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Research Development and Innovation Authority

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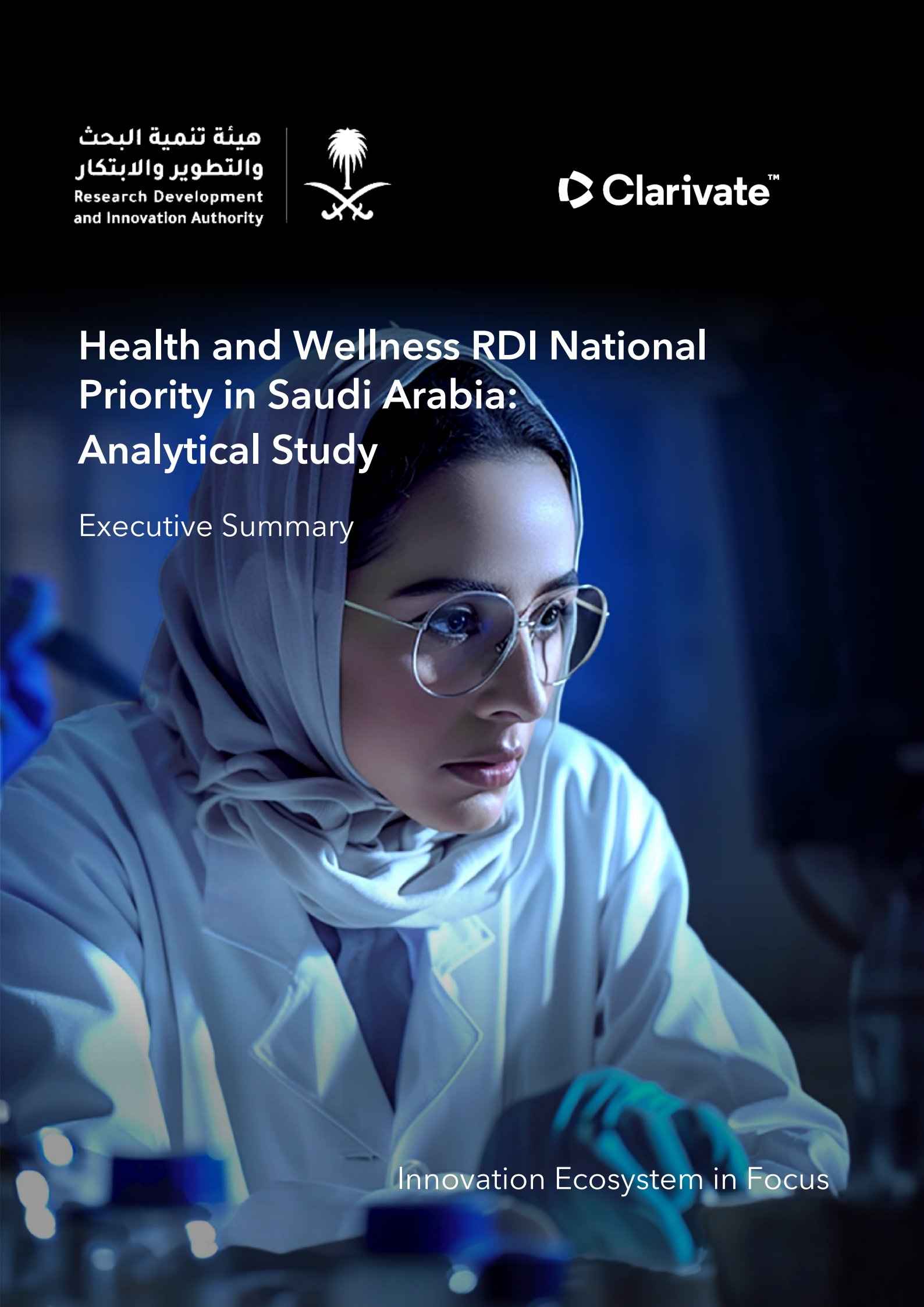
Health and Wellness RDI National Priority in Saudi Arabia: Analytical Study

Executive Summary



Innovation Ecosystem in Focus

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INTRODUCTION

The Kingdom of Saudi Arabia already delivers advanced world-class Healthcare and significant medical research. Expanding on these capabilities, the Kingdom aims to reduce the prevalence of infectious and non-communicable diseases by 50% by 2035 and increase the life expectancy in the Kingdom by 5 years by 2040.

This priority focuses on genetic, personalized and digital therapies. It also targets the uptake of these Saudi-developed technologies for interventions within the Saudi population.

This study prioritizes the following RDI Missions:

- Mission 1.2 Reduce the prevalence of non-communicable diseases by 50% through prevention, better management, and treatment by 2035.
- Mission 1.3 Reduce the incidence of infectious diseases significant to Saudi Arabia by 50% by 2035

Health and Wellness is a complex space. It is constantly evolving due to more recent impacts of digital health, advanced medical devices and the role of software, including artificial intelligence technologies. This new wave of technologies is rapidly advancing towards the prevention and cure of disease through risk detection. In contrast, the traditional approach prioritized disease management and treating symptoms. Health and Wellness research, innovation and global collaboration came to the forefront of all economies during the COVID-19 pandemic. Speed to market, novel vaccine technologies and academic-corporate partnerships (ACP), such as the Oxford-AstraZeneca vaccine, were key to bringing immunity to this highly infectious virus.

Health and Wellness challenges are unique and linked to global trends around climate and the global mobility of human and animal populations. While infectious diseases can be mitigated via vaccines in developed nations, warmer climates and lesser-researched biological ecosystems can provide the environment for new diseases to mutate and spread. Developed and often affluent nations can face differing Health and Wellness challenges linked to diet, lifecycle and nutrition, such as the research topics of Obesity, Diabetes, Cardiovascular Diseases, Gut Health and Neurological Disorders.

Within Health and Wellness related research topics, there are specific intellectual property factors to consider:

- While engineering and device-driven innovations in MedTech

have similar patentability possibilities to those of fitness technology, there are limitations. Health and Wellness technologies designed for diagnosis or treatment, such as the improved detection or treatment of ailments, diseases and conditions, may be patentable.

- In many jurisdictions, protecting cells, tissues, or naturally occurring processes with patent rights is impossible. However, it may be possible to protect synthetic innovations that mimic or optimize natural processes. This distinction could be particularly relevant in biological therapies and gene-based treatments.

- Software-driven and digital health innovation must usually show technical effect – and potentially even link to hardware – for a high chance of approved patent protection. Yet, there is varying case law across different jurisdictions regarding the patentability of these technologies.

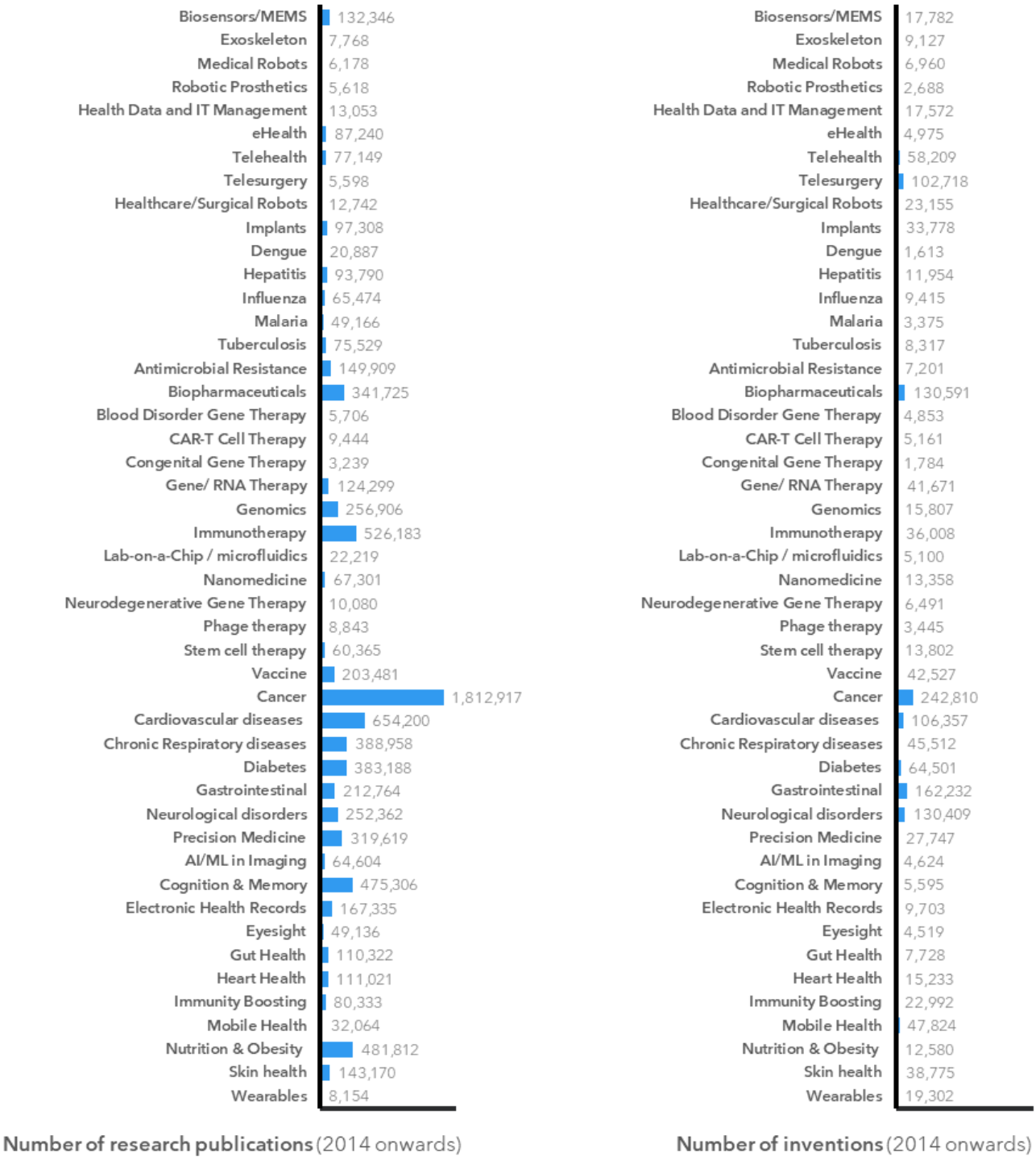
- Patent-term extensions in regulated industries, such as pharmaceuticals and agriculture, are possible due to the time-to-market delays required for regulatory approvals. A patent may be valid for up to twenty years. In contrast, pharmaceuticals specifically treating pediatric conditions could be valid for up to twenty-five and a half years.

- While the targeted practice of protecting a therapy is aimed at a single or related group of conditions, it can sometimes also apply the same therapy to new conditions with the same patent. In other scenarios, a new patent application may be necessary for a novel therapeutic application.

- Other Health and Wellness-specific considerations could relate to moral or ethical patentability objections, especially in human gene editing and human and animal testing.

The complete list of technologies that define the national priority area of Health and Wellness within this study, with global volumes across research publications and inventions, is shown in Figure 1.

Figure 1: Number of research publications and inventions for Health and Wellness globally between 2013-2024



OVERVIEW

The Health and Wellness priority area of RDI represents an opportunity to transform the lives of Saudi Arabia's population and deploy applied research globally through MedTech, Digital, Surgical and Preventative research topics targeting infectious and non-infectious diseases.

RDIA is dedicated to steering and executing the Kingdom’s RDI strategies across the four national priorities. It has led the organization of capacity-building activities, equipping Saudi leaders and practitioners with the vital skills needed for further enhancing existing the Health and Wellness research and innovation ecosystem.

There have been fluctuations in Saudi Arabia's research output on the research topics of CAR-T Cell Therapy, Stem Cell Therapies and Dengue. Balancing research quality while continuously increasing research output is key for national priority research topics. Strategies include collaborating with key publishing organizations and researchers and with top funding organizations identified in those research topics.

Globally, Health and Wellness research topics have a wide range of technology maturities; however, particularly within Health and Wellness, all research topics were between Technology Readiness Level (TRL) 4-9, with no low-maturity research topics. Notably, due to long R&D cycles of up to 10 years,

RDIA is evaluating opportunities for strategic resource allocation to maximize returns on investment for research and invention protection. Many high-maturity technologies have high entry barriers, and therefore, investments in earlier-stage technologies may bring higher chances of significant GDP addition to Saudi Arabia.

Saudi Arabia has a tremendous opportunity to train more Health and Wellness researchers, create jobs within Academic Institutions and the local private sector, and add significant GDP to the Saudi Arabian economy.

Key Opportunities within Health and Wellness:

- **Prioritize higher-performing and higher commercial potential research topics:** Four key research topics within Health and Wellness have significant commercial potential: Biopharmaceuticals, Diabetes, Cancer, and Cardiovascular Diseases. They can potentially generate $2.56Bn for the Saudi Arabian economy if 6,668 inventions are protected, generating the expected yield of very high-strength inventions, and are subsequently successfully commercialized.

- **Accelerate private organization creation through partnerships:** Working directly with international corporations to reach global markets may be more efficient for high-maturity research topics. For low-maturity and medium-maturity research topics such as Dengue, Antimicrobial Resistance and CAR-T Cell Therapy, Saudi Arabia could prioritize spin out, joint venture and incubator creation programs to nurture high-potential specialist start-ups. These start-ups could focus first on regulatory approvals and success outside Saudi Arabia, alongside commercializing therapies into local MENA markets.

- **Pivot funding conditions to advance from publication to protection:** Develop new funding metrics and frameworks to shift the research paper-to-inventions ratio within high TRL research topics to enable patent portfolio creation, licensing and commercialization. This will enhance the size and commercial acumen of Saudi Arabian technology transfer offices.

- **Leverage leading global academia through Academic partnerships:** In addition to large corporations, stand-out invention performance comes from international academic institutions, especially from the US, UK and France, such as the University of Pennsylvania and Harvard University. These collaborative developments provide sound insight into investing in Academic Partnerships.

- **Establish Academic, Corporate, and Start-up infrastructure within Health and Wellness:** The creation of technology-specific hubs could also attract international investment and the establishment of R&D facilities. Similar programs have been established in the UK, such as the Cell Therapy Catapult Centre. Suitable research areas include Biopharmaceuticals and Vaccines, Gene and RNA General Therapy and Cancer, Cardiovascular Diseases and Diabetes.

In conclusion, Saudi Arabia has a growing Health and Wellness research ecosystem. To move to the next stage in its development, further Academic-Corporate partnerships can help nurture the development of a diversified and robust private sector of organizations specializing in high-potential research topics. This sector can be deployed locally and internationally by producing more research and innovation.

This study's insight provides a multi-dimensional evaluation of research topics within the Health and Wellness priority area to provide key actions and options to consider and benchmarks against global leadership.

Subsequently the tailored insights, metrics and findings can enhance both the foundational research within Academia, and commercially applied innovation to achieve Saudi Arabia's national missions and aspirations.

120M SAR

funding allocated for 100 research groups across Health and Wellness

KEY FINDINGS

Drawing upon the insights from research and invention performance, Academic-Corporate Partnerships, and Technology Maturity evaluation for Saudi Arabian and global organizations this section provides key findings tailored to the relative position of Saudi Arabia for each technology by using industry-leading metrics to offer the next steps.

These findings outline the potential of the research topics specifically for Saudi Arabia, where to invest, and whether more academic funding is required, further Academic-Corporate Partnerships, transfer of technology from academic to private entities, and potentially to continue the existing strategies.

Table 1: Health and Wellness research topic scorecard

				High	Medium	Low
	Saudi Arabia's Research Strength	Saudi Arabia's Invention Strength	Saudi Arabia's Partnership Strength	Saudi Arabia's research productivity	Technology Maturity	Future Predicted Growth
Dengue	871	64	1.0%	1.9	5	6.8%
Antimicrobial Resistance	4972	2349	1.9%	2.1	5	8.5%
Biopharmaceuticals	6392	3470	2.2%	1.3	8	7.6%
CAR-T Cell Therapy	120	99	1.7%	0.5	5	8.1%
Gene/ RNA Therapy	1864	908	1.9%	0.9	7	7.6%
Genomics	3489	715	2.4%	1.2	8	7.9%
Stem Cell Therapy	610	655	1.8%	0.9	7	7.5%
Vaccines	5012	1649	2.5%	1.3	7	7.8%
Cancer	26943	19594	1.6%	1	8	7.5%
Cardiovascular Diseases	9396	3246	2.2%	0.8	9	6.3%
Diabetes	9931	3247	2.0%	1.8	8	6.3%
Nutrition & Obesity	8196	77	1.3%	1.1	7	6.7%

The scorecard above contains factors analyzing Saudi Arabia's position per research topic. They are defined as:

- **Research Strength:** Total number of Saudi Arabian research papers multiplied by CNCI. A publication's Category Normalized Citation Impact (CNCI) is calculated by dividing the actual count of citing items by the expected citation rate for documents with the same document type, year of publication and subject area.

- **Invention Strength:** Total number of Saudi Arabian inventions multiplied by the Derwent Strength Index (DSI). This is a Clarivate™ metric of the strength and quality of a patented idea. Based on the impact of the invention on others (based on the frequency of downstream citation by the patent applications of third parties), the global footprint of patents granted (based on the % of world GDP covered by the patent asset), the investment level in the invention by the applicant (based on the number of patent jurisdictions in which the applicant sought protection) and the inventions rarity (based on the number of inventions in the global database that share the same technology mix).

- **Partnership Strength:** The mean partnership % for research papers and inventions in Saudi Arabia.

- **Research Productivity:** Productivity relative to global productivity is measured by the number of Saudi Arabian papers on a specific research topic divided by the number of global documents in the same research topic and period.

- **Technology Maturity:** Each research topic within the National Priority Areas has been mapped to an individual Technology Maturity Index from 1 – least mature through 9 – most mature.

- **Future Predicted Growth:** CAGR predicted growth extrapolated from historic inventions level.

Vaccine and Diabetes score highly on research, invention volume and average strength by CNCI and DSI relative metrics. Similarly, both research topics have an average of 2.5% and 2.0% ACPs across research papers and inventions. The technology maturity is high in both research topics at 7 for Med-Tech Vaccine and

Diabetes 8, denoting high commercialization readiness. International examples could include COVID-19 Vaccines and Ozempic from Novo Nordisk. Future predicted growth levels of 7.8% and 6.3% show a steady growth rate. Research paper-to-invention ratios of 3,054: 48 and 8,333: 87 display a legacy focus on research papers.

To boost **Vaccine** invention levels, focusing on King Abdulaziz University's invention portfolio by collaborating with large international filers such as Sanofi, Novartis, Pfizer, Merck & Co, Bristol-Myers Squibb, GSK, Roche, Johnson & Johnson, BioNtech and Inmatics NV all with 100s of inventions in this field. Novartis and the University of Pennsylvania have previously collaborated to produce 14 inventions in vaccine research topics. The above pharmaceutical corporations seen in Figure 2 could **boost inventions from other vaccine research academic institutions in Saudi Arabia**, such as King Saud University and King Abdulaziz University, with over 450 research papers each.

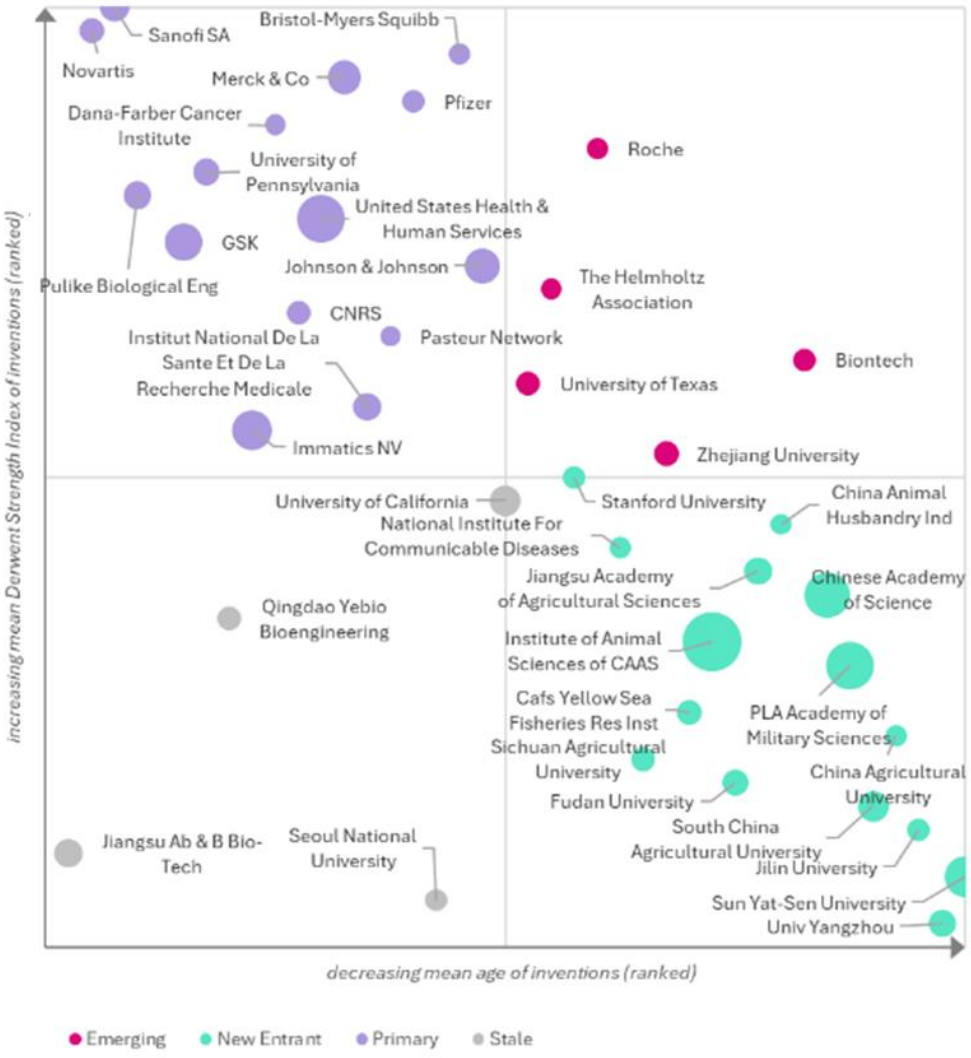


Figure 2: Commercial dynamics model for the top global patent assignees in the research topic Vaccines

To further enhance **Diabetes** treatments, leverage expertise from Saudi Arabian university inventions from organizations such as King Abdulaziz University, King Saud University, King Abdullah University of Science and Technology (KAUST), Imam Abdulrahman Bin Faisal University and King Faisal University. **Actions to consider include international ACP** with organizations such as Sanofi SA, Johnson & Johnson, Roche, Merck & Co, Bristol-Myers Squibb, Abbvie, Novo Nordisk Foundation, Pfizer, Novartis, C.H. Boehringer Sohn, AstraZeneca, Amgen, Bayer AG, Takeda Pharmaceutical, Eli Lilly or GSK. Diabetes research and commercialization could add **$0.65 billion to Saudi Arabia's economy.** If **1,667 inventions** are protected in this field, the likely yield would be around **15 very strong inventions**.

Gene Therapy and Obesity research topics have high research volume and quality in Saudi Arabia, but lower invention volumes and strength. These research topics have medium average ACP levels across research and invention data at 1.9% and 1.3%, and 7.6% and 6.7 predicted invention growth, respectively, accompanied by high technology maturity at 7 and 8. These research topics have a high research paper-to-invention ratio of 1,361:26 and 6,581:4, respectively.

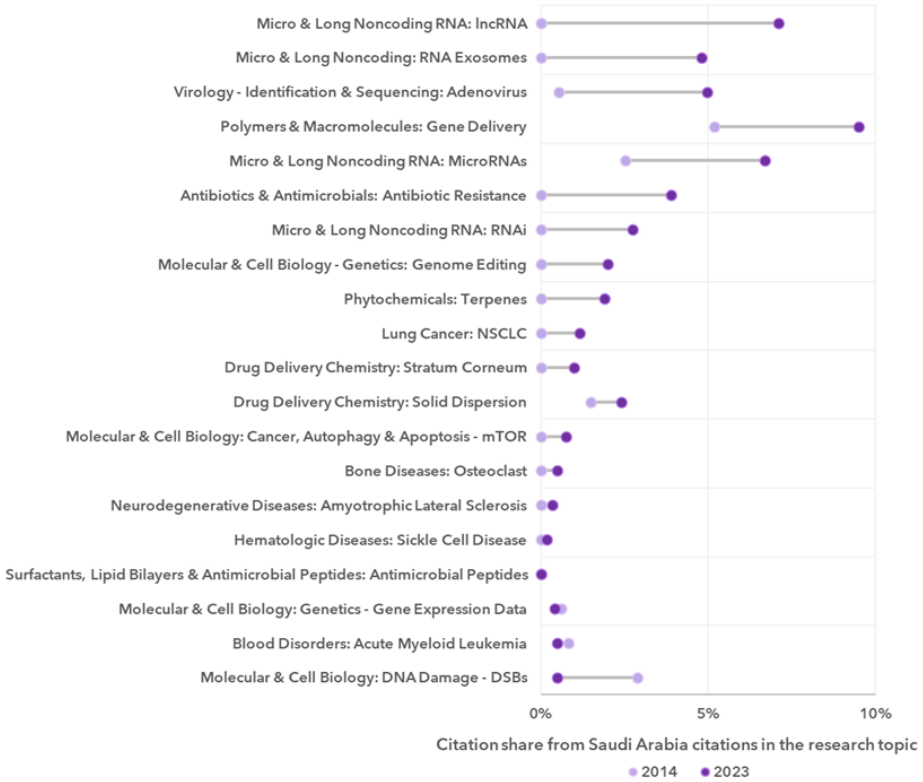


Figure 3: Top 20 emerging micro-topics in Saudi Arabia in the research topic Gene/ RNA Therapy in the period 2014-2023

Focusing on academic invention yield and conversion from papers to inventions may boost overall volumes and conversion to Saudi Arabian corporations. Gene therapy innovators such as KAUST, King Saud University and King Abdulaziz University have the highest volume and strength of inventions. Saudi Arabian research micro-topics, including rapidly increasing Polymers & Macromolecules: Gene Delivery, can be seen in Figure 3.

These innovators would benefit from ACPs with international innovators such as Novartis, Bristol-Myers Squibb, Sanofi, Roche, Inmatics NV, Johnson & Johnson, Moderna Therapeutics, BioNtech, Regeneron and Alnylam Pharmaceuticals, with invention portfolios of 150 – 305 inventions specialized in Gene therapy.

Academic research partnerships may also boost invention output from Saudi Academic institutions with international Academic institutions such as the University of London, University of Pennsylvania, Mass General Brigham, University of Texas, MIT, Broad Institute, Paris Cite University and Harvard University – all with over 180 inventions.

Notable collaborative invention production includes BioNtech with Univ Mainz Tron Translationale Onkologie with 56 inventions and Novartis with the University of Pennsylvania with 40 inventions.

In the field of Diabetes, expanding and increasing invention production from Saudi Arabia Academia, such as King Abdulaziz, King Saud University and King Faisal, would build upon existing high-strength invention portfolios.

International collaboration with leading established innovators such as Sanofi, Bristol-Myers Squibb, Roche, Pfizer, Amgen, GSK, Elil Lilly, Novartis, Johnson & Johnson, AstraZeneca, Takeda, Amgen, Abbvie, Novo Nordisk, Bayer, and Merck & Co—would leverage proven global pharmaceutical companies. Academic Collaboration with Harvard University, Mass General Brigham, CNRS and INSERM may also boost earlier-stage academic research.

The **Obesity** and related co-morbidities research field in Saudi Arabia could benefit from **producing greater volumes of inventions from existing research organizations such as King Saud University, King Abdulaziz University, University of Tabuk and King Saud University,** and others seen in the full Health and Wellness study.

Given the high maturity of the technology, it could be beneficial to **enhance APC levels** via international organizations such as Novo Nordisk, Danone, P&G, AstraZeneca, DSM-Firmenich, Merck & CO, BGI Group and Colgate-Palmolive.

CAR-T Cell Therapy and Stem Cell therapies have lower volume and strength in research and inventions in Saudi Arabia compared to other Health and Wellness research topics. They have medium levels of research and invention ACPs, with 1.7% and 1.8%, respectively, and medium levels of research productivity with 0.5% and 0.9% respectively.

The maturity level of Car-T Cell Therapy is medium at 5, whereas Stem Cell therapies are at 7, with 8.1% and 7.5% predicted invention growth. From a research paper-to-invention ratio, these research topics score 29 and 36, respectively. Typically, there is an expected lower research paper-to-invention ratio in more mature research topics.

CAR-T Cell Therapy may benefit from international academic partnerships to boost invention levels. Consider **working with established global pharmaceutical companies to strengthen commercially applied research**. The University of Pennsylvania, Shanghai Cancer Institute, Dana-Farber Cancer Institute, Fred Hutchinson Cancer Research Center, Keji Biological Medicine Shanghai, and University of Washington all appear as established high-strength innovators.

Potential Corporate collaborators include Novartis, Autolus, Cellectis, Carsgen Therapeutics, Bluebird Bio, Eureka Therapeutics, Bristol-Myers Squibb, Regeneron, Fate Therapeutics, Allogene, Gilead Sciences and Crage Medical. Notably, the University of Pennsylvania scores in the top forty technology portfolios for CAR-T-Cell therapy by high-strength inventions, with 18 averaging DSI score of 83.8.

Novartis and the University of Pennsylvania have 69 ACP-generated inventions. Similarly, the University of London and Autolus have created 38 inventions together in this field; Autolus was spun out of the University of London.

To develop further academic inventions, leverage existing academic research from institutions in **Stem Cell therapies** shown in Figure 4, such as King Abdulaziz University and King Saud University, which have high CNCI and the highest Saudi invention scores. However, due to the technology maturity and low levels of research and

invention strength across Saudi Arabia, prioritizing areas of greater strength and lower maturity may yield higher economic returns.

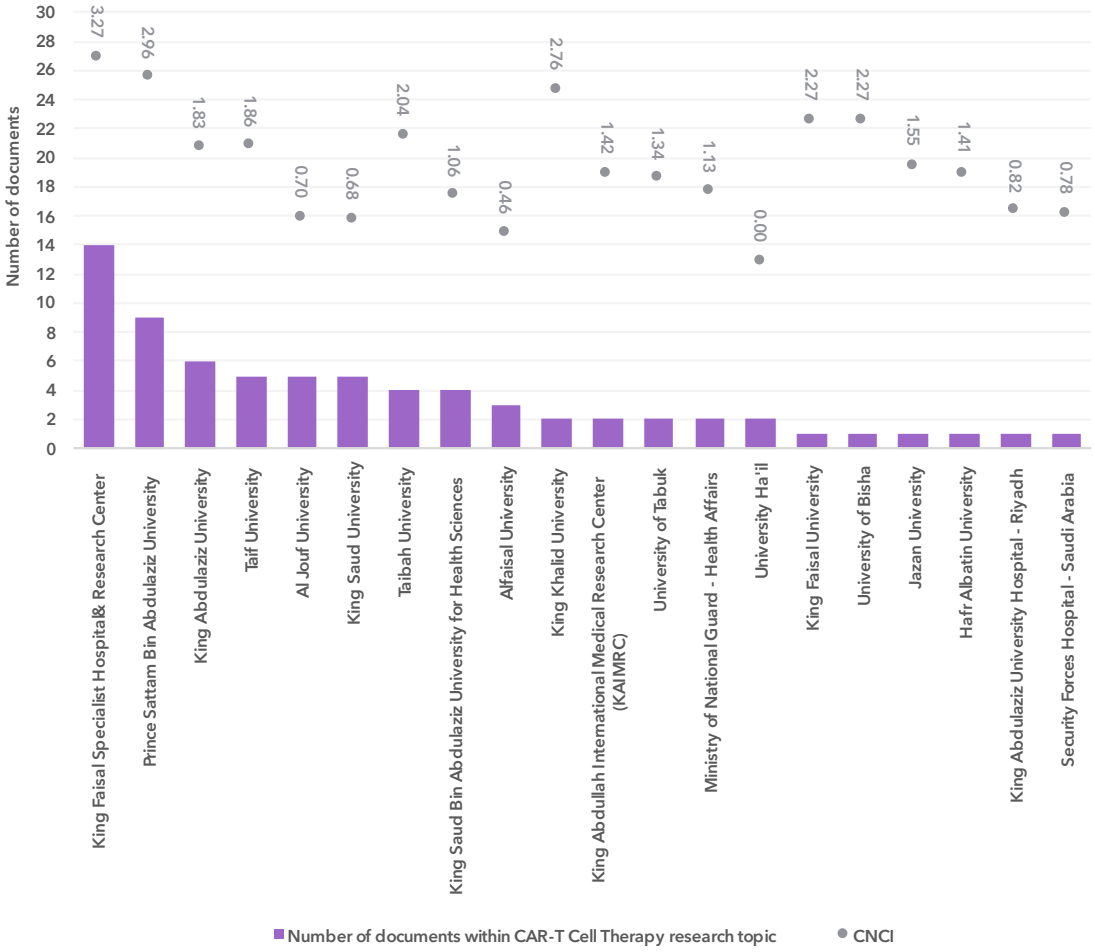


Figure 4: Top 20 Saudi organizations in terms of publications published in the research topic CAR-T Cell Therapy in the period 2014-2023 and their corresponding CNCI.

Genomics is a field of high research strength that is comprised of volume and CNCI. In Contrast, it has low invention strength, despite being an area of high ACP levels, high technology maturity, and high future predicted invention levels.

3,597 research papers have been published in the last 10 years compared to only 22 inventions; this ratio would be expected in a lower-maturity technology. Considering the historic low innovation in this field, the greatest opportunity is to focus on higher-strength **research topics such as Cancer Therapies within Health and Wellness.**

For this field to advance its production of inventions, ACPs with large, experienced corporations such as Abbvie, Pfizer, Johnson & Johnson, Takeda, Roche, Novartis, Bayer, Sanofi, and Vertex Pharmaceuticals would focus research efforts on more commercial applications. Suitable Saudi Arabian Academic Institutions would be King Saud University, King Abdulaziz University and King Saud Bin Abdulaziz University for Health Sciences.

Dengue therapies have a relatively lower research volume and CNCI, alongside lower invention volumes and strength, than other Health and Wellness research topics. There have historically been low ACP levels, high research productivity and medium technology maturity.

As there are low predicted levels of invention growth combined with this technology performing as strongly as other Health and Wellness research topics, **ad-hoc academic funding would be suitable.** KAUST has previously filed an invention in the area of Dengue. International corporations with strength in this technology include Merck & Co, Sanofi, Johnson & Johnson and Gilead Sciences—notably, their portfolios in this area are relatively small, **holding between 8 and 21 inventions each**. There are low and geographically distributed invention filing patterns, as seen in Figure 5.

Figure 5: Global distribution of inventions pertaining to Dengue. The size of each bubble corresponds to the number of unique inventions published in that country or jurisdiction

Antimicrobial Resistance and **Biopharmaceuticals** in Saudi Arabia perform as areas of medium research volume combined with CNCI, as well as invention volume and strength. Antimicrobial Resistance has experienced medium ACP levels and high

research productivity. It is considered a medium mature technology with predicted high levels of invention growth.

Biopharmaceuticals are highly collaborative research topics in Saudi Arabia with medium research productivity, **high technology maturity, and only medium prediction invention level growth.** Antimicrobial Resistance would benefit from **ad-hoc academic funding** into King Faisal University and King Abdulaziz University to develop further inventions as the technology matures.

The **100 biopharmaceutical inventions in Saudi Arabia may be candidates for transfer into commercial applications**. The strongest portfolios are held by King Abdulaziz University and KAUST. However, **it may be more efficient to establish further ACPs with large international pharmaceutical companies** such as Novartis, Bristol-Myers Squibb, Roche, Sanofi, Boehringer Ingersoll, GSK, Pfizer, Takeda, Abbvie, Merck & Co and AstraZeneca with significant portfolios and experience taking therapies to global markets.

It is predicted that Biopharmaceuticals could add **$0.75 billion to Saudi Arabia's economy.** If **1,667 inventions** are protected in this field, the likely yield would be around 17 very strong inventions.

Cardiovascular Diseases research topics are an area of high research volume by CNCI and high invention strength for Saudi Arabia. This field has medium levels of ACPs, low research productivity, high technology maturity and low predicted levels of invention growth. There are 6,608 published research papers compared to 94 inventions; however, inventions in Health and Wellness are often protected in many countries globally.

Considering the high maturity level and good levels of inventions in Saudi Arabia, **applying these inventions in products in the market will give more return on investment for research funding**. If further inventions are sought, ACPs with international organizations may provide further innovation to commercialize by Saudi Arabian organizations such as King Abdulaziz University with 24 inventions or King Saud University with nine inventions. International innovators such as Sanofi, Bristol-Myers Squibb, Pfizer, Roche, Takeda, Amgen, GSK, Boehringer Ingersoll, AstraZeneca, Bayer Merck & Co, Abbvie and Johnson & Johnson.

It is predicted that Cardiovascular Disease research topics could add **$0.54 billion to Saudi Arabia's economy**. If **1,667 inventions** are protected in this field, the likely yield would be around 7 very strong inventions.

Cancer is the research topic area with the **highest research volume, CNCI, and highest invention strength.** This is despite having relatively low levels of ACPs, low research productivity and only medium predicted invention-level growth.

This technology area has high technology maturity and the highest number of research papers across all RDI-prioritized research topics, with 22,527 and 513 inventions. There has been 9% ACP across inventions; however, only 1.43% within research paper partnerships. The academic institutions seen in Figure 6, with strongly established portfolios with more than five inventions, are KFUPM, KAUST, King Faisal Specialist Hospital & Research Centre; more recently, King Saud University, King Abdulaziz University, and Ministry of the National Guard – Health Affairs have obtained over ten inventions each. King Saud University leads with 96 inventions from Saudi Arabia; notably, Saudi Aramco also holds three inventions.

"The research topic cardiovascular diseases could add $0.54 billion to Saudi Arabia's economy. If 1,667 inventions are protected in this field, the likely yield would be around 7 very strong inventions."

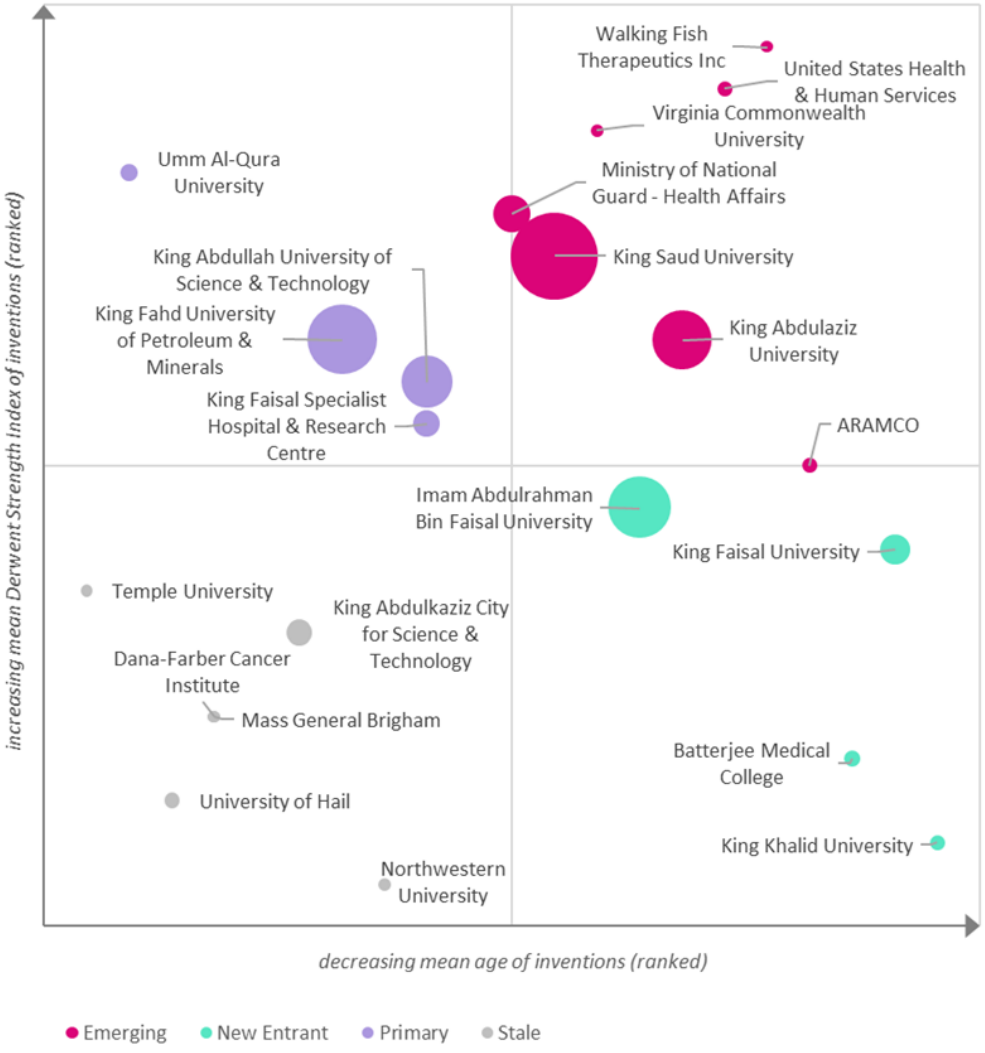


Figure 6: Commercial dynamics model for the top patent assignees active in Saudi Arabia in the research topic Cancer

Considering the maturity of the technology and the depth of both research and inventions in the Saudi Arabian health ecosystem, it would be suitable to take this technology to market and build upon the increasing volume of research in Cancer, as shown in Figure 7.

However, **there needs to be more private organizations** with products on the market. Routes to creating private organizations include **spin-offs from the above academic institutions and/or joint ventures with large, experienced international pharmaceutical organizations.** Potential joint ventures or further ACP partners include Sanofi, Bristol-Myers Squibb, Roche Novartis, Pfizer, Abbvie, Merck & Co, Johnson & Johnson, Amgen, AstraZenca and Immatics – which all appear in the established high-strength established portfolio quadrant.

Examples of those with over 40 inventions in collaboration with Academia include Novartis, BioNtech, Autolus and Bayer. It is predicted that Cancer research topics could add **$0.62 billion to Saudi Arabia's economy** if **1,667 inventions** are protected in this field. The likely yield would be around 14 very strong inventions.

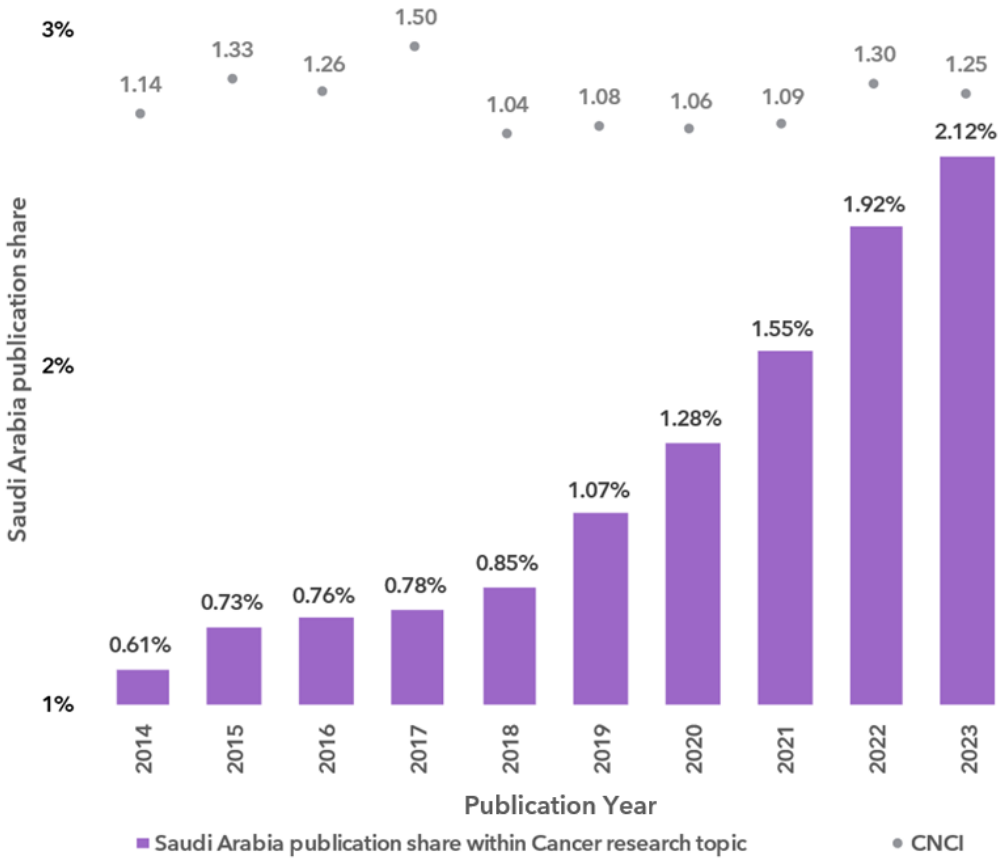


Figure 7: The share of Saudi Arabia from global publications and the CNCI of Saudi Arabia publications in the research topic Cancer

In conclusion the Health and Wellness priority area for Saudi Arabia has significant potential accumulated within the Academic Institutions, built upon a base of research projects yielding research papers. To successfully take the research to market, **further investment and focus are required to spin out specialist start-ups to prioritize specific therapies and therapeutic targets.**

The consistently impressive performance of the United States Health & Human Services across Health and Wellness research topics, exemplifies how centralized research funding with the requirement for Intellectual Property ownership, can secure high-value future technology assets at scale.

Considering the long research and development cycles within large international pharmaceutical companies, laying the groundwork for Academic-Corporate Partnerships with experienced organizations will fast-track taking Saudi research into international healthcare markets. Joint ventures, strategic R&D centers, incubators and merger & acquisition activity may also be suitable options to enhance Saudi Arabia's further commercially focused research in the field of Health and Wellness.

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