



**Assessing the state of health research in the Eastern
Mediterranean Region: towards a regional strategy for
health research**

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ABSTRACT

Member states across the Eastern Mediterranean region face unprecedented health challenges, buffeted by demographic change, a dual disease burden, rising health costs, and the effects of ongoing conflict and population movements – exacerbated in the near-term by instability arising from recent political upheaval in the Middle East. However, health actors in the region are not well positioned to respond to these challenges because of a dearth of good quality health research. This review presents an assessment of the current state of health research systems across the Eastern Mediterranean based on publicly available literature and data sources. The review finds that – while there have been important improvements in productivity in the Region since the early 1990s – overall research performance is poor with critical deficits in system stewardship, research training and human resource development, and basic data surveillance. Translation of research into policy and practice is hampered by weak institutional and financial incentives, and concerns over the political sensitivity of findings. These problems are attributable primarily to chronic under-investment – both financial and political – in Research and Development systems. This review identifies key areas for a regional strategy and how to address challenges, including increased funding, research capacity-building, reform of governance arrangements, and sustained political investment in research support. A central finding is that the poverty of publicly available data on research systems makes meaningful cross-comparisons of performance within the EMR difficult. We therefore conclude by calling for work to improve understanding of health research systems across the region as a matter of urgency.

Introduction

Health systems across the Eastern Mediterranean Region (EMR) stand at a cross-roads. In this strategically significant, natural-resource abundant region, demographic change, a dual disease burden and political and social upheaval all pose unprecedented challenges to health and health care delivery.¹ Our understanding of the nature, extent and determinants of these challenges – as well as the most appropriate interventions to tackle them – is poor, largely due to long-standing under-investment in health research.^{2,3,4,5}

The aims of this paper are two-fold. Firstly, we provide an overview of the current state of health research across the Eastern Mediterranean in a climate of renewed interest on an international level in links between research and health improvement.⁶ Secondly, we outline a health research strategy for the EMR that will direct investment – financial, institutional and political – into this neglected area of health system development, building on recent theoretical work on health system governance. For the purposes of this paper, the “Eastern Mediterranean Region” is taken to include all countries established within the WHO’s Eastern Mediterranean Regional Office, namely: Afghanistan, Bahrain, Djibouti, Egypt, the Islamic Republic of Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, the Occupied Palestinian Territories, Qatar, Saudi Arabia, Somalia, South Sudan, Sudan, Syrian Arab Republic, Tunisia, the United Arab Emirates and Yemen.

Conceptual framework

Recent theoretical work on health research emphasises a systems approach, beginning with the publication of the Commission on Health Research for Development’s first report in 1990,⁷ and latterly in the 2004 WHO World Report on Knowledge for Better Health.⁸ In this view, a health research “system” is understood to incorporate people, institutions and processes that underpin a range of health research activities; the relationship between health research systems and health systems should, ideally, be one of mutual interdependence. This approach has been advocated as a means of explicitly linking health research activity on a national level to health system objectives, with the aim of improving population health.

From an evaluation perspective, the systems approach responds to recognised limitations of methods that have historically been used for monitoring and evaluating health research activities. These have often modeled the

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3 research process as linear, focusing on input (e.g. financial and human resources) and output measures (e.g.
4 publications), at the expense of outcomes such as improved health and more effective health system activity.^{9, 10}

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7 Efforts to operationalise assessments of health research activity from a systems perspective can be divided into
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9 three categories:

- 10 1. Functional: a focus on core activities that a health research system should perform;
- 11 12 2. Process: examines aspects of the research cycle from needs assessment to downstream impact; and
- 13 14 3. Institutional: which focuses on institutions within the system that commission, carry out and utilize
15 research.¹¹

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21 Research system mapping and evaluation efforts have, to date, focused on activity at the national or sub-
22 national level – there is, to the best of our knowledge, no precedent for assessments of health research activity
23 at regional or international levels. This paper provides an overview of the current state of health research across
24 the EMR. Since a detailed, country-by-country analysis is beyond the scope of this review, we have adapted the
25 functional approach used elsewhere for *national* health research systems to incorporate *regional* initiatives as
26 part of a broader system for supporting research. We believe that this provides the fullest overview of all the
27 actors, resources and processes involved in health research at national level, while describing a model that is
28 capable of accommodating activity and initiatives at the regional level and possibly more broadly, internationally.
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39 In doing so, we draw on the clearest articulation of the functional perspective on health research assessment
40 currently available, after Pang and colleagues⁶⁶ who outline four cardinal features of effective health research
41 systems:
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- 43 ▪ Financing – through sustainable and transparent processes for mobilizing and allocating funds for research
- 44 45 ▪ Production and utilization of research – generation of scientifically valid research findings that respond to
46 47 local health challenges, and allow for translation into new tools (e.g. drugs, vaccines) and policies
- 48 49 ▪ Resources – in particular, human and institutional capacity to support research work
- 50 51 ▪ Stewardship – provision of strong leadership to direct, coordinate, manage and review research.

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54 In the discussion that follows, we map the current state of health research across the region using these criteria,
55 highlighting areas of strength and deficiency.
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Methods

This review article is based on findings from a rapid assessment of peer-reviewed literature in PubMed, and searches of grey literature sources held online by the WHO Eastern Mediterranean Regional Office's (EMRO) Index Medicus for the Eastern Mediterranean Region (IMEMR) Database and Google Scholar. We also conducted specific searches (using the same keywords – available on request from the authors) for reports and other literature sources produced by the WHO, United Nations Educational, Scientific and Cultural Organisation (UNESCO), United Nations Development Program (UNDP) and World Bank, as well as Thomson Reuters for data on research productivity from the EMR, before conducting snowball searches for relevant material drawing on citations from sources identified in the first round of results. Due to a dearth of published material on this subject matter, we included a full spectrum of peer-reviewed and non-peer reviewed documents, ranging from empirical research studies to editorials, dissertations and meeting reports. Global sources were consulted for research performance data because of issues of cross-comparability when drawing information from, for example, Health Ministry websites in EMR member states. Studies included were required to have been published after 1995, and to address research activity and performance at either the national or regional level.

Results

Financing

In the Eastern Mediterranean region health and health care research is not seen as a priority in funding terms by governments, the private or third sectors. Investment in research systems is low in comparative terms, as it is for health in general. In fact, available evidence indicates that Research & Development (R&D) funding in the region is among the lowest in the world, notwithstanding considerable Gross Domestic Product (GDP) differences between member states. R&D expenditures average around 0.3% of GDP, 97% of which is publicly provided.

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3 This is well below world leaders such as the UK (1.8%) and Japan (2.8%),^{33,44} Notably, R&D intensity
4 (expressed as the ratio of Gross domestic Expenditure on R&D (GERD) to GDP) is – with the exception of Qatar
5 – lowest among the Gulf States, where much of the regional wealth is concentrated, although raw levels of
6 investment are higher than in their regional neighbours. R&D intensity comparisons between Eastern
7 Mediterranean states as a whole and comparators such as Brazil and India are generally unfavourable (see
8 figure 1). There is evidence of a change of approach in some EMR member states recently, however: public
9 investment in R&D has been increased significantly in Iran (4%, compared with 0.59% of GDP in 2006), Qatar
10 (projected 2.8% by 2012) and Tunisia (1.25%, compared with 0.03% in 1996).^{12,13} The absence of recently
11 gathered data on health-specific research expenditure across EMR member states poses problems in terms of
12 meaningful cross-comparison, however.
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25 Importantly, the review found no reliable data on total funding for health research projects at a regional level, but
26 it is apparent that the WHO Regional Office is the only body offering financial support for funding on a regional
27 level. It does so through three funds offering small grants of up to \$20,000 for health research projects of
28 different types, the majority of beneficiaries thus far coming from Iran, Pakistan, Egypt, and Lebanon.¹⁴
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35 ***Producing and using health research***

36 The effects of systemic underinvestment on research productivity are becoming increasingly apparent. Although
37 volume of published journal papers has well recognized limitations as a proxy indicator for research productivity,
38 raw output from the Eastern Mediterranean is strikingly low when set against international comparators,
39 notwithstanding improvements across the region over the past 10 years.^{15,16} This picture is just as true for the
40 health and biomedical sciences as for scientific research output overall. As Figure 2 indicates, research output in
41 health and allied fields across the region is comparable only with sub-Saharan Africa and South East Asia – but
42 is still some way behind the latter. There are also considerable variations in productivity *within* the Eastern
43 Mediterranean. While Egypt and Pakistan contribute around 60% of all articles logged in Index Medicus for the
44 EMR, Iraq and Tunisia produce just 2.5% and 5.1% respectively, despite high levels of adult literacy and
45 comparatively strong education systems.¹⁷
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3 Assessments of research *impact* are more encouraging – where data are available. Since 1990, the citation
4 impact of papers published in Egypt, Iran, Saudi Arabia and Jordan relative to the world average has increased
5 by around 25%. Jordan and Egypt have been particularly strong performers since 2000. But overall citation
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9 impact for these countries still hovers at around 50% of the world average.¹⁵⁺⁵ And in a ground-breaking
10 international assessment of return on research investment published in 2004, Iran was the only country from the
11 EMR to feature in a study covering the countries of origin for 98% of the world's most highly cited publications.¹⁸
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17 Effective knowledge transfer (KT) of research into policy is, however, a major challenge across the region.
18 Recent findings from the EMR suggest there are problems of both demand for, and supply of, relevant
19 research.^{19, 20} While researchers and policymakers recognize the importance of using evidence in policy,
20 translation is hampered by limited opportunities for interaction during the policymaking process, the absence of
21 institutional and financial incentives to support translation, and concerns over the political sensitivity of research
22 findings. The Iranian model of university-health service integration seems to have brought some dividends in this
23 respect, but evidence suggests that the model needs further refining to help break down enduring barriers to
24 research translation.²¹ In recognition of the deficit in KT, the WHO EMRO established a regional Evidence
25 Informed Policy Network (EVIPNet) in January 2009 to host workshops bringing researchers and policymakers
26 together (see <http://goo.gl/jNnIX> (accessed on 16/08/2012)). Further work is however required, especially on
27 policy-readiness of health research – as exemplified by systematic review output and clinical trial registration.
28 Systematic review output by EMR member state researchers has improved since the mid-1990s, but it continues
29 to lag behind middle- and low-income country comparators.²² Clinical trial registration by member states,
30 meanwhile, has increased strikingly from a very low base in 2004, but this is overwhelmingly due to research
31 activity in one country – Iran.²³
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48 ***Creating and sustaining resources for health research***

49 The limitations of KT systems in the EMR are a product of low levels of financial investment and a predominantly
50 national focus for funding but also of reduced research *capacity* in four key areas. Firstly, human capacity to
51 support good quality health research work in the EMR is underdeveloped. Although the region performs well
52 against selected international comparators in terms of the number of R&D personnel trained (see Figure 3), poor
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3 remuneration and a shortage of appropriate training opportunities to develop research-relevant skills across the
4 EMR have long been recognized. Assessments of skills for health research in the region have consistently
5 identified weaknesses around knowledge of research methods, poor understanding of data analysis techniques,
6 communication skills and computer literacy.²⁴ Perhaps as a consequence of these factors, brain-drain has long
7 been a feature of the R&D landscape in the Eastern Mediterranean, especially among Arab member states.
8 Again, data specific to the health research sector are in short supply, but indicative figures are available: Egypt,
9 Iran, Lebanon, and Algeria fall within the bottom 40 countries worldwide in a World Economic Forum ranking of
10 vulnerability to “brain drain”, although the Gulf States (especially Qatar, Saudi Arabia, the UAE and Oman) score
11 well for work-force retention.²⁵ Arab member states are thought to lose 50% of their newly qualified physicians
12 and 15% of their scientists annually.¹

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25 Secondly, although the region is home to some innovative institutional models for supporting health research,
26 organizational support is generally weak. Low levels of investment are reflected in chronically overburdened
27 higher education systems which are unable to compete internationally. One – albeit controversial – indication
28 comes from the *Times Higher Education* World Ranking of universities, 2011-12, in which only two universities
29 from EMR member states features in the top 400 worldwide (<http://goo.gl/bbBH> (accessed on 16/08/2012)).
30 Exceptions to this pattern include Iran’s integration of university research with health service delivery (instituted
31 in 1984), but recent evidence suggests that this model may have been vulnerable to channeling of funding away
32 from research and into core health service delivery.^{21,26} Some initiatives are now attempting to draw researchers
33 back to the region with offers of generous funding and support on a par with major international research
34 establishments (for example, the King Abdullah University of Science and Technology in Saudi Arabia, and
35 Qatar Foundation’s Education City). However, these are concentrated in the Gulf States where the existing
36 research base is weaker, and in any case health projects form only a fraction of the wider remit of these
37 initiatives.

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52 Thirdly, mechanisms for fostering collaborative research that might address some of the health challenges
53 common to most EMR member states have been slow to develop. The review found little evidence of specific
54 policies intended to foster collaboration on an intra-regional or international level beyond one or two regional
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3 networks (in reproductive health, for example: <http://goo.gl/PIHKD> (accessed on 16/08/2012)), despite the
4 importance attached to this for research capacity-building in low- and middle-income countries by the 2004
5 World Report.⁸⁸ As a result, intra-regional cooperation on health research appears very limited indeed: taking
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7 journal paper co-authorship as a proxy, the review found that, where international collaborators for research are
8 sought, they are overwhelmingly concentrated in Europe and North America (see figure 4).
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15 Finally, effective, public health-oriented research to tackle key challenges facing the region is undermined by the
16 enduring absence of basic population-based surveillance of key health risks (including cardiovascular disease,
17 cancer, mental health and health inequalities), and health system performance data collection. Reliable and
18 above all transparent data collection remains limited or non-existent, even in the wealthier Eastern
19 Mediterranean countries.²⁷ A report published by the WHO EMRO concluded that this was due to “insufficient
20 commitment to the systems, lack of practical guidelines, overwhelming reporting requirements, weak
21 involvement of the private sector, lack of transparency, shortage of human resources, and poor analysis of
22 data”.^{24,24} The effects of this are often directly observable in scientific output; recent systematic reviews of
23 epidemiological work on chronic disease prevalence in the Gulf region, for instance, have noted considerable
24 variations in the quality of available observational studies, including inadequately describe population
25 characteristics, variable risk factor definitions, and failure to report confidence intervals for prevalence
26 estimates.²⁸
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43 **Stewardship**

44 Evidence examined for this review demonstrates clearly that research governance is a key area for development.
45 A 2008 WHO Eastern Mediterranean Regional Office (EMRO) study revealed that, of ten countries examined
46 only four had national governance structures for health research systems, two had dedicated national health
47 research policies, and three had identified national research priorities.³³ National-level ethical oversight
48 committees are present in a majority of EMR countries, but administrative and financial support for their work is
49 often lacking. A recent survey found that only 21% of respondents from national ethical committees across the
50 region had received any formal ethics training,²⁹ reflecting broader limitations in ethical training and
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3 understanding among the EMR health research community at large.³⁰ National academies of science which – as
4 advocates for science and impartial advisory bodies – have played a leading role in the development of scientific
5 research establishments in the United States, United Kingdom, and France for many years, are striking by their
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9 absence.¹³⁴³

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12 In the absence of strategic capacity, prioritization and coordination of health research initiatives is difficult and
13 responsiveness to local population health needs is reduced. It also makes effective oversight and performance
14 management of health research systems impossible because key benchmarks of performance are not available
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17 on a system-wide scale; of the ten countries examined in the above study,³³ just one had an established
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20 monitoring and evaluation processes in support of its national health research system.
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27 **Discussion**

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29 The review findings show that sustained under-investment in health research on a national level across the EMR
30 has given rise to critical skills shortages, weak capacity and comparatively low research productivity. Viewed
31 alongside the limitations of basic public health surveillance systems, these problems impose major constraints
32 on the capacity of governments and non-governmental organisations (NGOs) to address unprecedented health
33 challenges that member states face. Building sustainable, national research systems to support knowledge
34 transfer for improved health is one of the defining challenges facing governments across the region. The
35 imperative for an effective *regional* strategy for health research to help support national health research system
36 development is stronger than ever – a problem to which we turn below.
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47 **Limitations and caveats to the study**

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49 Some important limitations to the current study should be emphasized, however. First, data collection was based
50 exclusively on a review of literature and publicly-available data sources and may not have captured the full range
51 of local activities underway across the region. Our sense from the material reviewed was that many *ad hoc*
52 arrangements exist, and further work is needed to capture lessons learned from them. Secondly, often only
53 aggregate data on research system performance across all scientific disciplines was available. Caution is
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3 inevitably required in drawing lessons from this that may be applied to health research specifically. Third, in the
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5 absence of better data on health research in the EMR, we have included some indicators that can be regarded
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7 as crude proxies for research performance (e.g. raw journal paper output). Implicit in this review, therefore, is an
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9 urgent call for improved data collection on health research performance in the round.
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11 12 13 14 15 ***Towards a comprehensive strategy for health research in the EMR***

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17 Although each member state will wish primarily to pursue national policies to support health research (as, indeed,
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19 some already are) there exists an important opportunity for supranational organizations and groupings to steer
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21 improvements in health research in the Eastern Mediterranean, through a regional strategy.
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25 A central goal of the strategy should be to encourage more effective research **stewardship** in the EMR. The
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27 review found evidence that few member states had adopted national plans or strategies for health research and
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29 ethical oversight – while present – was often rudimentary. We also found some important examples of innovative
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31 approaches to health research governance – notably Iran’s integration of university research with health service
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33 delivery – that merit closer evaluation as possible models for replication elsewhere. Regional organizations like
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35 WHO EMRO can play an active role in improving stewardship through education, training in research
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37 management and monitoring.
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41 Second, there must be greatly improved mobilization of **funding** for health research across the EMR. The review
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43 found that Iran, Qatar and Tunisia are leading the way in boosting public funding for research. However, overall
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45 investment remains low and the absence of effective regional mobilization on common health problems is a
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47 concern given that financial resources in many member states are limited. The strategy should outline the case
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49 for pooled funding on a regional level to support research in key areas of need – drawing on contributions from
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51 international donors, governments, the private and third sectors. In the case of state funding for research, the
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53 strategy should highlight the need for re-balancing domestic political priorities to permit increased spending on
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55 research systems, given strong evidence linking R&D to increased economic productivity.⁸⁸
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3 Third, the strategy should emphasize the critical importance of **creating and sustaining resources** for research.
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5 In the near term, this will depend on increased investment in the chronically under-funded higher education
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7 sector. Collaborative work has a key role to play in boosting return on investment and more needs to be done to
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9 incentivize this both through existing regional funding schemes (e.g. via WHO EMRO) and new ones supported
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11 by international donors that emphasise South-South, rather than exclusively North-South, collaboration. The
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13 Reproductive Health Network already in place may provide a useful model for further cross-country networking
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15 by health researchers, but networks are difficult to operationalise without financial and administrative support.
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19 **Effective production and utilization** of health research represents perhaps the most difficult challenge over the
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21 long term, since it is fundamentally dependent on improvements in the other three areas, and will likely require
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23 greater transparency in the policymaking process than has hitherto been the case in many member states. The
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25 EVIPNet initiative is a significant development, and we encourage sustained support for it as platform for
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27 exchange and identification of good practice.
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31 Finally, the strategy should foster cross-regional data collection as a matter of urgency. Two key findings from
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33 our assessment of health research in the region conclude that: (1) there are many areas in which we simply do
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35 not know how research systems are performing, and (2) there is a particular difficulty in teasing out data on
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37 health research from aggregate information on R&D across all disciplines. If health research performance is to
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39 better meet the needs of populations in the EMR, improved tracking and analysis of research systems and
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41 productivity must be prioritized, starting with a full, cross-regional mapping exercise along the lines of the Health
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43 System Observatory (<http://goo.gl/GGTJ9> (accessed on 16/08/2012)) launched by WHO EMRO some years ago.
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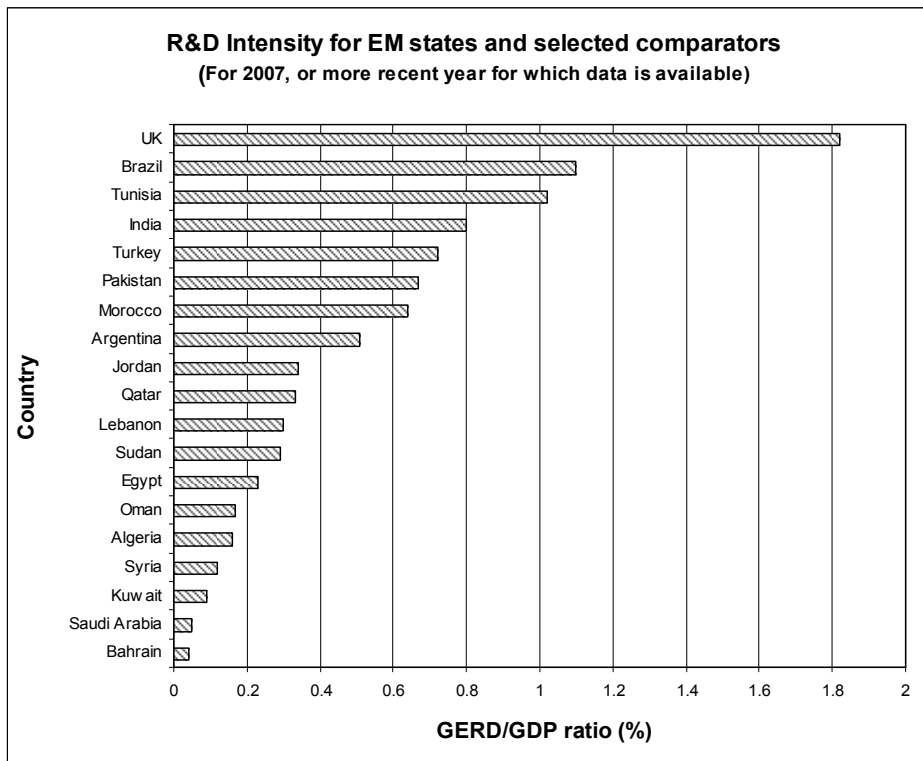


Figure 1: R&D intensity in 2007 (or more recent year for which data was available) for Eastern Mediterranean states and selected comparators (GERD = Gross domestic Expenditure on R&D). Source: UNESCO Science Report, 2010.

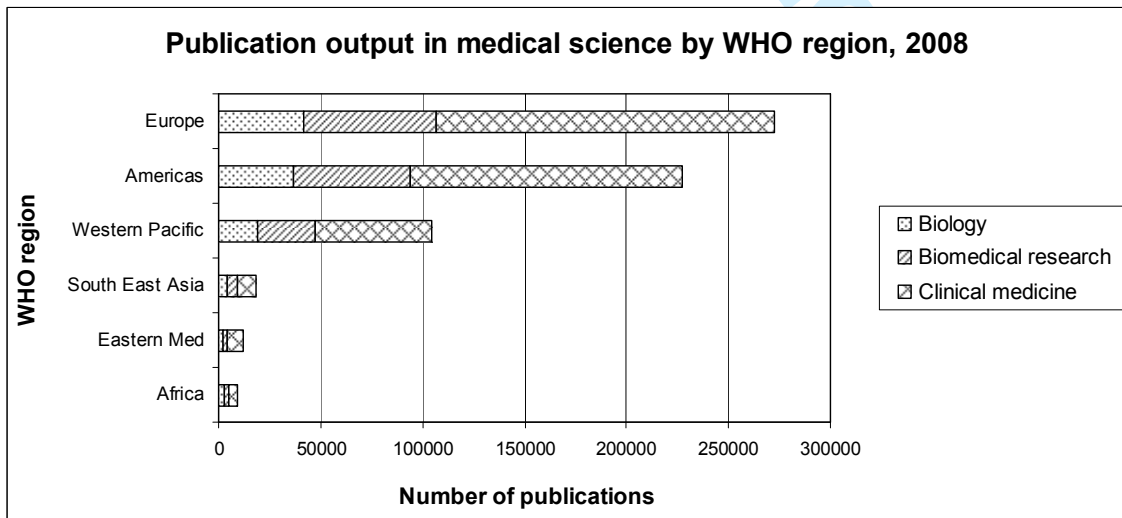


Figure 2: Research output in raw publication terms for medical and allied research by WHO region, 2008. Source: UNESCO Science Report, 2010.

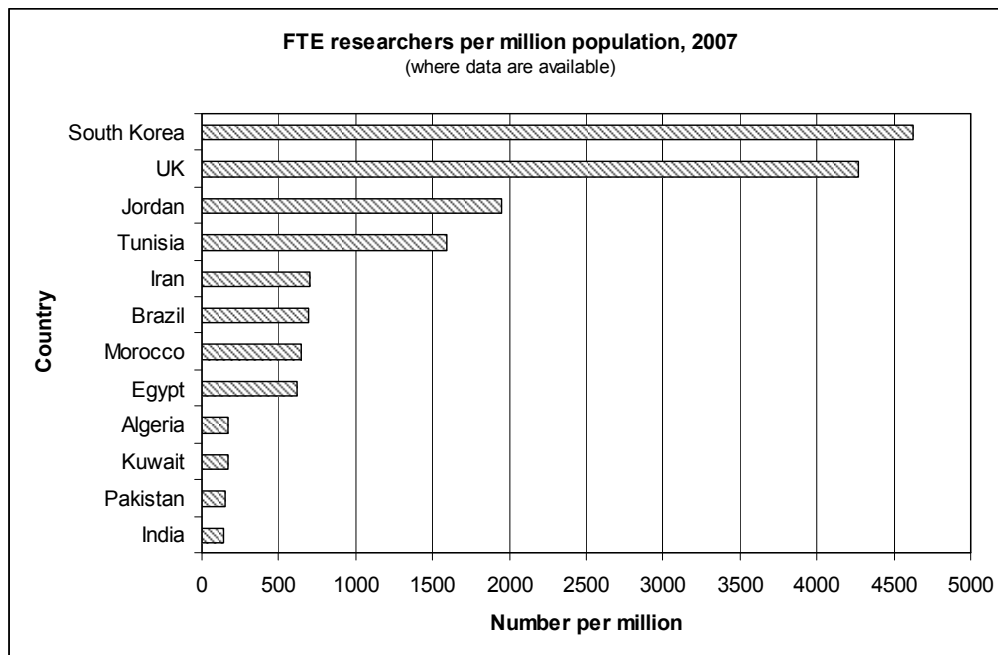


Figure 3: Number of full-time equivalent (FTE) researchers per million of population in selected EMR member states (where data were available) in 2007. Source: UNESCO Science Report, 2010.

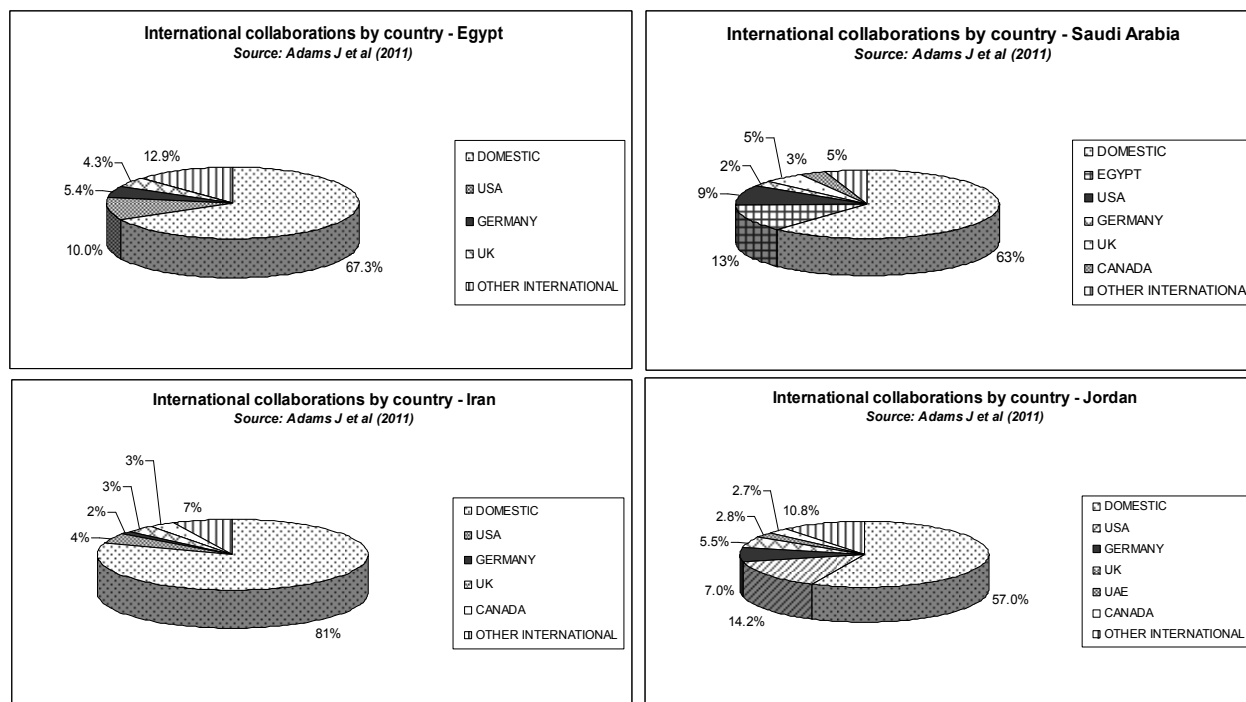


Figure 4: sources of international collaboration for papers published in Egypt, Iran, Jordan and Saudi Arabia. Source: Adams et al (2011).

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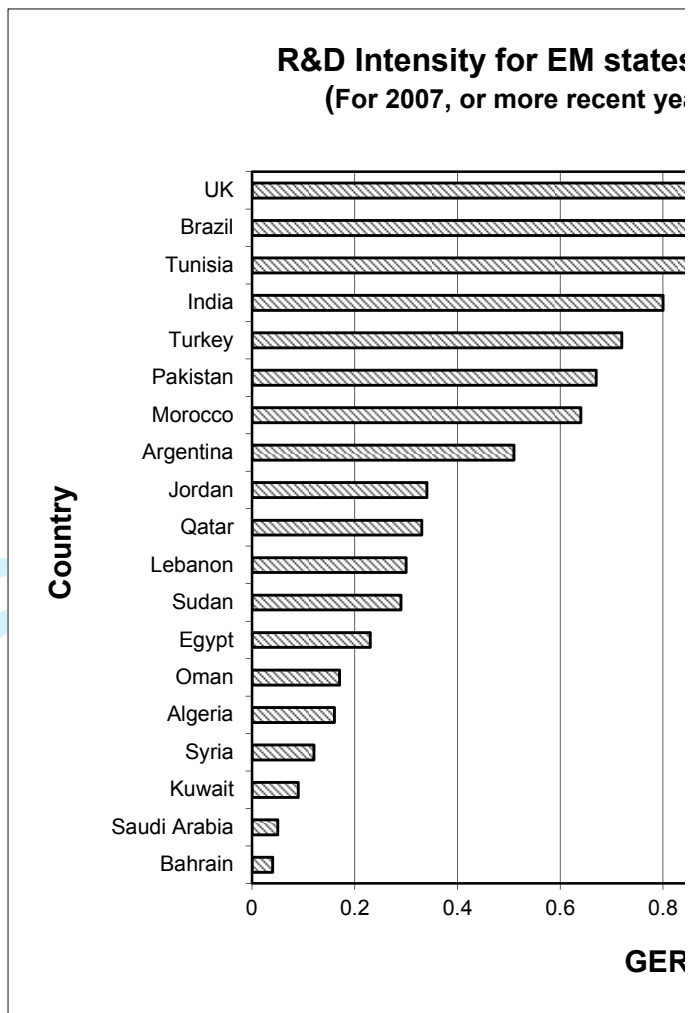
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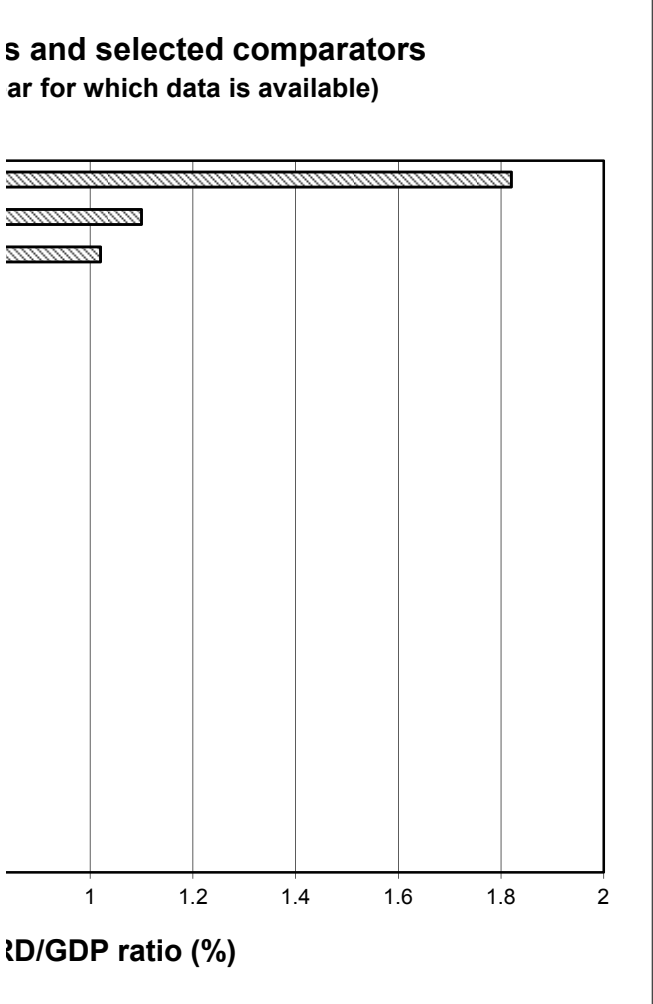
R&D intensity (GERD/GDP) - 2007 or latest year available

Country Value

Bahrain	0.04
Saudi Arab	0.05
Kuwait	0.09
Syria	0.12
Algeria	0.16
Oman	0.17
Egypt	0.23
Sudan	0.29
Lebanon	0.3
Qatar	0.33
Jordan	0.34
Argentina	0.51
Morocco	0.64
Pakistan	0.67
Turkey	0.72
India	0.8
Tunisia	1.02
Brazil	1.1
UK	1.82



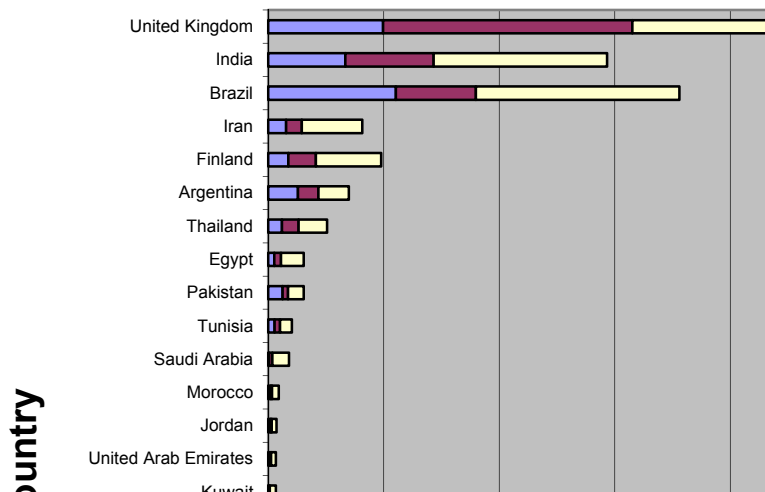
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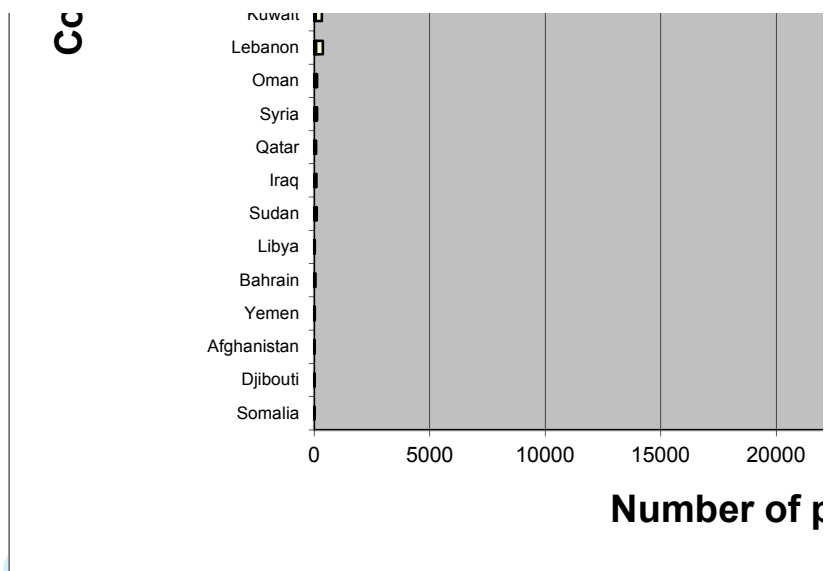
Review

Country	WHO REG	WHO COU	Biology		Biomedical research		Chemistry	
			2002	2008	2002	2008	2002	2008
Somalia	EASTERN	Somalia	–	–	–	–	1	–
Djibouti	EASTERN	Djibouti	–	–	1	–	–	1
Afghanistan	EASTERN	Afghanistan	–	–	–	–	3	–
Yemen	EASTERN	Yemen	4	3	3	3	1	6
Bahrain	EASTERN	Bahrain	3	8	2	8	6	3
Libya	EASTERN	Libya	3	6	5	3	7	19
Sudan	EASTERN	Sudan	19	25	7	22	4	5
Iraq	EASTERN	Iraq	7	12	–	10	11	24
Qatar	EASTERN	Qatar	3	3	2	19	4	10
Syria	EASTERN	Syria	30	75	4	19	13	14
Oman	EASTERN	Oman	22	30	10	16	21	24
Lebanon	EASTERN	Lebanon	16	34	30	57	16	37
Kuwait	EASTERN	Kuwait	15	22	63	55	37	57
United Arab Emirates	EASTERN	United Arab Emirates	14	32	33	91	25	29
Jordan	EASTERN	Jordan	46	100	39	51	61	126
Morocco	EASTERN	Morocco	99	107	49	62	220	155
Saudi Arabia	EASTERN	Saudi Arabia	43	44	62	134	137	157
Tunisia	EASTERN	Tunisia	63	283	63	230	115	196
Pakistan	EASTERN	Pakistan	135	628	60	230	179	542
Egypt	EASTERN	Egypt	192	259	146	295	672	861
Thailand	SOUTH EAST ASIAN	Thailand	261	591	202	730	216	491
Argentina	AMERICAS	Argentina	826	1287	664	883	536	669
Finland	EUROPE	Finland	755	871	1057	1189	562	591
Iran	EASTERN	Iran	150	772	129	681	645	2198
Brazil	AMERICAS	Brazil	1572	5526	1583	3467	1656	2390
India	SOUTH ASIAN	India	1579	3339	1901	3821	4552	7163
United Kingdom	EUROPE	United Kingdom	4515	4975	9586	10789	5469	5352

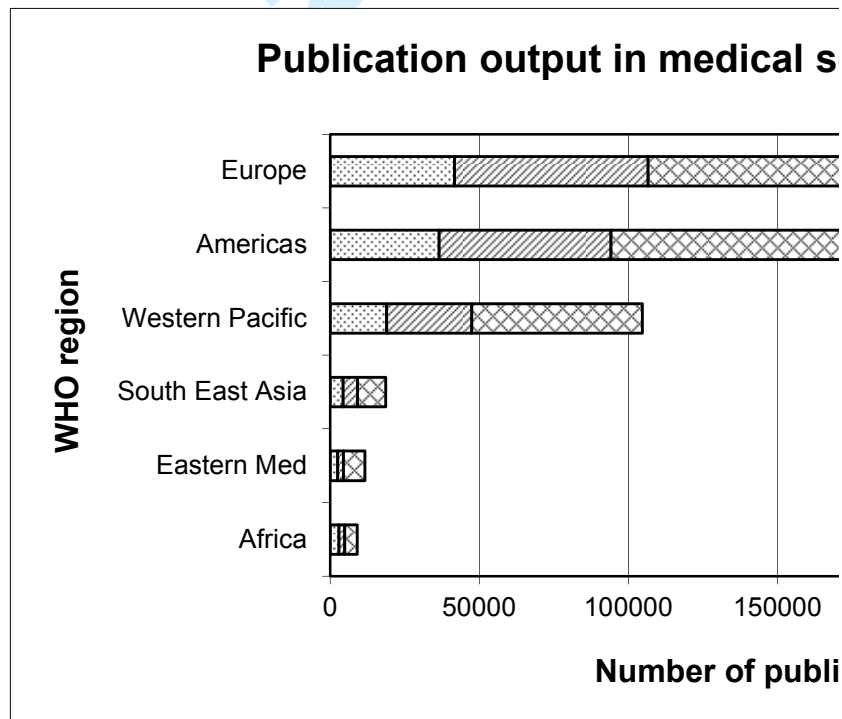
Number of publications by selected country



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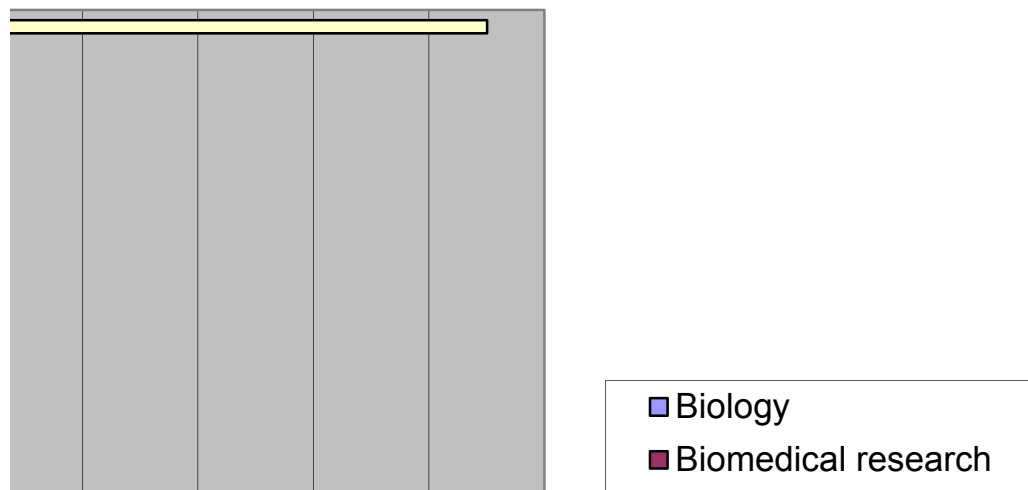


	Biology		Biomedical research		Chemistry		Clinical medicine	
Country	2002	2008	2002	2008	2002	2008	2002	2008
Africa	2002	2954	901	1934	531	811	2318	4175
Eastern Me	864	2444	707	1990	2174	4464	2760	7225
South East	2089	4342	2252	4798	4844	7793	4251	9392
Western Pa	11646	18934	17966	28485	24227	40353	37021	57202
Americas	25155	36472	49463	57604	22964	26600	98554	133118
Europe	28650	41702	53128	64924	48046	54236	121840	165495

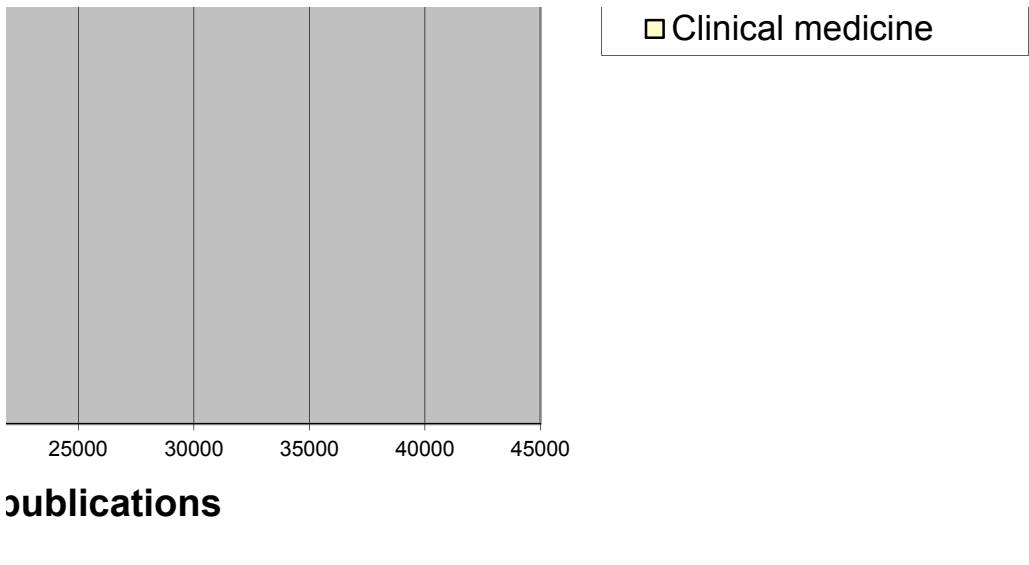


	Clinical medicine		Earth and space		Engineering and Tech		Maths	Physics	
	2002	2008	2002	2008	2002	2008	2002	2008	2002
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7	1	-	-	-	-	-	-	-	-
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9	-		12	-	1	-	-	-	-
10	13	21	1	5	6	8	2	2	1
11	17	38	3	4	6	16	3	5	3
12	12	22	5	9	6	31	-	2	4
13	47	73	1	5	6	10	-	1	8
14	24	73	-	9	15	27	1	5	5
15	18	70	2	5	14	45	1	10	3
16	16	39	9	13	14	20	3	5	13
17	72	79	16	35	60	75	17	19	19
18	150	285	19	33	38	86	9	19	34
19	165	259	14	27	114	137	25	30	15
20	97	213	20	46	88	175	28	30	22
21	130	211	34	75	115	222	20	64	66
22	232	292	93	133	111	151	85	127	182
23	627	723	28	63	280	329	52	151	100
24	160	512	30	106	143	377	80	138	93
25	131	685	38	102	61	293	12	141	87
26	478	992	111	205	510	714	121	167	339
27	580	1227	80	178	229	607	18	65	50
28	1078	1316	407	631	362	487	118	229	728
29	2562	2835	501	709	808	955	157	226	759
30	369	2626	57	433	390	2484	97	554	265
31	3243	8799	657	1028	1259	2209	398	708	2205
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Research subject for EM countries and comparators, 2008



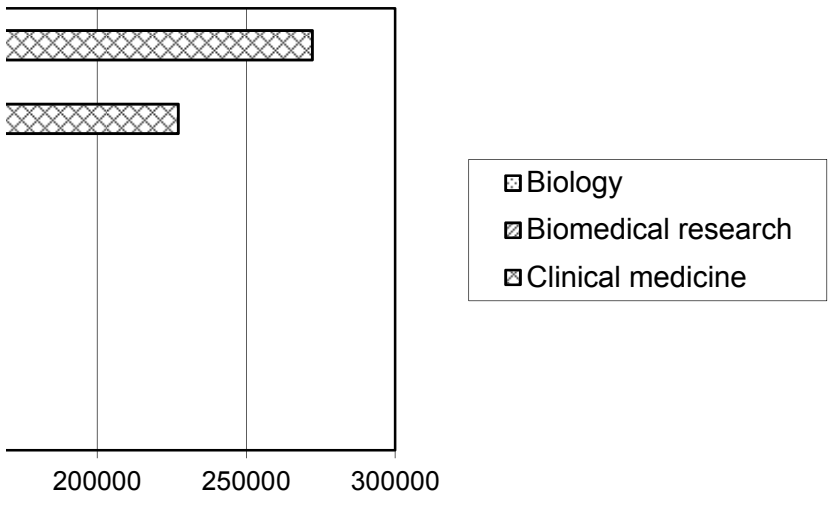
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Publications

Earth and space		Engineering and Tech Maths		Physics		Total	
2002	2008	2002	2008	2002	2008	2002	2008
704	1091	533	1106	208	478	738	7661
481	1309	1977	5200	556	1470	2784	10778
1346	2731	3331	6942	547	1067	5413	21679
7447	14240	28062	47083	4673	9358	41729	158232
20051	27163	30413	39281	8782	12770	34626	285904
28128	42324	46300	63413	14324	22238	74401	407927

Science by WHO region, 2008



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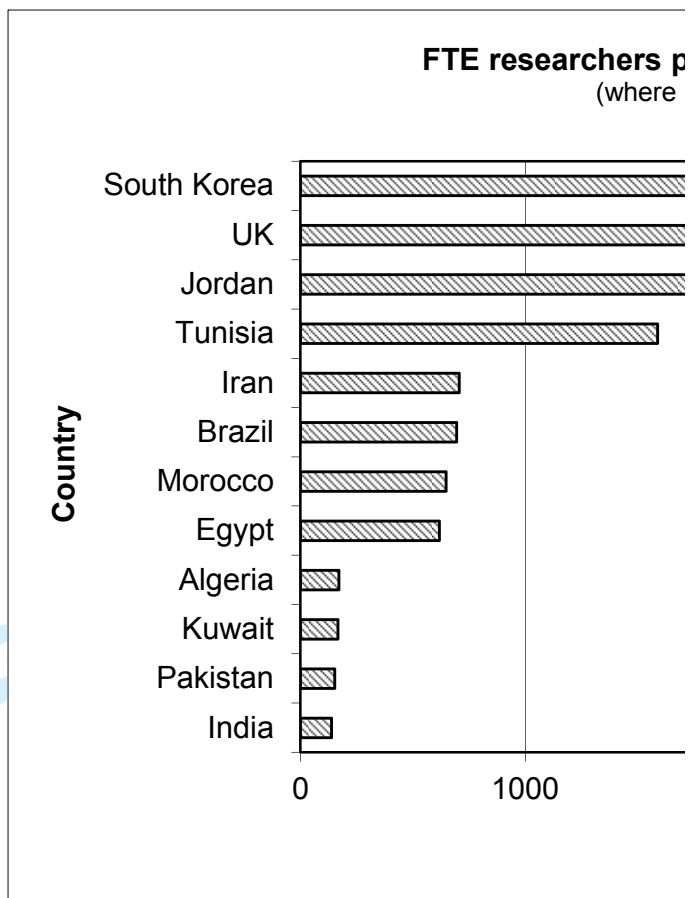
	Total		
	2008	2002	2008
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	8	31	56
	16	43	98
	8	42	100
	5	92	146
	24	63	184
	33	47	195
	13	102	198
	37	237	315
	40	312	591
	20	448	607
	44	327	660
	79	511	928
	140	1071	1167
	144	1329	1745
	184	747	2026
	373	703	2994
	470	2569	3963
	245	1636	4134
	695	4719	6197
	952	7161	8328
	1146	2102	10894
	2355	12573	26482
	5036	18911	36261
	7544	61073	71302

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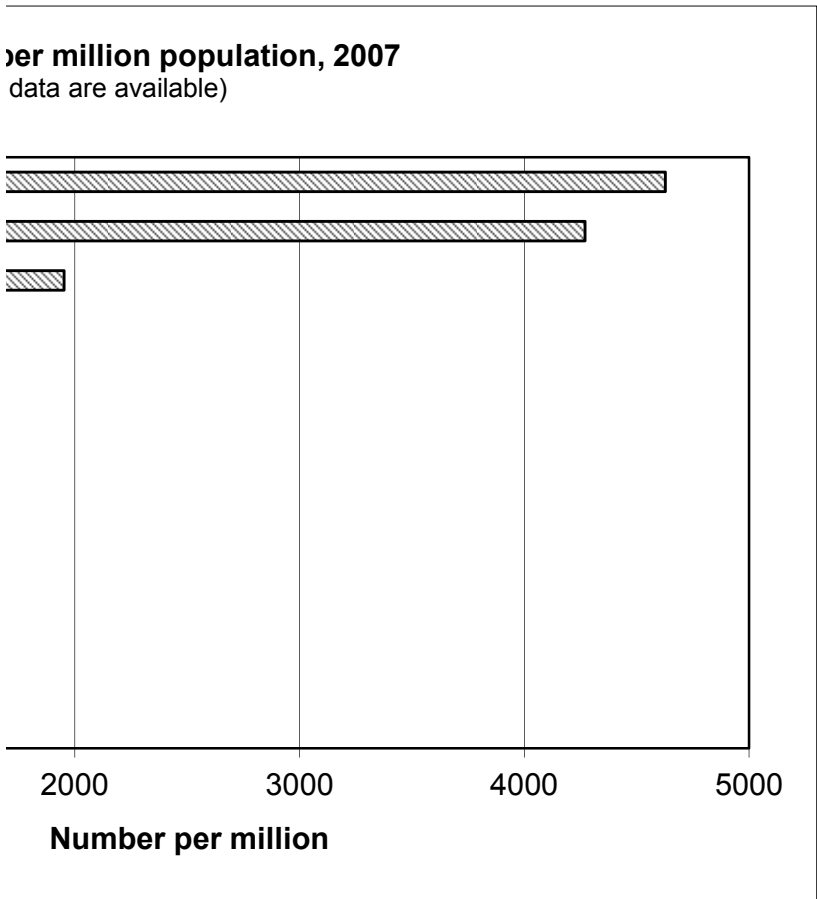
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Under Review

Country	FTE resear	Years +/- 2007
India	137	0
Pakistan	152	1
Kuwait	166	-9
Algeria	170	-1
Egypt	617	-1
Morocco	647	1
Brazil	694	-1
Iran	706	0
Tunisia	1588	-2
Jordan	1952	0
UK	4269	-1
South Kore	4627	-2



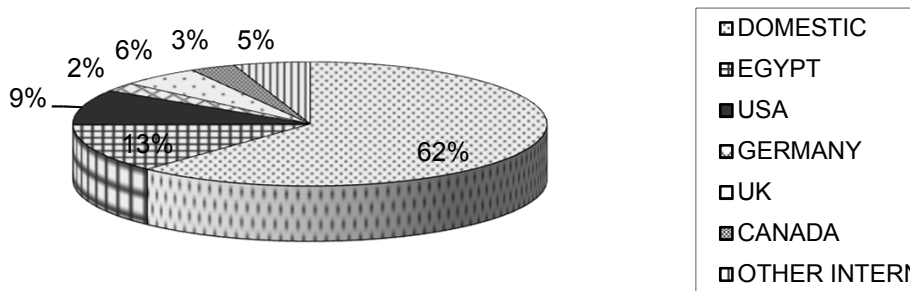
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Review

	DOMESTIC	EGYPT	USA	GERMANY	UK	CANADA	OTHER	INTERNATIOI
EGYPT	61		9.1	4.9	3.9		11.7	100
TUNISIA	49.8		2.8		2.1		7.5	
JORDAN	57		14.2	7	5.5	2.7	10.8	
IRAN	79		4.3	1.7	3.3	3.1	7	
SAUDI AR	62	12.8	9.2	2.3	5.4	3.1	5.2	100

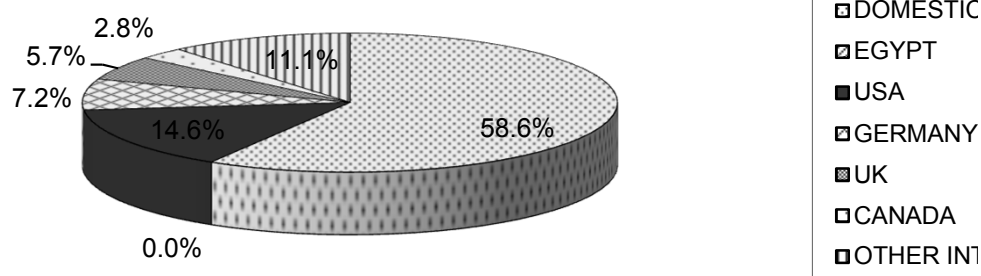
International collaborations by country - Saudi Arabia
 Source: Adams J et al (2011)



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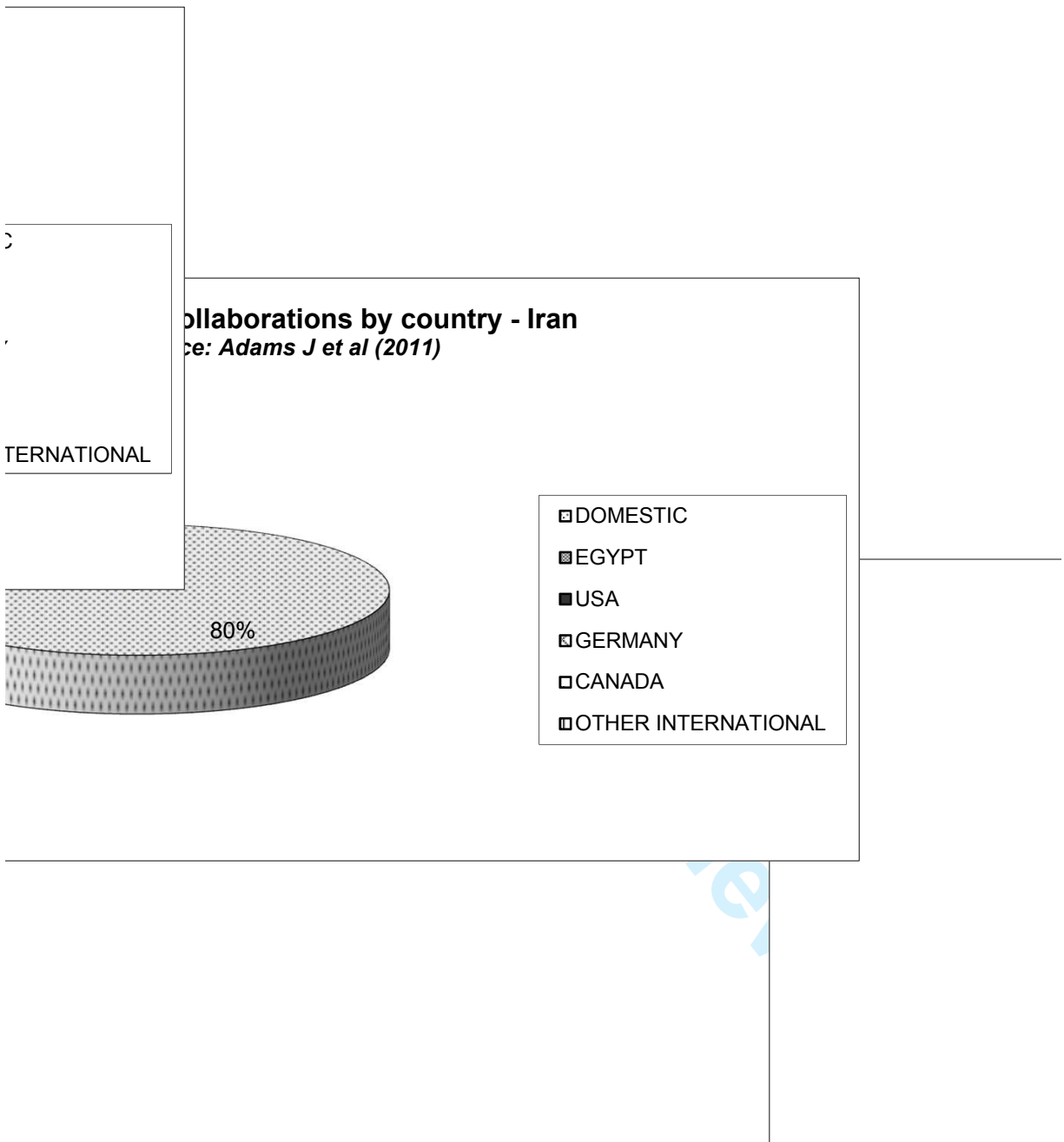
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International collaborations by country - Jordan
Source: Adams J et al (2011)



NATIONAL

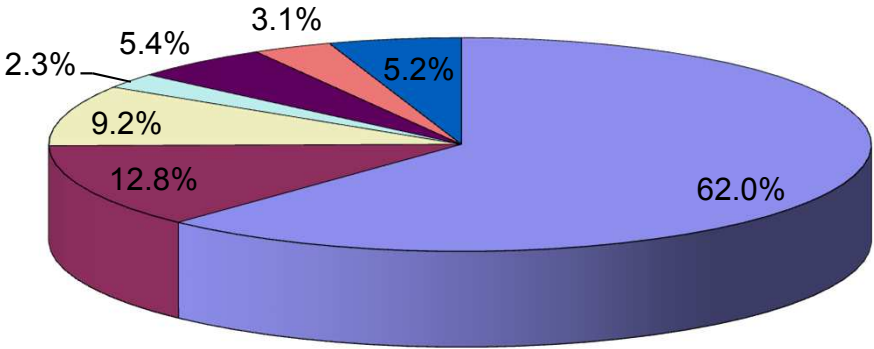
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Und

International collaborations by country - Saudi Arabia
Source: Adams J et al (2011)



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Under Review

- DOMESTIC
- EGYPT
- USA
- GERMANY
- UK
- CANADA
- OTHER INTERNATIONAL