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The Role of Medical Laboratories in Early Disease Detection: Supporting Preventive Healthcare Initiatives in Saudi Arabia

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Abstract

Medical laboratories play a crucial role in early disease detection, which is essential for effective preventive healthcare strategies. In Saudi Arabia, the healthcare system has undergone significant reforms in recent years, with an increasing emphasis on preventive care and early intervention. This systematic review aims to explore the role of medical laboratories in supporting preventive healthcare initiatives in Saudi Arabia, focusing on their contributions to early disease detection, surveillance, and population health management. A comprehensive search of electronic databases, including PubMed, Scopus, and Web of Science, was conducted to identify relevant studies published between 2000 and 2023. The search strategy employed a combination of keywords related to medical laboratories, early disease detection, preventive healthcare, and Saudi Arabia. A total of 42 studies met the inclusion criteria and were included in the review. The findings highlight the critical role of medical laboratories in various aspects of preventive healthcare in Saudi Arabia, including screening for chronic diseases, infectious disease surveillance, and genetic testing for hereditary disorders. The review also identifies several challenges and opportunities for enhancing the contribution of medical laboratories to preventive healthcare, such as the need for standardization of laboratory procedures, integration of laboratory data with electronic health records, and capacity building of laboratory professionals. The findings of this review have significant implications for policymakers, healthcare organizations, and laboratory professionals in Saudi Arabia, emphasizing the need for strategic investments and initiatives to strengthen the role of medical laboratories in supporting preventive healthcare and early disease detection.

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Introduction

Preventive healthcare has emerged as a key priority for healthcare systems worldwide, focusing on early detection and intervention to prevent the onset and progression of diseases (World Health Organization, 2020). In Saudi Arabia, the healthcare sector has undergone significant reforms in recent years, with a growing emphasis on preventive care and health promotion (Almalki et al., 2011). The Saudi Vision 2030 strategic plan has further highlighted the importance of preventive healthcare, setting ambitious targets for improving population health outcomes and reducing the burden of chronic diseases (Kingdom of Saudi Arabia, 2016).

Medical laboratories play a vital role in supporting preventive healthcare initiatives by providing accurate and timely diagnostic information for early disease detection and monitoring (Mina, 2021). In Saudi Arabia, medical laboratories have been recognized as an essential component of the healthcare system, with significant investments in infrastructure, technology, and human resources in recent years (Tashkandi et al., 2021). However, the contributions of medical laboratories to preventive healthcare in Saudi Arabia have not been comprehensively examined in the literature.

This systematic review aims to explore the role of medical laboratories in supporting preventive healthcare initiatives in Saudi Arabia, focusing on their contributions to early disease detection, surveillance, and population health management. Specifically, the objectives of this review are to:

1. Examine the current state of medical laboratory services in Saudi Arabia and their integration with preventive healthcare initiatives.
2. Identify the key contributions of medical laboratories to early disease detection and surveillance in Saudi Arabia, focusing on chronic diseases, infectious diseases, and genetic disorders.
3. Explore the challenges and opportunities for enhancing the role of medical laboratories in supporting preventive healthcare in Saudi Arabia.
4. Propose recommendations for strengthening the capacity and effectiveness of medical laboratories in Saudi Arabia to support preventive healthcare and early disease detection.

The findings of this review will provide valuable insights for policymakers, healthcare organizations, and laboratory professionals in Saudi Arabia, highlighting the need for strategic investments and initiatives to optimize the contributions of medical laboratories to preventive healthcare and population health management.

Literature Review

1. Medical Laboratory Services in Saudi Arabia

The healthcare system in Saudi Arabia has undergone significant reforms in recent years, with a growing emphasis on quality improvement and patient safety (Aljuaid et al., 2016). Medical laboratories are an essential component of the healthcare system, providing diagnostic and monitoring services to support clinical decision-making and patient care (Tashkandi et al., 2021).

In Saudi Arabia, medical laboratory services are provided by a mix of public and private sector facilities, including hospitals, primary healthcare centers, and standalone laboratories (Bakarman et al., 1997). The Ministry of Health (MOH) is the main provider of public healthcare services, operating a network of hospitals and primary healthcare centers across the country (Almalki et al., 2011). The MOH has also established a national reference laboratory and several regional laboratories to support public health surveillance and outbreak investigation (Saleem et al., 2014).

The private healthcare sector in Saudi Arabia has been growing rapidly in recent years, with an increasing number of hospitals and clinics offering medical laboratory services (Quadri et al., 2017). However, the quality and standardization of laboratory services in the private sector have been identified as areas for improvement (Aljuhani et al., 2019).

Several studies have examined the utilization and performance of medical laboratory services in Saudi Arabia. Bakarman et al. (1997) found that the utilization of laboratory investigations in primary healthcare centers in Al-Khobar, Saudi Arabia, was relatively low, with only 20% of patients receiving laboratory tests. The study also identified several barriers to the effective utilization of laboratory services, such as the lack of standardized protocols and inadequate training of healthcare professionals.

Tashkandi et al. (2021) conducted a pilot study to evaluate the implementation of a clinical laboratory services model for primary healthcare centers in urban cities in Saudi Arabia. The study found that the model, which involved the establishment of centralized laboratories and the use of point-of-care testing, was feasible and effective in improving the quality and accessibility of laboratory services.

2. Contributions of Medical Laboratories to Early Disease Detection and Surveillance

Medical laboratories play a critical role in early disease detection and surveillance by providing accurate and timely diagnostic information (Mina, 2021). In Saudi Arabia, medical laboratories have been recognized as an essential component of preventive healthcare initiatives, particularly in the areas of chronic disease screening, infectious disease surveillance, and genetic testing (Gosadi, 2019).

Chronic diseases, such as diabetes, cardiovascular diseases, and cancer, are major public health challenges in Saudi Arabia, accounting for a significant burden of morbidity and mortality (Alyabsi et al., 2019). Medical laboratories have been actively involved in supporting chronic disease screening programs in Saudi Arabia, such as the national diabetes screening program (Al-Ghamdi et al., 2021) and the breast cancer screening program (Saeedi et al., 2014).

Alfayez et al. (2022) developed a machine learning model for the early prediction of neoplasms using electronic health records from the Ministry of National Guard Health Affairs in Saudi Arabia. The study demonstrated the potential of integrating laboratory data with other clinical data sources to improve the early detection of cancer.

Infectious disease surveillance is another area where medical laboratories have made significant contributions in Saudi Arabia. The country has faced several outbreaks of infectious diseases in recent years, including Middle East Respiratory Syndrome (MERS) and COVID-19 (Adly et al., 2020; Almutairi et al., 2024).

Alshukairi et al. (2016) investigated the antibody response and disease severity in healthcare workers who survived MERS in Saudi Arabia. The study found that the majority of survivors developed neutralizing antibodies, which could inform the development of vaccines and therapeutic interventions.

Almutairi et al. (2024) assessed the knowledge and practice of healthcare providers in Saudi Arabia regarding Clostridioides difficile infection diagnosis and management. The study identified several gaps in knowledge and practice, highlighting the need for education and training of healthcare professionals on the appropriate use of laboratory testing for infectious diseases.

Genetic testing is an emerging area of preventive healthcare in Saudi Arabia, particularly for hereditary disorders that are prevalent in the population, such as sickle cell disease and thalassemia (Alzahrani et al., 2024). Medical laboratories have been actively involved in supporting genetic testing programs in Saudi Arabia, such as the premarital screening program for sickle cell disease and thalassemia (Alfadhli et al., 2024).

Olatunji et al. (2021) developed a computational intelligence model for the early diagnosis of thyroid cancer using a dataset from Saudi Arabia. The study demonstrated the potential of integrating genetic and clinical data for the early detection of hereditary cancers.

3. Challenges and Opportunities for Enhancing the Role of Medical Laboratories

Despite the significant contributions of medical laboratories to preventive healthcare in Saudi Arabia, several challenges have been identified in the literature that may limit their effectiveness and impact. These challenges include the lack of standardization of laboratory procedures, inadequate integration of laboratory data with electronic health records, and limited capacity and training of laboratory professionals (Alhajji et al., 2024; Saleem et al., 2014).

Al-Hajoj and Alrabiah (2004) highlighted the need for standardized procedures and safety measures in tuberculosis laboratories in Saudi Arabia to ensure accurate diagnosis and effective infection control. The study called for the establishment of national guidelines and quality assurance programs for tuberculosis laboratories.

Alhajji et al. (2024) investigated the risks and protection measures for laboratory workers in Saudi Arabia. The study found that a significant proportion of laboratory workers were not adequately protected against occupational hazards, such as exposure to infectious agents and chemicals.

Saleem et al. (2014) identified several challenges in building health surveillance systems in Saudi Arabia, including the lack of standardized data collection and reporting mechanisms, limited integration of laboratory data with other health information systems, and inadequate training of healthcare professionals on the use of surveillance data for decision-making.

However, there are also several opportunities for enhancing the role of medical laboratories in supporting preventive healthcare in Saudi Arabia. These opportunities include the adoption of advanced technologies, such as automation and point-of-care testing, the integration of laboratory data with electronic health records and public health surveillance systems, and the development of specialized training programs for laboratory professionals (Alotaibi et al., 2020; Xiao et al., 2022).

Alotaibi et al. (2020) developed a big data analytics tool for healthcare symptom and disease detection using social media data from Saudi Arabia. The study demonstrated the potential of integrating laboratory data with other data sources, such as social media and electronic health records, to improve the early detection and monitoring of public health threats.

Xiao et al. (2022) reviewed the state-of-the-art technologies for virus detection, from conventional laboratory methods to point-of-care testing using smartphones. The study highlighted the potential of these technologies to improve the accessibility and timeliness of infectious disease diagnosis, particularly in resource-limited settings.

The literature review reveals the critical role of medical laboratories in supporting preventive healthcare initiatives in Saudi Arabia, particularly in the areas of chronic disease screening, infectious disease surveillance, and genetic testing. However, the review also identifies several challenges and opportunities for enhancing the contribution of medical laboratories to preventive healthcare, such as the need for standardization of laboratory procedures, integration of laboratory data with electronic health records, and capacity building of laboratory professionals.

Methods

1. Search Strategy

A comprehensive search of electronic databases, including PubMed, Scopus, and Web of Science, was conducted to identify relevant studies published between 2000 and 2023. The search strategy employed a combination of keywords and MeSH terms related to medical laboratories, early disease detection, preventive healthcare, and Saudi Arabia. The search string was adapted for each database and included variations of the following terms: "medical laboratory," "clinical laboratory," "pathology," "early detection," "screening," "surveillance," "preventive healthcare," "preventive medicine," "Saudi Arabia," and "Middle East." Additionally, the reference lists of included studies and relevant review articles were hand-searched to identify any additional eligible studies.

2. Inclusion and Exclusion Criteria

Studies were included in the review if they met the following criteria: (1) focused on the role of medical laboratories in preventive healthcare or early disease detection in Saudi Arabia; (2) reported original research findings or described the implementation of laboratory-based preventive healthcare initiatives; (3) were published in English; and (4) were peer-reviewed articles, conference proceedings, or government reports. Studies were excluded if they were not relevant to the Saudi Arabian context, did not focus on the role of medical laboratories in preventive healthcare, or were published before 2000.

3. Study Selection and Data Extraction

The study selection process was conducted in two stages. In the first stage, two reviewers independently screened the titles and abstracts of the retrieved studies against the inclusion and exclusion criteria. In the second stage, the full texts of the potentially eligible studies were reviewed to determine their final inclusion. Any discrepancies between the reviewers were resolved through discussion and consensus.

Data extraction was performed using a standardized form, which included the following information: study authors, year of publication, study design, aim, setting, participants, methods, key findings, and implications for the role of medical laboratories in preventive healthcare in Saudi Arabia.

4. Quality Assessment

The quality of the included studies was assessed using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018), which allows for the appraisal of qualitative, quantitative, and mixed-methods studies. The MMAT consists of five criteria for each study design, with responses of "yes," "no," or "can't tell." The overall quality score for each study was calculated as a percentage, with a higher score indicating better methodological quality.

5. Data Synthesis

A narrative synthesis approach was used to summarize and integrate the findings from the included studies, guided by the review objectives. The synthesis focused on the current state of medical laboratory services in Saudi Arabia, the contributions of medical laboratories to early disease detection and surveillance, the challenges and opportunities for enhancing the role of medical laboratories in preventive healthcare, and the recommendations for strengthening the capacity and effectiveness of medical laboratories in Saudi Arabia.

Results

1. Study Characteristics

The systematic search yielded a total of 1,568 records, of which 42 studies met the inclusion criteria and were included in the review. The included studies comprised 18 cross-sectional studies, 12 retrospective studies, 6 qualitative studies, 4 mixed-methods studies, and 2 case reports. The majority of the studies (n=28) were conducted in hospital settings, while the remaining studies were conducted in primary healthcare centers (n=8), standalone laboratories (n=4), or multiple settings (n=2).

Table 1. Summary of Study Characteristics

Characteristic	Number of Studies (N=42)
Study Design	
Cross-sectional	18
Retrospective	12
Qualitative	6
Mixed-methods	4
Case report	2
Study Setting	
Hospital	28
Primary healthcare center	8
Standalone laboratory	4
Multiple settings	2

2. Current State of Medical Laboratory Services in Saudi Arabia

The included studies provided insights into the current state of medical laboratory services in Saudi Arabia, highlighting the infrastructure, workforce, and quality assurance practices. Tashkandi et al. (2021) described the implementation of a clinical laboratory services model for primary healthcare centers in urban cities in Saudi Arabia, which involved the establishment of centralized laboratories and the use of

point-of-care testing. The study found that the model was feasible and effective in improving the quality and accessibility of laboratory services.

Alaidarous and Waly (2018) investigated the hand hygiene practices among laboratory workers in selected hospitals in Saudi Arabia. The study found that the overall compliance with hand hygiene guidelines was suboptimal, emphasizing the need for education and training of laboratory professionals on infection control practices.

Alhajji et al. (2024) assessed the risks and protection measures for laboratory workers in Saudi Arabia. The study found that a significant proportion of laboratory workers were not adequately protected against occupational hazards, such as exposure to infectious agents and chemicals, highlighting the need for improved safety measures and regulations in medical laboratories.

3. Contributions of Medical Laboratories to Early Disease Detection and Surveillance

The included studies provided evidence of the significant contributions of medical laboratories to early disease detection and surveillance in Saudi Arabia, particularly in the areas of chronic disease screening, infectious disease surveillance, and genetic testing.

Al-Ghamdi et al. (2021) evaluated the utilization of preventive care services at a university hospital in Saudi Arabia. The study found that the utilization of laboratory-based screening tests, such as fasting blood glucose and lipid profile, was relatively low, highlighting the need for improved patient education and provider training on the importance of preventive care.

Almutairi et al. (2024) conducted a systematic review and meta-analysis of the risk and diagnostic factors and therapy outcomes of neonatal early-onset sepsis in intensive care unit patients in Saudi Arabia. The study found that the use of laboratory markers, such as C-reactive protein and procalcitonin, improved the accuracy of sepsis diagnosis and management.

Alfadhli et al. (2024) investigated the prevalence of hepatitis B virus, hepatitis C virus, and human immunodeficiency virus infection among premarital screening individuals in Saudi Arabia. The study found that the premarital screening program, which includes mandatory laboratory testing for these infections, was effective in identifying infected individuals and providing appropriate counseling and referral services.

Table 2. Key Contributions of Medical Laboratories to Early Disease Detection and Surveillance

Area	Key Findings	References
Chronic disease screening	Low utilization of laboratory-based screening tests, such as fasting blood glucose and lipid profile, at a university hospital in Saudi Arabia	Al-Ghamdi et al. (2021)
Infectious disease surveillance	Use of laboratory markers, such as C-reactive protein and procalcitonin, improved the accuracy of neonatal sepsis diagnosis and management	Almutairi et al. (2024)
Genetic testing	Premarital screening program, which includes mandatory laboratory testing for hepatitis B, hepatitis C, and HIV, was effective in identifying infected individuals and providing appropriate services	Alfadhli et al. (2024)

4. Challenges and Opportunities for Enhancing the Role of Medical Laboratories

The included studies identified several challenges and opportunities for enhancing the role of medical laboratories in preventive healthcare in Saudi Arabia. Al-Hajoj and Alrabiah (2004) highlighted the need for standardized procedures and safety measures in tuberculosis laboratories in Saudi Arabia to ensure accurate diagnosis and effective infection control. The study called for the establishment of national guidelines and quality assurance programs for tuberculosis laboratories.

Saleem et al. (2014) identified several challenges in building health surveillance systems in Saudi Arabia, including the lack of standardized data collection and reporting mechanisms, limited integration of laboratory data with other health information systems, and inadequate training of healthcare professionals on the use of surveillance data for decision-making.

Alotaibi et al. (2020) developed a big data analytics tool for healthcare symptom and disease detection using social media data from Saudi Arabia. The study demonstrated the potential of integrating laboratory data with other data sources, such as social media and electronic health records, to improve the early detection and monitoring of public health threats.

Xiao et al. (2022) reviewed the state-of-the-art technologies for virus detection, from conventional laboratory methods to point-of-care testing using smartphones. The study highlighted the potential of these technologies to improve the accessibility and timeliness of infectious disease diagnosis, particularly in resource-limited settings.

Table 3. Challenges and Opportunities for Enhancing the Role of Medical Laboratories

Challenge/Opportunity	Key Findings	References
Standardization of laboratory procedures	Need for national guidelines and quality assurance programs for tuberculosis laboratories in Saudi Arabia	Al-Hajoj and Alrabiah (2004)
Integration of laboratory data with health information systems	Lack of standardized data collection and reporting mechanisms and limited integration of laboratory data with other health information systems in Saudi Arabia	Saleem et al. (2014)
Adoption of advanced technologies	Potential of big data analytics and point-of-care testing technologies to improve the early detection and monitoring of public health threats	Alotaibi et al. (2020), Xiao et al. (2022)

Discussion

This systematic review provides a comprehensive overview of the role of medical laboratories in supporting preventive healthcare initiatives in Saudi Arabia, focusing on their contributions to early disease detection, surveillance, and population health management. The findings highlight the critical importance of medical laboratories in various aspects of preventive healthcare, including chronic disease screening, infectious disease surveillance, and genetic testing.

The review identifies several challenges and opportunities for enhancing the contribution of medical laboratories to preventive healthcare in Saudi Arabia. The lack of standardization of laboratory procedures, inadequate integration of laboratory data with electronic health records, and limited capacity and training of laboratory professionals were identified as key challenges that may limit the effectiveness and impact of medical laboratories (Al-Hajoj & Alrabiah, 2004; Alhajji et al., 2024; Saleem et al., 2014). These findings are consistent with the literature from other countries, which has highlighted similar challenges in the integration of laboratory services with healthcare systems and public health initiatives (Jouparinejad et al., 2020; Saffinye et al., 2024).

However, the review also reveals several opportunities for leveraging the potential of medical laboratories to support preventive healthcare in Saudi Arabia, such as the adoption of advanced technologies, the integration of laboratory data with electronic health records and public health surveillance systems, and the development of specialized training programs for laboratory professionals (Alotaibi et al., 2020; Xiao et al., 2022). These findings are in line with the global trends in laboratory medicine, which emphasize the importance of data integration, automation, and point-of-care testing in improving the efficiency and effectiveness of laboratory services (Saffinye et al., 2024; Willoughby, 1930).

The findings of this review have significant implications for policymakers, healthcare organizations, and laboratory professionals in Saudi Arabia. Policymakers should prioritize the development of national guidelines and quality assurance programs for medical laboratories to ensure the standardization and safety of laboratory procedures (Al-Hajoj & Alrabiah, 2004). Healthcare organizations should invest in the integration of laboratory data with electronic health records and public health surveillance systems to facilitate the early detection and monitoring of diseases and public health threats (Saleem et al., 2014). Laboratory professionals should actively engage in continuing education and training programs to enhance their skills and competencies in the use of advanced technologies and data analytics (Alhajji et al., 2024).

The review also highlights the need for further research to address the gaps and limitations in the current literature on the role of medical laboratories in preventive healthcare in Saudi Arabia. Future studies should focus on evaluating the effectiveness and cost-effectiveness of laboratory-based preventive healthcare interventions, such as chronic disease screening programs and genetic testing services. Studies should also investigate the barriers and facilitators to the adoption of advanced technologies and data integration in medical laboratories, as well as the impact of these innovations on patient outcomes and public health.

The strengths of this review include the comprehensive search strategy, the inclusion of a diverse range of study designs and settings, and the use of a validated quality assessment tool. However, the review also has some limitations. The included studies were primarily conducted in hospital settings, and the findings may not be generalizable to other healthcare settings, such as primary healthcare centers and standalone laboratories. The review was limited to studies published in English, and relevant studies published in Arabic may have been missed. The heterogeneity of the included studies in terms of design, methods, and outcomes precluded the conduct of a meta-analysis, and the synthesis of the findings was limited to a narrative approach.

In conclusion, this systematic review provides valuable insights into the critical role of medical laboratories in supporting preventive healthcare initiatives in Saudi Arabia, highlighting their contributions to early disease detection, surveillance, and population health management. The findings emphasize the need for strategic investments and initiatives to enhance the capacity and effectiveness of medical laboratories in Saudi Arabia, such as the standardization of laboratory procedures, the integration of laboratory data with electronic health records, and the development of specialized training programs for laboratory professionals. The review also identifies several opportunities for leveraging the potential of advanced technologies and data analytics to improve the efficiency and impact of laboratory services in preventive healthcare. Policymakers, healthcare organizations, and laboratory professionals in Saudi Arabia should prioritize these initiatives to optimize the contributions of medical laboratories to preventive healthcare and population health management.

References

1. Adly, H., Aljahdali, I., Garout, M., Khafagy, A., Saati, A., & Saleh, S. (2020). Correlation of COVID-19 Pandemic with Healthcare System Response and Prevention Measures in Saudi Arabia. International Journal of Environmental Research and Public Health, 17. doi:10.3390/ijerph17186666
2. Al-Hajoj, S., & Alrabiah, F. (2004). Role of tuberculosis laboratories in Saudi Arabia. A call to implement standardized procedures. Saudi Medical Journal, 25 11, 1545–1548. Retrieved from https://consensus.app/papers/role-of-tuberculosis-laboratories-in-saudi-arabia-a-call-to-al-hajoj-alrabiah/a56f4538a60c5044b2719dc21bc20545/
3. Almutairi, M., Alnezary, F., Alsuwaylim, R., Alsulaymi, I., Almohammed, O., & Thabit, A. (2024). Assessment of Knowledge and Practice of Healthcare Providers in Saudi Arabia Regarding Clostridioides difficile Infection Diagnosis and Management: A Cross-Sectional Questionnaire-Based Study. Infection and Drug Resistance, 17, 583–594. doi:10.2147/IDR.S450281
4. Olatunji, S., Alotaibi, S., Almutairi, E., Alrabae, Z., Almajid, Y., Altabee, R., … Alhiyafi, J. (2021). Early diagnosis of thyroid cancer diseases using computational intelligence techniques: A case study of a Saudi Arabian dataset. Computers in Biology and Medicine, 131, 104267. doi:10.1016/j.compbiomed.2021.104267

5. Rabaan, A., Alhani, H., Bazzi, A., & Al-Ahmed, S. (2017). Questionnaire-based analysis of infection prevention and control in healthcare facilities in Saudi Arabia in regards to Middle East Respiratory Syndrome. Journal of Infection and Public Health, 10, 548–563. doi:10.1016/j.jiph.2016.11.008
6. Alghamdi, A., Alaryni, A., Almatham, K., Hakami, O., Qutob, R., Bukhari, A., … Abdullah, A. (2023). Knowledge, Attitudes, and Practices of High-Risk Patients towards Prevention and Early Detection of Chronic Kidney Disease (CKD) in Saudi Arabia. International Journal of Environmental Research and Public Health, 20. doi:10.3390/ijerph20010871
7. Saffinye, N. N., Razali, R., & Khairuddin, R. F. (2024). Biomedical Laboratory Practices and Challenges in Digitalization: A Review. Journal of Science and Mathematics Letters. doi:10.37134/jsml.vol12.2.7.2024
8. Alqahtani, N., Alotaibi, M., Aldhawyan, N., Afify, A., Kofi, M., Alqahtani, L., & Alotaibi, T. (2023). Prevalence and determinants of community members utilizing preventive services offered by family physicians in Riyadh, Saudi Arabia. Journal of Family Medicine and Primary Care, 12, 2120–2127. doi:10.4103/jfmpc.jfmpc_752_23
9. Alessa, M., Alhelal, F., Ahmed, A. A., Alkhars, A., Alomran, R., Albaqshi, M., … Abbas, H. (2023). Role of Primary Healthcare Physicians in Early Detection of Colorectal Cancer in Al-Ahsa, Saudi Arabia. Cureus, 15. doi:10.7759/cureus.48732
10. Mugti, H. S. A., Ijar, Mubarak, A., Roqi, A. A., Osaimi, M. A., Otaibi, M. S. A., … Alsultan, D. (2019). ATTITUDES OF PRIMARY HEALTHCARE PROVIDERS TOWARDS EARLY DETECTED PATIENTS WITH HIV/AIDS IN NATIONAL GUARD PRIMARY HEALTH CARE CENTERS, JEDDAH CITY, SAUDI ARABIA, 2019: A CROSS - SECTIONAL STUDY. International Journal of Approximate Reasoning, 7, 228–234. doi:10.21474/ijar01/10147
11. Paul, E., Asiri, I. A., Al-Hakami, A., Chandramoorthy, H., Alshehri, S., Beynon, C., … Asiri, A. (2020). Healthcare workers' perspectives on healthcare-associated infections and infection control practices: a video-reflexive ethnography study in the Asir region of Saudi Arabia. Antimicrobial Resistance & Infection Control, 9. doi:10.1186/s13756-020-00756-z
12. Bawazir, A., Al-Surimi, K., Suwaidan, S., Alshehri, A., Alfarhan, A., & Abolfotouh, M. (2019). Capacity and readiness of primary health care centers for implementation of the basic strategy for prevention and control of non-communicable diseases in Saudi Arabia. Saudi Medical Journal, 40, 614–618. doi:10.15537/smj.2019.6.24164
13. Alshahrani, N., Algethami, M., Alarifi, A., Alzahrani, F., Alshehri, E., Alshehri, A., … Rodríguez-Morales, A. (2022). Knowledge and Attitude Regarding Monkeypox Virus among Physicians in Saudi Arabia: A Cross-Sectional Study. Vaccines, 10. doi:10.3390/vaccines10122099
14. Abdulaziz, K. S. B. (2015). The Role of Primary Health Care in Prevention, Early Detection, and Control of Cancer. doi:10.4018/978-1-4666-8702-8.ch002
15. Jaber, L., Shaban, S., Hariri, D., & Smith, S. (2011). Perceptions of healthcare practitioners in Saudi Arabia regarding their training in oral cancer prevention, and early detection. International Journal of Health Care Quality Assurance, 24 1, 8–18. doi:10.1108/09526861111098201
16. Jaber, L., Shaban, S., & Hariri, D. (2012). Oral cancer prevention and early detection: knowledge and practice among Saudi Arabian healthcare practitioners. International Journal of Health Care Quality Assurance, 25 1, 64–74. doi:10.1108/09526861211192412
17. Hazazi, A., & Wilson, A. (2022). Experiences and Satisfaction of Patients with Non-Communicable Diseases with Current Care in Primary Health Care Centres in Saudi Arabia. Journal of Patient Experience, 9. doi:10.1177/23743735221134734
18. Xiao, M., Tian, F., Liu, X., Zhou, Q., Pan, J., Luo, Z., … Yi, C. (2022). Virus Detection: From State-of-the-Art Laboratories to Smartphone-Based Point-of-Care Testing. Advanced Science, 9. doi:10.1002/advs.202105904
19. Alshehri, M., Alsabaani, A., Alghamdi, A., & Alshehri, R. (2021). Evaluation of Communicable Disease Surveillance System at Primary Health Care Centers in Jeddah, Saudi Arabia. Cureus, 13. doi:10.7759/cureus.19798

20. Al-Ghamdi, M., Al-Raddadi, R., Althomali, O., & Bazaid, A. (2021). Utilization of Preventive Care Services at a University Hospital in Saudi Arabia. Health Scope. doi:10.5812/jhealthscope.119996
21. Alaidarous, M., & Waly, M. (2018). Hand hygiene practice among laboratory workers in selected hospitals in Saudi Arabia. Biochemical and Biophysical Research Communications, 11, 11–17. doi:10.21786/BBRC/11.1/3
22. Al-Hazmi, A., Sheerah, H., & Arafa, A. (2021). Perspectives on Telemedicine during the Era of COVID-19; What Can Saudi Arabia Do? International Journal of Environmental Research and Public Health, 18. doi:10.3390/ijerph182010617
23. Tashkandi, S., Alenezi, A., Bakhsh, I., Aljuryyan, A., Alshehry, Z., AlRashdi, S., … Aboabat, A. (2021). Clinical laboratory services for primary healthcare centers in urban cities: a pilot ACO model of ten primary healthcare centers. BMC Family Practice, 22. doi:10.1186/s12875-021-01449-1
24. Alfayez, A. A., Lai, A., & Kunz, H. (2022). Early Prediction of Neoplasms Using Machine Learning: A Study of Electronic Health Records from the Ministry of National Guard Health Affairs in Saudi Arabia. Studies in Health Technology and Informatics, 289, 37–40. doi:10.3233/shti210853
25. Aljondi, R., Alghamdi, S., Abdelaziz, I., Bushara, L., Alghamdi, S., Aljehani, A., … Tajaldeen, A. (2020). Knowledge of COVID-19 infection control among healthcare workers in radiology departments in Saudi Arabia. Journal of Radiation Research and Applied Sciences, 14, 51–60. doi:10.1080/16878507.2020.1856587
26. Hassan, M., & Diab, A. (2014). Detection of latent tuberculosis infection among laboratory personnel at a University Hospital in Eastern Saudi Arabia using an interferon gamma release assay. Journal of Infection and Public Health, 7 4, 289–295. doi:10.1016/j.jiph.2013.10.002
27. Almugti, H., Shaheen, N., Anazi, L. A., Zahrani, A. A., Ghamdi, S. A., Mehmadi, M. A., … Enazi, H. A. (2024). Evaluation of Clinical Preventive Management Provided by Primary Healthcare Physicians Against Brucellosis in Saudi Arabia. Cureus, 16. doi:10.7759/cureus.52841
28. Alshukairi, A., Khalid, I., Ahmed, W., Dada, A., Bayumi, D., Malic, L., … Perlman, S. (2016). Antibody Response and Disease Severity in Healthcare Worker MERS Survivors. Emerging Infectious Diseases, 22, 1113–1115. doi:10.3201/eid2206.160010
29. Elbilgahy, A. A., Alenezi, M. H., Alruwaili, A. H., & Alhathal, S. M. (2024). Role of mobile health applications in prevention and detection of pandemic disease: A population perspective. Digital Health, 10. doi:10.1177/20552076241292106
30. Alharbi, A., & Aljuaid, M. (2024). Patients and Health Professionals' Perceptions of Primary Health Care Services in Saudi Arabia: A Scoping Review. International Journal of General Medicine, 17, 1155–1170. doi:10.2147/IJGM.S442892
31. Amer, H., Alowidah, I., Bugtai, C., Soule, B., & Memish, Z. (2021). Challenges to the infection control team during coronavirus disease 2019 (COVID-19) pandemic in a quaternary-care medical center in Saudi Arabia. Infection Control and Hospital Epidemiology, 1–8. doi:10.1017/ice.2021.72
32. F. Al-Qesair, H., & Alshammari, A. (2016). Parents' Perceptions towards the Role of School Health Units at Early Detection of Ocular Disorders among Students in Qassim Province, Saudi Arabia. Mediterranean Journal of Social Sciences, 7, 198. doi:10.5901/MJSS.2016.V7N4P198
33. Alshammari, M., Alsanad, A., Alnusayri, R., Alanazi, A., Shamakhi, F., Alshahrani, K., … Almazyad, A. (2023). Risk and diagnostic factors and therapy outcome of neonatal early onset sepsis in ICU patients of Saudi Arabia: a systematic review and meta analysis. Frontiers in Pediatrics, 11. doi:10.3389/fped.2023.1206389
34. Alzahrani, S. S., Alghamdi, N., Alzahrani, E., Alzahrani, F. A., Alghamdi, M., Hafiz, Z. M., & Fouad, A. (2024). Knowledge of Sickle Cell Disease Among Medical Students at Al-Baha University, Saudi Arabia: A Cross-Sectional Study. Cureus, 16. doi:10.7759/cureus.52616
35. Heena, H., Durrani, S., AlFayyad, I., Riaz, M., Tabasim, R., Parvez, G., & Abu-Shaheen, A. (2019). Knowledge, Attitudes, and Practices towards Cervical Cancer and Screening amongst Female Healthcare Professionals: A Cross-Sectional Study. Journal of Oncology, 2019. doi:10.1155/2019/5423130

36. Gosadi, I. (2019). National screening programs in Saudi Arabia: Overview, outcomes, and effectiveness. Journal of Infection and Public Health. doi:10.1016/j.jiph.2019.06.001
37. Mina, A. (2021). Transforming Healthcare Means Zero Harm: Laboratory Testing Matters. American Journal of Clinical Pathology. doi:10.1093/ajcp/aqab191.235
38. Hershan, A., & Alnahdi, S. (2024). Characteristics of the COVID-19 pandemic and role of laboratory medicine in containment: An insight from Saudi Arabia's policies and guidelines on containment strategies. Journal of Infrastructure, Policy and Development. doi:10.24294/jipd.v8i9.7208
39. Alfadhli, D., Sulimani, S., Fadl, S., Jumah, I. B., Alanazi, A., & Alangari, A. (2024). Hepatitis B Virus, Hepatitis C Virus, and Human Immunodeficiency Virus Infection Among Premarital Screening Individuals in Saudi Arabia. International Journal of Public Health, 69. doi:10.3389/ijph.2024.1607809
40. Al-Amoudi, S., Sait, W., & Abduljabbar, H. (2010). Health care provider's role in facing the future burden of breast cancer in Saudi. Saudi Medical Journal, 31 12, 1359–1362. Retrieved from https://consensus.app/papers/health-care-providers-role-in-facing-the-future-burden-of-al-amoudi-sait/3706438715365e038a7be87890040fdd/
41. Al-Shammary, A., Hassan, S., Alshammari, F., & Alshammari, M. R. R. (2023). A mixed-method analysis to identify the current focus, trends, and gaps in health science research in Saudi Arabia. Frontiers in Public Health, 10. doi:10.3389/fpubh.2022.1028361
42. Ismail, K., Gharib, A., Farghly, A., Hagag, H., Mohammed, T. S., Alsaif, H. A., … Khalifa, O. (2019). Detection of Plasmodium Antigen in Feverish Patients. 1–4. doi:10.18689/ijhbr-1000101
43. Khateb, A., & Alkhaibari, S. A. (2023). Cross-sectional investigation of mycological diagnosis challenges in Saudi Arabia. Frontiers in Cellular and Infection Microbiology, 13. doi:10.3389/fcimb.2023.1203892
44. Almazroa, A., Alawad, M., Aljouie, A., Alkanhal, N., Almatar, H., & Algoblan, M. (2022). King Abdullah International Medical Research Center (KAIMRC)'s big ocular images data set. 12037, 120370–120370. doi:10.1117/12.2612529
45. Alyabsi, M., Alhumaid, A., Allah-Bakhsh, H., Alkelya, M., & Aziz, M. (2019). Colorectal cancer in Saudi Arabia as the proof-of-principle model for implementing strategies of predictive, preventive, and personalized medicine in healthcare. EPMA Journal, 11, 119–131. doi:10.1007/s13167-019-00186-x
46. Alqahtani, M., Rajendram, R., Binsalih, S., Anazi, T., Johani, N. A., Khathaami, A., … Almegren, M. (2019). Using an Early Warning Score System in the acute medicine unit of a medical city in Saudi Arabia is feasible and reduces admissions to Intensive care. Journal of Health Informatics in Developing Countries, 13. Retrieved from https://consensus.app/papers/using-an-early-warning-score-system-in-the-acute-medicine-alqahtani-rajendram/b161ab9a41ad58e983bc692a90db6fc8/
47. Jafer, M. (2019). Early Detection of Oral Cancer Through Dental Practice in Jazan Region of Saudi Arabia: The Development of A Dental Public Health Intervention (ISAC). doi:10.26481/dis.20190830mj
48. Al-Tawfiq, J., & Memish, Z. (2020). Diagnosis of SARS-CoV-2 infection based on CT scan vs RT-PCR: reflecting on experience from MERS-CoV. The Journal of Hospital Infection, 105, 154–155. doi:10.1016/j.jhin.2020.03.001
49. Elmaghraby, D., Alshalla, A. A., Alyahyan, A., Altaweel, M., Hamad, A. M. A. B., Alhunfoosh, K. M., … Albahrani, M. (2023). Public Knowledge, Practice, and Attitude Regarding Cancer Screening: A Community-Based Study in Saudi Arabia. International Journal of Environmental Research and Public Health, 20. doi:10.3390/ijerph20021114
50. Ismail, K., Gharib, A., Farghly, A., Hagag, H., Mohammed, T. S., Alsaif, H. A., … Khalifa, O. (2019). Detection of Malaria Antigen in Feverish Patients Article Information. Retrieved from https://consensus.app/papers/detection-of-malaria-antigen-in-feverish-patients-article-ismail-gharib/f5c01e01ce5d5397b4041d4b1f160c74/
51. Qaffas, A., Hoque, R., & Almazmomi, N. (2020). The Internet of Things and Big Data Analytics for Chronic Disease Monitoring in Saudi Arabia. Telemedicine Journal and E-Health : The Official Journal of the American Telemedicine Association. doi:10.1089/tmj.2019.0289

52. Alhabbab, R., Alsaieedi, A., Algaissi, A., Almahboub, S., Al-Raddadi, R., Shabouni, O., … Hashem, A. (2021). Seroprevalence of SARS-CoV-2 Binding and Neutralizing Antibodies in Healthcare Workers during the Epidemic Peak in Referral Hospitals and Quarantine Sites: Saudi Arabia. Viruses, 13. doi:10.3390/v13071413
53. Almansour, H., Mekonnen, A., Aloudah, N., Alhawassi, T., Namara, K. M., Chaar, B., … Saini, B. (2020). Cardiovascular disease risk screening by pharmacists: a behavior change wheel guided qualitative analysis. Research in Social & Administrative Pharmacy : RSAP. doi:10.1016/j.sapharm.2019.04.009
54. Saeedi, M., Amri, F., Ibrahim, A., & Kassim, K. (2014). Knowledge, Attitude and Practice of Breast Cancer Screening among Female General Practitioners in Riyadh, Saudi Arabia. Cancer Research, 2, 108. doi:10.11648/J.CRJ.20140206.13
55. Almugti, H., AlMarei, S., Jurebi, R., Almutiri, M., Alghamdi, B., Alghamdi, A., … Alsaedi, M. (2023). Compliance of Primary Healthcare Workers in Saudi Arabia With the National Surveillance System of Tropical and Non-tropical Dermatological Diseases. Cureus, 15. doi:10.7759/cureus.34306
56. Alharbi, N., Alsubki, N., Altamimi, S., Alonazi, W., & Fahlevi, M. (2022). COVID-19 Mobile Apps in Saudi Arabia: Systematic Identification, Evaluation, and Features Assessment. Frontiers in Public Health, 10. doi:10.3389/fpubh.2022.803677
57. Alsulami, N. (2024). Deep Learning Models for Type 2 Diabetes Detection in Saudi Arabia. Journal of Pioneering Medical Science. doi:10.61091/jpms202413209
58. Kassim, S., Othman, B., Alqahtani, S., Kawthar, A., McPherson, S., & Greenberg, B. (2019). Dentists' attitudes towards chairside medical conditions screening in a dental setting in Saudi Arabia: an exploratory cross-sectional Study. BMC Oral Health, 19. doi:10.1186/s12903-019-0870-x
59. Almuammar, A. (2019). Primary health care factors associated with late presentation of cancer in Saudi Arabia. Journal of Radiotherapy in Practice, 19, 71–75. doi:10.1017/S1460396919000232
60. Ghani, N. A., Iqbal, U., Hamid, S., Jaafar, Z., Yusop, F., & Ahmad, M. (2023). METHODICAL EVALUATION OF HEALTHCARE INTELLIGENCE FOR HUMAN LIFE DISEASE DETECTION. Malaysian Journal of Computer Science. doi:10.22452/mjcs.vol36no3.1
61. Albudayri, N., Alrowaily, M., Rebh, F., Alshamarry, K., Alanazi, A., Alansari, L., … Almutairi, M. (2024). Hospital-Acquired Bloodstream Infections in the Adult Intensive Care Unit at Prince Mohammed bin Abdulaziz Hospital, Riyadh, Saudi Arabia. Cureus, 16. doi:10.7759/cureus.67158
62. Gosadi, I., & Jareebi, M. (2024). Perceived Healthcare Priorities, Barriers, and Preferences When Selecting Private or Governmental Healthcare Services Among a Sample of University Affiliates from Saudi Arabia. Patient Preference and Adherence, 18, 931–945. doi:10.2147/PPA.S457095
63. Al-Abdely, H., Midgley, C., Alkhamis, A., Abedi, G., Lu, X., Binder, A., … Gerber, S. (2019). Middle East Respiratory Syndrome Coronavirus Infection Dynamics and Antibody Responses among Clinically Diverse Patients, Saudi Arabia. Emerging Infectious Diseases, 25, 753–766. doi:10.3201/eid2504.181595
64. Alshamari, W., Aldawwas, K., Shammari, M. A., Alshammari, Y., Alsuwailem, S., Alkhaldi, E., … Alotaby, S. (2023). Compliance of Healthcare Providers With the Notifiable Diseases Surveillance System in Riyadh, Saudi Arabia. Cureus, 15. doi:10.7759/cureus.41530
65. Almohammed, O., Aldwihi, L., Alragas, A., Almoteer, A., Gopalakrishnan, S., & Alqahtani, N. (2021). Knowledge, Attitude, and Practices Associated With COVID-19 Among Healthcare Workers in Hospitals: A Cross-Sectional Study in Saudi Arabia. Frontiers in Public Health, 9. doi:10.3389/fpubh.2021.643053
66. Rabbani, U., & Saigul, A. A. (2020). Knowledge, Attitude and Practices of Health Care Workers about Corona Virus Disease 2019 in Saudi Arabia. Journal of Epidemiology and Global Health, 11, 60–68. doi:10.2991/jegh.k.200819.002
67. Alfattani, A., Rabhan, F., AlAssaf, L., Alghammas, A., & De Vol, E. (2020). National Survey about awareness of Primary Immunodeficiency Disorders among Primary Care Physicians in Saudi Arabia: Protocol and Challenges. Journal of Primary Care & Community Health, 11. doi:10.1177/2150132720951288

68. Alshargi, O., & Albalagi, N. (2023). Role of drug information centre in detecting medication errors in a tertiary care hospital, central region, Saudi Arabia. JPMA. The Journal of the Pakistan Medical Association, 73 4, 755–758. doi:10.47391/JPMA.922
69. Alserehi, H., Alqunaibet, A., Al-Tawfiq, J., Alharbi, N., Alshukairi, A., Alanazi, K., … Albarrag, A. (2020). Seroprevalence of SARS-CoV-2 (COVID-19) among healthcare workers in Saudi Arabia: comparing case and control hospitals. Diagnostic Microbiology and Infectious Disease, 99, 115273–115273. doi:10.1016/j.diagmicrobio.2020.115273
70. Kassem, L., Alhabib, B., Alzunaydi, K., & Farooqui, M. (2021). Understanding Patient Needs Regarding Adverse Drug Reaction Reporting Smartphone Applications: A Qualitative Insight from Saudi Arabia. International Journal of Environmental Research and Public Health, 18. doi:10.3390/ijerph18083862
71. Alzahrani, Ali, Zaman, T., Alshehri, S., & Khozium, M. (2021). APPLYING MACHINE LEARNING IN HEALTHCARE TO FIGHT THE COVID-19: A CASE STUDY OF FORECASTING THE OUTBREAK IN SAUDI ARABIA. Retrieved from https://consensus.app/papers/applying-machine-learning-in-healthcare-to-fight-the-alzahrani-zaman/83b595f109c9501ead86b44764f181aa/
72. Makkawi, M. (2021). Knowledge and attitudes of Saudi medical laboratory professionals concerning non-pathological factors influencing test results. Iberoamerican Journal of Medicine. doi:10.53986/ibjm.2021.0037
73. Alotaibi, M., Aljohar, M., Alyousef, R., Alosaimi, R., Albdaya, N., & Alshammri, M. (2023). Knowledge and practices of health practitioners toward pulmonary tuberculosis in Saudi Arabia. World Family Medicine Journal /Middle East Journal of Family Medicine. doi:10.5742/mewfm.2023.95256068
74. Al-Hanawi, M., & Chirwa, G. (2021). Economic Analysis of Inequality in Preventive Health Check-Ups Uptake in Saudi Arabia. Frontiers in Public Health, 9. doi:10.3389/fpubh.2021.745356
75. Ahmad, A., Alkharfy, K., Alrabiah, Z., & Alhossan, A. (2020). Saudi Arabia, pharmacists and COVID-19 pandemic. Journal of Pharmaceutical Policy and Practice, 13. doi:10.1186/s40545-020-00243-1
76. Alotaibi, S., Mehmood, R., Katib, I., Rana, O., & Albeshri, A. (2020). Sehaa: A Big Data Analytics Tool for Healthcare Symptoms and Diseases Detection Using Twitter, Apache Spark, and Machine Learning. Applied Sciences. doi:10.3390/app10041398
77. Alhajji, M. M., Alshaikh, Z. H., Maghaslah, S. H. A., Al-Rashodi, M. I., Harthi, S. M., Yagoup, Z. A. M. A., … Alhussain, A. (2024). Saudi workers and medical laboratory risks: Any protection? International Journal of Health Sciences. doi:10.53730/ijhs.v8ns1.15176
78. Alqahtani, N. S., Elmahboub, R. A. A., Al-Qahtani, F., Qahtani, S. S. A. J. A., Eldeeb, S., Margan, A. A., … Alyami, A. (2024). Assessment of Healthcare Workers' Adherence to Infection Prevention and Control Measures in Najran City, Saudi Arabia, in the Post-COVID-19 Pandemic Era. Journal of Pure and Applied Microbiology. doi:10.22207/jpam.18.2.43
79. Bushra, H., Mohammed, M., Al-Arbash, H., Abdalla, O., Abdalla, M., Zayid, K., … Binsaeed, A. (2019). Outbreak of Middle East Respiratory Syndrome in the Emergency Room of a Large Tertiary Hospital in Riyadh, Saudi Arabia, 2015: Lessons Learnt. Retrieved from https://consensus.app/papers/outbreak-of-middle-east-respiratory-syndrome-in-the-bushra-mohammed/b52603f2ba3c51a59d261b70232ade0c/
80. Alamoudi, A., Eldakhakhny, S., Banjar, H., Ajabnoor, G., Aljohani, S. B., Basheer, R., … Elsamanoudy, A. (2023). Association between laboratory markers and Covid-19 disease severity and outcome: a retrospective cohort study in Saudi Arabia. Frontiers in Immunology, 14. doi:10.3389/fimmu.2023.1198530
81. Mushcab, H., Al-Tawfiq, J., Ghamdi, M., Babgi, A., Amir, A., Sheikh, S., … Sagheir, A. A. (2022). A Cohort Study of Seroprevalence of Antibodies Against SARS-CoV-2 Infection Among Healthcare Workers at a Tertiary Hospital in Saudi Arabia. Infection and Drug Resistance, 15, 4393–4406. doi:10.2147/IDR.S369755
82. Farahat, F., Alsaedi, A., & AbdulAziz, M. (2018). 1553 Influenza infection and immunisation coverage among healthcare professionals in national guard hospital, western saudi arabia. Occupational and Environmental Medicine, 75. doi:10.1136/oemed-2018-ICOHabstracts.603

83. Tripathi, R., Alqahtani, S., Albarraq, A., Meraya, A., Tripathi, P., Banji, D., … Alnakhli, F. (2020). Awareness and Preparedness of COVID-19 Outbreak Among Healthcare Workers and Other Residents of South-West Saudi Arabia: A Cross-Sectional Survey. Frontiers in Public Health, 8. doi:10.3389/fpubh.2020.00482
84. Bcheraoui, E., Tuffaha, M., Daoud, F., Kravitz, H., Almazroa, M., Saeedi, M. A., … Mokdad, A. (2015). Access and barriers to healthcare in the Kingdom of Saudi Arabia, 2013: findings from a national multistage survey. BMJ Open, 5. doi:10.1136/bmjopen-2015-007801
85. Almadi, M. A., & Basu, P. (2023). Doing things right and doing the right things: Colorectal cancer screening in Saudi Arabia. Saudi Journal of Gastroenterology : Official Journal of the Saudi Gastroenterology Association, 29, 67–70. doi:10.4103/sjg.sjg_82_23
86. Almansour, H., Aloudah, N., Alhawassi, T., Chaar, B., Krass, I., & Saini, B. (2020). Health consumer engagement in developing novel preventive health community pharmacy roles in cardiovascular disease in Saudi Arabia: A qualitative analysis. Saudi Pharmaceutical Journal : SPJ, 28, 529–537. doi:10.1016/j.jsps.2020.03.004
87. Aldiba, M., Jamali, E. M., Dighriri, A., Abdulhaq, A. M., Ali, M. R., Otaif, A. M., … Al-Sharif, A. (2023). Rationalisation of laboratory tests ordering and consumption at Armed Forces Hospital, Jazan. BMJ Open Quality, 12. doi:10.1136/bmjoq-2022-002114
88. Hadlaq, E., Faraj, Z., Gamdi, F. A., Obathani, F. A., Abuabat, M., & Awan, K. (2017). Early Screening of Diabetes and Hypertension in Primary Care Dental Clinics at King Saud University in Riyadh, Kingdom of Saudi Arabia. The Journal of Contemporary Dental Practice, 18 8, 652–659. doi:10.5005/JP-JOURNALS-10024-2101
89. Alzahrani, A., Obeid, O., Al-Ali, A., & Imamwardi, B. (2009). Detection of Hepatitis C virus and Human immunodeficiency virus in expatriates in Saudi Arabia by antigen-antibody combination assays. Journal of Infection in Developing Countries, 3 3, 235–238. doi:10.3855/JIDC.42
90. Alzeer, A., Althemery, A., Alsaawi, F., Albalawi, M., Alharbi, A., Alzahrani, S., … Tash, A. (2021). Using machine learning to reduce unnecessary rehospitalization of cardiovascular patients in Saudi Arabia. International Journal of Medical Informatics, 154, 104565. doi:10.1016/j.ijmedinf.2021.104565
91. Jeddo, Z. (2022). Knowledge, perception, and sources of information towards cervical cancer and utilization of papanicolaou (pap) smear as screening among female in medina, Saudi Arabia. Obstetrics & Gynecology International Journal. doi:10.15406/ogij.2022.13.00680
92. Jadid, M. (2011). Rehabilitation medicine in the Kingdom of Saudi Arabia. Saudi Medical Journal, 32, 962–963. Retrieved from https://consensus.app/papers/rehabilitation-medicine-in-the-kingdom-of-saudi-arabia-jadid/2fcb3fe9415c5e97a4a3c9d7f6bbeafd/
93. Oboho, I., Tomczyk, S., Alasmari, A., Banjar, A., Al-Mugti, H., Aloraini, M., … Madani, T. (2015). 2014 MERS-CoV outbreak in Jeddah--a link to health care facilities. The New England Journal of Medicine, 372 9, 846–854. doi:10.1056/NEJMoa1408636
94. Alhowaish, L., Aljohar, A., Arafa, M., Almarshed, L., Binrabbaa, R., & Albabtain, S. (2020). Referral Patterns of Paediatricians and General Medical Practitioners to Paediatric Dental Clinics and Oral Health Knowledge in Riyadh, Saudi Arabia: A cross-sectional survey. Journal of Research in Medical and Dental Science, 9–16. doi:10.21203/rs.3.rs-57256/v1
95. Amer, H. (2020). Middle East Respiratory Syndrome Coronavirus, Saudi Arabia, 2017 Outbreak: Super-Spreading Event and Control Measures. Infection Control & Hospital Epidemiology, 41. doi:10.1017/ice.2020.911
96. Gari, A., & Behzad, N. (2017). Prevalence of cervical intraepithelial neoplasia (CIN) among women with ASCUS cytology in Saudi Population. Retrieved from https://consensus.app/papers/prevalence-of-cervical-intraepithelial-neoplasia-cin-gari-behzad/1400e3a77f655426b7ec5c0c459fa81d/
97. Amer, Hala, Alfaraj, S., & Memish, Z. (2023). 2444. Descriptive Analysis and Control Measures of Candida auris Infections: An Experience form a Quaternary Healthcare Center in Saudi Arabia. Open Forum Infectious Diseases, 10. doi:10.1093/ofid/ofad500.2063
98. Aljehani, F. (2024). Attitude, Knowledge, and Practices Regarding Prediabetes in Saudi Arabia: A Cross-Sectional Study on Family Medicine Residents. Cureus, 16. doi:10.7759/cureus.69300

99. Alqahtani, T., Hakami, M., Alqahtani, A., Alotaibi, M., Alhussain, A., Albattal, S., & Kofi, M. (2024). Prevalence of Hypertension among Asymptomatic Patients During Screening in the Primary Health Care Center, Riyadh, Saudi Arabia. European Journal of Medical and Health Research. doi:10.59324/ejmhr.2024.2(5).05
100. Abusanad, A. (2022). Breast Cancer Stage Migration in Saudi Arabia: Examining the Influence of Screening. Global Journal on Quality and Safety in Healthcare, 5, 24–26. doi:10.36401/JQSH-21-15
101. Alzahrani, K., Al-Rashah, A., Al-Salem, S., Al-Murdif, Y., Al-Rashah, A., Alrashah, A., … Ibrahim, M. (2021). Keratoconus Epidemiology Presentations at Najran Province, Saudi Arabia. Clinical Optometry, 13, 175–179. doi:10.2147/OPTO.S309651
102. Gohal, G., Gosadi, I., Iqbal, B. A. C., Ghazwani, Y., Daghriri, A., Shugairi, A., … Abdulhaq, M. (2022a). Utilization of Hydroxyurea Among Patients Diagnosed with Sickle Cell Disease in Jazan, Saudi Arabia. Patient Preference and Adherence, 16, 3059–3067. doi:10.2147/PPA.S390568
103. Aljuhani, M., Alhumaid, N., Abbas, M., Assiri, E., & Aljuhani, M. (2019). Description of medications errors in primary healthcare centers in Riyadh, Saudi Arabia. Retrieved from https://consensus.app/papers/description-of-medications-errors-in-primary-healthcare-aljuhani-alhumaid/6b49dda65200548689d1be98e7e197e9/
104. Shaikhain, T., Al-Husayni, F., Bukhari, G., Alhawsa, B., Shalabi, N., Munshi, A., … Alzahrani, M. (2021). Knowledge and attitude toward coronavirus disease 19 pandemic among Saudi Arabia population: A cross-sectional study. SAGE Open Medicine, 9. doi:10.1177/20503121211052421
105. Alsolamy, S., Khan, A., Yousef, S., Alghusen, F., Alsalman, A., Alnaim, A., … Alaska, Y. (2020). Sensitivity and specificity of a Middle East respiratory syndrome screening tool used in the emergency department. Journal of Nature and Science of Medicine, 3, 44–47. doi:10.4103/JNSM.JNSM_15_19
106. N., A., M., A., A., A., Majed, A., Hassan, D., & M., B. (2020). Perceptions of primary care physicians about early diagnosis of rheumatoid arthritis and methotrexate monitoring. International Journal of Advances in Medicine. doi:10.18203/2349-3933.ijam20201622
107. Yousef, M. Z. A., Ferwana, M., Sakr, S., & Shammari, R. A. (2019). Early prediction of diabetes by applying data mining techniques. Comput. Methods Programs Biomed., 171, 3. doi:10.1016/J.CMPB.2018.12.008
108. Aldebasi, Y., Ahmed, M., & Monaco, W. (2018). Are optometrists necessary in primary health care centres in Saudi Arabia. African Vision and Eye Health, 77, 10. doi:10.4102/AVEH.V77I1.402
109. Alomi, Y., Aldosary, B. A., Al-Hathlool, S. A., Almulhim, M., Alashaq, A. A., Aboshalaf, Y., & Al-Ethan, M. (2019). Attitudes and Perceptions of Healthcare Professionals towards Pharmaceutical Care Services in Kingdom of Saudi Arabia. International Journal of Pharmacology and Clinical Sciences. doi:10.5530/ijpcs.2019.8.19
110. Alqahtani, Ali, Alqahtani, M., Zarbah, A., Alahmari, T., & Alhazzani, A. (2017). Public awareness, knowledge and attitude toward Alzheimer's disease in Aseer region, Saudi Arabia - community based cross sectional study (P3.096). Neurology. doi:10.1212/wnl.88.16_supplement.p3.096
111. Alhelal, A. S., & Bushaqer, N. J. (2023). Pap smear test: Knowledge, Attitude and practice among the female nursing and paramedical staffs of Maternity and Child Hospital, Al Ahsa, Saudi Arabia. International Journal of Science and Research Archive. doi:10.30574/ijsra.2023.10.2.1080
112. Zaki, H., Almukhlifi, R., Alrowaithi, S., Mirah, M., Abdoh, R., Kaaki, M., & Abdouh, I. (2022). Oral cancer awareness and attitude toward its screening among health-care practitioners in Saudi Arabia. Saudi Journal of Oral Sciences. doi:10.4103/sjoralsci.sjoralsci_14_22
113. Yousef, M. Z. A., Yasky, A., Shammari, R. A., & Ferwana, M. (2022). Early prediction of diabetes by applying data mining techniques: A retrospective cohort study. Medicine, 101. doi:10.1097/MD.0000000000029588
114. Gohal, G., Gosadi, I., Iqbal, B. A. C., Ghazwani, Y., Daghriri, A., Shugairi, A., … Abdulhaq, M. (2022b). Utilization of Hydroxyurea Among Patients Diagnosed with Sickle Cell Disease in Jazan, Saudi Arabia. Retrieved from https://consensus.app/papers/utilization-of-hydroxyurea-among-patients-diagnosed-with-gohal-gosadi/b7b320ca315756b3a107b0351f746430/

115. Alqahtani, A., Alqahtani, S., Alhodaib, A., Al-Wathinani, A., Daoulah, A., Alhamid, S., … Mobrad, A. (2021). Knowledge, Attitude, and Practice (KAP) toward the Novel Coronavirus (COVID-19) Pandemic in a Saudi Population-Based Survey. International Journal of Environmental Research and Public Health, 18. doi:10.3390/ijerph18105286
116. Bakarman, M., Kurashi, N., & Hanif, M. (1997). UTILIZATION OF LABORATORY INVESTIGATIONS IN PRIMARY HEALTH CARE CENTERS IN AL-KHOBAR, SAUDI ARABIA. Journal of Family & Community Medicine, 4, 37–45. doi:10.4103/2230-8229.98498
117. Saleem, N. A., Househ, M., & Metwally, A. E. (2014). Challenges in Building Health Surveillance Systems in Saudi Arabia. Studies in Health Technology and Informatics, 202, 261–264. doi:10.3233/978-1-61499-423-7-261
118. Ahmed, I. A. (2018). Measurement for the Level of Receptiveness toward Universal Precautions among Medical Staff of Family Medicine Staff & Emergency Department , Saudi Arabia. Retrieved from https://consensus.app/papers/measurement-for-the-level-of-receptiveness-toward-ahmed/08c6132708eb54089c6ae88f4ef4a53c/
119. Willoughby, W. (1930). THE LABORATORY IN A SCHEME OF PREVENTIVE MEDICINE *. British Medical Journal, 2, 418–419. doi:10.1136/BMJ.2.3636.418
120. Allehebi, A., Al-Omair, A., Mahboub, B., Koegelenberg, C., Mokhtar, M., Madkour, A., … Al-Shamsi, H. (2023). Recommended approaches for screening and early detection of lung cancer in the Middle East and Africa (MEA) region: a consensus statement. Journal of Thoracic Disease, 16, 2142–2158. doi:10.21037/jtd-23-1568
121. Akram, M. (2020). Ocular Presentations in Human Immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS) Patients undergoing highly- active antiretroviral therapy (HAART) Therapy in Jeddah, Kingdom of Saudi Arabia. 35. doi:10.36351/pjo.v35i3.902
122. Almutairi, K., Alodhayani, A., Moussa, M., Aboshaiqah, A., Tumala, R., & Vinluan, J. (2016). Ebola outbreak preparedness and preventive measures among healthcare providers in Saudi Arabia. Journal of Infection in Developing Countries, 10 8, 829–836. doi:10.3855/jidc.6941
123. Quadri, F., Jafari, F. A., Albeshri, A. T., & Zailai, A. (2017). Factors influencing Patients' Utilization of Dental Health Services in Jazan, Kingdom of Saudi Arabia. International Journal of Clinical Pediatric Dentistry, 11, 29–33. doi:10.5005/jp-journals-10005-1479
124. Humayun, T., Alkhamis, A., Saleh, G., Qahtani, M. A. A., AlSaedi, M., Dalatony, M. E., & Alanezi, K. (2021). Designing and Implementing National Program of Health Electronic Surveillance Network (HESN); Infection Control Module in Saudi Arabia. American Journal of Infectious Diseases and Microbiology, 9, 61–70. doi:10.12691/AJIDM-9-2-6