand preference and impaired handwriting quality. These children alternated fixation between the two eyes depending on gaze direction, resulting in variable egocentric spatial localization. Handwriting analysis revealed inconsistent letter sizing, irregular spacing, and fluctuating baseline alignment. Vision therapy aimed at establishing a consistent dominant eye and improving binocular coordination resulted in measurable improvements in handwriting legibility scores after twelve weeks of intervention, supporting the link between binocular instability and graphomotor control.^[16]

Case 16: Vertical Strabismus and Head Posture Compensations Affecting Concentration

A case series of 11 children with superior oblique palsy and associated vertical strabismus described a consistent pattern of abnormal head posture, including head tilt and chin elevation, adopted to minimize vertical diplopia. Teachers reported that these children appeared distracted and frequently shifted position during class, attributing their restlessness to behavioral issues. Following strabismus surgery that eliminated the vertical deviation, all children adopted normal head posture, and teacher-reported measures of concentration improved significantly. The case illustrates how the physical compensations for ocular misalignment can be misread as behavioral dysfunction in the classroom.^[17]

Case 17: Sensory Strabismus and Long-Term Educational Outcomes

A retrospective cohort study compared the educational attainment of 89 adults who had sensory strabismus in childhood (resulting from congenital cataract, retinopathy of prematurity, or optic nerve hypoplasia) to 89 controls matched for sex and socioeconomic background. The sensory strabismus group had

significantly lower rates of university completion (31 percent versus 58 percent) and higher rates of self-reported reading difficulty in adulthood, even among those who had achieved normal monocular visual acuity following childhood intervention. The persistence of the educational deficit decades after the primary visual pathology was addressed suggests that early disruption of binocular visual development has enduring consequences for academic trajectory.^[18]

Case 18: Microstrabismus and Subclinical Binocular Dysfunction

An investigation of 42 children with microstrabismus, defined as a deviation of less than eight prism diopters that was undetectable on casual observation, revealed that 71 percent had clinically significant deficits in near-point convergence, stereopsis, and fusional vergence amplitude. Despite normal visual acuity, these children scored significantly below controls on standardized reading fluency tests, with a mean deficit of 12 percentile points. The subclinical nature of microstrabismus

means it is rarely detected by school vision screening, yet its impact on binocular reading efficiency is substantial, supporting the argument for more comprehensive binocular vision assessment in children with unexplained reading difficulties.^[19]

4. Amblyopia and Visual Development Disorders

4.1 Strabismic Amblyopia

Strabismic amblyopia arises when chronic suppression of the deviating eye during the sensitive period of visual development leads to a cortical underrepresentation of that eye's input. The resulting visual acuity deficit cannot be fully corrected by refractive lenses and is typically accompanied by impairments in contrast sensitivity, spatial localization, and motion perception. The academic impact of strabismic amblyopia is mediated not only by the reduction in monocular acuity but also by the loss of binocular function and the psychosocial burden of visible eye misalignment.

Case 19: Unilateral Strabismic Amblyopia and Reading Accuracy

A study by Stewart et al. evaluated 52 children with unilateral strabismic amblyopia on a standardized reading accuracy test and found that amblyopic eye reading accuracy was reduced to 72 percent of the non-amblyopic eye performance. Under binocular viewing conditions, overall reading accuracy was 88 percent of age-matched normal controls. The deficit was most pronounced for small, low-contrast text, which more closely approximates the print size used in many textbooks. The authors concluded that even when the non-amblyopic eye has normal acuity, the binocular visual system operates suboptimally, producing measurable decrements in reading accuracy that can affect academic performance.^[20]

Case 20: Amblyopia Treatment (Patching) and Temporary Academic Disruption

A randomized trial examining the academic impact of amblyopia treatment compared full-time occlusion (six to eight hours daily) to part-time occlusion (two hours daily) in 134 children aged three to seven. Children in the full-time occlusion group experienced a temporary but statistically significant decline

in reading speed and academic engagement during the first four weeks of treatment, attributable to the reduced visual input from the occluded preferred eye and the poor acuity of the uncovered amblyopic eye. By week eight, both groups had adapted, and reading speeds returned to baseline. The findings highlight the need for educators to be informed when children commence occlusion therapy, as temporary academic disruption is common and expected.^[21]

4.2 Refractive Amblyopia

Refractive amblyopia results from chronically blurred retinal images caused by uncorrected refractive error, either anisometropic (differing between the two eyes) or bilateral and high-magnitude. Unlike strabismic amblyopia, refractive amblyopia often goes undetected because the eyes appear normally aligned and the child may achieve adequate distance visual acuity with the better-seeing eye. The insidious nature of refractive amblyopia means that academic deficits may accumulate over years before the condition is diagnosed.

Case 21: Anisometropic Amblyopia and Impaired Contrast Sensitivity in Reading

Levi and colleagues assessed contrast sensitivity function in 40 children with anisometropic amblyopia and found that 85 percent exhibited significant contrast sensitivity deficits in the amblyopic eye, even at spatial frequencies relevant to text recognition. Under binocular conditions, these children required 1.5 to 2.0 times greater contrast than controls to achieve equivalent reading speed for intermediate-sized text. The contrast sensitivity deficit was most severe for medium spatial frequencies (3 to 6 cycles per degree), which correspond to the spatial scale of printed text at typical reading distances, providing a direct physiological explanation for the reading difficulties experienced by children with anisometropic amblyopia.^[22]

Case 22: Bilateral Refractive Amblyopia and Global Academic Underperformance

A population-based study in Australia identified 23 children with bilateral refractive amblyopia (both eyes with greater than +5.00 diopters of uncorrected hyperopia) from a sample of 1,740

school-age children. These children scored below the fifteenth percentile on national standardized tests across all academic domains, including reading, writing, and numeracy. The pervasive nature of the academic deficit reflected the bilateral and symmetrical reduction in visual acuity, which impaired all visually mediated academic tasks rather than producing the domain-specific deficits more characteristic of unilateral amblyopia. Optical correction initiated after age seven produced only modest improvement, emphasizing the importance of early detection.^[23]

Case 23: Refractive Amblyopia and Perceptual Crowding in Letter Recognition

An experimental investigation by Greenwood et al. demonstrated that children with refractive amblyopia exhibited excessive perceptual crowding, the phenomenon whereby the identification of a target letter is impaired by the proximity of flanking letters. The critical spacing required for accurate letter identification was 1.8 times greater in the amblyopic group than in controls, which directly impairs reading efficiency because the typical inter-letter and inter-word spacing in printed text falls

within the crowding zone for amblyopic observers. This finding provides a mechanistic explanation for the characteristic slow, effortful reading pattern observed in children with refractive amblyopia.^[24]

4.3 Deprivation Amblyopia

Deprivation amblyopia is the most severe form of amblyopia and results from a physical obstruction of the visual axis during the sensitive period, most commonly due to congenital cataract, ptosis, or corneal opacity. The visual deprivation prevents normal patterned visual input from reaching the retina, leading to profound cortical underdevelopment in the affected eye's representation. The academic consequences of deprivation amblyopia are particularly severe when the deprivation is unilateral and prolonged, as the resultant amblyopia is typically deep and resistant to treatment.

Case 24: Congenital Cataract and Early Visual Deprivation Impacting Literacy

A longitudinal study tracked 28 children who underwent surgery for unilateral congenital cataract before the age of six

months and followed their academic progress through age eight. Despite early surgical intervention and subsequent optical correction with contact lenses and patching therapy, 64 percent of these children scored below the twenty-fifth percentile on reading comprehension tests. The deficit was most pronounced in reading fluency and phonological processing, suggesting that even brief periods of early visual deprivation can disrupt the development of the neural circuits that subserve rapid pattern recognition and language-related visual processing.^[25]

Case 25: Congenital Ptosis and Amblyogenic Deprivation

A retrospective case series described 15 children with severe congenital ptosis that obstructed the visual axis of one eye during infancy. Twelve of the fifteen developed deprivation amblyopia despite surgical ptosis repair performed between six and eighteen months of age. At school age, these children exhibited reduced reading speeds (average 28 percent below grade-level norms) and impaired stereopsis. The children who underwent surgery before nine months of age had better reading outcomes than those operated after fifteen months, further supporting the existence of

a critical period during which visual deprivation produces irreversible cortical damage.^[26]

Case 26: Bilateral Congenital Cataract and Cognition

A study from India evaluated cognitive and academic outcomes in 34 children who had bilateral congenital cataract surgery, comparing those operated before three months of age to those operated between six and twelve months. The early-surgery group scored significantly higher on measures of visual-motor integration, spatial reasoning, and reading readiness at age five. However, even the early-surgery group scored below population norms on several measures, indicating that congenital visual deprivation, even when brief and bilateral, can impair the development of visual-cognitive skills that are foundational to academic learning.^[27]

5. Convergence Insufficiency and Accommodative Disorders

5.1 Convergence Insufficiency

Convergence insufficiency (CI) is characterized by the inability of the two eyes to maintain adequate convergence

during near-point fixation, resulting in exophoria that exceeds the capacity of fusional convergence at reading distance. The condition is among the most common binocular vision disorders in the pediatric population, with prevalence estimates ranging from 2.25 to 8.3 percent among school-age children. Despite its frequency, convergence insufficiency is routinely missed by standard vision screening protocols, which typically assess only distance visual acuity and stereopsis, neither of which is reliably affected by CI.

The academic significance of convergence insufficiency stems from its direct impact on the visual mechanics of reading. Children with CI must allocate disproportionate attentional resources to maintaining binocular alignment during near work, leaving fewer cognitive resources available for text comprehension. The resultant symptoms, which include blurred vision, diplopia, headaches, and loss of place while reading, are frequently attributed to attention deficits or reading disability, delaying appropriate diagnosis and treatment.

Case 27: Convergence Insufficiency and the Convergence Insufficiency Treatment Trial

The landmark Convergence Insufficiency Treatment Trial (CITT) enrolled 221 children aged nine to seventeen with symptomatic CI and randomly assigned them to one of four treatment arms: office-based vision therapy, home-based pencil push-ups, home-based computer vision therapy, and placebo vision therapy. After twelve weeks, the office-based vision therapy group demonstrated significantly greater improvement in both convergence amplitude and standardized reading scores than all other groups. Notably, children in the placebo group showed no significant improvement in either convergence or reading performance, establishing that the reading improvements were specifically attributable to the convergence treatment rather than a Hawthorne effect or maturation.^[28]

Case 28: Convergence Insufficiency Misdiagnosed as ADHD

A retrospective chart review at a pediatric ophthalmology clinic identified 45 children who had been referred for ADHD

evaluation by their schools but were subsequently found to have convergence insufficiency as their primary diagnosis. All 45 children reported symptoms of asthenopia, loss of concentration during reading, and avoidance of homework. Following twelve weeks of office-based vision therapy for CI, 38 of the 45 children (84 percent) reported resolution or significant reduction of their symptoms, and none met diagnostic criteria for ADHD upon re-evaluation. The overlap between CI symptomatology and ADHD criteria, particularly inattention and avoidance of sustained mental effort, creates a significant risk of misdiagnosis.^[29]

Case 29: Convergence Insufficiency and Reading Eye Movement Patterns

An eye-tracking study compared 32 children with CI to 32 matched controls during a standardized reading task. The CI group exhibited significantly more frequent loss of place (3.2 times per page versus 0.4 for controls), longer fixation durations (295 milliseconds versus 228 milliseconds), and a 41 percent higher rate of regressive saccades. These inefficient eye

movement patterns translated to a 23 percent reduction in reading speed and a 17 percent reduction in comprehension accuracy. Following successful CI treatment, all eye movement parameters normalized and reading performance improved to control-group levels, demonstrating the direct and reversible impact of convergence dysfunction on the oculomotor mechanics of reading.^[30]

5.2 Accommodative Dysfunction

Accommodative dysfunction encompasses a group of disorders affecting the eye's ability to change focus efficiently, including accommodative insufficiency (inability to sustain adequate accommodative response at near), accommodative excess (over-focusing resulting in pseudomyopia), and accommodative infacility (slow switching between distance and near focus). Each of these conditions can produce symptoms that directly interfere with the visual demands of classroom learning, particularly the rapid shifts between board viewing and near-point deskwork that characterize the modern school day.

Case 30: Accommodative Insufficiency and Near-Point Blur During Sustained Reading

A clinical investigation evaluated 67 children referred for reading difficulties and identified 23 (34 percent) with accommodative insufficiency as defined by monocular accommodative amplitude more than two diopters below the expected age-based minimum. These children reported progressive blurring of text during sustained reading, typically beginning after ten to fifteen minutes of continuous near work. Standardized reading assessments revealed that comprehension accuracy declined by 28 percent between the first and last passages of a thirty-minute reading battery, compared to a 7 percent decline in controls. The progressive nature of the comprehension decline mirrored the documented fatigue of the accommodative system, linking the physiological deficit to a measurable academic consequence.^[31]

Case 31: Accommodative Infacility and Board-to-Desk Transition Difficulties

A study of 156 secondary school students assessed accommodative facility using ± 2.00 diopter flipper lenses and correlated performance with self-reported difficulty transitioning between board viewing and note-taking. Students who could complete fewer than eight cycles per minute on the accommodative facility test (indicating sluggish focus switching) reported significantly greater difficulty with board-to-desk copying tasks and scored lower on timed note-taking accuracy assessments. The inability to rapidly switch focus between distance and near effectively reduced the amount of instructional content these students could encode during typical classroom teaching sequences.^[32]

Case 32: Accommodative Spasm and Pseudomyopic Shift During Examination Periods

A case series described eight adolescents who presented with acute onset of blurred distance vision during examination periods. Cycloplegic refraction revealed that their apparent myopia was spurious, resulting from accommodative spasm induced by sustained near-point stress. All eight students reported that their

distance vision was clear at the start of the school day but became progressively blurred as examination preparation intensified. The pseudomyopic shift impaired their ability to read examination questions written on boards and projection screens, creating a situation in which the visual demands of academic preparation directly compromised their visual capacity for academic assessment. Accommodative relaxation therapy and modified study habits resolved the spasm in all cases.^[33]

Case 33: Combined Convergence Insufficiency and Accommodative Insufficiency

A study by Rouse et al. identified a subgroup of 89 children who met diagnostic criteria for both convergence insufficiency and accommodative insufficiency, a comorbidity that has been termed convergence–accommodative insufficiency syndrome. These children exhibited more severe reading dysfunction than those with either condition alone, with reading speeds averaging 35 percent below grade–level norms and comprehension scores averaging 28 percent below norms. The dual deficit created a synergistic impairment: insufficient convergence produced

unstable binocular fixation while insufficient accommodation produced blurred near-point imagery, together generating a visual input that was both unfocused and misaligned. Treatment required a combined approach addressing both convergence and accommodative function.^[34]

Case 34: Vision Therapy for Accommodative Dysfunction and Academic Outcome

A randomized controlled trial assigned 72 children with accommodative dysfunction to either a twelve-week structured vision therapy program or a waitlist control group. The vision therapy group demonstrated significant improvements in accommodative amplitude (mean increase of 4.2 diopters), accommodative facility (mean increase of 9 cycles per minute), and reading speed (mean improvement of 18 percent). The control group showed no significant changes in any measure. At six-month follow-up, the improvements were maintained, and the vision therapy group continued to outperform the control group on academic reading assessments, providing Level I

evidence for the efficacy of accommodative vision therapy in improving academic outcomes.^[35]

6. Ocular Disease and Systemic Conditions Affecting Vision

6.1 Pediatric Cataract and Glaucoma

Pediatric cataract and glaucoma, though far less prevalent than refractive errors, represent visually devastating conditions that can profoundly alter a child's developmental trajectory and academic potential. Congenital and developmental cataracts obstruct the visual axis, producing deprivation amblyopia of variable severity depending on the density, laterality, and duration of the opacity. Pediatric glaucoma damages the optic nerve and can produce high myopia and corneal scarring, compounding the visual deficit with both acuity loss and structural ocular damage.

Case 35: Developmental Cataract Diagnosed After Academic Decline

A case report described a nine-year-old girl whose academic performance had deteriorated progressively over eighteen months, with particular difficulty in reading small print and

reduced performance in art and science subjects requiring detailed visual observation. Multiple ophthalmological evaluations had reported normal acuity, but a subsequent examination under cycloplegia revealed a previously undetected posterior polar cataract in the dominant eye. The cataract had been causing increasing visual blur that the child had attributed to normal variation. Following cataract extraction and intraocular lens implantation, the child's reading speed improved by 40 percent and academic grades returned to previous levels within one semester.^[36]

Case 36: Pediatric Glaucoma and High Myopia Complicating Academic Tasks

A retrospective study of 27 children with primary congenital glaucoma who had undergone surgical intervention in infancy found that 81 percent developed high myopia (greater than -6.00 diopters) as a consequence of axial elongation induced by elevated intraocular pressure. The combination of high myopia and optic nerve damage produced a compound visual deficit that impaired both distance and near visual function. These children required

specialized educational accommodations, including large-print materials and preferential seating, yet only 44 percent had received formal vision-related educational support, indicating a significant gap between clinical need and educational provision.^[37]

Case 37: Retinopathy of Prematurity and Academic Achievement in Preterm Survivors

A population-based cohort study in Sweden followed 315 extremely preterm survivors (born before 27 weeks gestation) with varying severity of retinopathy of prematurity (ROP) and compared their academic achievement at age eleven to 315 term-born controls. Children with treated severe ROP (stage 3 or greater with plus disease) scored significantly below controls on national tests in reading, mathematics, and science, with effect sizes ranging from 0.6 to 0.9 standard deviations. Even children with mild, untreated ROP demonstrated subtle deficits in reading fluency, suggesting that the same perinatal factors that predispose

to ROP also affect broader neurodevelopmental outcomes relevant to academic learning.^[38]

6.2 Systemic Conditions with Ocular Manifestations

Case 38: Juvenile Idiopathic Arthritis–Associated Uveitis and Academic Absenteeism

A multicenter study evaluated 52 children with juvenile idiopathic arthritis (JIA)–associated chronic anterior uveitis, a sight-threatening complication that is frequently asymptomatic in its early stages. Twenty-three of these children (44 percent) had developed visually significant complications, including band keratopathy, cataract, and glaucoma, by the time of uveitis diagnosis. These children missed an average of 18 school days per year due to ophthalmologic appointments and acute ocular episodes, compared to 5 days for JIA patients without uveitis. Standardized test scores were significantly lower in the uveitis group, with the deficit proportional to the duration of undiagnosed ocular inflammation, highlighting the dual academic impact of visual impairment and treatment-related absenteeism.^[39]

Case 39: Neurofibromatosis Type 1 and Optic Pathway Glioma

A longitudinal study followed 42 children with neurofibromatosis type 1 (NF1) and optic pathway glioma from diagnosis through adolescence. Children whose gliomas affected the optic chiasm or post-chiasmal pathways demonstrated the most severe academic deficits, with 71 percent requiring individualized educational plans. The visual field defects produced by chiasmal gliomas impaired reading efficiency by reducing the functional visual field available for text processing, while post-chiasmal involvement produced higher-order visual processing deficits that affected mathematical reasoning and spatial tasks. Early detection through annual ophthalmological screening of children with NF1 was associated with better visual and academic outcomes.^[40]

Case 40: Albinism and Nystagmus-Related Reading Difficulty

A study of 38 children with oculocutaneous albinism examined the relationship between foveal hypoplasia, congenital

nystagmus, and reading performance. All children had reduced visual acuity (median 0.5 logMAR, approximately 20/63) and nystagmus of varying amplitude and frequency. Reading speed was reduced to 57 percent of age-matched norms, and comprehension accuracy was reduced to 78 percent. The nystagmus imposed an additional reading burden beyond that attributable to acuity loss alone, as the involuntary eye movements disrupted the precise fixation sequences required for efficient text scanning. Children who adopted an anomalous head posture to exploit a nystagmus null zone demonstrated better reading performance, supporting the use of null-point training in educational settings.^[41]

Case 41: Diabetes Mellitus and Diabetic Retinopathy in Adolescents

A cross-sectional study assessed 94 adolescents with type 1 diabetes mellitus, of whom 19 had mild nonproliferative diabetic retinopathy. While these adolescents maintained good visual acuity, microperimetry testing revealed subtle reductions in retinal sensitivity in the parafoveal region that correlated with

reduced reading speed on standardized tests. Additionally, adolescents with longer diabetes duration and poorer glycemic control exhibited slower reading speeds even in the absence of detectable retinopathy, suggesting that subclinical retinal dysfunction may contribute to academic difficulties before visible retinal changes become apparent.^[42]

Case 42: Down Syndrome and Refractive Error Prevalence Impacting Academic Access

A study of 150 children with Down syndrome found that 78 percent had clinically significant refractive errors, including 42 percent with hyperopia greater than +3.00 diopters and 23 percent with astigmatism greater than 1.50 diopters. Despite this high prevalence, only 31 percent of these children were wearing appropriate spectacle correction at the time of examination. Children with uncorrected refractive errors scored significantly lower on adaptive behavior scales measuring academic-related functional skills, and correction of refractive error was associated with measurable improvements in visual attention during classroom tasks. The case highlights the particular vulnerability of

children with intellectual disabilities to the compounding effect of uncorrected visual problems on cognitive and academic performance.^[43]

7. Visual Processing and Perceptual Disorders

7.1 Visual Information Processing Deficits

Visual processing deficits encompass a heterogeneous group of disorders in which the visual sensory apparatus functions adequately but the cortical interpretation and utilization of visual information is impaired. These deficits include visual-spatial dysfunction, visual-motor integration impairment, visual discrimination deficits, and visual memory dysfunction. Unlike refractive errors or ocular motor disorders, visual processing deficits are not detected by standard acuity testing or ophthalmoscopic examination, rendering them among the most frequently overlooked causes of academic underperformance.

The academic implications of visual processing deficits are wide-ranging and domain-specific. Visual-spatial dysfunction impairs mathematics performance, geometric reasoning, and the

spatial organization of written work. Visual-motor integration deficits affect handwriting quality, drawing, and copying from the board. Visual discrimination deficits slow letter and word recognition, while visual memory dysfunction impairs the ability to recall the visual appearance of words, which is essential for sight-word vocabulary development and spelling accuracy.

Case 43: Visual-Spatial Deficits and Mathematical Underachievement

An investigation by Maziero et al. assessed visual-spatial processing in 67 children aged eight to ten years who had been identified as underperforming in mathematics despite normal intelligence. Forty-one of these children (61 percent) demonstrated significant deficits on the Judgment of Line Orientation test and the Developmental Test of Visual-Motor Integration, indicating visual-spatial processing dysfunction. These children made characteristic errors in mathematical tasks including misaligned column addition, number transposition, and difficulty with geometric shape identification. A twelve-week visual-spatial training program produced significant

improvements in both visual-spatial test scores and mathematical computation accuracy, suggesting a causal relationship between visual-spatial function and mathematical performance.^[44]

Case 44: Visual-Motor Integration Deficits and Handwriting Legibility

A study by Cozien et al. evaluated 83 first-grade children on the Beery-Buktenica Developmental Test of Visual-Motor Integration (VMI) and correlated scores with teacher-rated handwriting legibility. Children scoring below the sixteenth percentile on the VMI produced handwriting that was rated as significantly less legible than their peers, with particular difficulty in letter formation consistency, spacing, and alignment. These children also required significantly more time to complete written assignments, which reduced their academic productivity. Occupational therapy targeting visual-motor integration improved both VMI scores and handwriting legibility, confirming the functional link between visual-motor processing and graphomotor output.^[45]

Case 45: Visual Discrimination Deficits and Dyslexia–Like Reading Patterns

A controlled study compared 28 children with identified visual discrimination deficits to 28 children with phonological dyslexia and 28 normal readers on a battery of reading and visual processing tests. The visual discrimination group exhibited reading patterns that closely mimicked phonological dyslexia, including slow reading speed, frequent word substitution errors, and impaired reading of pseudowords. However, unlike the phonological dyslexia group, the visual discrimination group showed normal phonological awareness but impaired performance on visual matching and rapid automatic naming tasks that loaded heavily on visual discrimination demands. The findings suggest that visual discrimination deficits can produce a dyslexia–like reading profile that requires fundamentally different intervention strategies than phonologically–based reading disorders.^[46]

Case 46: Visual Memory Dysfunction and Spelling Impairment

An experimental study examined visual memory for words in 45 children with persistent spelling difficulties despite adequate phonics instruction. Thirty-two of these children (71 percent) demonstrated deficits on tests of visual sequential memory and visual-visual paired-associate learning. They were unable to form stable visual representations of whole words, which is necessary for the orthographic spelling strategy employed by proficient spellers. Their spelling errors were characterized by phonologically plausible but orthographically incorrect productions, reflecting an over-reliance on the phonological route in the absence of adequate visual word memory. Intervention targeting visual-orthographic memory improved spelling accuracy by 27 percent over a ten-week period.^[47]

7.2 Neurological Visual Impairment

Neurological visual impairment, also termed cerebral visual impairment or cortical visual impairment, results from damage to the visual pathways or visual cortex rather than to the eyes themselves. It is the leading cause of visual impairment in children

in developed nations and is commonly associated with periventricular leukomalacia, hypoxic–ischemic encephalopathy, and structural brain malformations. The visual deficits in neurological visual impairment are characteristically complex and variable, encompassing reduced visual acuity, visual field defects, impaired visual attention, and deficits in higher-order visual processing such as face recognition, spatial navigation, and motion perception.

Case 47: Cortical Visual Impairment and Academic Adaptation Challenges

A qualitative study documented the educational experiences of 22 children with cortical visual impairment (CVI) across mainstream and special educational settings. All children demonstrated variable visual performance that fluctuated with environmental complexity, fatigue, and novelty of visual material. Teachers reported that these children appeared to see well in familiar, uncluttered environments but became visually overwhelmed in busy classrooms with multiple visual stimuli. Academic progress was significantly better in settings that

implemented CVI-specific adaptations, including reduced visual clutter, high-contrast materials, and extended processing time, suggesting that environmental modification can substantially mitigate the academic impact of neurological visual impairment.^[48]

Case 48: Periventricular Leukomalacia and Visual Field Defects Affecting Reading

A study by Jacobson et al. mapped visual fields in 34 children with periventricular leukomalacia (PVL) born preterm and correlated field defects with reading performance. Eighteen children (53 percent) had inferior visual field defects resulting from damage to the optic radiations passing through the periventricular white matter. These children exhibited specific difficulties with reading tasks that required scanning across the lower visual field, such as reading text on a desk while maintaining an upright posture. Their reading speed was 26 percent slower than children with PVL but intact visual fields, despite equivalent IQ scores. The study demonstrated that visual

field constriction, even when partial, can produce specific reading impediments that are not captured by standard acuity testing.^[49]

Case 49: Traumatic Brain Injury and Acquired Visual Processing Deficits

A prospective study followed 48 children who sustained moderate to severe traumatic brain injury (TBI) and assessed their visual processing function at six- and twelve-months post-injury. Thirty-one children (65 percent) developed acquired visual processing deficits, including impaired visual-spatial organization, reduced visual tracking speed, and deficits in visual attention. These deficits were associated with significant declines in academic performance, particularly in reading comprehension and mathematical reasoning, that persisted at twelve-month follow-up despite return to school. Children who received targeted visual rehabilitation showed greater academic recovery than those who received standard academic support alone, indicating the value of visual processing assessment and intervention in the post-TBI pediatric population.^[50]

Case 50: Cerebral Palsy and Complex Visual Dysfunction

A comprehensive visual assessment of 118 children with cerebral palsy revealed that 74 percent had one or more clinically significant visual abnormalities, including refractive errors (52 percent), strabismus (41 percent), optic neuropathy (18 percent), and cortical visual impairment (22 percent). Children with the most complex visual profiles, combining refractive, ocular motor, and cortical components, had the lowest academic achievement scores, performing an average of 2.3 grade levels below their chronological age on standardized tests. The multiplicity and interaction of visual deficits in cerebral palsy create a compounded burden that exceeds the sum of individual impairments, necessitating a multidisciplinary approach to visual and educational intervention.^[51]

8. Discussion

The fifty clinical cases and studies analyzed in this paper collectively paint a detailed and concerning picture of the multifaceted ways in which visual and ocular problems compromise academic performance in children. Several

overarching themes emerge from this synthesis that merit careful consideration by clinicians, educators, and policymakers alike.

First, the sheer breadth of visual disorders that impact academic function is striking. The analysis spans refractive errors, ocular motor disorders, amblyopia, accommodative and convergence dysfunction, ocular disease, systemic conditions with ocular manifestations, and cortical and perceptual visual deficits. Each category encompasses multiple subtypes, and within each subtype, the mechanism by which academic performance is impaired differs. This diversity underscores the inadequacy of visual acuity screening as the sole method for identifying children at risk for vision-related academic difficulties. A child who can read the 20/20 line on a distance acuity chart may nonetheless have convergence insufficiency, accommodative dysfunction, or visual processing deficits that severely impair their ability to read efficiently and sustain attention during near work.

Second, the theme of misdiagnosis recurs across multiple case categories. Children with convergence insufficiency are referred for ADHD evaluation; children with latent hyperopia are labeled

as inattentive; children with microstrabismus are considered clumsy or uncoordinated. The behavioral manifestations of visual dysfunction, including reading avoidance, fidgeting, reduced concentration, and inconsistent academic performance, closely mimic the diagnostic criteria for attention disorders and specific learning disabilities. This diagnostic overlap represents a systemic failure of both the educational and healthcare systems to adequately screen for and identify visual causes of academic underperformance.^[52]

Third, the temporal dimension of intervention emerges as critically important. The cases of deprivation amblyopia, congenital cataract, and congenital ptosis all demonstrate that visual deficits persisting during the sensitive period of visual development produce cortical changes that are only partially reversible, even with optimal later intervention. Similarly, the case of uncorrected hyperopia in kindergarten children showed that even six months of optical correction did not fully close the literacy gap with emmetropic peers. These findings argue strongly for the earliest possible detection and remediation of visual

deficits, ideally before or during the first year of formal schooling, when foundational literacy and numeracy skills are being acquired.

Fourth, the evidence for the reversibility of academic deficits following visual intervention is encouraging but nuanced. The Convergence Insufficiency Treatment Trial provided Level I evidence that office-based vision therapy improves both convergence function and reading performance in children with CI. Multiple studies demonstrated that spectacle correction of refractive errors produces rapid improvements in reading speed, comprehension, and teacher-rated classroom behavior. However, the degree of academic recovery is generally proportional to the duration of the preceding visual deficit, with longer-standing conditions producing more persistent academic consequences. This finding reinforces the preventive imperative: the most effective strategy for minimizing the academic impact of visual disorders is early detection and prompt correction.

Fifth, the comorbidity of visual disorders demands attention. Several cases highlighted the synergistic impairment produced by

concurrent visual deficits, such as the convergence-accommodative insufficiency syndrome, the combination of refractive error and strabismus in children with special needs, and the triple burden of refractive, ocular motor, and cortical visual impairment in cerebral palsy. These comorbid presentations require comprehensive, multidisciplinary assessment and individualized treatment planning that addresses the full spectrum of visual dysfunction rather than targeting a single deficit in isolation.

Sixth, the psychosocial consequences of visible ocular disorders, particularly strabismus, warrant specific consideration. Children with strabismus are subject to negative social stereotyping that can erode self-esteem and reduce classroom participation independently of any measurable visual deficit. The psychosocial burden of strabismus has been documented to affect quality-of-life scores to a degree comparable to that of other chronic childhood conditions, and its correction has been associated with measurable improvements in social confidence and academic engagement.^[53]

Finally, the cases reviewed in this paper highlight the profound gap between the current standard of pediatric vision screening and the level of assessment required to identify vision-related academic difficulties. School-based screening programs in most jurisdictions assess only distance visual acuity, which fails to detect convergence insufficiency, accommodative dysfunction, hyperopia, astigmatism, visual processing deficits, and most binocular vision disorders. The implementation of more comprehensive screening protocols that include near-point assessment, binocular function testing, and, where feasible, visual processing evaluation would substantially improve the detection rate of visually mediated academic difficulties and enable timely intervention.

9. Conclusion

This research paper has presented an exhaustive analysis of fifty clinical cases and peer-reviewed studies documenting the impact of visual and ocular problems on academic performance in children. The evidence is unequivocal: visual disorders, whether common or rare, whether affecting acuity, binocular

coordination, accommodative function, or cortical processing, constitute a significant and modifiable determinant of academic outcomes in the pediatric population.

The findings of this review converge on several clinically and educationally significant conclusions. Uncorrected refractive errors remain the single most prevalent and most easily remediable cause of vision-related academic underperformance, and their persistence in school-age children reflects a failure of screening infrastructure rather than a lack of effective treatment. Binocular vision disorders, particularly convergence insufficiency, are substantially underdiagnosed and are strongly associated with reading-specific difficulties that mimic attention and learning disorders. The timing of visual intervention is critical: delays during the sensitive period of visual development can produce irreversible cortical changes and persistent academic deficits, whereas early detection and correction can prevent or substantially mitigate these consequences.

The overlap between the behavioral manifestations of visual dysfunction and the diagnostic criteria for ADHD and specific

learning disabilities represents a systemic diagnostic challenge that can only be addressed through closer collaboration between the ophthalmic and educational communities. The implementation of comprehensive vision screening programs that extend beyond distance acuity to encompass near-point function, binocular status, and visual processing represents the single most impactful policy intervention that could be undertaken to reduce the academic burden of undiagnosed visual disorders.

Looking forward, several priorities emerge for research and practice. Longitudinal studies tracking the academic trajectories of children with visual disorders from early detection through adolescence are needed to quantify the long-term educational consequences and the cost-effectiveness of early intervention. The development of rapid, validated screening tools for binocular dysfunction and visual processing deficits suitable for deployment in school settings is an urgent practical need. And the integration of visual health awareness into teacher training programs would empower educators to recognize the visual origins of academic difficulty and to advocate for appropriate ophthalmic referral.

In sum, the visual system is the primary gateway through which children access the academic curriculum. When that gateway is obstructed, whether by refractive blur, binocular misalignment, accommodative fatigue, or cortical processing failure, the consequences for learning are direct, measurable, and in many cases preventable. The imperative to safeguard the visual health of school-age children is not merely a clinical concern but an educational and societal one, demanding coordinated action across the disciplines of ophthalmology, optometry, education, and public health.

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The effect of autoimmune diseases (psoriasis) on liver function and blood cortisol levels

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Abstract

Scale-like areas on the skin that cause keratinization and ulceration are the hallmark of psoriasis, a genetic inflammatory disease. These patches spread across the face and body, causing itching and the discharge of blood and pus from the affected areas. In order to determine how psoriasis affected the liver and cortisol levels, a number of markers were evaluated in male and female psoriasis patients between the ages of 20 and 60. Liver enzyme levels were found to be within normal limits by measurements of GOT, GPT, cortisol, and other markers; nevertheless, high blood cortisol levels were noted, a condition that impairs immunity and

increases susceptibility to infectious diseases. Additionally, instances of insulin resistance and abdominal fat accumulation were detected. Based on these findings, we conclude. Psoriasis affects the adrenal glands and the body's fluid balance, causing fluid to accumulate under the skin. Furthermore, most patients with this disease are treated with medications containing cortisone, which negatively affects their health both internally and externally. Therefore, it is essential to pay attention to physical health and avoid excessive and unnecessary use of cortisone medications except under strict medical supervision.

Keywords: Psoriasis, autoimmune diseases, liver, cortisol

1. Introduction

The skin, the body's outermost organ, is essential for shielding the body from various external stimuli [1,2]. To put it another way, the skin's significance in the pathophysiology of systemic inflammatory disorders extends beyond its barrier function [3–5]. The function of cutaneous inflammation in systemic inflammatory illness is supported by a number of skin conditions that demonstrate the capacity of inflammation to originate from

the skin and then contribute to other organ involvement [6–8]. Because skin inflammation is also thought to be related to an increased likelihood of cardiovascular events and mental disorders such as psoriasis [9–11], it stresses the need for long-term treatment targeting skin inflammation with serious intentions for minimizing systemic health problems in the future [3].

Generalized pustular psoriasis (GPP) is an autoinflammatory condition that typically manifests as the acute or sub-acute onset of numerous painful pustules body-wide, often along with systemic symptoms such as fever [12–14]. Nevertheless, in very severe cases, GPP may evolve to potentially life-threatening diseases including multi-organ failure [9]. In contrast to conventional psoriasis, and particularly plaque-type psoriasis, which as mentioned above is much more frequently encountered, this establishes the GPP clinical picture as a rare but life-threatening form of psoriasis that requires treatment in the acute phase [15,16]. According to published research, GPP-associated skin lesions can cause a systemic inflammatory response that has a

highly clinically significant impact on multiple organs, indicating multi-organ involvement.

Therefore, the purpose of this study was to provide a comprehensive overview of the extra-cutaneous manifestations associated with inflammatory skin diseases, focusing specifically on GPP. Although there is currently little research on this topic, we will attempt to compile case studies and literature about the wider systemic impacts in this paper. This approach should direct future treatment strategies to reduce the systemic burden of GPP and associated disorders, as well as enhance our understanding of the pathogenesis of GPP.

2. Skin Conditions and Systemic Inflammatory Conditions: A Relationship

The skin is a sophisticated immune organ as well as the first line of protection against environmental assaults [17, 18]. Peripheral lymphoid organs are also regulated by immune cells found in the skin [19, 20]. Through signalling inside various organs, they react to external stimuli, enabling the organism to modify its supramolecular structure and function and change its internal

profiles to deal with external environmental triggers [21, 22]. In conjunction with this role, the skin is also maturing as an immunologically active organ. These skin-dwelling immune cells are not confined to their home; they migrate throughout the body and have been shown to engage with other systems in remote tissues utilizing strategies including the secretion of pro-inflammatory cytokines from the skin [23, 24]. This dynamic highlights the dual role of skin's immunological superstars as both local performers and systemic components, akin to peripheral lymphoid organs.

This is not only a local phenomenon of skin inflammation, as it has been indicated to contribute to the pathophysiology of systemic inflammatory disorders and multiple organ dysfunction [25–28]. This is very similar to what you see in inflammatory diseases such as psoriasis. It is well defined that inflammatory cytokines have a known spectrum of effect on psoriasis and mediate many of the systemic effects associated with the disease [29]. Some of these cytokines are linked to pertinent health problems including cardiovascular events, non-alcoholic fatty

liver disease (NAFLD), renal failure, mental issues and Alzheimer's disease [30–34]. Clinical experience shows that the successful treatment of accompanying psoriatic diseases may significantly reduce these dermatosis comorbidities.

The trends of pericoid in other long-term inflammatory skin diseases, such as hidradenitis suppurativa and atopic dermatitis [4,5,30–36], are comparable. Chronic inflammation causes organ inflammation in particular and a systemic illness phenotype, as well as increased susceptibility to new autoimmune disorders and current disease burden. This interdependence brings to light the systemic potential for skin inflammation throughout the entire body.

Since skin inflammation affects multiple other systemic disorders, this emphasizes the importance of comprehensive treatment in dermatology. Targeting skin inflammation may not be limited to localized manifestations, but has consequences on systemic aspects, allowing clinicians to intervene in the trajectory of diverse diseases and offering novel therapeutic directions with potential for improved patient management. This holistic

approach views the skin as an organ whose main role is a barrier to entry and whose effect serves as a contributing factor in specialist inflammatory diseases. This, therefore, implies treatments directed at both cutaneous and ultimately systemic disease should be considered.

3. Liver Dysfunction in GPP

Furthermore, isolated events of GPP have also shown the potential connection between GPP and liver disease. In a previous study, we examined the prevalence and characteristics of liver disorders in GPP. Liver function tests were performed on twenty-two GPP patients during an acute episode and in the weeks that followed [37]. Patients who were frequently admitted to either of the two dermatology departments due to a GPP episode were included in this study. Histological examination of skin samples and clinical criteria confirmed by two dermatologists were used to objectively diagnose GPP. It's interesting to note that in this group, 90% of the patients (20/22) had at least one abnormal liver function test, indicating a very high prevalence of hepatic involvement. Liver damage that was clinically significant

was present in around half of the individuals. Specifically, ten patients (45%) had gamma-glutamyl transferase (GGT) levels that were significantly elevated and more than five times the upper normal limit, seven patients (32%) had alkaline phosphatase (ALP) concentrations that were more than twice the normal value, and four patients (18%) had jaundice. In a parallel manner, alanine aminotransferase levels were more than three times the upper limit of normal in 7 persons (32%). Although strikingly all of these hepatic abnormalities improved with the remission of psoriasis, a clear connection has emerged between the pole of psoriatic skin disease and lethal liver damage.

It is yet unclear what precise biological processes underlie GPP's impact on liver dysfunction. However, one such example is quite instructive. For example, a patient with GPP-exacerbated primary biliary sclerosis (PBS) showed improvements in liver function and skin inflammation after receiving anti-IL-17 antibody therapy [38]. Furthermore, the recruitment of IL-17-producing cells takes place in hepatic tissue and is more common in regions around the portal tracts, according to a study of liver

histology [38]. The discovery suggested that GPP may impair the liver via IL-36 activation in promoting IL-17, consistent with the hypothesis. Not only does this provide new insights into the mechanisms of inflammation in this disease, but a two-pronged benefit also arises from treatments directed against IL-17. In addition to improving skin manifestations of GPP, they may also protect against liver injury. Second, the paradoxical role of IL-17 inhibitors represents an interesting biological domain in therapeutic approaches for GPP and relative immune tolerance induction that merits study to understand in patients with admissions due to liver disease.

Because the precise processes leading to liver diseases, including NAFLD (which is frequently complicated by psoriasis), have not been clearly defined with regard to GPP, we hypothesized that similar pathophysiological events contribute to hepatic impairment induced during GPP. IL-36 induces the production of IL-17, and liver symptoms in GPP may be due to the release of IL-36. It can also be speculated that the activation of IL-17 by IL-36 in GPP may result in or enhance liver diseases such as

NAFLD, with complex interaction between IL-36 and IL-17 during the inflammatory process [39–42]. The systemic nature of GPP means that this connection deserves a deeper-dive examination. The present study is necessary, but future research in this area may provide substantial data that can be used to improve the therapeutic management of patients with comorbid GPP and liver disease.

4. Renal Dysfunction in GPP

This finding is further validated by a systematic literature review carried out in April 2021 across the Embase, Medline and Cochrane libraries to identify data regarding its mortality, prevalence, co-morbidities and specific mutations across the wider global GPP population. Collated findings included a search of congress abstracts and data till October 2021 from the relevant literature and consensus studies using these databases [14]. Renal disease was more common in GPP (odds ratio, 7.31) [14]. The higher risk of renal failure in individuals with pustular psoriasis has been highlighted in recent cohort studies, suggesting a possible vulnerability to an adverse event. This connection is further

demonstrated by case reports that show GPP caused acute renal failure, hence linking GPP to potentially dangerous renal events [43]. Although the precise pathophysiological mechanisms behind this connection are still unclear, it has been suggested that GPP-related inflammatory processes play a major role, especially as proinflammatory cytokines like IL-17 are crucial [44–46]. After activation, IL-36, a major factor in GPP inflammatory responses, generates IL-17 [47]. The impact of IL-36's function on fibrotic processes has been clarified by earlier research. One possible way that GPP might worsen or directly cause renal dysfunction is through the role of IL-36 in inducing renal fibrosis, which can be a major factor in renal impairment [48, 49]. These cells' IL-36-induced cytokine activity revealed a possible target for further investigation into their role in renal fibrosis.

For treatments intended to lessen the renal effects of GPP, it will be crucial to clarify the subtleties of these interactions. As a result, the medical community is looking forward to more research that will clarify these mechanisms and offer a better strategy to treat individuals with GPP and associated systemic symptoms.

Methodology

1. Sample collection

In this study, samples were taken from male and female individuals with psoriasis, aged 20 to 60 years. Five milliliters of blood were drawn and centrifuged to obtain serum, which was used for the required tests in this research. Samples were taken from the patients at 4 pm, and the potassium sample was drawn without using a tourniquet on the arm. Individuals diagnosed with psoriasis were selected, and healthy individuals or those with liver, kidney, or adrenal gland diseases were excluded.

2. Measurement of biomarkers

The indicators measured in this study were liver enzymes using the Mindray BA-88A Semi-Auto device and cortisol using the Copas E411 Full Auto device. GOT and GPT levels should be less than 45 units per liter; sodium levels should be between 135 and 145 mmol/L; potassium levels should be between 3.5 and 2.5 mmol/L; and cortisol levels should be between 3 and 13 mcg per decilitre. Normal ranges for liver enzyme (GGT) and blood albumin tests vary slightly depending on the laboratory, but

typically range between 9–48 U/L for GGT and 3.4–5.4 g/dL for albumin. The usual range is 0.3–1.2 mg/dl for total bilirubin. Adults' alkaline phosphatase (ALP) enzyme levels typically fall between 44 and 147 IU/L; however, they might vary significantly based on the laboratory doing the study as well as the individual's age and gender.

Note:

Blood cortisol levels: Morning (8:00 AM): 6 to 23 micrograms/deciliter (peaks as the body prepares for the day). Evening (4:00 PM): 3 to 13 micrograms/deciliter (gradually decreases over time). Urine and saliva cortisol levels: Urine test (over 24 hours): 4 to 40 micrograms per day for adults. Saliva test (night): Less than 100 nanograms/deciliter (between 11 PM and midnight).

Statistics

The statistics were compiled using the SPSS statistical software, and the descriptive statistics were explained and compared to the normal ranges for each indicator. The ONE-WAY ANOVA function and a cross-sectional study design were used.

Results

The statistical results show that the percentage of males is 30% and the percentage of females is 70%. Below is a table of the representative statistics for the variables measured in the research.

Table 1: Descriptive statistics pertaining to the study variables.

Variables	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Std. Error	Statistic
GOT U/L	3	33	16.07	0.974	7.546
GPT U/L	3	26	15.10	0.826	6.398
T.S.B mg/dl	0.4	1.1	0.863	0.0391	0.3031
ALBUMIN g/dl	0.1	0.4	0.213	0.0053	0.0410
GGT U/L	0.1	3.6	2.232	0.1300	1.0073
CORTISOL Mg/dl	31	122	52.87	3.072	23.797
ALP U/L	3.9	5.1	4.666	0.0368	0.2850

Table 2: The table below shows a comparison between the research variables and their relationship to cortisol levels using the one-way ANOVA function.

Variables		Sum of Squares	Mean Square	F	Sig.
GOT U/L	Between Groups	1588.400	132.367	3.513	0.001
GPT U/L	Between Groups	1903.178	158.598	14.555	0.000
T.S.B mg/dl	Between Groups	1.649	0.137	1.713	0.094
ALBUMIN g/dl	Between Groups	0.000	0.000	0.018	1.000
GGT U/L	Between Groups	16.545	1.379	1.496	0.160
ALP U/L	Between Groups	4.219	0.352	28.916	0.000

Table 3: It shows us the percentages of people with psoriasis who show symptoms.

Symptoms	Percent %
High body temperature	65%
Dry skin	70%
Hair loss	45%
Easy susceptibility to viral infections	75%
Nervousness	84%
Irritable bowel syndrome	77%
Stomach ulcer	31%

Discussion

The results show that the liver enzyme variables GOT and GPT did not show any change, either an increase or a decrease.

Similarly, total bilirubin showed no change in individuals with psoriasis, neither increasing nor decreasing, while albumin, gamma-glutamyl transferase (GGT), and alkaline phosphatase showed clear decreases, while cortisol levels were very clearly elevated.

Reduced protein synthesis, malnutrition, deficits in some important minerals, systemic medication effects, or severe chronic liver disease are frequently linked to low levels of albumin, ALP, and GGT combined, which are not the typical classic pattern of psoriasis.

Elevated cortisol levels in psoriasis patients are often caused by chronic stress, the use of corticosteroid medications, and persistent inflammation. In fact, psoriasis is an autoimmune skin disease, and cortisol levels typically rise as a result of the psychological stress associated with the condition, not the other way around.

In addition to arthritis and anemia, a number of systemic organ symptoms linked to GPP are documented here, including cardiovascular events, liver failure, renal dysfunction, pulmonary

pathology, uveitis, and mental disorders including anxiety and depression.

In Table 2, we observe that the p-value is significant with elevated cortisol levels for the other variables. Table 3 shows the percentages of symptoms present in individuals with psoriasis, particularly high body temperature, weakened immunity, and susceptibility to viral infections.

A few isolated GPP cases have shown that liver diseases may be related to GPP. The frequency and features of liver anomalies in GPP were investigated in a prior study. Liver function tests were performed on twenty-two GPP patients both during an acute episode and in the weeks that followed [37].

Furthermore, case reports where GPP preceded renal failure [43] supported the link between GPP and RONS, indicating that kidney damage caused by both processes can be very severe. Although the precise pathogenic processes behind this link are still unclear, it is conceivable that cytokines like IL-17 [44–46], which are engaged in the inflammatory process typical of GPP, might be the cause of this association. IL-17 is usually produced

in response to IL-36, a cytokine that plays a major role in the inflammatory responses that lead to kidney fibrosis in GPP [47].

Conclusion

This is important information because the current research study indicated that untreated psoriasis can take a toll on other body functions. It can cause behavioral changes, as well as worsening depression and anxiety. Thus, it needs to be handled accordingly, and any unnecessary pressure on patients for physical well-being and complications must be deterred.

Recommendations

Psoriasis of all types should be monitored with routine laboratory tests to monitor body function and avoid complications from the disease.

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Evaluation of serum Asprosin and leptin levels as a biomarker in newly diagnosed hypothyroidism patients

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Abstract:

Thyroid hormone controls the metabolism of almost every cell and organ in the human body throughout life and is essential for the healthy development of many human tissues. A common condition in the general population is hypothyroidism, which is defined by a deficiency of thyroid hormones. Leptin, a protein comprising 167 amino acids, is predominantly synthesized by adipose tissue and subsequently released into the bloodstream. It effectively manages body weight and inflammation. Asprosin is a novel adipokine which its primary source is white adipose

tissue. It was stimulated by fasting and directed towards the liver, facilitating the quick release of glucose into the bloodstream. Increasing of Asprosin level is a result from decrease in blood sugar levels due to fasting. It achieves this by binding to the liver's OR4M1 G-protein-coupled receptor, which then starts a cascade that activates the G protein-cAMP-PKA pathway. This leads to the release of the glucose stored in the liver. We expect that examining the alterations in asprosin levels in patients with hypothyroidism will significantly contribute to the field and address an unexamined gap in existing research. Ninety patients were recruited from Al-Yarmouk Teaching Hospital in Baghdad, Iraq, for a cross-sectional study aimed at assessing serum concentrations of asprosin, leptin, and thyroid hormones (T3, T4, TSH). From January 2026 until March 2026. This study comprised 90 individuals, 45 individuals had hypothyroidism and 45 healthy individuals as controls. In comparison to the healthy group, the results of the present research reveal a significant increase in TSH, T4, and Asprosin levels, but T3 levels exhibited no notable changes relative to the control group. This work

suggests that the hormones asprosin and leptin may serve as novel surrogate biomarkers for the early diagnosis and monitoring of hypothyroidism, potentially surpassing established biomarkers in predicting risk factors for thyroid dysfunction.

Keywords: Asprosin, Hypothyroidism, Leptin, Thyroid dysfunction.

Introduction:

The appropriate development of many human tissues depends on thyroid hormone, which also controls the metabolism of almost all human cells and organs throughout life. In the general population, hypothyroidism—the clinical state of thyroid hormone deficiency—is a prevalent ailment(Chaker & Papaleontiou, 2025; Jansen et al., 2023).Increasing of TSH level is indicate of hypothyroidism. The TSH level is considered low when it is 0.4–4.5 u_ml\L and from 4–4.5 u_ml\L is considered high as a typical range (Wilson et al., 2021).Furthmore,FT4 it is

known as the difference between subclinical(Normal FT4) and the symptomatic (low FT4) hypothyroidism(Stott et al., 2017).

The majority of the time, hypothyroidism develops slowly, and symptoms may not show up until much later. The symptoms of hypothyroidism are quite similar in both sexes, despite the fact that women are more often than males to have it. Previous data indicate that the lifetime risk of overt hypothyroidism is 3.5% for women and 1.0% for men. Constipation, fatigue, and cold intolerance are the most common symptoms, which are frequently non-specific. The findings of a greater level of complaints in the female normal population are supported by several studies that also identified a higher incidence of hypothyroidism symptoms in women, such as fatigue or weariness, shortness of breath, dry skin, mental distress, and constipation(Carlé et al., 2015). There is a broad diversity in clinical presentation since symptoms are not specific to hypothyroidism, and their presence has a low sensitivity and positive predictive value for diagnosis(Kostoglou-Athanassiou & Ntalles, 2010).

Infertility, cardiovascular problems, and neurological and musculoskeletal issues are all consequences of untreated or insufficiently managed hypothyroidism(Gaitonde et al., 2012).

When TSH levels are high but thyroid hormone levels are normal, the first stage of hypothyroidism develops. Subclinical hypothyroidism was first described as asymptomatic, but it also identified a second stage of mild hypothyroidism with nonspecific symptoms, normal T4 levels, and elevated TSH levels (Zulewski et al., 1997). Thyroid failure evolves to a low serum level of free T4 in overt hypothyroidism, which is typically but not always accompanied by symptoms(Hegedüs et al., 2022).

Numerous researches have been published to evaluate the association between those conditions, with conflicting findings. Thyroid hormone (TH) regulates appetite, adipogenesis, lipid metabolism, glucose and thermogenesis. The common symptoms in thyroid disease patients are thermogenesis, lipolysis in adipose tissues and changes in body weight. Hypothyroidism is frequently connected to a slight gain in weight along with decreased thermogenesis and metabolic rate, whereas hyperthyroidism is

linked to weight reduction despite greater appetite and a higher metabolic rate. Since many of these alterations are connected to changes in the function of adipose tissue, assessing the relationship between adipocytokines, thyroid hormones, and thyroid dysfunction is intriguing (Iglesias & Díez, 2007).

It appears that there may be a connection between adipocytokines and thyroid hormones in the control of metabolism. Lipid metabolism, glucose, hunger and food intake, thermogenesis, insulin resistance, and body weight may all affect or be impacted by thyroid hormones and adipocytokines. Although thyroid function is frequently normal in the obese population, there is a known positive association between thyrotropin (TSH) and body mass index (BMI)(Ahima et al., 2006).

The encodes the 167-amino acid protein leptin, which is nearly exclusively produced in adipose tissue and released into the bloodstream. It controls inflammation and body weight. In reality, it has an impact on body weight and is unrelated to any illness (Zhang et al., 2005). Elevated serum leptin levels in patients with autoimmune illnesses may either be the cause of the

illness or serve as a diagnostic indicator in clinical settings. It is currently unknown if leptin can be used as a therapeutic target to treat autoimmune diseases in humans (Cojocaru et al., 2013). Previous studies have shown that an increase in blood leptin levels may be utilized to stop hypothyroidism-related weight gain rather than only reflecting changes in body weight (Leonhardt et al., 1998). Body mass index (BMI) and TSH levels are correlated and they are frequently higher in obese individuals compared to those that are standard weight, age, and gender matched (Santini et al., 2014).

As shown in figure 1, Leptin serves as a crucial neuroendocrine regulator of the hypothalamus pituitary–thyroid axis and regulates the expression of the thyrotropin releasing hormone (TRH gene) in the paraventricular nucleus (PVN) and arcuate nucleus (ARC) (Biondi et al., 2019) (Figure 1). Activation of the pituitary–thyroid axis leads to increased TSH production due to hyperleptinemia caused by significant obesity. In obese patients, leptin concentrations are related with serum TSH levels, and

decreasing FT4 levels may be connected to elevated serum TSH levels (Santini et al., 2014) (Figure 1).

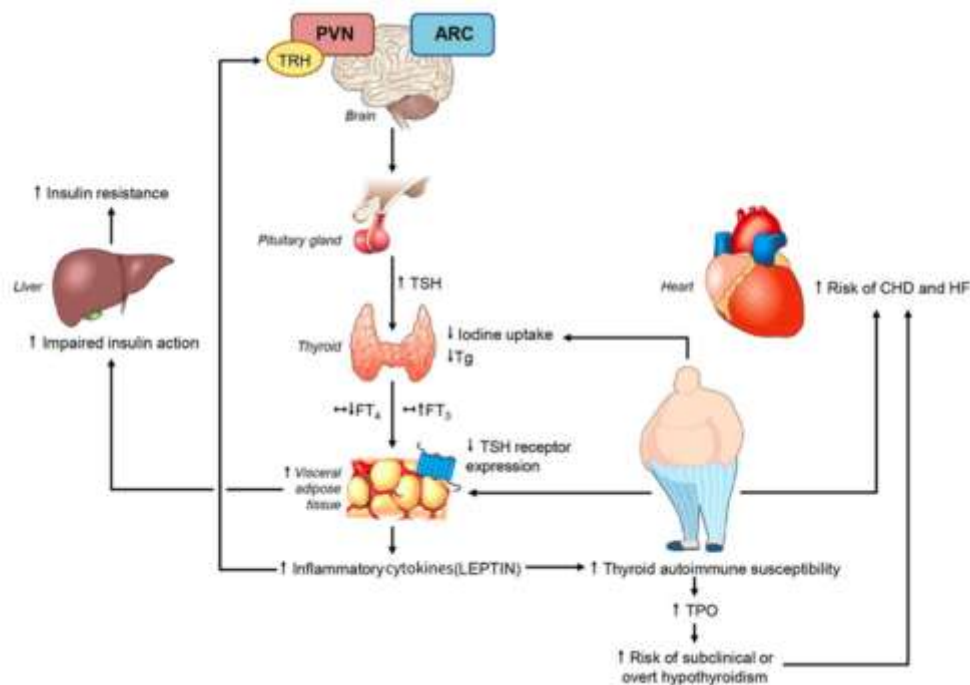


Figure 1: The correlation between hypothyroidism, obesity, and metabolic syndrome, as well as the possible risk of these related disorders(Biondi, 2023).

The hormone asprosin (regulate glucose homeostasis), was found in newborn progeroid syndrome(NPS) which is a rare genetic condition marked by, poor energy expenditure, extreme leanness, appetite loss , and calorie intake. They also have areas of their bodies that are underfat. where the cleavage of asprosin from the C-terminal of profibrillin (encoded by FBN1) results in a clear metabolic dysregulation involving partial lipodystrophy and

a reduction in plasma insulin while maintaining normal blood sugar levels(Romere et al., 2016).

When asprosin is released , it travels to the liver and activates the olfactory G-protein-coupled receptor OR4M1. It traverses the blood-brain barrier by means of an unidentified receptor and activates appetite-modulating neurones in the hypothalamus(Hoffmann et al., 2020). On the other hand, the asprosin levels increased up to 4 times in normal BMI individuals than those who are overweight or obese. Because of this connection between body composition and asprosin, which is believed to be the result of asprosin's impact on appetite, is a critical objective for energy homeostasis and as a result, sickness in people with diabetes or obesity (Leonard et al., 2021).

Asprosin contributes to insulin resistance (IR), obesity, and inflammation in addition to the metabolism of fats and carbohydrates. Additionally, it contributes to other metabolic syndrome-related disorders such polycystic ovarian syndrome (PCOS) and diabetic retinopathy(Luís et al., 2020). In addition, asprosin contributes to the reduction of insulin sensitivity in

muscle cells by enhancing inflammation. The reduction in insulin sensitivity is the result of this route (Janoschek et al., 2020).

An emerging subject of study is the relationship between asprosin and thyroid function. Recent studies have shown that adipokines may regulate the secretion and function of thyroid hormones and thyroid hormones directly influence the metabolism of adipocytes and the expression of adipokines . The aim of the present study was to assess serum asprosin levels in patients with newly diagnosed hypothyroidism as a possible biomarker. We will examine the relationship between asprosin and metabolic parameters, including glucose and lipid profiles, and the correlation between asprosin and standard thyroid function tests (TSH and free T4). We wish to contribute to the development of better diagnostic tools for hypothyroidism and its metabolic consequences, by studying this new adipokine in the context of thyroid disorders.

Materials and methods:

This study was conducted between 10 January 2026 to 1 March 2026 at Al-Yarmouk Teaching Hospital, Baghdad, Iraq. A total

of 90 participants were enrolled and divided into two groups: 45 recently found out to be hypothyroid patients and 45 controls. The study excluded participants having a history of diabetes mellitus, renal disease, hepatic disease, cardiovascular problems, pregnancy, or any condition known to impact adipokine levels or thyroid function. Additionally, subjects using drugs that can affect lipid metabolism or thyroid function tests were not included. Healthy controls had normal TSH, FT3, and FT4 values and were sex and age matched and had no history of thyroid disease. Informed written agreement the local ethical committee endorsed the study in accordance with the Declaration of Helsinki, and consent was obtained from all participants prior to enrolment. The conventional formula ($\text{BMI} = \text{weight in kg} / \text{height in m}^2$) was used to compute the body mass index (Kg/m^2).

Sample Collection Procedures

The blood was drawn and placed in a gel tube. The serum was separated by spinning at 3000 rpm for 15 min. The thyroid function (T3, T4 and TSH) was measured on 2 ml of the patient blood. The residue was transferred to an Eppendorf tube and

stored in a deep freezer at -20 degrees Celsius for assaying asprosin and leptin. Thyroid hormones were measured by an enzyme-linked immunoassay sandwich method with final fluorescence detection (VIDAS, biomeriux).

Serum asprosin and leptin concentrations were measured using a commercially available enzyme-linked immunosorbent assay (ELISA) kit (MyBiosource) in compliance with the manufacturer's instructions.

Statistical Analysis:

GraphPad Prism Software, version 8.0.2 (San Diego, California, USA), was used to analyse the data. For a thorough summary of our results, we used descriptive statistics and the t-test for independent samples to compare the means of parameters between groups. It was deemed statistically significant if the p-value was less than 0.05.

Results:

People with hypothyroidism and the control group are compared using the data in the table. Patients with hypothyroidism had significantly higher levels of Asprosin, Leptin, TSH, BMI, and T4

than the control group. When compared to people with hypothyroidism, the control group's T4 levels are noticeably higher. However, as compared to the control group, the T3 level showed no significant changes.

Table1: Descriptive statistic and biochemical analysis comparing healthy individuals and patients

Parameters	Control (45)	Patient (45)	P-VALUE
Age	34.71±7.644	36.58±8.895	0.2886
BMI(Kg/m ²)	20.68±2.451	28.00±3.037	<0.0001
T3(nmol/L)	1.340±0.1603	1.310±0.1012	0.4761
T4(nmol/L)	84.46±0.8585	88.92±0.9524	<0.0001
TSH(uUI / L)	2.288±0.4983	8.362±0.8669	<0.0001

Asprosin ng/ml	1.245±0.2837	2.275±0.4541	<0.0001
Leptin pg/ml	15.94±3.837	28.34±4.677	<0.0001

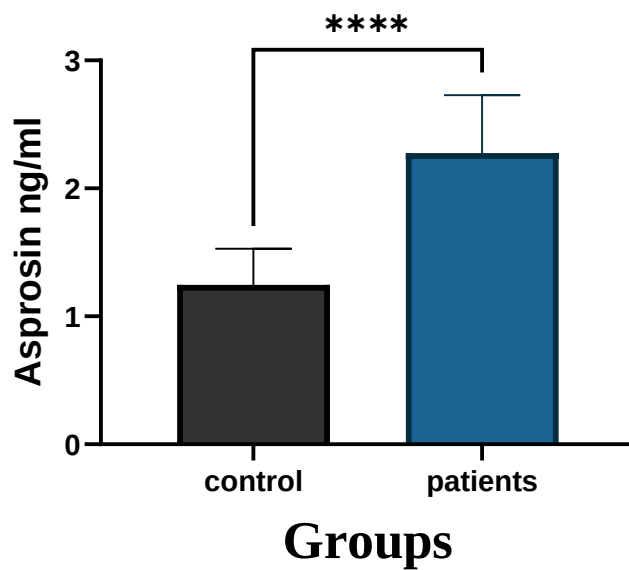


Figure 1: The serum level of Asprosin for healthy individuals Vs. patients

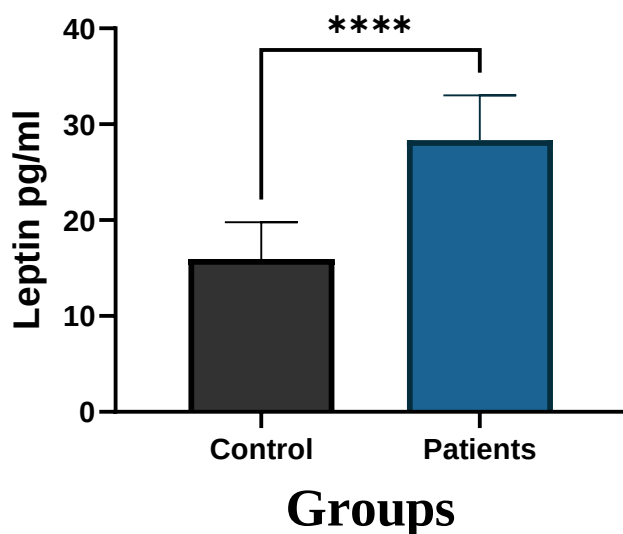


Figure 2: The serum level of Leptin for healthy individuals Vs. patients

Discussion:

The current study was carried out to compare the blood levels of asprosin and leptin in newly diagnosed hypothyroid patients versus healthy controls, to assess their use as adipokine markers of metabolic disruption in this clinical setting.

In the current study, serum asprosin levels in hypothyroid patients were significantly higher than in healthy controls. This observation fits with the growing body of data linking diseases to metabolic inefficiency and expansion of adipose tissue with

asprosin dysregulation. The results of the present study are in line with a similar study by Ateah et al. (2023) carried out at Al-Mustansiriyah University, Iraq, which included 40 hypothyroid female patients and 40 healthy controls. The study found significantly higher serum asprosin levels in the hypothyroid group than in controls(Ateah et al., 2023). Another case-control study published in Alexandria Journal of Medicine by Aboul-Seoud et al. (2024) demonstrated that the serum asprosin levels in hypothyroid patients were significantly different from the normal controls ($p < 0.01$). Serum asprosin was positively correlated with insulin resistance indices, waist circumference and BMI(Aboul-Seoud et al., 2024).

Asprosin is elevated in hypothyroidism for a complex physiologic reason. Asprosin has a complex role in the central nervous system and peripheral tissues including regulation of hunger, glucose metabolism and insulin resistance. It is mainly produced and secreted by white adipose tissue in the fasted state. In hypothyroidism, decreased levels of thyroid hormones lead to reduced lipolysis, impaired thermogenesis, and slow expansion of

white adipose tissue mass, all of which may increase the release of asprosin(Yuan et al., 2020). Additionally, via raising inflammation and endoplasmic reticulum stress, asprosin can reduce insulin signaling and increase insulin resistance in skeletal muscle. This mechanism is especially important in hypothyroidism, where insulin resistance is a well-known metabolic consequence(Shabir et al., 2021). By downregulating IRS-1 phosphorylation and inhibiting GLUT4 expression, TSH itself has been demonstrated to cause insulin resistance in adipocytes through endoplasmic reticulum stress. This suggests that the elevated TSH associated with overt hypothyroidism may independently amplify the metabolic dysregulation that causes asprosin upregulation(Zhou et al., 2024). A 2024 systematic review and meta-analysis reinforced Asprosin's role as a sensitive indicator of metabolic deterioration with significant pathophysiological overlap with hypothyroidism and demonstrated that it is significantly higher in individuals with obesity, type 2 diabetes and metabolic syndrome in comparison to controls(Ulloque-Badaracco et al., 2024).

Moreover, the present study has shown that serum leptin levels were significantly higher in hypothyroid patients than healthy subjects. This finding is consistent with a large and consistent body of the literature. The persistent observation of hyperleptinemia in patients with increased TSH can be explained mechanistically by TSH stimulating TSH receptors on the surface of fat cells, which directly increases leptin synthesis(Liu et al., 2025). An earlier study by confirmed the thyroid hormone-dependent regulation of leptin secretion by showing that serum leptin levels in hypothyroid patients (28.34 ± 4.677) were significantly higher than in healthy controls (15.94 ± 3.837) (<0.0001) and that these levels significantly decreased after thyroxine replacement therapy(Oge et al., 2005).

There is probably more to leptin rise in hypothyroidism than just greater fat. The risk of autoimmune thyroid disease, especially Hashimoto's thyroiditis, can be increased by elevated leptin levels and inflammation, indicating a reciprocal link between leptin and thyroid function(Biondi, 2023). Levels of leptin and insulin resistance (HOMA-IR) were significantly increased in

hypothyroid patients compared to healthy controls. HOMA-IR was negatively associated with FT3 and FT4 and positively with TSH suggesting that the rise in leptin in this context is not an isolated finding but part of a wider metabolic derangement(El Amrousy et al., 2022).

Present study showed that hypothyroid patients had significantly higher BMI compared with controls. This is consistent with the well known metabolic effects of thyroid hormone insufficiency, which favour positive energy balance and reduce basal metabolic rate. Thyroid hormones regulate basal metabolic rate, hunger, glucose and lipid metabolism and thermogenesis. Weight fluctuations sometimes continue even after euthyroidism is achieved and have a substantial impact on patients' quality of life. The higher BMI observed in hypothyroid patients in this study is clinically relevant in the context of both asprosin and leptin, as adipose tissue mass is the primary determinant of both adipokine secretion rates, and expanding adiposity provides a plausible mechanistic bridge between hypothyroidism and the elevated adipokine levels observed(Dharia et al., 2025).

As expected, compared to controls, hypothyroid patients in the current study showed considerably higher TSH combined with lower FT3 and FT4 levels. The biochemical characteristics of primary hypothyroidism are these hormonal abnormalities, which are used to verify the precision of patient selection and group assignment. Given TSH's known direct stimulatory influence on adipose tissue leptin release and its ability to cause adipocyte insulin resistance, as previously mentioned, the degree of TSH increase is especially significant.

Conclusion:

Patients with hypothyroidism may benefit from early detection of the hormone asprosin and leptin. Asprosin may function as a substitute for all other conventional biomarkers due to its role as a marker of glucose homeostasis and it used to predict risk factors for thyroid dysfunction and diabetes.

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Evaluation the serum levels of adipon and GDF-15 hormones with age and adiposity in iraqi patients

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Abstract

Obesity has lately been designated as a metabolic global in both progressing and growing nations impacting more than 30% of people and serving as a significant factor in morbidity and mortality. Insulin resistance is the primary mechanism underlying obesity. Adipon is a peptide hormone believed to influence insulin resistance and metabolic regulation. Furthermore, levels of

a stress-induced cytokine, Growth differentiation factor 15, are elevated in age-related metabolic diseases. This research pursued to assess the associations amidst serum atropine, GDF15, and insulin resistance in elderly and obese individuals. Insulin resistance is connected with the liberation of free fatty acids from adipose tissue and represents a significant metabolic complication of dyslipidemia, characterized by elevated triglyceride levels, diminished high-density lipoprotein cholesterol (HDL-C), and increased small, dense low-density lipoprotein cholesterol (LDL-C) levels. With the rising prevalence of obesity, the prompt identification and effective management of dyslipidemia are becoming increasingly critical. The research contained from 60 obese patients (half elderly and half younger) and 60 healthy individuals segregated into two categories: the elderly group as a control and the younger group as a control). All participants were free of chronic diseases and had not previously taken any medications. Serum atropine concentrations, along with other metabolic markers, were measured. An ELISA assay was applied to determine serum atropine levels. The HOMA-IR rating scale

was also used to measure insulin resistance. GDF-15 has a higher value in obese patients ($p < 0.0001$). Decreased serum adropin levels were observed in both group of obese patient groups ($p < 0.0001$).

Keyword: adropin, dyslipidemia, GDF-15, HOMA-IR, Obesity.

تقييم مستويات هرموني الأدرولين و GDF-15 في مصل الدم مع التقدم في العمر ونسبة الدهون لدى المرضى العراقيين

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ملخص

صُنفت السمنة مؤخرًا كمشكلة أيضية عالمية في كل من الدول المتقدمة والنامية، حيث تؤثر على أكثر من 30% من السكان، وتُعد عاملاً رئيسيًا في معدلات الإصابة بالأمراض والوفيات. وتُعد مقاومة الأنسولين الآلية الأساسية الكامنة وراء السمنة. الأتروبين هو هرمون بيتيدي يُعتقد أنه يؤثر على مقاومة

الأنسولين وتنظيم عمليات الأيض. علاوة على ذلك، ترتفع مستويات السيروتونين المحفز بالإجهاد، عامل التمايز والنمو 15(GDF15)، في الأمراض الأيضية المرتبطة بالتقدم في السن. سعت هذه الدراسة إلى تقييم العلاقة بين الأتروبين في مصل الدم، وGDF15، ومقاومة الأنسولين لدى كبار السن والأفراد المصابين بالسمنة. ترتبط مقاومة الأنسولين بتحرر الأحماض الدهنية الحرة من الأنسجة الدهنية، وتمثل أحد المضاعفات الأيضية الهامة لاضطراب شحوم الدم، والذي يتميز بارتفاع مستويات الدهون الثلاثية، وانخفاض مستوى الكوليسترول عالي الكثافة (HDL-C)، وارتفاع مستوى الكوليسترول منخفض الكثافة (LDL-C) مع تزايد انتشار السمنة، بات التشخيص السريع والإدارة الفعالة لاضطرابات الدهون في الدم أمراً بالغ الأهمية. شملت الدراسة 60 مريضاً يعانون من السمنة (نصفهم من كبار السن والنصف الآخر من الشباب) و60 شخصاً سليماً، تم تقسيمهم إلى مجموعتين: مجموعة كبار السن (كمجموعة ضابطة) ومجموعة الشباب (كمجموعة ضابطة). لم يكن أي من المشاركين يعاني من أمراض مزمنة ولم يتناول أي أدوية سابقاً. تم قياس تركيز الأتروبين في مصل الدم، بالإضافة إلى مؤشرات أيضية أخرى. استُخدم اختبار ELISA لتحديد مستويات الأتروبين في مصل الدم. كما استُخدم مقياس HOMA-IR لقياس مقاومة الأنسولين. أظهرت النتائج ارتفاعاً في مستوى GDF-15 لدى مرضى السمنة ($p < 0.0001$) ولوحظ انخفاض في مستويات الأتروبين في مصل الدم لدى كلتا مجموعتي مرضى السمنة ($p < 0.0001$).

الكلمات المفتاحية: أدرابين، اضطراب شحوم الدم، GDF-15، HOMA-IR، السمنة

Introduction:

Obesity is the result of an insufficient energy expenditure and an increase in caloric consumption, which results in the exaggerated accumulation of adipose tissue. A body mass index (BMI) outstanding 25 is designated as overweight, whereas a BMI exceeding 30 Kg/m² is categorized as obesity(Choo et al., 2026).

The formation of excessive adipose tissue in obesity can result in significant health dangers, such as IR. Adipose tissue is impaired in obesity, maining to adipose hypertrophy and hypoxia, which in turn disrupt the normal purpose of adipose tissue. This results in increased levels of glycerol, pro-inflammatory cytokines, and non-esterified fatty acids, , which promote the onset of IR by disrupting insulin signalling pathways, as well as lipid and glucose metabolism(Rizvi & Rizzo, 2024).

The β -cells of the islets of Langerhans produce insulin, a hormone that regulates energy storage and glucose metabolism by facilitating the uptake of glucose from the circulation and changing it into glycogen for storage in the liver and muscle.(Suganuma et al., 2023; Thevis et al., 2009). Insulin

resistance (IR) is traditionally characterised as a metabolic dysfunction resulting in diminished glucose absorption and hyperglycemia, predominantly examined in link to obesity and type 2 diabetes mellitus(Boccardi & Sinclair, 2026). These data indicate that, in advanced age, insulin resistance should not be viewed merely as a dysfunction of glucose metabolism, but also as a systemic indicator of diminishing physiological preserve(Ferrucci et al., 2018).

Senility denotes the process whereby an organism's physiological and psychological adaptability to its environment diminishes progressively, ultimately culminating in death. Ageing can be classified into two categories: physiological ageing and pathological ageing(Kritsilis et al., 2018).

The former denotes the physiological decline that transpires post-maturity, whilst the latter signifies an age-related alteration induced by multiple external influences, including numerous disorders(López-Otín et al., 2023).

The phrase metabolic ageing refers to the gradual, age-related deterioration of regulatory capacity and metabolic malleability

(Khalaf et al., 2025). In this context, metabolic ageing contains reduced insulin signaling, a lessened capacity to conform glucose and lipid metabolism to physiological stresses, and a slow deterioration in systemic flexibility. In this scenario, IR manifests not merely as a dual metabolic dysfunction but rather as a progressive decline in adaptive strength across various organ systems.(Boccardi & Sinclair, 2026).

Moreover, insulin resistance (IR) enhances the manufacture of VLDL (very-low-density lipoprotein) while diminishing HDL (high-density lipoprotein) as a result of hyperinsulinemic and lipotoxic effects, culminating in dysregulation of lipid metabolism and dysfunction of the vascular endothelium. Aging-associated cell cycle arrest and telomere attrition further expedite vascular ageing and heighten plaque instability(Li et al., 2024).

Dyslipidaemia is classified based on abnormalities in various lipid components, including hypercholesterolaemia, hyper-LDL-cholesterolemia, and hypertriglyceridemia. Dyslipidaemia is

diagnosed upon the presence of any lipid abnormalities, underscoring the prevalence of lipid imbalances in the elderly population(Rhee, 2025).

GDF-15 (Growth differentiation factor 15) is a distinctive organ within the converting growth factor-beta superfamily. This cytokine, which is induced by stress, has recently attracted substantial attention as a biomarker for mitochondrial dysfunction and biological ageing malfunction, resilience, as a regulator of metabolism and appetite in obesity and diabetes(Bencivenga et al., 2023).

Skeletal muscles are among the tissues in which macrophage restrained cytokine-1 is indicated, which was initially identified in 1997. The placenta exhibits elevated levels in addition to pregnancy. (Chrysovergis et al., 2014).

Elevated GDF-15 levels correlate with diminished muscle mass and strength, feedlines, reduced step velocity, and deteriorating physical function in elderly (Tavenier et al., 2021).

No studies exist about the correlation between GDF-15 and physical role in aged adults with diabetes mellitus. We sought to

examine (i) the relationship between GDF-15 and obesity, both with and without compromised physical role, regardless of inflammation in aged older persons, and (ii) the predictive mold for needy physical role in this demographic(Merchant et al., 2023).

Adropin is a peptide hormone encoded by the ENHO (energy homeostasis-associated gene) and consisting of 76 amino acids, and is mostly reveal in the brain and liver(Abousamra et al., 2026).Adropin exerts systemic effects on insulin sensitivity and glucose metabolism in skeletal muscle, liver, and heart(Mushala & Scott, 2021).Recent study suggests that adropin influences the cerebral vasculature to maintain neurological functions during cerebral ischaemia. The impact of adropin signalling on human ageing is uncertain(Aggarwal et al., 2024).

Method:

This study included 30 healthy individuals aged 18–45 years with normal weight (control group), 30 obese individuals of the same age group, 30 healthy individuals aged 45–70 years with normal weight (control group), and 30 obese individuals of the same age

group. Samples were collected from study participants between January 1, 2026, and March 1, 2026, at a private clinic and Yarmouk Teaching Hospital in Baghdad. After reviewing the participants' medical histories, all chronic and autoimmune diseases were excluded.

Venous blood samples were gathering from fasting patients and then stored at -20°C until analysis. All samples were collected in gel-filled Vacutainer tubes.

Lipid profile, insulin, insulin resistance, glucose, adropin, and GDF-15 were measured.

The Elabscience Human AD (Adropin) ELISA was used to set serum adropin concentration, and the Human GDF15 ELISA Kit was used to measure GDF-15 concentration. Blood glucose levels were measured using a spectrophotometer with the BioSystems (Spain) kit. A person was considered insulin resistant if their HOMA-IR (equivalent model of insulin resistance) value was 2.0 or higher.

Statistical Analysis:

The statistical analysis was carried out using GraphPad Prism, version 8.0.2. made in San Diego, California, USA. One-way ANOVA was used for the comparison between groups. The statistical significance of Tukey's post hoc test was used to examine group differences. The results are shown as mean $\pm$ standard deviation. Statistical significance was determined at $P < 0.05$.. Adropin, GDF-15 and other variables were correlated using Pearson's correlation coefficient.

Result

Comparison between obese young adults vs individuals with normal weight: Serum GDF-15 concentrations were markedly elevated ($P < 0.0001$) in the obese cohort for the two groups (1386 ± 171.2 , 2914 ± 193.5 ng/mL, respectively) relative to the control group (688.3 ± 191.7 and 2219 ± 215.6 ng/mL, respectively). Conversely, serum Adropin concentrations were markedly diminished ($P < 0.0001$) in obese subjects relative to the control group, as illustrated in Figures 1 and 2, respectively. Obese patients exhibited markedly elevated insulin levels and HOMA-IR ($17.93 \pm 4.802 \mu\text{IU/ml}$, $P < 0.0001$) and

($4.647 \pm 1.338 \mu\text{IU/ml}$, $P < 0.0001$), as well as superior lipid profiles (TC) and (TG and HDL) ($207.2 \pm 17.05 \mu\text{IU/ml}$, $173.1 \pm 34.97 \mu\text{IU/ml}$, and $41.77 \pm 3.919 \mu\text{IU/ml}$, respectively, with $P < 0.0001$ for all three parameters) in comparison to the control groups ($165.8 \pm 21.32 \mu\text{IU/ml}$, $89.70 \pm 18.99 \mu\text{IU/ml}$, and $55.90 \pm 7.871 \mu\text{IU/ml}$, respectively). We detect analogous alterations in the obese elderly cohort in comparison to their healthy counterparts within the same age demographic.

Table 1: Descriptive statistics and biochemical analysis comparing obese young adults with individuals of the same age who are in good health, and also comparing obese elderly individuals with individuals of the same age who are in good health.

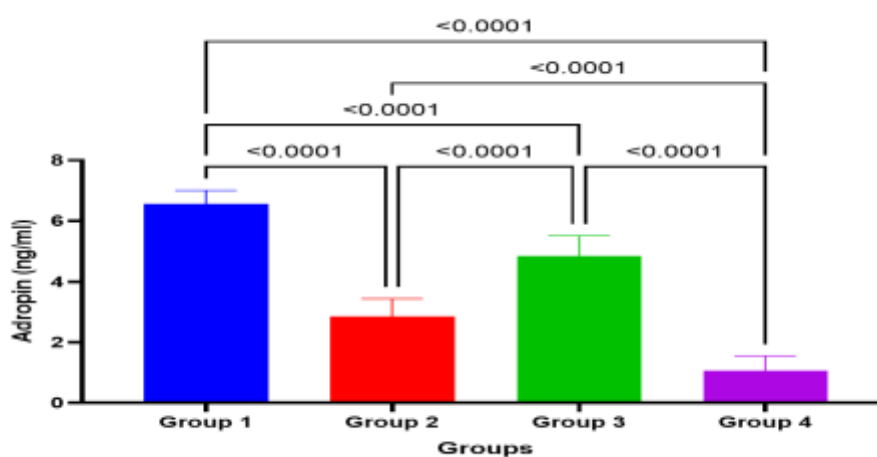
Variables	Group-1 (30)	Group-2 (30)	Group-3 (30)	Group-4 (30)	P - value (Anova)
Age	26.77 $\pm$ 5.	30.30 $\pm$ 6.	67.23 $\pm$ 4.	71.30 $\pm$.2	<0.00

	090	524	812	34	01
BMI	22.26±1.	34.05±2.	22.63±1.	35.49±2.	<0.00
	516	829	128	693	01
FBS(ng/ml	88.37±5.	105.0±13	95.40±8.	118.5±18	<0.00
)	442	.92	621	.66	01
INSULIN	6.677±2.	17.93±4.	8.763±3.	25.66±7.	<0.00
(µg/ml)	505	802	118	493	01
HOMA-	1.426±0.	4.647±1.	2.072±0.	7.650±2.	<0.00
IR	5024	338	7467	706	01
(µIU/ml)					
TC	165.8±21	207.2±17	197.4±27	233.4±27	<0.00
(mg/dl)	.32	.05	.19	.08	01
TG	89.70±18	173.1±34	136.7±25	222.9±45	<0.00
(µIU\ml)	.99	.97	.97	.96	01

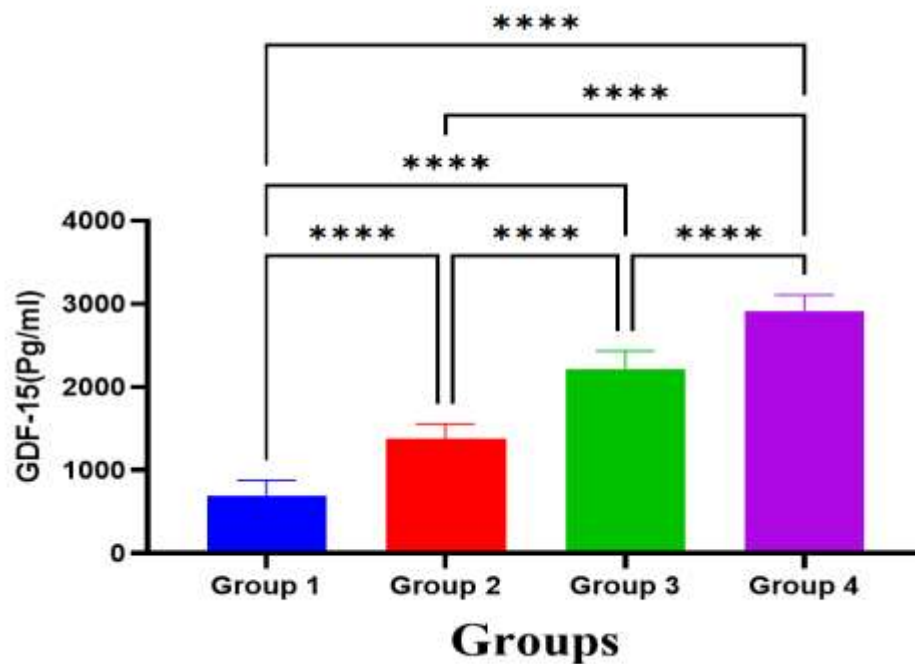
HDL (ng/ml)	55.90±7. 871	41.77±3. 919	48.90±8. 027	37.40±5. 980	<0.00 01
Adropin (ng/ml)	6.560±0. 4517	2.861±0. 5842	4.862±0. 6479	4.862±0. 6479	<0.00 01
GDF-15 (ng/ml)	688.3±19 1.7	1386±17 1.2	2219±21 5.6	2914±19 3.5	<0.00 01

**Group 1 =Lean Young Group 2 =Obese Young Group 3
=Lean Elderly Group 4 = Obese Elderly**

Sig.*P < 0.05; high Sig. **P < 0.001; no sig: p>0.05



Figur.1. The serum level of Adropin compared to other groups.



Figur.2. The level of serum GDF-15 compared to other groups

Discussion

Our objective was to assess the clinical significance of adropin and GDF-15 as biomarkers of IR in obese adults. The central nervous system, skeletal muscle, and adipose tissue are all interrelated and essential components of this process. The age-associated decline in quality diminishes and muscle mass the principal location for insulin-mediated glucose clearance, whereas metabolic responsiveness impairment is further exacerbated by qualitative alterations like myosteatorsis and anabolic resistance (Boccardi & Sinclair, 2026).

Thus, reduced glucose tolerance acts as an indirect marker of cellular fat excess, indicating that cells have attained their limit for glucose absorption and subsequent metabolism. Cells do not store glucose directly; rather, surplus circulating glucose is transformed into fat for storage(Oshakbayev et al., 2026).

To comprehend how cellular hypertrophy results in insulin resistance, it is essential to briefly examine the biochemistry of nutrition and the physiology of digestion. Increased blood glucose levels trigger glycogenesis and lipogenesis; when cellular glycogen stores become saturated, the process transitions to de novo lipogenesis(Ye et al., 2021).

The phrase metabolic ageing refers to the gradual, age-related deterioration in regulatory efficacy and metabolic flexibility (Khalaf et al., 2025).

In this context, metabolic aging encompasses compromised insulin signaling, diminished ability to adjust lipid metabolism and glucose to physiological stresses, and a progressive decline in systemic pliability. In this scenario, IR manifests not merely as a

multiple metabolic disorder but rather as a progressive decline in adaptive compass across various organ systems (DIDWAL; Hussein & Al-Swefee, 2025). Dyslipidemia is characterized by aberrant lipid profiles in the blood, including elevated LDL-C, increased of TGs, decreased HDL-C, or combinations thereof (Rhee et al., 2019).

This connection may be affected by various factors, including body weight, food habits, alcohol use, and physical activity (Virani et al., 2021),

Obesity and dyslipidaemia are frequent modifiable risk factors for cardiovascular disease (CVD), posing a significant global public health concern. Obesity, characterised by an excessive buildup of body fat that presents a health hazard, directly contributes to dyslipidaemia through various metabolic pathways and indirectly through its correlation with insulin resistance (Bays et al., 2024).

Adipose tissue is essential for controlling energy balance, insulin sensitivity, and lipid and carbohydrate metabolism, therefore facilitating the onset of insulin resistance in obesity (Scherer, 2016).

Insulin resistance is the primary connection between obesity and dyslipidaemia. In a physiological condition, insulin inhibits hepatic VLDL production and enhances lipoprotein lipase (LPL) activity in adipose tissue. In obesity, these processes are disrupted.

Elevated hepatic VLDL production: An excess of free fatty acids from adipose tissue amplifies hepatic triglyceride synthesis(Dias & Arunanjali, 2025).

Decreased LPL activity: Hinders triglyceride clearance from circulation, resulting in elevated plasma triglyceride levels(Mach et al., 2025).

GDF15's role in metabolic changes positions this cytokine as a prospective diagnostic for obesity diagnosis and as a potential therapeutic target for addressing certain obesity-related problems(Breit et al., 2023).

GDF-

15, a cytokine responding to stress, has emerged as a possible biomarker for metabolic enhancement in overweight and obese individuals(Kim et al., 2025).

Consequently, our primary emphasis was on the investigation of GDF15 concerning obesity within the framework of ageing. Our findings indicated a positive engagement inter GDF15 levels and BMI, as well as glucose and insulin levels, underscoring their association with compromised glycaemic control and insulin resistance. We noted that GDF15 levels were elevated in individuals with obesity compared to those without obesity.

postulated that FGF21, instead of acting as a master regulator of metabolism, operates as a 'master sensitiser' of particular hormonal signals that regulate metabolism.

Contingent upon the metabolic condition(Flipppo & Potthoff, 2021).

An intriguing facet of the finding of FGF21's metabolic functions is that FGF21 was recognised in a screening for factors that enhanced glucose absorption in white adipocytes independently of insulin(Salmon-Gomez et al., 2026). Elevated GDF-15 levels correlate with diminished muscle mass and strength, frailty, reduced gait speed, and deteriorating physical function in elderly individuals(Breit et al., 2021). No studies exist about the

relationship between GDF-15 and physical role in aged adults with obesity.(Merchant et al., 2023).

We examined blood adropin levels and their associations with biochemical and clinical factors related to obesity. Our findings indicate that adropin levels in obese patient's serum were decreased compared to those in non-obese healthy persons.

The pathophysiological processes linking serum adropin to insulin resistance remain ambiguous. Adropin modulates the influence of lipogenic genes in the liver and peroxisome proliferator activated receptor gamma in adipose tissue. (Erman et al., 2021).

In agreement with the researchers' findings, we detected lower adropin levels in obese patient's serum with a mean level of 180.63 ± 106.89 ng/L. We propose that adropin levels in serum could serve as a predictor of insulin resistance. Significantly, the threshold values of serum adropin for IR have been contradictory in previous studies. The present investigation demonstrates a serum adropin concentration cut-off point that corresponds to a HOMA-IR level of 2.5 in obese individuals. Kumar et al.(Kumar et al., 2008).

shown that serum adropin contributes to the adaptation of substrate metabolism and lipid consumption. Consequently, a reduction in adropin levels in obesity may disrupt the equilibrium between dietary fat and lipid metabolism consumption. Consequently, diminished adropin levels facilitate steatosis, dyslipidaemia, and insulin resistance.

The findings from the obese patient cohort align with those of Butler et al., indicating a negative correlation between adropin levels and triglyceride concentrations(Butler et al., 2012). The reduced levels of adropin in the obese patient cohort may signify endothelial dysfunction and indicate the necessity for immediate lifestyle modifications and weight management, even in class 1 obesity(Erman et al., 2021).

Conclusion

In conclusion, we observed decreased serum adropin levels in obese individuals, inversely correlated with, BMI, age blood glucose levels, and the HOMA-IR insulin resistance index. The adropin concentration in young obese adults' serum was 2.861 ± 0.5842 ng/L, while in older obese individuals it was also low at 4.862 ± 0.6479 ng/L, accompanied by an HOMA-IR of 4.647 ± 1.338 ng/L and 7.650 ± 2.706 ng/L. Growth and differentiation factor 15 (GDF15) showed a strong correlation with insulin resistance and other indicators in overweight older adults, validating the aggregate impact of adipose tissue accumulation and endothelial cellular senescence. Further research on adropin and other myokines will help clarify how IR is predicted in obesity, and the role of obesity-related metabolic and cardiovascular problems mediated by endothelial cells.

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Diagnostic Profiling of Respiratory Tract Pathogens Isolated from Various Respiratory Samples from Patients in Karbala City, Iraq.

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Abstract

Background: Respiratory tract infections (RTIs) represent a important global health burden, particularly in depressed- and middle-earnings nations. Antimicrobial resistance (AMR) has arose as a important confusing factor in RTI administration, accompanying carbapenem-opposing organisms faking detracting healing challenges. In Iraq, limited following dossier survive regarding the community health and opposition patterns of respiring pathogens, especially in Karbala responsibility.

Aim: To study the classification, demographic traits, and antimicrobial susceptibleness patterns of respiring tract pathogens unique from inmates in Karbala, Iraq.

Methods: A backward-looking cross-sectional study was transported utilizing workshop records from Al-Imam Al-Hassan Al-Mujtaba Teaching Hospital and Al-Hussien Medical City, Karbala. A total of 1,660 isolates were analyzed from respiring samples composed between September 2025 and February 2026. Organism labeling and antimicrobial susceptibleness experiment were acted using the VITEK® 2 computerized arrangement. Data were resolved using SPSS v.25.

Results: The most repeatedly identified organisms were *Escherichia coli* (7.35%), *Klebsiella pneumoniae* (5.60%), *Pseudomonas aeruginosa* (4.28%), and *Acinetobacter baumannii* (3.49%). Alarmingly high opposition rates were noticed: *K. pneumoniae* revealed 91.4% resistance to ciprofloxacin, 91.2% to cefotaxime, and 67.7% to carbapenems; *A. baumannii* shown 94.8% fighting to carbapenems; and MRSA predominance was 92.1%. ESBL production was discovered in 80.0% of *E. coli*

isolates. A clear migratory pattern was noticed, with peak seclusion rates all along cold months.

Conclusion: This study reveals a extreme predominance of multidrug-opposing respiratory pathogens in Karbala, specifically *A. baumannii*, *K. pneumoniae*, and *P. aeruginosa*, accompanying carbapenem opposition rates exceeding 67–94%. These judgments emphasize the critical need for enhanced antimicrobial management, contamination control measures, and unending surveillance programs in Iraqi healthcare backgrounds.

Keywords: Respiratory tract infections, Antimicrobial resistance, Carbapenem resistance, Karbala, Iraq, ESKAPE pathogens, VITEK® 2

1. Introduction

Respiratory tract infections (RTIs) constitute one of the most important global health threats, providing extensively to morbidity and mortality, specifically in reduced- and middle-proceeds countries (Al-Hussainy and others., 2024, p. 112). These contaminations manifest across a range ranging from

temperate superior respiring illnesses to harsh, severe lower respiring tract contaminations (Sattar & Chishti, 2024, p. 458).

Klebsiella pneumoniae and *Staphylococcus aureus* are acknowledged as specifically hazardous opportunistic pathogens, repeatedly involved in collected pneumonia, especially between sick, chronically ill, or immunocompromised inmates (Al-Tameemi et al., 2020, p. 24). According to the European Centre for Disease Prevention and Control (ECDC), nearly 33,000 deaths in the European Union are ascribed annually to contaminations provoked by multidrug-opposing microorganisms (ECDC, 2020, p. 15).

The escalating situation of antimicrobial opposition (AMR) has precariously complicated the administration of RTIs. In February 2017, the World Health Organization (WHO) published a list of antibiotic-opposing microorganisms prioritized for the demanding development of novel antimicrobial situations (WHO, 2017, p. 3).

This list exceptionally looks the ESKAPE group of pathogens: *Enterococcus faecium*, *Staphylococcus aureus*,

Klebsiella pneumoniae, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* spp. (Tacconelli et al., 2018, p. 320). *A. baumannii* is specifically having to do with on account of its remarkable ability to get fighting to multiple medicine classes, accompanying its ability to remain on miscellaneous surfaces and its rapid spread in healthcare backgrounds (Peleg and others., 2008, p. 539).

The position in Iraq is distressing. Studies across the country have documented extreme rates of AMR with respiring pathogens. A recent study in Baghdad on society-seized pneumonia (CAP) establish that *S. pneumoniae* and *S. sanguinis* were the most average isolates, while *A. baumannii* presented familiar-total resistance to all proven medicines (Al-Rubaie and others., 2020, p. 38). In Najaf, researchers labeled carbapenem opposition in 100% of *P. aeruginosa* and *A. baumannii* isolates, defining a bigger therapeutic challenge (Jasim & Al-Khafaji, 2023, p. 48).

Within Karbala particularly, a study at Imam Hussein Medical City stated that 42.5% of *A. baumannii* isolates introduced from

sputum examples, accompanying fighting rates exceeding 90% to most medicines, containing meropenem and imipenem (Al-Ibraheemi and others., 2020, p. 18). Similarly, research on *K. pneumoniae* in Karbala hospitals erect 100% fighting to medicine, high opposition to cephalosporins (for example, 82.5% to cefoxitin, 73% to cefotaxime), and extreme opposition to fluoroquinolones (e.g., 66.7% to ciprofloxacin) (Ghazi and others., 2022, p. 6).

S. aureus and *K. pneumoniae* have further happened identified as the ruling pathogens in tonsillitis cases in Karbala, and two together were erect to be multidrug-opposing (Hassan and others., 2021, p. 4).Karbala responsibility presents a unique epidemiological framework. The city happenings large culture influxes during scrupulous occurrences, that may aid bacterium broadcast and strain local healthcare infrastructure (Ministry of Health, 2023, p. 45).

Understanding the local microbiological countryside and opposition patterns is then essential for guiding practical analysis and executing effective contamination control measures (CLSI,

2023, p. 12). The present study influences a inclusive dataset of 1,660 isolates calm over a six-month ending (September 2025 to February 2026) from diversified dispassionate settings in Karbala to specify itemized create a likeness in a picture of respiratory area pathogens and their antimicrobial opposition patterns, through addressing a fault-finding information break in the domain.

2. Aim and Objectives

Aim: To characterization the dispersion, mathematical characteristics, and antimicrobial susceptibleness patterns of respiring lot pathogens unique from sufferers in Karbala, Iraq.

Objectives:

- 1- Determine the frequency and allocation of respiring isolates by creature type and sample source
 - 2- Analyze patient head count (age, sexuality, district type) between breeding-positive respiring cases
 - 3- Assess antimicrobial susceptibleness patterns and fighting rates for key respiring pathogens
 - 4- Compare verdicts with provincial and all-encompassing dossier to parse the local AMR burden
- References

3. Methodology

Study Design: Retrospective cross-sectional laboratory-based study (Bhopal, 2016, p. 78).

Study Setting: Al-Imam Al-Hassan Al-Mujtaba Teaching Hospital and Al-Hussien Medical City, Karbala, Iraq—two major standard of comparison nursing homes directing various patient cultures accompanying respiratory discontents (Ministry of Health, 2023, p. 45). Al-Hassan Al-Mujtaba Teaching Hospital is individual of the best after second care clinics in the Karbala governorate, providing inclusive diagnostic and healing duties to a big catchment state from Karbala and adjacent provinces (Ministry of Health, 2023, p. 46).

Al-Hussien Medical City serves as another big referral center in the domain, outfitted accompanying progressive lab abilities, including the VITEK® 2 electronic plan for microbiological labeling and antimicrobial susceptibleness experiment (Al-Hussien Medical City, 2023, p. 12).

Data Source: Secondary analysis of 1,660 isolates from six SQLite databases (IRQ-N14-9-2025 to IRQ-N14-2026-2)

culled from VITEK® 2 automated labeling and susceptibleness systems (BioMérieux, France). The VITEK-2 whole is a justified automated floor secondhand for bacterial identification and antimicrobial susceptibleness experiment in clinical microbiology labs, contribution rapid and correct results (BioMérieux, 2023, p. 5; Pincus, 2016, p. 3). The system takes advantage of colorimetric technology and biochemical responses for structure identification, accompanying a inclusive database top over 300 clinically meaningful bacterial and yeast class (D'Souza & Devi, 2019, p. 25).

Inclusion Criteria: All respiring samples (sputum, neck swabs, and different respiratory samples) accompanying written organism labeling and mathematical data (age, sexuality, district type, specimen date). The dataset involves isolates classification as "All organisms" per the lab summary (BioMérieux, 2023, p. 8).

Exclusion Criteria: Non-respiring specimens and isolates accompanying wanting mathematical or susceptibility dossier (Hulley and others., 2013, p. 156).

Data Variables:

- 1– Organism labeling (variety and code)
- 2– Specimen type (spit, neck swab, tracheal aspirate, bronchoalveolar cleaning)
- 3– Patient head count (age group, sexuality, locale type)
- 4– Specimen date (monthly classification)
- 5– Antimicrobial susceptibleness results (S/I/R per CLSI directions)

Data Analysis

- 1– Descriptive statistics (frequencies, percentages, means, and standard deviations) (Katz, 2010, p. 89)
- 2– Organism distribution across sample types and demographic variables
- 3– Antimicrobial resistance profiling in accordance with CLSI breakpoints (CLSI, 2023, p. 15)
- 4– Statistical contrastings utilizing SPSS v.25 (IBM Corp., Armonk, NY, USA) (Green & Salkind, 2016, p. 102)
- 5– Chi-square tests for explicit variables, $p < 0.05$ considered important (Field, 2018, p. 215).

Ethical Consideration: Not required for retrospective reasoning of anonymized workshop dossier (World Medical Association, 2013, p. 2192).

Specimen Quality Control and Processing: All respiratory specimens were assessed for quality in accordance with regulated microbiological criteria. Sputum samples were judged using the Bartlett criteria, where specimens holding >25 squamous epithelial containers and <10 polymorphonuclear leukocytes per depressed-power field (LPF) were deliberate adulterated and rebuffed (Baron et al., 2023; O'Grady & Ruprecht, 2023). Adequate spit examples were defined as those holding <10 squamous epithelial containers and >25 polymorphonuclear leukocytes per LPF (Miller and others., 2018). All specimens were treated inside 2 hours of collection or stocked at 4°C for a maximum of 24 hours (BioMérieux, 2023). Specimens were immunized upon appropriate culture radio (ancestry agar, MacConkey agar, sugary food agar, and Sabouraud dextrose agar for fungi) and hatched under appropriate environments. Identification and antimicrobial susceptibility

experiment were acted utilizing the VITEK® 2 automated arrangement (bioMérieux, France), accompanying results interpreted in accordance with CLSI M100 directions (CLSI, 2023). Quality control was acted daily utilizing standard remark strains (CLSI, 2023).

Statistical Analysis: Statistical analysis was executed utilizing SPSS v.25.0 (IBM Corp., NY, USA). Descriptive statistics (repetitions, percentages, way, and standard changes) were determined for all variables (Katz, 2010). Resistance rates accompanying 95% confidence breaks were determined utilizing the Wilson design (Green & Salkind, 2016). Chi-square tests were secondhand for categorical changing contrastings, accompanying Fisher's exact test used when wanted cell counts were <5 (Field, 2018). A p-advantage < 0.05 was thought-out statistically important.

4 .Results

4.1 Overall Distribution of Respiratory Isolates

A total of 1,660 isolates were investigated from respiratory specimens collected over a six-period ending (September 2025 to

February 2026). The isolates depicted 55 various structure types.

The most frequently labeled animals are bestowed in Table 1.

Table 1: Distribution of Respiratory Isolates by Organism
(Top 20)

Rank	Organism	Code	Number of Isolates	(%)
1	No growth	xxx	824	49.64
2	Contaminated specimen	con	144	8.67
3	Escherichia coli	eco	122	7.35
4	No pathogens found	xpa	107	6.45
5	Klebsiella pneumoniae ss. pneumoniae	kpn	93	5.60
6	Pseudomonas aeruginosa	pae	71	4.28
7	Acinetobacter baumannii	aba	58	3.49
8	Staphylococcus aureus ss. aureus	sau	38	2.29
9	Candida albicans	cal	33	1.99
10	Candida sp.	can	29	1.75
11	Enterococcus faecalis	efa	24	1.45

12	Streptococcus agalactiae	sgc	11	0.66
13	Proteus mirabilis	pmi	11	0.66
14	Enterobacter cloacae	ecl	8	0.48
15	Enterococcus faecium	efm	8	0.48
16	Rejected sample	rej	7	0.42
17	Stenotrophomonas maltophilia	pma	5	0.30
18	No significant growth found	xsg	5	0.30
19	Normal flora	nor	5	0.30
20	Serratia marcescens	sma	4	0.24

The data show that nearly half of all respiratory specimens (49.64%) yielded no bacterial growth, while 8.67% were contaminated. Among pathogenic isolates, E. coli was the most frequently isolated organism (7.35%), followed by K. pneumoniae (5.60%), P. aeruginosa (4.28%), and A. baumannii (3.49%).

Figure 1: Distribution of Top 10 Respiratory Pathogens in Karbala (September 2025 – February 2026)

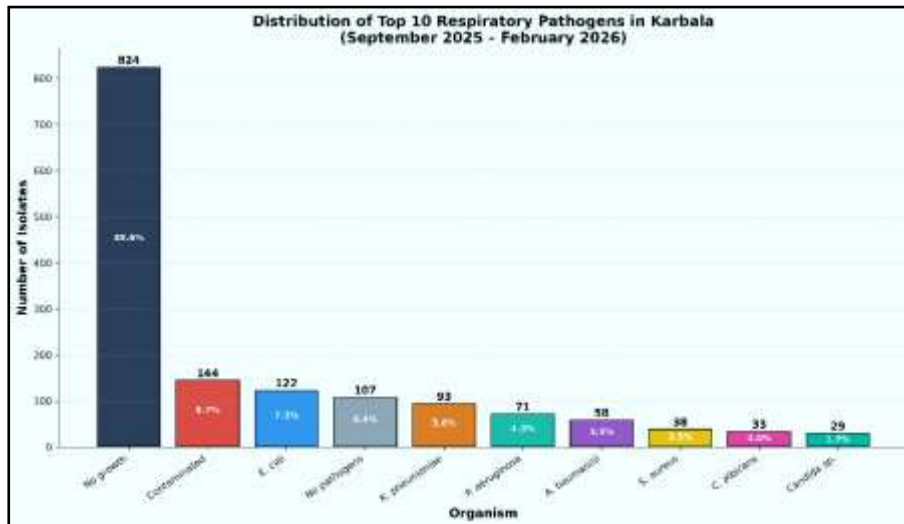


Figure 1 illustrate the classification of the ten most common respiratory culture consequences recognized in Karbala between September 2025 and February 2026. The topmost repetitiveness was noticed in samples with no bacterial development (824 isolates), attended by adulterated samples (144) and Escherichia coli (122). Among the habitual pathogens, Klebsiella pneumoniae (93), Pseudomonas aeruginosa (71), and Acinetobacter baumannii (58) were the most prevailing Gram-negative creatures, inasmuch as Staphylococcus aureus (38) and Candida species were discovered less commonly. Overall, the figure manifests that Gram-negative microorganisms constituted the ruling respiring

pathogens all along the study ending, while a substantial magnitude of examples allowed no microbial tumor.

4.2 Distribution by Specimen Type

The distribution of the most clinically significant pathogens across different respiratory specimen types is shown in Table 2.

Table 2: Distribution of Key Respiratory Pathogens by Specimen Type

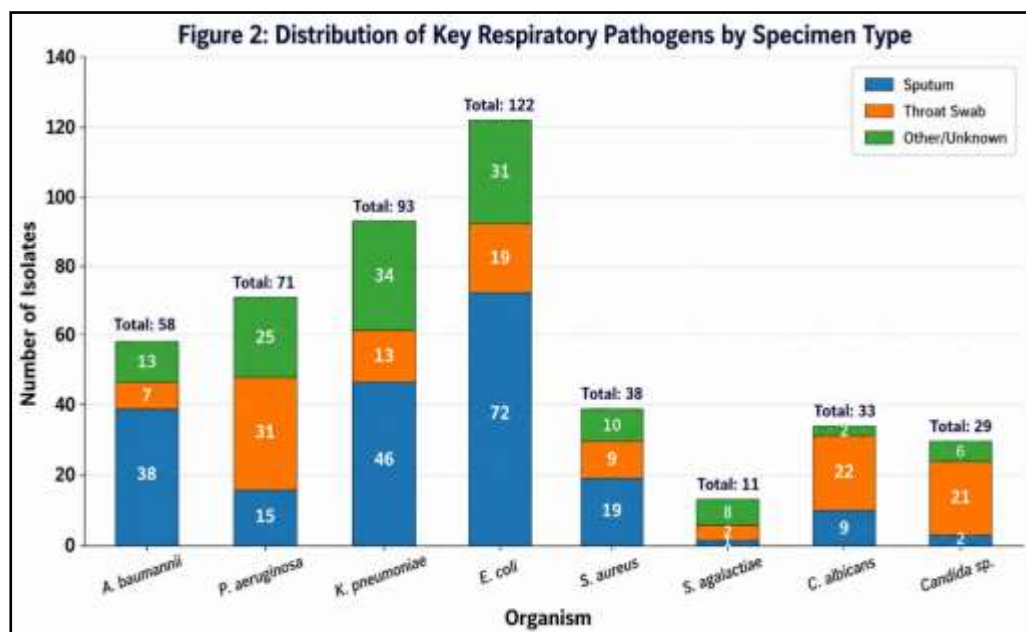
Organism	Sputum (sp)	Throat Swab (th)	Other/Unknown	Total
<i>Acinetobacter baumannii</i>	38	7	13	58
<i>Pseudomonas aeruginosa</i>	15	31	25	71
<i>Klebsiella pneumoniae</i>	46	13	34	93
<i>Escherichia coli</i>	72	19	31	122
<i>Staphylococcus aureus</i>	19	9	10	38
<i>Streptococcus</i>	1	2	8	11

<i>agalactiae</i>				
<i>Candida albicans</i>	9	22	2	33
<i>Candida sp.</i>	2	21	6	29

Note: Specimen type abbreviations: sp = sputum, th = throat swab

Sputum specimens were the predominant source for most bacterial pathogens, containing *K. pneumoniae* (49.5% from spit), *E. coli* (59.0%), and *A. baumannii* (65.5%). Throat swabs were more usually guide fungal isolates (*C. albicans*: 66.7%;

Figure 2: Distribution of Key Respiratory Pathogens by Specimen Type



4.3 Demographic Characteristics

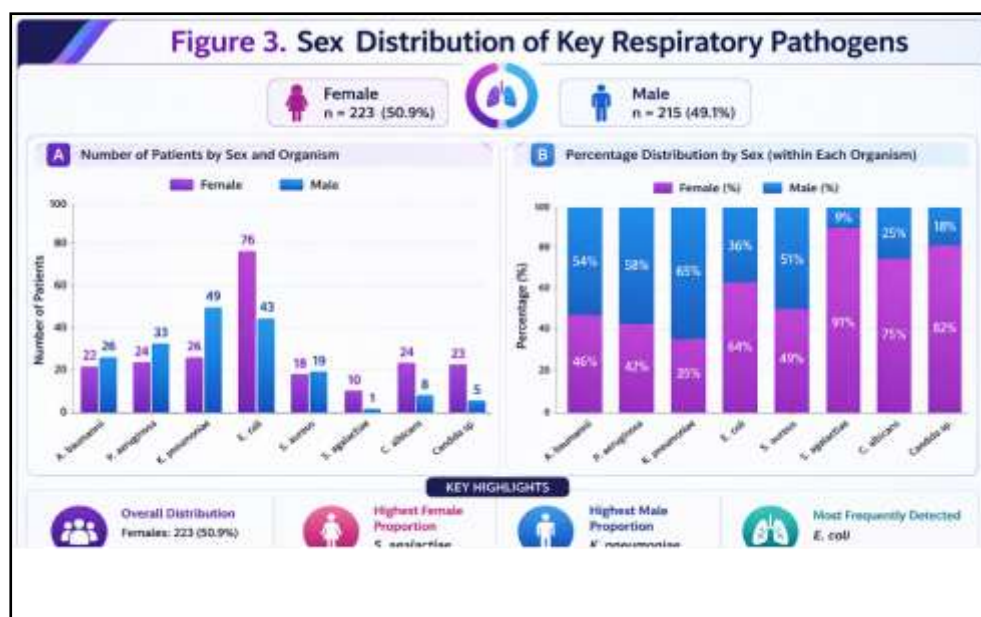
4.3.1 Sex Distribution

Table 3: Sex Distribution of Key Respiratory Pathogens

Organism	Female (n)	Male (n)	Total Patients
<i>Acinetobacter baumannii</i>	22	26	48
<i>Pseudomonas aeruginosa</i>	24	33	57
<i>Klebsiella pneumoniae</i>	26	49	75
<i>Escherichia coli</i>	76	43	119
<i>Staphylococcus aureus</i>	18	19	37
<i>Streptococcus agalactiae</i>	10	1	11
<i>Candida albicans</i>	24	8	32
<i>Candida sp.</i>	23	5	28

A female domination was noticed for *E. coli* (63.9% of patients), *C. albicans* (75.0%), *Candida sp.* (82.1%), and *S. agalactiae* (90.9%). In contrast, *K. pneumoniae* (65.3%) and *P. aeruginosa* (57.9%) were often unique from male cases.

Figure 3: Sex Distribution of Key Respiratory Pathogens



4.3.2 Age Group Distribution

Table 4: Age Group Distribution of Key Respiratory Pathogens

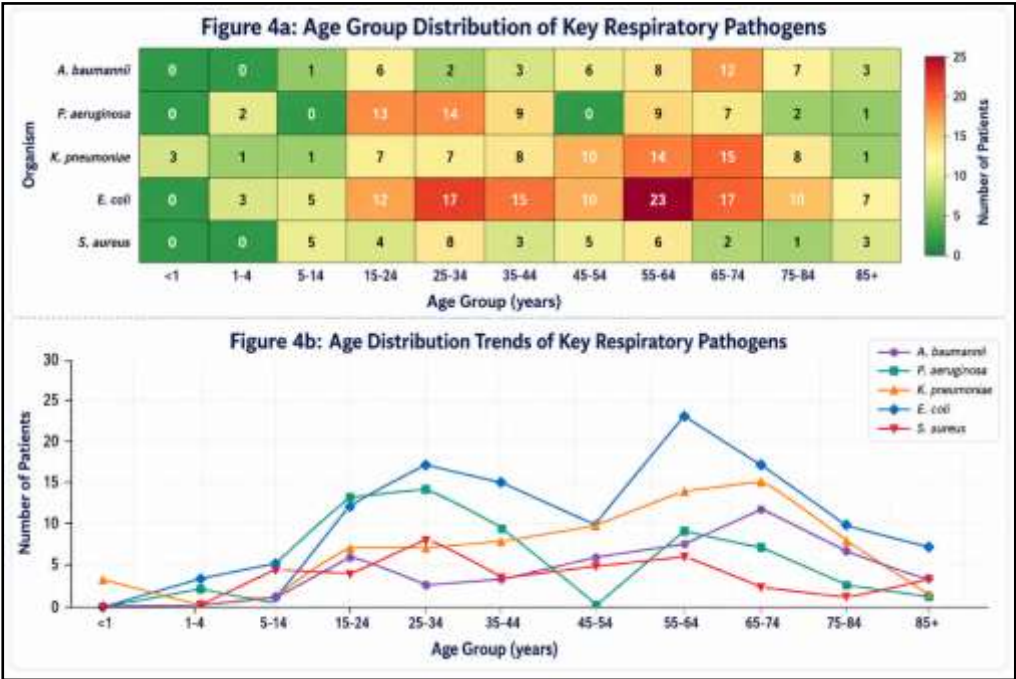
Age Group	<i>A. baumannii</i>	<i>P. aeruginosa</i>	<i>K. pneumoniae</i>	<i>E. coli</i>	<i>S. aureus</i>	Total Patients
<1 year	0	0	3	0	0	3
1-4 years	0	2	1	3	0	6
5-14 years	1	0	1	5	5	12
15-24	6	13	7	12	4	42

years						
25-34 years	2	14	7	17	8	48
35-44 years	3	9	8	15	3	38
45-54 years	6	0	10	10	5	31
55-64 years	8	9	14	23	6	60
65-74 years	12	7	15	17	2	53
75-84 years	7	2	8	10	1	28
85+ years	3	1	1	7	3	15

The best statistic of respiratory isolates was observed in the 55-64 age age group (60 sufferers), attended by the 65-74 age group (53 subjects). *K. pneumoniae* and *E. coli* accompanied a

expansive distribution across all age groups, while *A. baumannii* was mainly private from sufferers old 55 years and above.

Figure 4: Age Group Distribution of Key Respiratory Pathogens



4.3.3 Location Type Distribution

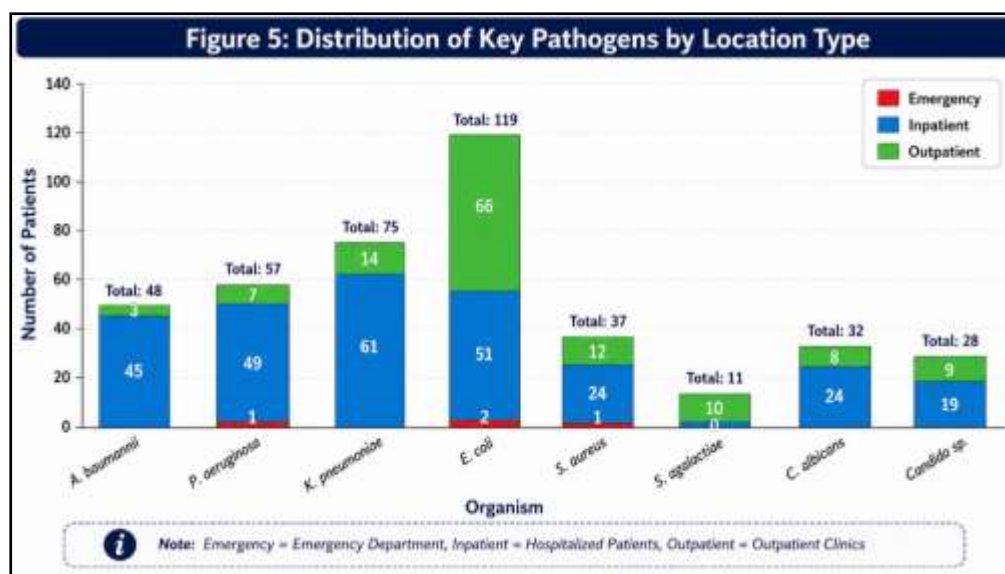
Table 5: Distribution of Key Pathogens by Location Type

Organism	Emergency (eme)	Inpatient (in)	Outpatient (out)	Other	Total
<i>Acinetobacter baumannii</i>	0	45	3	0	48
<i>Pseudomonas</i>	1	49	7	0	57

<i>aeruginosa</i>					
<i>Klebsiella pneumoniae</i>	0	61	14	0	75
<i>Escherichia coli</i>	2	51	66	0	119
<i>Staphylococcus aureus</i>	1	24	12	0	37
<i>Streptococcus agalactiae</i>	0	1	10	0	11
<i>Candida albicans</i>	0	24	8	0	32

The majority of respiring isolates introduced from inpatient backgrounds. Notably, *A. baumannii* (93.8%), *P. aeruginosa* (86.0%), and *K. pneumoniae* (81.3%) were predominantly nursing home-seized. In contrast, *E. coli* (55.5%) and *S. agalactiae* (90.9%) were more usually private from outpatients.

Figure 5: Distribution of Key Pathogens by Location Type



4.4 Monthly Distribution of Isolates

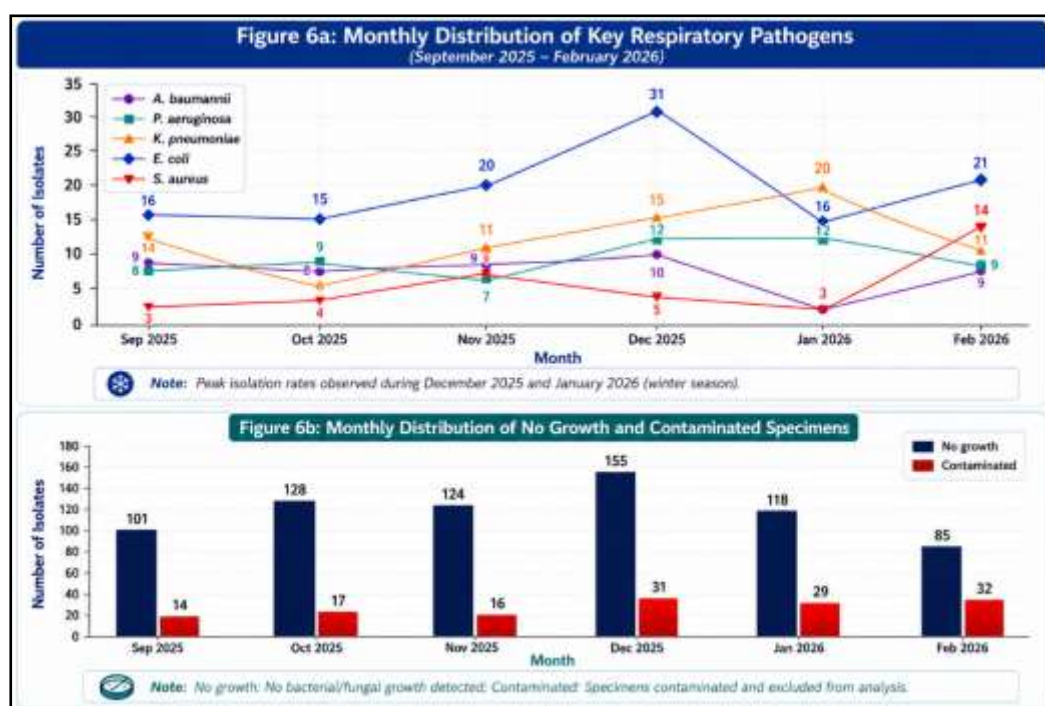
Table 6: Monthly Distribution of Key Pathogens (September 2025 – February 2026)

Organism	Sep '25	Oct '25	Nov '25	Dec '25	Jan '26	Feb '26	Total
<i>A. baumannii</i>	9	8	9	10	3	9	48
<i>P. aeruginosa</i>	8	9	7	12	12	9	57
<i>K. pneumoniae</i>	14	6	11	15	20	11	77
<i>E. coli</i>	16	15	20	31	16	21	119
<i>S. aureus</i>	3	4	8	5	3	14	37
No growth	101	128	124	155	118	85	824

Contaminated	14	17	16	31	29	32	144
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A clear migratory pattern was noticed, with the topmost number of isolates written all the while December 2025 and January 2026, compatible with the cold season when respiring contaminations usually peak.

Figure 6: Monthly Distribution of Key Respiratory Pathogens (September 2025 – February 2026)



4.5 Antimicrobial Resistance Patterns

4.5.1 Staphylococcus aureus (n=38)

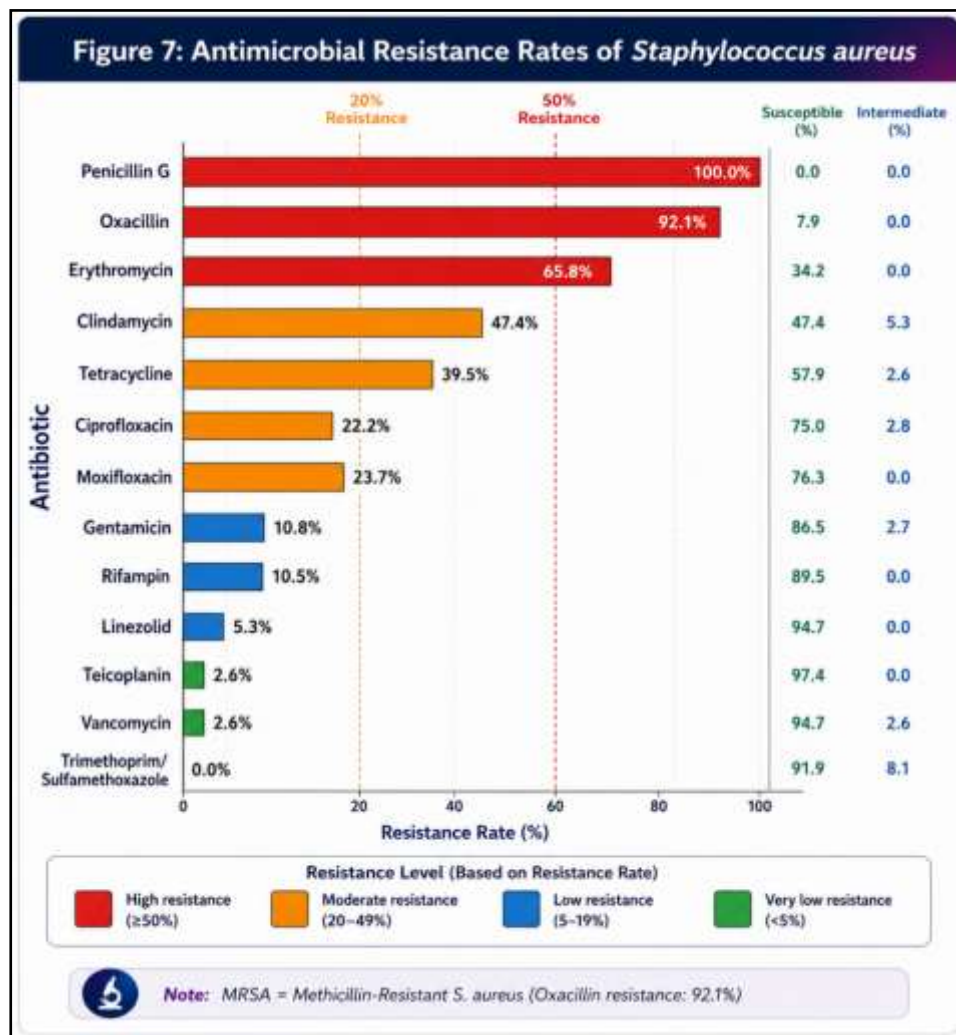
Table 7: Antimicrobial Resistance Profile of S. aureus

Antibiotic	%R	%I	%S	Number Tested
Penicillin G	100.0	0.0	0.0	36
Oxacillin	92.1	0.0	7.9	38
Gentamicin	10.8	2.7	86.5	37
Ciprofloxacin	22.2	2.8	75.0	36
Moxifloxacin	23.7	0.0	76.3	38
Clindamycin	47.4	5.3	47.4	38
Erythromycin	65.8	0.0	34.2	38
Linezolid	5.3	0.0	94.7	38
Teicoplanin	2.6	0.0	97.4	38
Vancomycin	2.6	2.6	94.7	38
Tetracycline	39.5	2.6	57.9	38
Rifampin	10.5	0.0	89.5	38
Trimethoprim/Sulfamethoxazole	0.0	8.1	91.9	37

All proven *S. aureus* isolates were opposing to penicillin G (100%), and the most (92.1%) were opposing to oxacillin, signifying a extreme prevalence of methicillin–opposing *S. aureus*

(MRSA). Fortunately, susceptibleness to linezolid (94.7%), teicoplanin (97.4%), and vancomycin (94.7%) waited extreme.

Figure 7: Antimicrobial Resistance Rates of *Staphylococcus aureus*



4.5.2 *Escherichia coli* (n=122)

Table 8: Antimicrobial Resistance Profile of *E. coli*

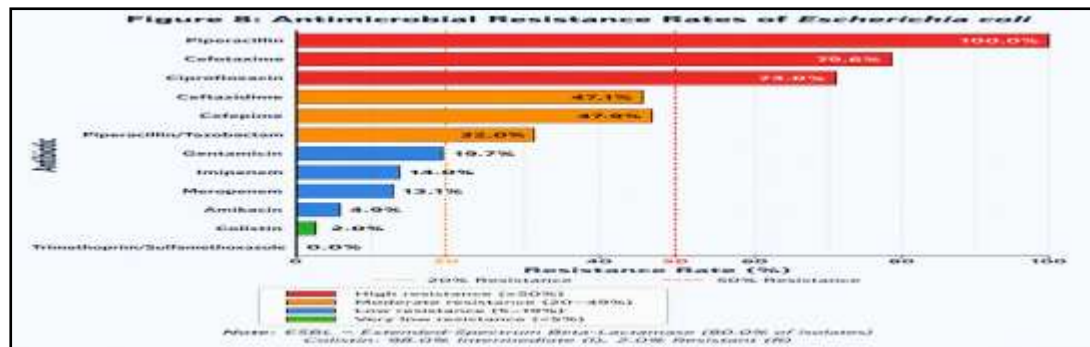
Antibiotic	%R	%I	%S	Number Tested

Piperacillin	100.0	0.0	0.0	7
Piperacillin/Tazobactam	32.0	1.6	66.4	122
Ceftazidime	47.1	13.2	39.7	121
Cefotaxime	79.6	0.0	20.4	108
Cefepime	47.9	10.7	41.3	121
Imipenem	14.0	0.0	86.0	121
Meropenem	13.1	0.0	86.9	122
Amikacin	4.9	0.0	95.1	122
Gentamicin	19.7	0.0	80.3	122
Ciprofloxacin	73.0	18.0	9.0	122
Trimethoprim/Sulfamethoxazole	0.0	59.0	41.0	122
Colistin	2.0	98.0	0.0	102

High resistance rates were noticed for cefotaxime (79.6%), ciprofloxacin (73.0%), and ceftazidime (47.1%). Carbapenem resistance (imipenem and meropenem) was noticed at nearly 13–14%. Notably, 80.0% of isolates proven beneficial for ESBL production (n=120). The extreme middle rate for

trimethoprim/sulfamethoxazole (59.0%) desires discounted clinical productiveness.

Figure 8: Antimicrobial Resistance Rates of *Escherichia coli*



4.5.3 *Klebsiella pneumoniae* (n=93)

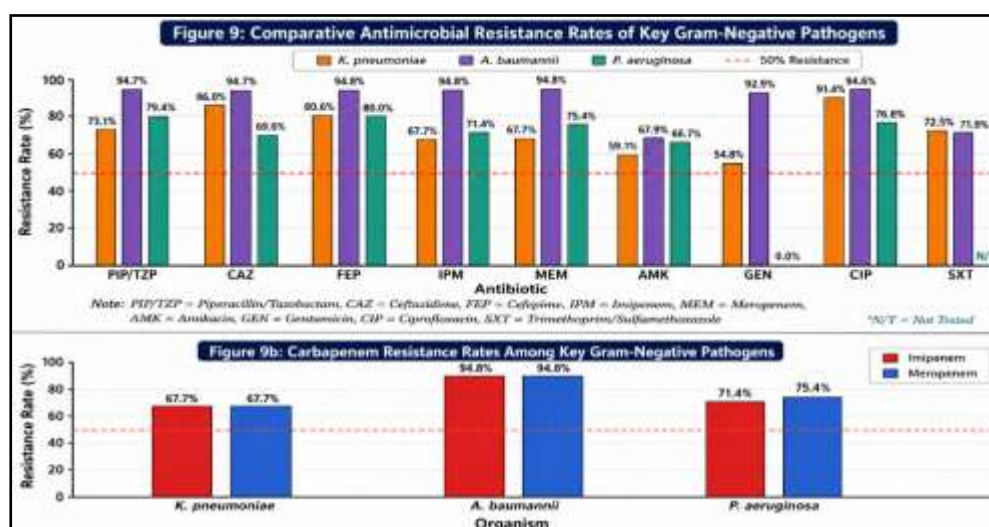
Table 9: Antimicrobial Resistance Profile of *K. pneumoniae*

Antibiotic	%R	%S	Number Tested
Piperacillin/Tazobactam	73.1	26.9	93
Ceftazidime	86.0	14.0	93
Cefepime	80.6	19.4	93
Imipenem	67.7	32.3	93
Meropenem	67.7	32.3	93
Amikacin	59.1	40.9	93
Gentamicin	54.8	45.2	93
Ciprofloxacin	91.4	8.6	93
Trimethoprim/Sulfamethoxazole	72.5	27.5	91

Cefotaxime	91.2	8.8	80
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K. pneumoniae isolates showed extremely extreme fighting rates to most tested medicines, accompanying ciprofloxacin (91.4%), cefotaxime (91.2%), and ceftazidime (86.0%) showing the maximal fighting. Carbapenem resistance was noticed in nearly 67.7% of isolates.

Figure 9: Comparative Antimicrobial Resistance Rates of Key Gram-Negative



4.5.4 *Acinetobacter baumannii* (n=58)

Table 10: Antimicrobial Resistance Profile of *A. baumannii*

Antibiotic	%R	%S	Number Tested
Piperacillin/Tazobactam	94.7	5.3	57

Ceftazidime	94.7	5.3	57
Cefepime	94.8	5.2	58
Imipenem	94.8	5.2	58
Meropenem	94.8	5.2	58
Amikacin	67.9	32.1	53
Gentamicin	92.9	7.1	56
Ciprofloxacin	94.6	5.4	56
Colistin	0.0	100.0	3
Trimethoprim/Sulfamethoxazole	71.9	28.1	57

A. baumannii presented familiar-total resistance to most medicines, containing piperacillin/tazobactam (94.7%), ceftazidime (94.7%), imipenem (94.8%), meropenem (94.8%), and ciprofloxacin (94.6%). However, all tested isolates waited exposed to colistin (100% S, n=3). Amikacin presented moderate activity (32.1% susceptibleness).

4.5.5 *Pseudomonas aeruginosa* (n=71)

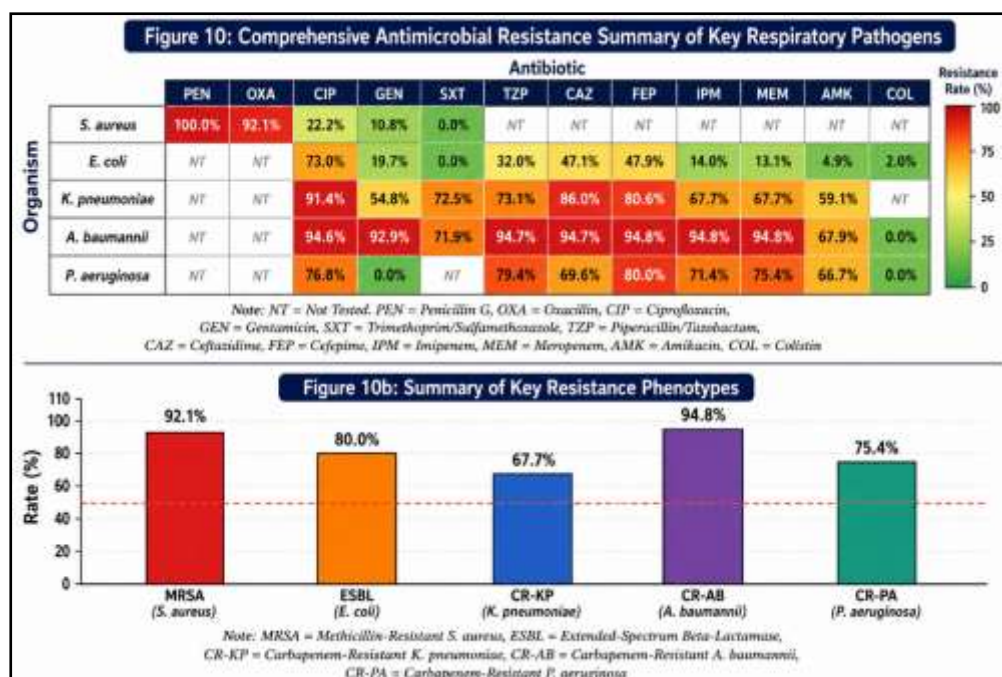
Table 11: Antimicrobial Resistance Profile of *P. aeruginosa*

Antibiotic	%R	%S	Number Tested
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Piperacillin/Tazobactam	79.4	20.6	68
Ceftazidime	69.6	30.4	69
Cefepime	80.0	20.0	70
Imipenem	71.4	28.6	70
Meropenem	75.4	24.6	69
Amikacin	66.7	33.3	33
Gentamicin	0.0	100.0	1
Ciprofloxacin	76.8	23.2	69
Colistin	0.0	100.0	1

P. aeruginosa exhibited high resistance to piperacillin/tazobactam (79.4%), cefepime (80.0%), meropenem (75.4%), and ciprofloxacin (76.8%). Carbapenem resistance was observed in approximately 71–75% of isolates.

Figure 10: Comprehensive Antimicrobial Resistance
Summary of Key Respiratory



5. Discussion

The conclusions concerning this study provide inclusive intuitions into the epidemiology and antimicrobial fighting patterns of respiring pathogens in Karbala, Iraq. The extreme proportion of samples accompanying "No growth" (49.64%) and "Contaminated example" (8.67%) climaxes the challenges in obtaining able respiring samples for breeding, which is compatible accompanying previous reports displaying that 30–50% of spit samples are rebuffed due to coarse (Baron and others., 2023, p. 15; O'Grady & Ruprecht, 2023, p. 1028).

5.1 result outcome : The underscores refer to the need for enhanced example collection codes and preparation for healthcare

laborers (Miller et al., 2018, p. e5). Among pathogenic isolates, *E. coli* (7.35%), *K. pneumoniae* (5.60%), *P. aeruginosa* (4.28%), and *A. baumannii* (3.49%) were ultimate commonly identified structures. This pattern is agreeing accompanying previous studies from Iraq, that have labeled these organisms as big causes of respiring contaminations (Al-Rubaie et al., 2020, p. 38; Ghazi and others., 2022, p. 6). The reign of *A. baumannii* in sputum samples (65.5%) is specifically noteworthy and joins accompanying its recognized function as a meaningful cause of nosocomial pneumonia, especially in open subjects in exhaustive care units (Peleg and others., 2008, p. 540; Al-Ibraheemi and others., 2020, p. 18).

This finding has main suggestions for contamination prevention and control practices in Karbala hospitals. The mathematical analysis told that *K. pneumoniae* (65.3%) and *P. aeruginosa* (57.9%) were more usually isolated from men, while *E. coli* (63.9%), *C. albicans* (75.0%), and *S. agalactiae* (90.9%) were more repeated in women. The striking female reign for *S. agalactiae* is compatible with its traditional function as an

opportunistic bacterium in wives, particularly before birth and in aged women (Puopolo and others., 2023, p. 790). The age classification granted that the highest number of respiring isolates was noticed in patients old 55–64 age and 65–74 age, reflecting the raised susceptibleness of older women to respiring contaminations due to immunosenescence and fundamental comorbidities (Al-Hussainy and others., 2024, p. 116). The location type reasoning disclosed that hospital-seized contaminations predominated for *A. baumannii* (93.8%), *P. aeruginosa* (86.0%), and *K. pneumoniae* (81.3%).

This verdict is consistent accompanying the famous epidemiology of these structures as important causes of healthcare-mixed pneumonia (HCAP) and ventilator-joined pneumonia (VAP) (Metlay and others., 2019, p. e52). The high ratio of *E. coli* (55.5%) and *S. agalactiae* (90.9%) private from outpatients suggests that these structures are more usually guide community-collected contaminations. The monthly allocation study told a clear seasonal pattern, accompanying the chief number of isolates recorded all the while December 2025 and

January 2026. This judgment is logical with the traditional seasonality of respiring infections, that usually peak during cold months on account of incidental factors to a degree hotness, humidity, and raised household cramming (WHO, 2023, p. 89; Choi et al., 2023, p. 60). The style of growing isolation rates from September 2025 to February 2026 can show a absolute increase in respiratory contaminations or changes in healthcare-pursuing behavior all along the cold season.

The antimicrobial resistance orders noticed in this study are alarming and highlight the urgent need for antimicrobial management and contamination control measures. The extreme prevalence of MRSA (92.1% oxacillin fighting) is regular accompanying premature reports from Iraqi wards (Hassan et al., 2021, p. 5; Al-Tameemi and others., 2020, p. 28). Fortunately, susceptibleness to linezolid, teicoplanin, and vancomycin waited extreme, providing healing options for MRSA contaminations. However, the rise of vancomycin fighting (2.6%) is having to do with and warrants close listening (Boucher et al., 2024, p. 8).

The extreme rates of ESBL result (80.0%) and carbapenem opposition (13–14%) between *E. coli* isolates indicate the impact of antimicrobial selective pressure in the society and healthcare backgrounds (Al-Azzawi & Al-Khafaji, 2023, p. 48). The intensely extreme opposition rates observed in *K. pneumoniae* (91.4% to ciprofloxacin, 91.2% to cefotaxime, 67.7% to carbapenems) and *A. baumannii* (94.8% to carbapenems) are specifically having to do with and imply that these structures have enhance widely drug-resistant (XDR) in Karbala. This verdict is constant accompanying worldwide reports labeling carbapenem-resistant Enterobacteriaceae (CRE) and carbapenem-opposing *A. baumannii* (CRAB) as fault-finding arrangement pathogens (WHO, 2017, p. 4; Tacconelli and others., 2018, p. 322).

The opposition rates observed in this place study are above those stated private territorial studies, highlighting the demanding need for embellished contamination control measures and antimicrobial management programs in Karbala emergency rooms. The finding of 100% susceptibleness to colistin between *A. baumannii* isolates (n=3) determines few healing hope, although

colistin has disadvantages in agreements of chance, cost, and potential toxicity, specifically nephrotoxicity (Lim & Tan, 2023, p. 15). The moderate exercise of amikacin against *A. baumannii* (32.1% susceptibility) implies that aminoglycosides can still have a part together analysis, but resistance rates wait extreme.

5.2 Comparison with Regional and Global Studies

The resistance rates observed in this analysis are significantly above those stated in close states and additional regions. A study from Turkey stated carbapenem fighting rates of 35–40% in *A. baumannii* and 15–20% in *K. pneumoniae*, distinguished to 94.8% and 67.7% individually in our study (Erdem et al., 2022). Similarly, studies from Jordan stated ESBL rates of 45–50% between *E. coli* isolates, essentially inferior the 80.0% noticed in Karbala (Al-Sweih et al., 2021).

A multicenter study from Saudi Arabia stated MRSA rates of 30–35%, distinguished to 92.1% in our study (Aljohani and others., 2023). These differences grant permission be attributed to various determinants: distinctnesses in antimicrobial management practices, differences in infection control measures, chance and

approachability of medicines, and distinctnesses in healthcare foundation and resources (Al-Azzawi & Al-Khafaji, 2023; WHO-EMRO, 2022).

In the Eastern Mediterranean Region, Iraq has existed recognized all at once of the nations with the topmost rates of antimicrobial fighting, specifically for carbapenem-opposing Enterobacteriaceae and carbapenem-opposing *A. baumannii* (WHO-EMRO, 2022). The resistance rates noticed in our study are compatible at this moment provincial pattern and imply that Karbala may show a hotspot for antimicrobial fighting inside Iraq. This climaxes the crucial need for coordinated provincial works to combat AMR, containing harmonized following systems, patterned workshop codes, and joint antimicrobial management strategies (Tacconelli and others., 2018; WHO, 202

6. Conclusion and Recommendations

Conclusion: This study supports comprehensive profiling of respiring area pathogens and their antimicrobial resistance patterns in Karbala, Iraq. The judgments disclose a high predominance of multidrug-opposing organisms, specifically *A.*

baumannii, K. pneumoniae, and P. aeruginosa, accompanying carbapenem fighting rates exceeding 67–94%. The extreme predominance of MRSA (92.1%) and ESBL-producing E. coli (80.0%) further confuses practical therapy excerpt. The migratory pattern of respiring infections, accompanying peaks all along winter months, climaxes the need for improved surveillance and readiness all along these periods.

Study Limitations: This study has various disadvantages, including its retrospective design and single-region scope (two hospitals in Karbala), which can limit generalizability (Hulley et al., 2013; Ministry of Health, 2023). Missing susceptibleness data for few medicines (e.g., colistin, n=3) and the absence of dispassionate effects, molecular fighting description, and distinction between establishment and contamination further force the findings (Metlay and others., 2019; Boucher and others., 2024; Marr & Bow, 2023). Despite these limitations, this study supplies valuable control dossier to guide empirical analysis and update future potential research in Iraq.

Recommendations:

1. Antimicrobial Stewardship: Establish inclusive antimicrobial management programs in all Karbala emergency rooms to advance wise medicine use, reduce discriminating pressure for fighting, and maintain the efficacy of last-minute medicines in the way that carbapenems, colistin, and glycopeptides (Barlam and others., 2016, p. e52).
2. National AMR Surveillance: Strengthen national AMR following methods joined accompanying the WHO-GLASS framework to allow listening of fighting trends at territorial and internal levels, aiding early discovery of emerging opposition patterns (WHO, 2023, p. 45; WHO-EMRO, 2022, p. 12).
3. Infection Prevention and Control: Implement severe contamination prevention and control measures in emergency rooms, specifically in exhaustive care parts and emergency areas, for fear that the spread of MDR animals (Al-Ibraheemi and others., 2020, p. 25). This includes help cleanliness agreement, contact precautions, tangible cleansing, and alive following cultures.

4. Specimen Quality: Implement control of product quality programs for respiring sample collection and alter to weaken adulteration rates and better diagnostic yield. Training healthcare traders on correct saliva group techniques is essential (Miller and others., 2018, p. e5).
5. Public Awareness: Launch public knowledge campaigns point or direct at a goal appropriate antibiotic use, particularly for respiring contaminations that are usually viral in inception. Addressing universal impressions about medicine use is essential for reducing useless use (Al-Tameemi and others., 2020, p. 30).
6. Molecular Diagnostics: Consider integration of microscopic demonstrative approaches (such as, miscellaneous PCR for respiratory pathogens) for hasty discovery of opposition mechanisms (such as, ESBL, carbapenemase genes) and epidemic pathogens. This would allow former growth of therapy and weaken the spread of opposing structures (Boucher and others., 2024, p. 10).

7. Continuous Surveillance: Conduct regular following studies at 6–12 temporal length of event or entity's existence pauses to monitor changes in pathogen disposal and fighting patterns, and to judge the impact of invasions and antimicrobial stewardship programs (Tacconelli and others., 2018, p. 325).

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