

Setting the Health Research Priority Agenda for the Ministry of Health (MoH), Kingdom of Saudi Arabia 2020-2025 Project

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Research

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Abstract

Background

The Saudi Vision 2030 project recognized the integral role of health research in transforming, modernizing and governing the healthcare system, as well as improving health. The nature of health research prioritization is context-specific, and there is an obligation to effectively allocate resources to initiatives that will achieve the greatest impact, which is discussed in this paper.

Methods

The best practice for health research prioritization depends on the existing needs and context. The e-Delphi technique was conducted via an online self-administered questionnaire that covered health research topics, topics related to Vision 2030, as well as collaborative research. Criteria used for scoring the selected topics were: appropriateness, relevance, feasibility, urgency, collaboration and impact of research outcome. Research domains were prioritized by ranking the weighted mean aggregate score and all topics of the top five ranked domains, along with the aggregate scores of the answers of those in leadership positions were pooled together, validated, verified, summarized, refined and then classified into themes.

Results

The participants included those from a full range of health specialties and subspecialties (46.5% physicians, 39% health specialists, 10% pharmacists and 3.6% dentists), and the study achieved balanced regional participation and covered a wide spectrum of qualification and professional levels. In total there were 2252 participants and 98% belonged to MoH. Of those from the MoH, 134 were leaders (85 Headquarters policy makers and 49 regional decision makers), while the rest were made up from individuals from 16 Health Affairs Directorates spanning 75 hospitals and specialized health centers, 24 primary health care centers, 2 healthcare clusters, in addition to five medical cities. Community involvement was represented by 26 organizations. Approximately half of stakeholders contributed to scientific research, while 24% had previous publications, and only 6% had a direct influence in health policymaking. The study deliverables were listed into three agendas:

- 1. Health System Research Priority Themes:** Service Delivery, Workforce, Information Systems, Access to Essential Medicines, Financing, Governance & Leadership and Disaster Response.
- 2. Diseases and Health Problems Themes:** Non-Communicable and Communicable Diseases, Trauma, Public Health, Dental Health, Environmental Health, Pilgrims' Health, Women's Health, Child & Geriatric Health, Biomedical Technology, Radiology and Physical Technology.
- 3. National and International Collaborative Research Themes:** Major research areas impacted by COVID-19, Public Health, Healthcare Access, Medical Care & Universal Health Coverage, Value-based Healthcare, Health System Financing and Economics, Health Information and Communication Technology, Health System Governance, Health Workforce Development and Health System Preparedness and Response to Emergency.

Conclusion

Adequate description of the stakeholders and the methodology can strengthen legitimacy, credibility and maximize the impact of the priority setting process. Involvement of policymakers, researchers and funding organizations increases the opportunity of translation into actual research, supports redesigning the research landscape and ensures uptake of results and integration.

Background

The Ministry of Health (MoH) and its associated regulatory agencies and advisory bodies are undergoing a transformational reform as part of the Kingdom's Vision 2030. A significant number of strategic initiatives have been developed to ensure that the Kingdom has a health sector characterized by sustainable funding, appropriate access and continuously improving service quality. The Vision Realization Office (VRO), a function within the MoH, has a mandate to design, operate and monitor these initiatives. The successful and sustainable transformation of Saudi healthcare requires; dedicated research resources and capacity aligned with health system priorities, focus on research into clinical services, health services and population health, an understanding of individual and community health risk, outcome evaluation and appraisal of effectiveness of healthcare intervention. (1)

Priority setting (PS) is an essential process to align health research activities, resources and capacity across the Kingdom to meet MoH priorities and needs. There is currently no consensus on the definition of research PS, but most definitions refer to a range of activities that involve identifying, prioritizing, and achieving a consensus on the research areas or questions of importance to stakeholders. However, guidance is needed on evaluation tools that can be applied to research PS. (2–4)

On the other hand, policymakers require clear declaration of research findings and implications for practice. The World Health Organization (WHO) emphasizes the use of policy briefs & actionable messages and the conduct of policy dialogues to maintain effective communication of research findings with the most appropriate target audiences. (5)

Broad stakeholder involvement (multisectorial and multidisciplinary) is beneficial for the outcomes of a research PS exercise for several reasons. Firstly, it minimizes the chances of research options being overlooked; as different groups of stakeholders tend to prioritize research differently. (6) Secondly, participation in the exercise fosters ownership of the established priorities among those involved, thus increasing the chances of implementation of the priorities. Thirdly, broad participation makes priorities correspond to the needs of those who will implement and benefit from the research priorities. As such, the prioritized research will be a better response to societal and policy needs, increasing the overall credibility of the exercise, and the potential impact on

health and health equity. (7) Finally, broad stakeholder involvement may prevent unnecessary duplication of prioritization efforts and hence wasting of resources. (8)

Research Objectives

This study aims to identify, empower and support financing important research projects that can respond to the health needs of the country.

Literature Review

PS plays an important role in health care systems, as it guides investments in health care, health research and respects resource constraints. (9) The public health sector in KSA is led and represented by the MoH. The MoH has concentrated on the National Vision 2030 to focus on a number of objectives to enhance the quality of medical care. These objectives concentrate on health care access, value-based health care, management of road traffic accidents (RTA) and public health. (1) Hence, the MoH needs to set research priorities to meet national and international health needs, as well as funding research domains that match the priority agenda.

In addition, the research priority agenda is targeting researchers who solve health problems, which in turn contributes to improving the life of the Saudi population; it is very important for the MoH to identify and declare their priorities for researchers. PS objectives must consider the following criteria; social justice, equitable allocation, efficiency and burden of disease. (10) The WHO analyzed data in five developing countries in the Eastern Mediterranean Region, and showed that the explanation behind the wide variation in research PS is accounted for by the fragmented and poorly coordinated status of their national health research system, which should be considered. (11)

The assessment of impact and effectiveness of health research PS necessitates the existence of published information on the implementation or evaluation of these researches. (12) The research funding is controlled by the interests of research founders, hence the funded health research do not always serve the interests of health policy and strengthening local health systems. (9) Furthermore, there is a need to make sure that research funds are allocated to high quality research projects. Research enhances the economic competitiveness of a country, increasing efficacy of public services and policy and promoting quality of life and health. Moreover, it can give important predictive information about disease risk factors and trends, outcomes of treatment or public health interventions, functional abilities, patterns of care, and health care costs and use. (13) Without national priorities for health research, countries cannot guide research expenditure, promote science, technology and innovation in health, build research capacity nor negotiate with partners for targeted funding and long-term efforts. (14) No one method is consistently used, however two recent reviews of approaches, tools and methods used to prioritize health research provide interesting insight into the uptake of the various methods. For example, Yoshida (2016) identified 165 studies that set health research priorities, noting that only 60% used a defined method. The Child Health and Nutrition Research Initiative Approach (CHNRI) was most common (26%), followed by the Delphi method (24%). Of the 40% of studies that did not use a defined method, they listed combinations of expert panel interviews, focus group discussions, literature reviews and questionnaires as an alternative. (15, 16)

Burden of Disease Approach

Global Burden of Disease (GBD) can be used at the national level to assess current and upcoming health challenges by collecting data that help to measure the magnitude of disease burden. In the 1990s, the GBD concept was developed to describe death and loss of health due to disease, injury and risk factors for all regions of the world, (17) and is defined as the burden that a particular disease process has in a particular area, measured by cost, morbidity and mortality. (18)

There are a variety of measures to assess health dimensions such as cause of deaths, health expenditure, years of life lost (YLLs), years lived with disability (YLDs), disability-adjusted life-years (DALYs), and the Healthcare Access and Quality (HAQ) Index. (19) DALYs is the most commonly used indicator in national burden of disease studies and was the first comprehensive attempt made to summarize the world's burden of injury, disease and premature death across the world and to make projections for the future. (10)

The burden of disease approach relates research to burden of disease and determinants, cost-effectiveness, and financial flows, however, it requires sophisticated health information systems and high levels of statistical expertise. (14) Using burden of disease data has drawbacks, in particular in uncertainty of estimating the real situation; it is based on historical data which is heterogeneous and can be inconsistent and non-comprehensive. Furthermore, by applying the burden of disease in research PS, we cannot see the whole picture about health status (temporal trends in mortality, incidence and prevalence). According to the study completed by Stefanos Tyrovolas and his colleagues 2020 in Saudi Arabia, the issues with burden of disease measures were mainly related to the sources of data, estimation uncertainty, lags in data availability, variation in coding practices and limitations of existing analytical tools. (19)

The top causes of deaths in Saudi Arabia are cardiovascular diseases, neoplasms, diabetes and kidney diseases, maternal and neonatal disorders, respiratory infections and tuberculosis, and nutritional deficiencies. In line with this, in 2017, the 10 most frequent causes of DALYs in Saudi Arabia were ordered as; cardiovascular diseases, musculoskeletal disorders, neoplasms, neurological disorders, transport injuries, mental disorders, diabetes & kidney diseases, other non-communicable diseases, unintentional injuries, and maternal & neonatal disorders. Moreover, the top-ranked causes of age-standardised YLDs in both sexes were; lower back pain, migraines, opioid use disorders, major depressive disorder, type 2 diabetes, and anxiety disorders. (19)

In 2017, major risk factors for all-cause age-standardized YLDs that were responsible for persistence of the burden in Saudi Arabia were identified as high BMI, high fasting plasma glucose concentration, drug use, and dietary risks, all of which have been identified as risk factors since the 1990s. Furthermore, the trend of high low density lipoprotein cholesterol, alcohol use, hypertension and low physical activity are increasing over time. There is incomprehensive data regarding HAQ Index analysis. (19)

Delphi Approach

The Delphi technique is a structured process, which uses a series of questionnaires (known as "rounds") to gather information. Many studies in the literature used the Delphi technique due to flexibility of this method. The Delphi technique is useful particularly for difficult topics that can be influenced by subjective judgments on a collective basis, an acceptable consensus level of 51 to 80% can be achieved from this technique. (20) The e-Delphi technique does not require face-to-face meetings and therefore, is relatively free of social pressure, dominance of individuals or groups, and in addition is inexpensive. (21)

Methods

Research Project Design & Methodology

Many different approaches to health research prioritization exist, but there is no agreement on what might constitute gold standard or best practice. Moreover, attempting to produce one best practice is in fact not appropriate, as the optimal approach varies according to the exercise. (3) Therefore, the PS team decided to consider the e-Delphi technique for the online survey of the current research PS cycle, and to conduct the General Directorate of Research and Studies (GDRS)-developed, pilot-tested and self-administered questionnaire in both Arabic and English, which was available online. Involving stakeholders in an explicit manner in PS research can help to: 1) ensure that funding decisions and research meet critical evidence gaps to inform decision making; 2) facilitate shared responsibility and accountability in implementing the research agenda; 3) improve the relevance and legitimacy of research; and 4) ultimately achieve better health outcomes. (22, 23)

e-Delphi Technique

The application of e-Delphi as a foresight methodology brings a useful perspective to more traditional priority-setting methods. The Delphi method is a systematic interactive forecasting method, which uses a panel of experts who answer questionnaires in two or more rounds and the mean or median scores of the final round determine the results. (14)

Several different methods can be used to decide on priorities, which broadly fall into two groups: consensus-based approaches and metrics-based approaches. The former lead priorities to be decided by group consensus, the latter involve metrics or an algorithm that results in pooling of individual rankings of research options. Consensus tends to improve the acceptability of the exercise, while individual ranking prevents dominance of a few participants. Given that all stakeholders are typically not equal and are knowledgeable in different areas, it is especially important for consensus-based approaches to take into account differing values and viewpoints. The Delphi technique is an example of a metrics-based approach. (3, 14) Ranking priorities can be performed per research option, with a criteria as guidance. (24, 25) Another option is to differentiate between ranking priority issues and priority research questions. The former could be performed by a broad stakeholder group up front and the latter by technical experts. (25)

Study Design

The most widely reported method used to identify priorities in previous studies is expert consultation. (25) These range from meetings or surveys that collect expert opinion, to more systematic methods that combine a review of the literature, inclusive Delphi surveys of stakeholders and a recognised method for identifying the priorities against weighted criteria. (26) Although objective approaches to health research prioritization that are solely based on burden of disease data or cost-effective analyses do exist, most literature on health research PS that was found as well as the experts that were consulted considered stakeholder involvement to be a fundamental part of the process of research prioritization. (27) Ideally, PS should involve a broad representation of stakeholders, utilize objective and clearly defined criteria for generating priorities, and be evaluated. (4)

The current study was conducted throughout 2019 and applied the Delphi technique via addressing burden of disease approach criteria by its dimensions which include; the magnitude of a health problem, the likelihood of reducing disease burden through controlling its determinants, cost-effectiveness, the present level of knowledge, current resource flows and the degree of equitability. (28) We applied the combined consensus-based and metrics-based approach according to Viergever *et al*, 2010; as they noted that approaches combining consensus with some form of metrics are common. (3)

Study Questionnaire

Data was gathered through completion of the online GDRS-developed self-administered questionnaire. The questionnaire was composed of three sections:

- Section A: Socio-demographic and other characteristics focused on age, gender, nationality, region, professional category and specialty.
- Section B: Official information involved; job/position, affiliated institution, job title, years of experience, level of education, administrative qualification and contribution to research activities and policymaking process. (9)
- Section C: Research priority topics options covered; questions about health research topics (75), research topics regarding the MoH initiatives to realize Vision 2030 (1), and collaborative research topics.

The questionnaire also included specific criteria to focus thinking around research priorities and to ensure that important considerations were not overlooked. The six criteria were further divided into sub-criteria termed 'items'. The list below contains the original six criteria in bold, followed by 'items' used for scoring the selected research topics:

1. **Appropriateness**: availability of pre-existing data, ethically & culturally acceptable etc.
2. **Relevance**: equity focus and community concern/demand, problem size, contribution to national objectives.
3. **Feasibility**: capacity of the system to support the research, financial and human resources available, the cultural/political environment.

4. **Impact of research outcome:** opportunity to implement, use of research results, link of research to policy decisions, overall reduction of the problem, including cost.
5. **Opportunity to strengthen collaboration with partners:** presence of capable partners, available infrastructure and resources, possibility of collaboration and greater research outcome with partner involvement. (29)
6. **Urgency:** Whether information is not urgently needed, information could be used right away but a delay of some months would be acceptable, or data is very urgently needed for decision-making. (30)

From the items under the criteria, we selected a final 10 to use to score the answers, eight of these items were selected from the first four criteria, with the remaining two items selected from the fifth and sixth criteria. The selected items allowed different research dimensions to be balanced against one another, depending on the identified values or principles of the exercise. (24, 25, 30) The chosen topics were given appropriate scores for each of the selected 10 items and scoring was conducted based on a rating scale of 1 to 3. The total aggregate score out of 30 for the research priority topic was then computed by clicking 'calculate' at the bottom of the page (metric based approach). The criteria can be categorized into one of three dimensions: Public health benefit (should we do it?), feasibility (can we do it?) and cost. (31)

Study Questionnaire Development and Evaluation

GDRS have developed a pilot-tested online self-administered questionnaire in accordance to Boateng *et al*, 2018, focusing on three phases (item development, scale development, and scale evaluation). Therefore, the questionnaire passed through the following steps: **first, identification of domain and item generation:** The study aim is to identify priority areas for research to which funding will be allocated, which is targeted by PHASE 1: ITEM DEVELOPMENT (31). There are many analogous methods used for setting health research priorities (30, 32), but adjustments are necessary to be aligned with the context and needs. The developed 19 questions in the questionnaire were aggregated into three groups – sociodemographic factors, official information and options for priority research topics – represented by questions 1–6, 7–16, and 17–19, respectively. The questions were made up of a number of formats, including multiple-choice questions, dichotomous options (yes/no), and open-ended questions.

Second, content validity

We assessed if the measure adequately captured the concept's full meaning or not, and how accurately an assessment or measurement tool tapped into the various aspects of the specific construct in question. Our developed questionnaire was revised and formulated based on five experts' views to ensure clarity of the meaning, relevance to study objectives and easy understanding by participants. Afterwards, the questionnaire was assessed and tested by a sample of target experts, to determine which questions should be included in the survey and which should be not. All the construct questions were assessed, topic-relevant questions were included, and it was insured that the questions were representative of all aspects of the construct, and could fully measure the relevant domain. After that, the experts were agreed on the assessment tool and the Delphi method was used to come to a consensus on which questions were a reflection of the construct we want to measure. The target experts were specialized in research management, health policy implementation, public health and healthcare quality.

Expert judgment was completed, and the final version was modified based on focus group discussions' feedback and on the expert consensus on what items will be accepted, rejected, or modified.

Evaluation by the target population was complete through interviews to establish if the items of the assessment tool were appropriate to the topic and a good measure of the topic domains.

PHASE 2: SCALE DEVELOPMENT

Third, pre-testing questions

we shared the draft questionnaire with 50 participants over two rounds, in order to validate the pre-tested questions according to their feedback. Following this, we conducted interviews to further refine and assess item interpretation and finalize the survey.

Fourth, survey administration and sample size

The sample size was calculated through software, the large sample size (2500 participants) was selected to cover a wide range of specialists, and the study included both quantitative and qualitative data.

Fifth & Sixth: Items reduction & extraction

The tool was reviewed to identify items that were not or were the least related to the study domain for deletion or modification, subsequently unnecessary variables were deleted.

PHASE 3: SCALE EVALUATION

Test-retest reliability:

Test-retest reliability or simply stability testing was computed through correlation, which indicates the degree to which values were consistent through repeated testing. The most direct way of estimating reliability is to manage the test two times with an identical set of themes, and then correlate the two

measurements at each time point, with the correlation coefficient (r) between the two sets of values designating the degree of reliability. (33) The correlation magnitude for the administered study questionnaire on two occasions separated by two weeks was 0.95.

Content validity test

Content validity is an assessment of how fitting the factors being measured are according to a panel of assessors with good subject matter knowledge. It speaks of how precisely a measurement tool taps into the various features of the particular construct in question. There is no correlation coefficient, as this method of testing is a logical method rather than empirical one, due to dependence on relevance of the test task with the content of the construct. (33) The developed questionnaire aimed to identify health research priorities for the concerned populations using criteria that allowed different research dimensions to be balanced against one another. The content validity was evaluated as a subjective decision and was highly rated (98%) by a MoH panel of relevant experts.

Data Collection

- The data collection process started with sending circular letters by GDRS to invite the enrolled Health Affairs' General Directors & Directors and medical cities' Executive Directors to participate in the survey. Other participants were communicated with via e-mail.
- The research team conducted five workshops for the assigned coordinators, supplied them with information sheets and communicated with them throughout the data collection period.
- The designated coordinators facilitated questionnaire fulfilment via different hierarchical groups of stakeholders at the MoH headquarters, along with participants affiliated to the Health Affairs Directorates, Medical Cities and other key Saudi partner organizations.
- The research team reviewed the received fulfilled questionnaires, recorded their observations, and provided the coordinators these observations in a timely manner.

Data management and analysis

Data was validated and verified according to the ESSnet ValiDat Foundation 2016; they defined data validation as an activity aimed at verifying whether the value of a data item comes from the given (finite or infinite) set of acceptable values. According to this definition, the validation activity referred to single data items, while verification related to consistency among different data items. (34)

Study variables were summarized in terms of frequency distribution and by computing quantitative measures using descriptive statistics. Bivariate analysis was performed to test the association between variables (Pearson correlation) using the software program Stata version 15, and qualitative analysis was conducted as appropriate.

Results

The study included 2252 participants with a 90% response rate; the majority (68%) were Saudi natives. Their ages varied from (25 to > 60 years), with the majority (76%) aged between 25 and 45 years. Two thirds of respondents were males and the study achieved balanced regional participation. Inclusiveness was attained in terms of participants representing a full range of health specialties and subspecialties (46.5% physicians, 39% health specialists, 10% pharmacists and 3.6% dentists) & related domains (1%).

The kingdom was represented by 16 regions and their contribution was proportional to healthcare providers' density, as (30%) was achieved by Riyadh, Makkah and Jeddah, whereas only (9%) of the total belonged to Jazan, Najran and Al-Bahah. Broad stakeholder involvement was attained as the study covered a wide spectrum of levels of qualification (from Bachelor degrees [45%] up to Doctoral degrees [18%]) and professional levels (specialist [49%] to consultant [24%]). This mix of speciality from a number of disciplines was included in the study to achieve a fully comprehensive model.

The clear majority of participants (98%) belonged to the MoH, of which 134 were leaders (85 Headquarters policy makers & 49 regional decision makers), while the rest were made up from individuals from 16 Health Affairs Directorates spanning 75 hospitals & specialized health centers, 24 primary health care centers, 2 healthcare clusters, in addition to 5 medical cities. Community involvement was represented by 26 organizations; 7 universities, 9 scientific health associations, 5 charitable associations, and 5 key Saudi health partner organizations. Nearly half of stakeholders (45%) contributed to scientific research, while around a quarter (24%) had previously published. In addition, only 6% had a direct influence in health policymaking. (Tables 1–3)

Table 1
Distribution of The Health Facilities Enrolled in the Study

No	Region	MoH Health Affairs Directorates								Referral Hospitals		Hig Hea regi mal Nur
		PHCs		G. Hs		Sp. & Cen. Hs		H. Cs.		Medical Cities		
		Number	Participants	Number	Participants	Number	Participants	Number	Participants	Number	Participants	
1	Riyadh	1	6	2	185	1	2	1	1	2	23	1
2	Makkah	2	7	1	112	0	0	0	0	1	62	1
3	Jeddah	1	2	4	138	1	9					1
4	Ta`if	1	3	1	20	3	99					1
5	Medinah	2	5	2	169	3	11					1
6	Qaseem	1	1	1	55	4	58					1
7	Eastern region	3	6	1	77	7	154	1	1	1	82	1
8	Al-Ahsa	3	8	4	86	4	15					1
9	Hafr Al-Baten	1	6	1	115							1
10	Aseer	1	5	4	96	3	37			1	3	1
11	Tabouk	2	6	2	30	3	80					1
12	Ha`il	2	5	2	40	4	27					1
13	Northern border	2	2	1	44	3	5					1
14	Jazan	0	0	7	37	1	3					1
15	Najran	1	6	2	63	2	3					1
16	Al-Bahah	1	4	1	67	0	0					1
	Total. No	24	72	36	1334	39	503	2	2	5	170	16

Table 2
Distribution of Key Saudi partner Organizations Involved in the Study

No.	Region	Scientific Health Association		Charitable Associations		Saudi Universities		Key Saudi health/ partner organizations		Total	
		No.	participants	No.	participants	No.	participants	No.	participants	No.	participants
1	Riyadh	6	6	3	3	4	10	5	7	18	26
2	Makkah	1	1							1	1
3	Jeddah	1	1			1	1			2	2
4	Ta`if										
5	Medinah										
6	Qaseem	1	1	1	1					2	2
7	Eastern region			1	1					1	1
8	Al-Ahsa										
9	Hafr Al-Baten										
10	Aseer					1	4			1	4
11	Tabouk										
12	Ha`il										
13	Northern border										
14	Jazan										
15	Najran					1	1			1	1
16	Al-Bahah										
	Total. No	9	9	5	5	7	17	5	7	26	37

Table 3
The Top 5 Research Priority Themes for All Health Domains and MoH Headquarters' Leaders

Priority Theme Rank	Ministry of Health Headquarters Leaders	Physicians	Dentists	Pharmacists	Health Specialists	Nurses
1	Health system	Critical care medicine, emergency medical services & emergency medicine	General dentistry and all related branches	Pharmacy	Biomedical technology, clinical biochemistry, clinical laboratory sciences, medical microbiology	Health system
2	Public health	Internal medicine & COVID 19	Dental hygiene	Clinical pharmacy	Health system, healthcare & hospital administration and medical records	Health education
3	Health informatics and E-health	Pediatric medicine, pediatric general surgery and pediatric neurology	Oral and maxillofacial surgery	Health system, healthcare and hospital administration	Radiology	Critical care medicine
4	Health education	Obstetrics & gynecology	Healthcare & hospital administration	Public health	Physical medicine, therapy & rehabilitation	Midwifery and nursing
5	Biological domains and all related branches	General surgery	Pediatric dentistry	Health education	E-health	Community medicine and public health

The study clarified that there was no correlation between contribution to scientific research, publications and the other studied variables such as regions, age, gender and nationality as correlation coefficient was ($r \sim 0$).

Discussion

Reporting the PS Process

Health research PS should not be a one-time exercise, it is a complete cycle, as shown in Fig. 1. Comprehensive reporting and improved transparency in research PS study may strengthen the acceptance and implementation of the research priorities identified, so that efforts and funding are invested in generating evidence that is of importance to all stakeholders. Ensuring the transparency of the process can strengthen legitimacy and credibility to support implementation and maximize impact. A reporting checklist for research PS may facilitate more consistent and comprehensive reporting and enable researchers and end-users to better understand the processes taken in developing research priorities. The Reporting guideline for PS of health research (REPRISE) has 31 reporting items that cover 10 domains: context and scope, governance and team, framework for PS, stakeholders/participants, identification and collection of priorities, prioritization of research topics, output, evaluation and feedback, translation and implementation, and funding and conflict of interest. (35) However, reviews of published research PS exercises have consistently demonstrated a lack of transparency due to suboptimal reporting. (23) Inadequate descriptions of the stakeholders and the methods used makes it difficult to assess the validity of research priorities identified, and limits the ability to aggregate, analyze or compare research priorities that have been previously established. (25)

Guidelines are useful for assessing whether the PS process is achieving key constructs relevant to the planning process, deciding on priorities and post-PS work. Ultimately, the implementation of an effective research PS process will facilitate the allocation of resources to research priorities that have the greatest impact on policy or practice. (2)

A. Context and Scope

A.1. Geographical scope

The MoH represents organizations at different levels all over Saudi Arabia, under the national umbrella of health and community associations as well as key Saudi health partner organizations representatives. In the current study, two rounds of the e-Delphi technique were applied. According to the Council of Health Research for Development (COHRED)'s 2010 paper there is not 'one best method' for PS. (14) Therefore, the PS study team decided to consider the e-Delphi technique for the online survey of the current research PS cycle, using a GDRS-developed self-administered questionnaire in Arabic and English, which was published online. The study was conducted throughout 2019 and included a full range of MoH healthcare professional categories; including headquarters policy & decision makers, directors, managers, multilevel healthcare provider specialties and health-related domains affiliated to 16 health affairs directorates and 5 medical cities & specialized hospitals. Universities, health and charitable associations, and other key health partner organizations joined the survey to provide community involvement. Descriptive analysis of the studied sample is available in Tables 1–3.

A.2. Health area, field and focus

The study questionnaire allowed enrolment of research topic options through the following three topics:

- Health research topics: risk factors, diseases, problems and health system dimensions
- Relevant Vision 2030 initiative research topics: healthcare access, value-based healthcare, management of RTAs and public health
- National and international collaborative research topics

A.3. Intended beneficiaries

The general population are the intended beneficiaries through provision of solutions for the gaps and problems relating to clinical services, health services and population health.

A.4. Target audience of the priorities

Policy makers leading KSA Vision 2030 are interested, as they recognized the integral role of health research in transforming and modernizing the healthcare system and improving the health of the Saudi population. Research and development in terms of the need to centralize national research agenda setting and facilitation via funding, grants, research regulations and safety, is one of the essential pillars of the future governance framework of Saudi health system transformation. In addition, funders, researchers, industry professionals or others who have the potential to implement the identified priorities are concerned with the outputs of this work.

A.5. Research area

Public health, health system, clinical research and basic science.

A.6. Type of research questions

The resulting priority agendas included varied types of research options (topics / questions) and covered a broad range of domains as; etiology, diagnosis, prognosis, treatment, behavioural and social science, economic evaluation and implementation.

A.7. Time frame

The current PS cycle is scheduled to take place over a 5-year period, with the next PS cycle planned to take place in 2025.

A.8. The previous PS process

The previous research priority agenda of the MoH was set in 2013 following two expert consultation workshops. The selected priority topics were: cancer, accidents, diabetes mellitus and health system research. As the research priority agenda should be regularly updated, the GDRS undertakes the responsibility of setting the current priorities for health research in the MoH under a national umbrella, in order to rationalize use of health research resources and to achieve health system transformation goals.

B. Governance and team

Selection, structure, characteristics of the leadership and management team and experience relevant to conducting PS

According to "The Research and Studies by Law", issued by the Saudi Ministerial Council Decree, (36) GDRS is the structure responsible for proposing the health research priority agenda. Following this, the suggested agenda should be shared with the "MoH Research Priority Adoption Committee" for approval. This was put into practice following the application of both the 1st and 2nd rounds of the e-Delphi technique.

The GDRS team was led by the General Director and guided by the MoH Advisory Authority who initiated, developed, and carried out the PS process. The PS team included a public health consultant and a specialist, in collaboration with highly qualified managers of health research departments in the involved MoH health affairs directorates and medical cities. Additionally, a group of qualified cooperators helped in the facilitation of online questionnaire fulfilment as well as data validation and verification.

C. Framework for PS

The 1st and 2nd rounds of the e-Delphi technique were applied according to the process outlined by COHRED in 2010 (14) and modified to accommodate the national governance context.

Comparison between Delphi technique and burden of disease approach

The Delphi approach was preferred and adopted as opposed to the burden of disease method for the current PS study. This was based on the Delphi technique being a forecasting method which is inclusive of key stakeholders, including policy makers, researchers, charitable & scientific health associations and funding organisations, and addresses health system research while improving the chance of better health outcomes concerning policy and practice, as illustrated in Figs. 2–4.

D. Stakeholders or participants

D.1.2. Inclusion criteria and strategy for stakeholders involved in PS

The sampling for survey participation was defined as MoH Leaders, as well as the full range of healthcare professionals from the range of specialties and subspecialties of the MoH, in addition to relevant community organization representatives as follows:

1. MoH Main Campus: headquarters policy & decision makers at all levels (Main Campus Leader population based)
 2. MoH Health Affairs Directorates: Multistage stratified random sampling technique and recruitment through the selected 16 health affairs directorates; hospitals, specialized health centers, two health care clusters and primary health care centers.
- The study clusters were composed of the highest 14 health affairs regions with regard to the overall percentage of physicians (3% and more). The remaining regions where physician percentages were less than 3% were merged to form two strata, each of them was represented by 5% of the total MoH physicians. Northern borders and Hafr Al-Baten represented the two merged categories as they had the highest physician density within their clusters.
 - Strategy for surveying and sampling technique: The survey team decided to consider "Major City-based sample" as a comprehensive approach rather than "Hospital-based sample".
1. The MoH regional sample was estimated for professional categories and regions through online sample size calculator, which is accessible via the following website: (www.surveysystem.com, <https://www.checkmarket.com/sample-size-calculator/>). (37) Due to wide range of specialties for the physicians and allied health professionals, the estimated samples were multiplied by 300% and 150% respectively to cover the varied strata. The data source was the MoH, KSA Statistical Year Book 1438 H. The estimated sample included five MoH Medical Cities & Specialized Hospitals. (38)
 2. Community Participation (one or more participant/organization) via communication/partnership with organizations, which included:
 - Saudi Universities
 - Health Scientific Associations
 - Charitable Associations
 - Key Saudi health/partner organizations

The GDRS conducted 5 workshops for the MoH health research departments' leaders and other coordinators, prepared and disseminated survey information sheets and communicated with them via WhatsApp groups, e-mails and phone calls to ensure proper data collection. The total calculated sample was 2500, while 2252 participants (90% response rate) completed the survey.

D.3.4. Characteristics of stakeholders; demography, research expertise, specialty and affiliations

Descriptive analysis of the included sample is shown in Tables 1–3.

D.5. Provision of reimbursement for participation

Participants received verbal acknowledgement; as they evaluated the importance and impact of research PS in health care.

E. Identification and collection of research priorities

E.1. Methods for collecting initial priorities

The online e-Delphi survey, preceded by announcements and invitation messages for stakeholders was completed. In addition, workshops and meetings for survey coordinators to explain the optimal methods for questionnaire fulfillment, priority topic scoring, data validation and verification via information sheets were conducted. The study questionnaire focused on the values that stakeholders should adhere to.

E.2. Methods for collating and categorizing priorities

Taxonomy and other frameworks were used to organize, summarise and aggregate research topics/questions.

E.3. Methods and reasons for modifying (removing, adding, transferring, refining and reframing) priority research topics or questions

This was based on project team revisions which were made according to the scope, adding clarity, definition, avoiding duplication, in response to recent events, and for validation and verification.

E.4. Number of priorities at each stage of the process

The project team classified participants into six categories as presented in the results section (Table 3), and for each group the priority fields were ranked. The applied parallel approach; kept track for each category and prevented dominance of data belonging to one professional group over the others. The ranking process was considered a mixed method, and combined both consensus- and metric-based methods in accordance with completion of the pilot-tested study questionnaire. The second step included defining the top five priority themes for each category, all research topics and questions of the top five ranked domain, as well as research topics related to VRO office's initiatives to realize Vision 2030, and collaborative research. All topics options were pooled together, validated, verified, tallied, summarized, refined and classified into themes. The study deliverables were listed into three research priority agendas;

1. **Health System Research Priority Themes:** Health Service Delivery, Health Workforce, Health Information and Communication Technologies' Systems, Access to Healthcare, Essential Medical Products, Vaccines, Innovative Approaches and Technologies, Health Systems Financing and Economics, Health System Governance and Leadership and Health System Preparedness and Response to Disasters and Emergency Care.
2. **Diseases, Health Problems, Public Health and Medical Care Themes:** Non-Communicable Diseases, Communicable Diseases, Basic and Therapeutic Nutrition, Holistic Approaches to Health and Wellness, Behavior & Lifestyle, Public Health, Family Medicine & Home Care, Trauma and General Management, Environmental Health, Pilgrims' Health, Women's Health, Child and Neonatal Health, Geriatric Health, Biomedical Technology Related Fields & Devices, Medical Radiology & Devices, Dental Health, Medications, General Management and Innovative Approaches and Interventions, Emergency Management (Critical Care Medicine), Physical Therapy & Rehabilitation.
3. **National and International Collaborative Research Themes:** Major research areas impacted by COVID-19, Public Health, Healthcare Access, Medical Care & Universal Health Coverage, Value-based Healthcare, Health System Financing and Economics, Health Information and Communication Technology, Health System Governance, Health Workforce Development and Health System Preparedness and Response to Emergency.

F. Prioritization of research topics/questions

Methods and criteria for prioritizing, including/excluding research topics or questions

The e-Delphi survey was conducted through fulfilment of the pilot-tested questionnaire by setting and scoring research topic/topics within the defined lines according to the predetermined criteria. Prioritization was performed by ranking weighted mean aggregate scores via application of the combined consensus-based and metrics-based approach. The weighted mean aggregate score was calculated by multiplying research topic field average mean of aggregate score by the proportion of the participant group who selected it. The uppermost five fields/categories were included, while the lowest were excluded.

G. Output included three research priority agendas:

1. Health System Research Priority Themes

2. Diseases, Health Problems, Public Health and Medical Care Themes

3. National and International Collaborative Research Themes

Previous research has focused on classification of priorities into themes to facilitate implementation. (3) Moreover, others have addressed the sequence of systematic ordering of the research priority agenda, starting with themes, which include priority areas, while fields included relevant terminology and were commonly used. (39) Therefore, the adopted approach for formulating the delivered research priority agendas was via addressing research themes, then areas as broad titles, which were further classified into subtitles for relevant domains of the research topics/questions according to the literature. Extra ordering was avoided to prevent fragmentation and complexity of the agendas.

Agenda 1: Health System Research Priority Themes

The Health System Research Domain addresses health system and policy questions that are not disease-specific, but concern systemic problems that have repercussions on the performance of the health system as a whole. It addresses a wide range of questions, from health financing, governance and policy, to problems with structuring, planning, management, human resources, service delivery, referral and quality of care in the public and private sector. This research can provide a robust and accurate understanding of health system challenges and their potential solutions, thereby improving the utility of the findings in other settings. (41)

Health system research by necessity is highly multidisciplinary, with a strong emphasis on social sciences, economics, and anthropological investigations. Much ongoing research consists of descriptive, comparative and evaluative studies and secondary analytical research. Although experimental studies are less common, partly because of the operational and ethical challenges in experimenting at the health system level, they can be very informative and provide convincing evidence on the benefits of innovations in health system efficiency and health impact. (42)

The proposed goals of the KSA Health Sector Transformation Strategy are; firstly, to improve health: increase the length, wellbeing and quality of life of Saudi citizens, which includes the Vision 2030 goal of increasing the life expectancy of citizens to 80 years by 2030. Secondly, to improve healthcare: by improving the quality and consistency of services and the performance and accountability of healthcare organizations and staff to deliver care that is safe, effective, patient-centered, timely and equitable. Thirdly, to improve value: by containing costs, improving outcomes, controlling public healthcare expenditure and guiding new investment. All three transformation goals conform with, and are enablers of, the Vision 2030 strategic objectives for health: access, value and public health. (1)

Health systems are already struggling to meet current demands and the challenges facing society over the next 40 years will add further stress. As a result, solutions may require more innovative approaches that address the wider determinants of health and require multi-disciplinary partnerships, which are traditionally outside the remit of health policy-makers. The environmental determinants, which include climate change, disasters and emergencies, interact with and potentially have an impact on the social and economic determinants of health, including an ageing population and economic decline in many parts of the world. (43)

The WHO framework describes health systems in terms of six core components or “building blocks”, as shown in Fig. 19: (i) service delivery, (ii) health workforce, (iii) health information systems, (iv) access to essential medicines, (v) financing, and (vi) leadership/governance. The six building blocks contribute to the strengthening of health systems in different ways. Some wider spanning components, such as leadership/governance and health information systems, provide the basis for the overall policy and regulation of all the other health system blocks. Key input components to the health system include financing and the health workforce. A third group, namely medical products and technologies and service delivery, reflects the immediate outputs of the health system, i.e. the availability and distribution of care. (44) Fig. 5

The WHO has addressed improving the quality of health services, and highlights research as an adaptable tool and resource that can support local quality improvement efforts. It aims to support implementation of quality improvement approaches to make health services more effective, safe and people-centric. There is an increasing collective recognition that quality health services should be; effective, safe, people-centric, timely, equitable, integrated and efficient. (45) Health system research provides evidence that, when applied, it can make healthcare affordable, safe, effective, equitable, accessible, and patient-centric. The Agency for Healthcare Research and Quality invests in research to generate new evidence to help healthcare systems and healthcare professionals improve the lives of the patients they serve. (46)

Good service delivery is a vital element of any health system. Service delivery is a fundamental input to population health status, along with other factors, including social determinants of health. The network of service delivery in any well-functioning health system should have the following key characteristics; comprehensiveness, accessibility, coverage, people-centricity, continuity, quality, coordination, accountability and efficiency. (44)

The Framework for action for health workforce development in the Eastern Mediterranean Region has been developed in response to the health workforce challenges facing the Region, in line with Sustainable Development Goal (SDG) target 3.C to increase the recruitment, development, training and retention of the health workforce. It is imperative that the Region strives towards institutionalizing strategic planning as an approach in responding to health workforce challenges. The framework aims to guide country and regional action to strengthen the health workforce to ensure access for all people to an adequate, competent, well-balanced, motivated and responsive health workforce which contributes to health systems strengthening and progress towards universal health coverage in the Region. (47)

A health information system refers to a system designed to manage healthcare data. This includes systems that collect, store, manage and transmit a patient's electronic medical record, a hospital's operational management or a system supporting healthcare policy decisions. Health information systems also include those systems that handle data related to the activities of providers and health organizations. Data is analysed to improve patient outcomes, inform research, and influence policy-making and decision-making. (48)

Health information technology (health IT) involves the exchange of health information in an electronic environment. Widespread use of health IT within the healthcare industry will improve the quality of healthcare, prevent medical errors, reduce healthcare costs, increase administrative efficiencies, decrease paperwork, and expand access to affordable healthcare. It is imperative that the privacy and security of electronic health information be ensured as this information is maintained and transmitted electronically. (49)

eHealth has been defined by the European Commission as “the use of Information and Communication Technologies (ICT) in health products, services and processes combined with organizational change in healthcare systems and new skills, in order to improve health of citizens, efficiency and productivity in healthcare delivery, and the economic and social value of health”. (50) eHealth is an umbrella term that covers a wide range of health and care services delivered through ICTs, such as electronic health records (EHRs), health information systems, remote monitoring and consultation services (e.g. telehealth, telemedicine, telecare), tools for self-management, and health data analytics. Health is a subset of eHealth that is linked to mobile telephony and applications. (51)

eHealth has experienced a period of significant growth and maturity in recent years. Such investments are most often seen in the context of achieving health system reform, providing new and innovative modes of healthcare delivery or offering efficient methods of access and exchange of health information. Most notable, however, is the transition of eHealth to a subject of strategic importance for policy-makers. (52)

Improving access to health products is a multidimensional challenge that requires comprehensive national policies and strategies. These should align public health needs with economic and social development objectives and promote collaboration with other sectors, partners and stakeholders; they also need to be aligned with legal and regulatory frameworks and cover the entire product lifecycle, from research and development to quality assurance, supply chain management and use. (52)

Development of an 'innovation ecosystem' is a key approach to ensure that companies can collaborate with researchers and to engage effectively in areas of impact to innovate and develop new products, services, solutions and new business models to underpin leadership positions in international markets and to meet global and societal challenges. (52) In an era of ageing populations and growing health expenditures, medical innovations are needed to improve the quality of people's lives and increase the efficiency of healthcare systems, as well as contributing to significant cost savings and economic growth. (39)

The WHO 2019 road map supports countries' abilities to allocate resources more effectively through evidence-based decisions. This ensures that cost-effective health products are included in a country's essential medicines list, essential diagnostics lists or reimbursement lists, all through more efficient procurement and supply processes and rational use of medicines. Support for fair pricing and policy implementation to reduce out-of-pocket expenditures is also important. There is a pressing need to improve access to timely, robust and relevant information concerning health products, and unbiased information that is free of any conflict of interest is vital for the sound selection, incorporation, prescription and use of health products. (52)

Health financing is a core function of health systems that can enable progress towards universal health coverage, all by improving effective service coverage and financial protection. Today, millions of people do not access services due to the cost, with many others receiving poor quality services even when they pay out-of-pocket. Carefully designed and implemented health financing policies can help to address these issues. For example, contracting and payment arrangements can incentivize care coordination and improved quality of care; sufficient and timely payment of funds to providers can help to ensure adequate staffing and medicines to treat patients. (54) Cost-effectiveness, costs and strategic planning can help guide policy decisions to ensure that money spent on health is allocated in a way that the greatest possible health outcomes are achieved in the most feasible manner. (55)

Leadership and governance involves ensuring strategic policy frameworks exist and are combined with effective oversight, coalition-building, regulation, attention to system-design and accountability. Three main categories of stakeholders who interact with each other determine the health system and its governance:

- The State (government organizations and agencies at central and sub-national level)
- The health service providers (public and private; for and not for profit; clinical, para-medical and non-clinical health services providers; unions and other professional associations; networks of care or of services)
- The citizen (population representatives, patients' associations, civil society organisations, non-governmental organisations, citizens associations protecting the poor, etc.) who become service users when they interact with health service providers. (56)

All communities are at risk of emergencies and disasters including those associated with infectious disease outbreaks, conflicts, natural disasters and technological hazards amongst others. The health, economic, political and societal consequences of these events can be devastating. Climate change, unplanned urbanization, population growth and displacement, antimicrobial resistance and state fragility are contributing to the increasing frequency, severity and impacts of many types of hazardous events that may lead to emergencies and disasters without effective risk management.

Health emergency and disaster risk management emphasizes assessing, communicating and reducing risks across the continuum of prevention, preparedness, readiness, response and recovery, and building the resilience of communities. (57) Meanwhile, the WHO's Emergency, Trauma and Acute Care program is dedicated to strengthening the emergency care systems that serve as the first point of contact with the health system for so much of the world, and to supporting the development of quality, timely emergency care accessible to all. (58) Additionally, the World Health Assembly has now committed to recognizing emergency care a key health focus; with an importance on better and faster services for time-sensitive health conditions, including injuries, heart attacks, mental health conditions, infections or pregnancy complications.

A functional emergency care system is essential to universal health coverage, and investing in frontline care saves lives, increases impact and reduces costs in other parts of the health system. It is known that timelines are an essential component of quality care, and that millions of deaths and long-term disabilities could be prevented if emergency care services existed, and patients were able to reach them in time. Steps that have been agreed to strengthen countries' emergency care include developing policies for sustainable funding, governance and universal access to emergency care for all, and integrating emergency care into health delivery and training strategies at all levels. The application of the WHO emergency care system assessment helps to identify gaps and context-relevant priorities. (59)

Adequate planning for a pandemic such as COVID-19 is critical for maintaining healthcare services during a response. Sufficient health system and public health capacities should be in place to enable the major shift from detecting and treating cases to detecting and isolating all cases. Detection: suspect cases should be detected quickly after symptom onset through active case finding, self-reporting and entry screening; Testing: all suspected cases should have test results within 24 hours of identification and sampling, and to verify the virus-free status of patients who have recovered; Isolation: all confirmed cases should be effectively isolated immediately and until they are no longer infectious; Quarantine: all close contacts should be traced, quarantined and monitored for 14 days. (60) The project team classified participants into six categories as presented in the results section (Table 3), and for each group the priority fields were ranked. The applied parallel approach; kept track for each category and prevented dominance of data belonging to one professional group over the others. The ranking process was considered a mixed method, and combined both consensus- and metric-based methods in accordance with completion of the pilot-tested study questionnaire. The second step included defining the top five priority themes for each category, all research topics and questions of the top five ranked domain, as well as research topics related to VRO office's initiatives to realize Vision 2030, and collaborative research. All topics options were pooled together, validated, verified, tallied, summarized, refined and classified into themes. The study deliverables were listed into three research priority agendas;

Health System Research Priority Themes: Health Service Delivery, Health Workforce, Health Information and Communication Technologies' Systems, Access to Healthcare, Essential Medical Products, Vaccines, Innovative Approaches and Technologies, Health Systems Financing and Economics, Health System Governance and Leadership and Health System Preparedness and Response to Disasters and Emergency Care.

Diseases, Health Problems, Public Health and Medical Care Themes: Non-Communicable Diseases, Communicable Diseases, Basic and Therapeutic Nutrition, Holistic Approaches to Health and Wellness, Behavior & Lifestyle, Public Health, Family Medicine & Home Care, Trauma and General Management, Environmental Health, Pilgrims' Health, Women's Health, Child and Neonatal Health, Geriatric Health, Biomedical Technology Related Fields & Devices, Medical Radiology & Devices, Dental Health, Medications, General Management and Innovative Approaches and Interventions, Emergency Management (Critical Care Medicine), Physical Therapy & Rehabilitation.

National and International Collaborative Research Themes: Major research areas impacted by COVID-19, Public Health, Healthcare Access, Medical Care & Universal Health Coverage, Value-based Healthcare, Health System Financing and Economics, Health Information and Communication Technology, Health System Governance, Health Workforce Development and Health System Preparedness and Response to Emergency. **See Supplementary topics list at Additional File**

Agenda 2: Diseases, Health Problems, Public Health and Medical Care Themes

The Health Sector Transformation Strategy of Kingdom of Saudi Arabia clarified that rates of avoidable injury and non-communicable disease remain high by regional and international standards. The Kingdom has made notable progress in improving the health of its population over recent decades, particularly in areas of child and maternal mortality and the reduction of communicable diseases. For both males and females, life expectancy at birth improved from 64 years in 1970 to 75 years in 2015. There are targets set to ensure it increases to 80 years by 2030. There is considerable scope to reduce avoidable mortality and morbidity in both the working and elderly populations, with particular areas of concern including heart disease, stroke, DM, respiratory disease, mental health, RTAs and congenital diseases, all of which are amenable to reduction. There is a need to strengthen the prevention of non-communicable disease and injury thereby reducing avoidable illness and death. The risk of major outbreaks of communicable disease also remains substantial, especially at Hajj or following natural or man-made disasters. (1) KSA is facing a rising burden of non-communicable diseases and road traffic injuries as a result of rapid changes in behaviors, with a resulting clear need for major intervention to reduce these burdens and to engage other sectors of the government and the community in these efforts. (61)

Reforming healthcare financing should not be the only goal of healthcare transformation in Saudi Arabia, transformation should also include a move toward integrative health and medicine, and to promote a culture of wellness. (62)

Saudis are more likely to seek healthcare only when they are sick, which may be too late in the face of the lifestyle disease epidemics. (63) More investment is needed in behavior change and to promote self-responsibility, because wellbeing is not only achieved by intervention from a social/professional health practice, but is also informed by our own self-care and resilience. (64) Investment in behavior change and wellbeing outside the boundaries of the healthcare system in the Saudi 2030 vision, will have more impact on health and wellness of the Saudi citizen than direct spending on healthcare facilities. (65)

Chronic diseases – including heart disease, stroke, diabetes and cancer – account for some of the most common health problems in the United States, according to statistics from the Centers for Disease Control and Prevention (CDC). However, many of these chronic diseases are preventable, as they are linked to poor diet and lifestyle choices including tobacco use, excessive alcohol consumption, and inadequate physical activity. (66)

Malnutrition has been researched and addressed within two distinct silos, focusing either on undernutrition, food insecurity and micronutrient deficiencies, or on increased weight, obesity, and dietary excess. Long-lasting effects of malnutrition in early life can be attributed to interconnected biological pathways, involving imbalance of the gut microbiome, inflammation and metabolic dysregulation. Life-course exposure to early undernutrition followed by subsequently becoming overweight increases the risk of non-communicable disease, and in women increases the risk of childbirth complications. These life-course trajectories are shaped both by societal driving factors – i.e., rapidly changing diets, norms of eating, and physical activity patterns – and by broader ecological factors such as pathogen burden and extrinsic mortality risk. (67) The WHO addressed the double burden and the global risks of malnutrition in all its forms, which threaten the economic, social and environmental health of individuals, families, entire communities, countries and the planet. The WHO intends to accelerate political commitment and advance the achievement of the SDGs, especially SDG 2 and SDG 3. (68)

Humans interact with the environment constantly. These interactions affect quality of life, years of healthy life lived, and health disparities. The WHO defines environment, as it relates to health, as “all the physical, chemical, and biological factors external to a person, and all the related behaviors.” Environmental health consists of preventing or controlling disease, injury, and disability related to the interactions between people and their environment. Globally, 23% of all deaths and 26% of deaths among children under age 5 are due to preventable environmental factors.(69)

The goal of oral health is to prevent and control oral and craniofacial diseases, conditions, and injuries, and improve access to preventive services and dental care. The health of the teeth, the mouth, and the surrounding craniofacial (skull and face) structures is central to a person's overall health and wellbeing. Oral and craniofacial diseases and conditions include: dental caries (tooth decay), periodontal (gum) diseases, cleft lip and palate, oral and facial pain, oral and pharyngeal (mouth and throat) cancers and xerostomia (dry mouth). There are also social determinants that affect oral health. In general, people with lower levels of education and income, and people from specific racial/ethnic groups, have higher rates of disease. People with disabilities and other health conditions, like diabetes, are also more likely to have poor oral health. (70)

New, innovative therapeutics make it possible to prevent, treat and possibly cure a wider range of diseases than before, delivering better clinical outcomes and improving quality of life for patients. Gene editing technologies such as CRISPR-Ca9 could make it possible to stop disease development completely and help address genetic disease predispositions. Targeted drugs such as anti-obesity or dementia-preventing drugs, as well as immunotherapeutics to treat

debilitating diseases, will increase the ability to address the growing healthcare challenges. Countering antibiotic resistance will be crucial to ensure effective drug treatment overall, and technologies such as those countering anti-microbial resistance will be important to minimise and stop the spread of anti-microbial resistance. (39) Pharmaceutical products are a fundamental component of both modern and traditional medicine and it is essential that such products are safe, effective and of good quality, and are prescribed and used rationally. (71)

Innovation in medical devices as a research priority area aims to contribute to the continued improvement of patient safety and outcomes at an affordable cost; developing medical device technologies will provide affordable transformative solutions for chronic diseases such as heart disease, diabetes and musculoskeletal diseases. The diagnostics research priority area should focus on the development of next-generation biomedical diagnostic devices for diagnosing diseases and sustaining human health. Diagnostic products form a critical part of healthcare delivery, as enabling the early and accurate detection is vital in ensuring successful treatment, and reducing health costs. (39) Equitable access to health products is a global priority, and the availability, accessibility, acceptability, and affordability of health products of assured quality need to be addressed in order to achieve the SDGs, in particular target 3.8. Every disease management strategy requires access to health products for prevention, diagnosis, treatment, palliative care and rehabilitation. (53)

EHRs are real-time, patient-centred records that provide immediate and secure information to authorized users. EHRs typically contain a record of the patient's medical history, diagnoses and treatment, medications, allergies and immunizations, as well as radiology images and laboratory results. They expand on the information in a traditional paper-based medical record by making it digital and thus easier to search, analyze and share with other authorized parties. An EHR system plays a vital role in universal health coverage by supporting the diagnosis and treatment of patients through provision of rapid, comprehensive and timely patient information at the point of care. (52)

All around the world, acutely ill and injured people seek care every day. Frontline providers manage children and adults with medical, surgical and obstetric emergencies, including injuries and infections, heart attacks and strokes, asthma and acute complications of pregnancy. Prioritising an integrated approach to early recognition and resuscitation reduces the impact of all of these conditions. (58) In the coming years, there is expected to be an increasing emphasis on primary care in order to improve the common problem of the ER being treated as the gateway to the hospital. Moreover, promising trends in the development of simulation-based education, improvements in residency programs and curricula, and diversification of healthcare providers indicate that the rapid progress experienced over the last decade is to continue for the next decade and beyond. Roadmaps like the National Transformation Plan 2020 and the Saudi Vision 2030 have also begun to pave the way for future developments. It is now the task of Saudi emergency medicine physicians and healthcare policymakers to conduct practical research and implement data-driven, evidence-based policies and procedures, to guide efforts to move towards a more preventive and primary care healthcare-based model. (72) **See Supplementary topics list at Additional File**

Agenda 3. National And International Collaborative Research Topics' Themes

Collaborative practices take considerable time and effort to mature, and to deliver effective results. Therefore, the current agenda is an effort to support successful research collaborations. Healthy collaboration built upon shared goals, interests and enthusiasm, provides added value to the process and ensures a higher potential to achieve a project's goals. (73)

There is a clear need to adopt a "collaborative research agenda" as complex health problems should be addressed in a comprehensive way. The confronted complexity requires input from multiple expert areas, pooling scientific, technological, human capital resources and the associated data.

Moreover, institutions reported that their research activities are largely evaluated in terms of inputs and outputs such as the grants received, the number of publications produced, and the number of training activities delivered. Meanwhile, evaluation of the actual outcomes (as perceived by their communities) is rare, with limited formal connection to the research beneficiaries. Effective collaboration at both micro (among professionals) and macro (participation of public and other stakeholders) levels is important to achieve impact and deliver benefit. (73)

The COVID-19 pandemic is a public health emergency of international concern. Hence, there is an urgent requirement for conducting academic research on several aspects of this highly contagious disease, to find effective means of containment and treatment of the disease, for now, and in the future. Significant areas have been identified for academic research to contain, prevent and treat this viral infection, and extensive research is required for the development of a vaccine for the prevention of COVID-19. There is an urgent need for early production and manufacturing of essential items such as personal protective equipment, medicines, and ventilators to combat this pandemic, and all measures to maintain social distancing by the public must be ensured. In addition to the healthcare measures to deal with the pandemic, there is also an imminent requirement for research to improve the global economy, which has been negatively impacted. COVID-19 has posed new challenges to the global research community, as there is a need for a better understanding of COVID-19 and its socio-economic ramifications on society. Future research needs to promote multi-disciplinary and international approaches, particularly in the biological and the medical sciences. (74)

Collaborative research topic options were recorded by participants who addressed the holistic and interdisciplinary vision of MoH headquarters leaders, and they considered the unexpected emerging health challenges represented by COVID-19 pandemic and relevant international significant research areas. (74) **See Supplementary topics list at Additional File**

Critical situation analysis of the previously published research priorities

Several health research priority exercises have been conducted. These were context-specific and need-driven, so are variable in focus, scope and extent (national, sub national, institutional, specific health service delivery level as Primary Health Care etc.). (14)

With regard to the locally available information about the previous research priority themes of the MoH, the previous priorities were set in 2013 through two expert consultation workshops, and the selected priority topics were cancer, accidents, diabetes mellitus and health system research.

The Sultanate of Oman summarized health research priorities for the MoH in 2014, into two themes:

1. Health System Building Blocks: Service Delivery, Health Workforce, Health Information System, Medical Products, Vaccines and Technology, Health Funding, Leadership and Governance.
2. Research Priorities of Diseases and Risk Factors: Chronic Non-communicable Diseases, Congenital Anomalies and Genetic Disorders, RTAs and Injuries, Age-related Diseases, Disability, Handicap and Rehabilitation, Health Promotion, Communicable Diseases, Malnutrition, Eye Health, Women and Child Health, School and University Students/Teenagers, Environmental and Occupational Health. (40)

A rigorous PS exercise including extensive consultation was undertaken by Ireland's government to direct their 2018–2023 strategy for health research and development. The delivered agenda included six themes; ICT, Health and Wellbeing, Food, Energy, Climate Action and Sustainability, Manufacturing and Materials and Services & Business Processes with a total of 14 priority areas. (39)

H. Priority Dissemination, Evaluation and Feedback

The planned strategy is to declare the established priority via online publication of a peer reviewed journal article and issuing the "Bulletin of MoH Research Priorities". In addition, there will be communication by means of MoH internal communication announcements and engagement on social media.

I. Implementation

I.1. Strategy or action plans for implementing priorities

For attaining a feasible and sustainable implementation of the established research priorities, the following actions were achieved:

- The involvement of policymakers, researchers and funding organizations from the beginning increases the opportunity for research priorities to be translated into actual research.
- Classification of priorities into themes and adaptation of global research priorities facilitate implementation.
- Moreover, supporting written evidence of informed policy briefs and making effective use of health research evidence in policymaking will be considered to maximize the impact of the established priorities.
- It is planned to declare priorities via announcements and calls for proposals by the GDRS. Subsequently, the submitted research proposals' arbitration, grant offering and study progress follow up are the authority of the MoH Priority Adoption Committee according to the MoH research governance bylaw.

I. 2. Plans, strategies, or suggestions to evaluate impact

The strategy includes assessment of policy brief submission, policy dialogue conduction, range of priority domains translated into actual research, research deliverable integration in decision-making, the influence of research in solving health problems, funding allocation as well as review of other relevant documents.

Strengths Of Study

1. It applied both historical and foresight approaches
2. It endorsed both metric- and consensus-based approach
3. It used community-based participatory research as its orienting framework
4. It provided a realistic model & paved the way for the national survey concept
5. It adopted inclusiveness, equity and transparency to support translation into actual research
6. It catalyzed capability for implementing and evaluating research projects' outcomes
7. It supported commitment to Vision 2030, via maximizing cost-effectiveness of research investment
8. It harmonizes with MoH transformation & modernization program 2020
9. It enhances application of the adopted "Health in all Policies" strategy
10. It creates and activates health researchers & decision maker's alliance
11. It helps to close the gap between knowledge generators & users
12. It coincides with concurrent WHO & Gulf Cooperation Council strategies and announcements
13. It considers the updated global approaches in terms of Sustainable Development Goals, and the G20 Health Ministers' Declaration
14. The study applied the e-Delphi technique via addressing burden of disease approach criteria by its dimensions which include; the magnitude of a health problem, the likelihood of reducing disease burden, cost-effectiveness, the present level of knowledge, current resource flows and the degree of equitability
15. It helps in redesigning the MoH health research landscape, by promoting dual complementary aims:
 - Structuring knowledge creation in the health field
 - Ensuring uptake of research results and integration of research and care

16. It provided integrated themes for health system research and met the main aim of the MoH

Limitations

- Given the evident mismatch between the research interests of patients and researchers, investment into health research may be misdirected to areas of low priority or fail to address important needs of relevant stakeholders. The current health research priority exercise relied mainly on the healthcare community in KSA, with limited input from other stakeholders including patients and caregivers. However, people-centeredness, patient satisfaction and related issues were addressed. Another factor is to differentiate between ranking priority issues and priority research questions. The former could be performed by a broad stakeholder group up-front and the latter by technical experts.
- Many accept burden of disease-based methods as a 'gold standard'. However, when there is no comprehensive contemporary burden of disease data, using a burden of disease approach may be prohibitive in cost. Instead, considering "developing an updated health information system" as a national priority, and using Delphi method in the interim is the alternative approach according to COHRED. (14)
- The current study outputs included integrated themes for health system research that meet the main intent of MoH, whereas burden of disease focuses on diseases, injuries, and risk factors sequelae in terms of DALYs (YLDs and YLLs).

The challenges encountered throughout the progress of PS project and the applied solutions

1. Lack of consultants due to the scarcity of the PS research projects in the region.
2. Technical problems that hinder data collection, validation verification and analysis.
3. The low level of spontaneous response to the online questionnaire link by MoH employees despite the issuance of three announcements
4. Some resistance by the targeted stakeholders to complete the questionnaire in spite of the importance of participation.
5. Delay in starting data collection in some regions and organizations.
6. The long time spent in reviewing, validating and verifying the research data.
7. The high level of effort exerted for qualitative data analysis as they are prioritized, pooled together, validated, verified, tallied, summarized, refined and classified into themes.
8. There were no financial rewards for supervisors and data collectors in the regions.
9. The lack of research capabilities in the regions, which delayed data collection .
10. Scarcity of publications available in the literature focussing on PS.

Applied solutions:

1. Certificates of thanks and appreciation were issued to supervisors and data collectors as rewards.
2. Issuing several circular letters to the leaders in the regions and conducting training workshops for research coordinators.

Conclusion

PS exercise approaches can be tailored to match a specific exercise depending on the context and needs. The current study applied the e-Delphi technique via addressing the criteria of the burden of disease approach, which include; the magnitude of a health problem, the likelihood of reducing disease burden, cost-effectiveness, present level of knowledge, current resource flows and the degree of equitability. The study output included three priority agendas; 1. Health System Research Priority themes, which harmonized with the MoH vision transformation & modernization program, 2. Diseases, Health Problems, Public Health and Medical Care themes, and 3. National and International Collaborative Research themes. Adhering to guidelines can facilitate comprehensive reporting of research PS studies. In addition to improved transparency in research, PS may strengthen the acceptability and implementation of the research priorities identified, so that efforts and funding will be invested in generating evidence that is of importance to all stakeholders.

Recommendations

- An emphasis to evaluate collaborative research during priority translation into actual research and to address outcome in impact evaluation stage is crucial. In fact, there is a clear need to adopt a "collaborative research agenda" as complex health problems should be addressed in a comprehensive way.
- Healthcare is multidisciplinary, collaborative, preventive and integrated, and research topics are the umbrella of the "health in all policies" concept. Therefore, the study output of this research addressed issues related to the impact of other sectors including healthy lifestyle, environmental health, RTAs, disasters, pandemics etc. Consequently, advocating translation of research projects that support "health in all policies" concept into actual research and subsequent evaluation of their impact is very important.
- The MoH must start working on the preparation of national data for the burden of diseases in Saudi Arabia to be ready for the next PS cycle.

Declarations

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Conflict of interests

There are no competing interests that may affect the process, output or implementation.

Ethical approval and consent to participate

Central IRB log No.: 2019-0016M, Central Institutional Review Board (IRB), GDRS, MoH, KSA.

Consent to participate was obtained and the purpose of the study and its significance were provided to all participants in a text format, and the questionnaire linked informed consent form was available for participants before conduction of the survey.

Study online questionnaire

The questionnaire was hosted at the following link: <https://researchpriority.lean.sa/en/login>.

Competing interests

The authors declare that they have no competing interests.

Author's contributions

All authors provided substantial inputs and approved the final version.

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Figures

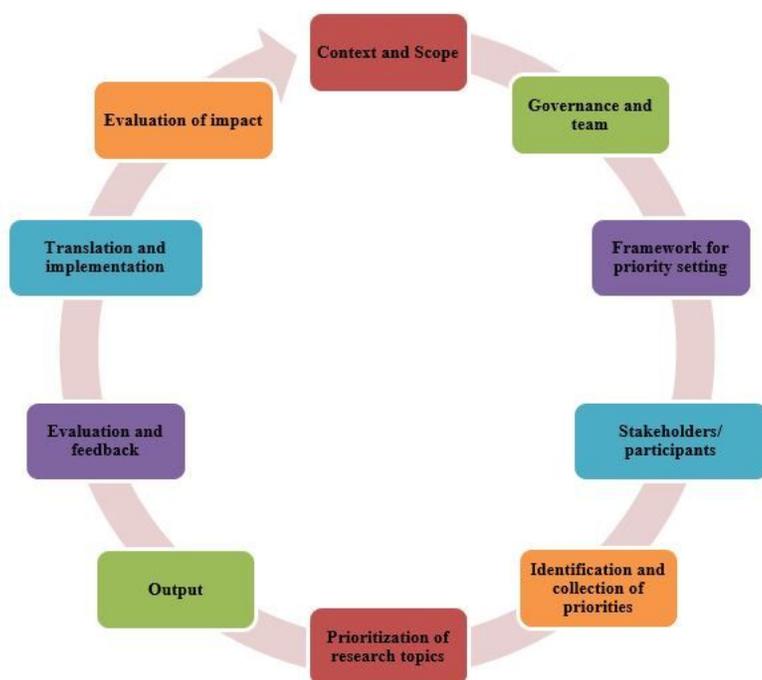
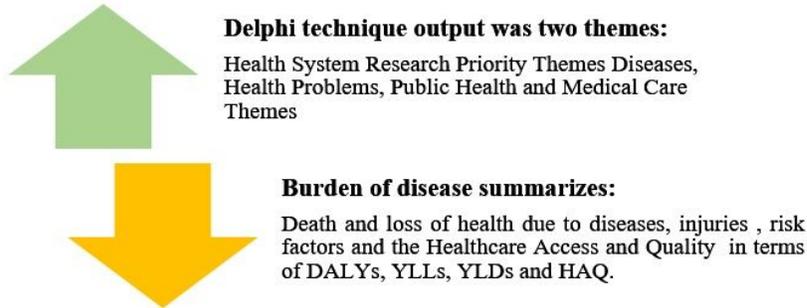


Figure 1

Research priority setting cycle



A



DALYs, disability-adjusted life-years; YLLs, years of life lost; YLDs, years lived with disability; HAQ, healthcare access and quality.

B

Figure 2

2A Delphi technique versus burden of disease. Adapted from Montorzi G et al 2010 (28). 2B Delphi technique versus burden of disease. Adapted from Tyrovolas S et al 2020 (19).

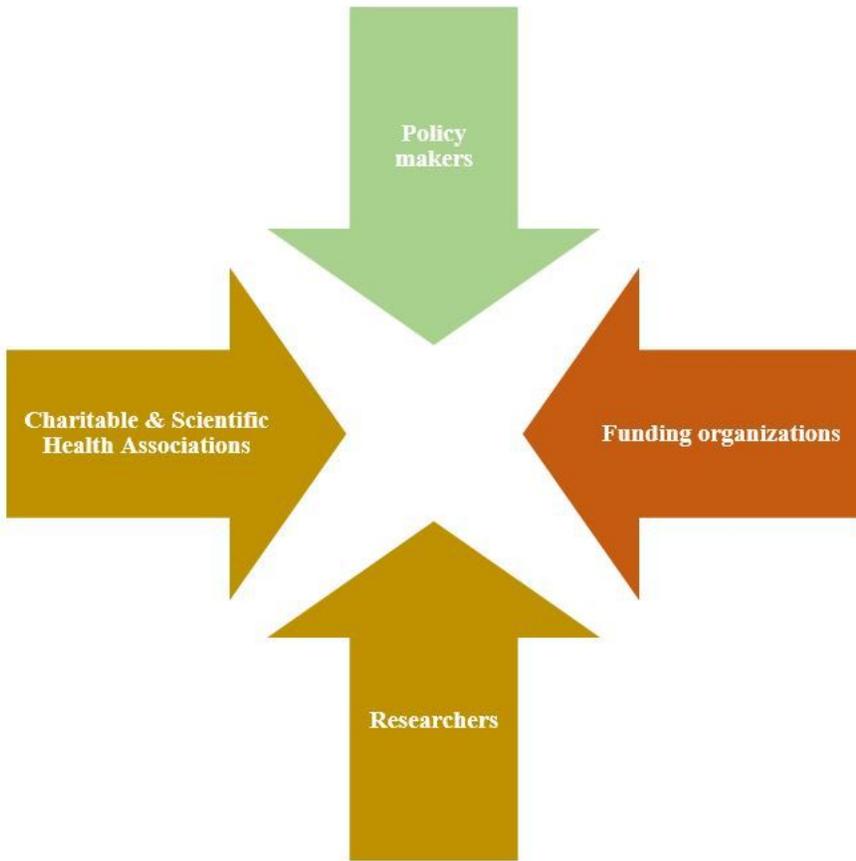


Figure 3

Key health research stakeholders. Adapted from Viergever R and Matsoso MP 2010 (3).



Figure 4

Impact of key stakeholder involvement. Adapted from Bhaumik S et al 2015 and Tomlinson M et al 2011 (22,23).



Figure 5

World Health Organisation six building blocks of Health Systems Framework.

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