Nutrition Research in India: Underweight, Stunted or Wasted?

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Abstract

Background—India has experienced dramatic economic growth in the past two decades accompanied by a rising burden of non-communicable diseases (NCDs), which co-exists with the unfinished agenda of under-nutrition. Tackling these dual challenges requires strong investment in nutrition research.

Methods—We compared India’s research output with another rapidly developing country (China) and an established developed country (USA). We analyzed trends for each country between 2000–2005 and 2006–2010, in terms of quantity (measured by number of publications in PubMed) and quality (measured by weighted impact factor, using Journal Citation Report [JCR]) of the publications identified. The number of articles in each journal was multiplied by each journal’s most recent impact factor (2009) to determine each country’s “Journal Impact Factor”. All “Journal Impact Factors” were summed to obtain the overall “Country Impact Factor”. The relative contribution of each country to the top ten nutrition journals in the world (JCR Science Edition 2009 impact factor) was also computed.

Results—India produced 2,712 articles (1.9% of the global total) in 2000–2005 and 3,999 articles (2.1%) in 2006–2010. In comparison, China produced 5,146 articles (4.7%) and 10,982 (5.8%), and the USA 42,089 (26.0%) and 47,408 articles (25.2%), respectively, in 2000–2005 and 2006–2010. The “Country Impact Factors” for 2000–05 and 2006–10, respectively, were 191 and 174 for India, 96 and 360 for China, and 10,675 and 11,293 for the USA. The contributions to the top 10 nutrition journals during 2006–10 were 1% (India), 1.4% (China), and 29% (USA). India’s nutrition research output remains very small, albeit modest gains have occurred in the past 5 years.

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Author Contributions:
SK, KRS and KMV- designed the study
SK- performed the extractions
KRS- analyzed the data
SK, KRS and KMV wrote and revised the paper.
Conclusions—Based on the low numbers of publications from India, we suggest that India must increase investment in and attention towards quality nutrition research. Further, India should urgently address potential barriers to publish by promoting curriculum changes, training, mentorship, attractive opportunities for young investigators, and academic partnerships with developed countries.

Keywords
nutrition; global health; research capacity; policy; publications

BACKGROUND

India is undergoing rapid economic growth and development [1]. Despite this positive trend, India remains burdened with an unfinished agenda of under-nutrition and communicable diseases on the one hand, and a burgeoning epidemic of over-nutrition and non-communicable diseases (NCD) on the other.

Addressing this dual burden of over- and under-nutrition is critical to achieving improved health and sustained economic growth throughout India, and nutrition research is key to effectively tackling the challenges [2]. For example, there is evidence that poor health resulting from nutritional deficiencies can perpetuate poverty and undermine economic growth [3,4]. The Copenhagen Consensus noted that nutrition interventions generate returns among the highest of 17 potential development investments [5]. Furthermore, investment in research is a cost-effective way of improving health [6]. Previous studies suggest a deficiency in India’s research output in the fields of science and public health [7–11], however no studies have specifically examined the country’s research output in nutritional sciences.

Here, we analyze trends in India’s nutrition research output from 2000–2005 and from 2006–2010, in terms of quantity (measured by number of publications) and quality (measured by impact factor) and compare it to China, another rapidly growing emerging economy facing similar dual health threats, and the USA, a developed country with a well-established field of nutrition research [12]. The disease burden related to nutrition is high in all these three countries. While India and China grapple with the dual burden of malnutrition [13–15], USA is in the midst of an obesity epidemic, where no state has a prevalence of obesity less than 20% [16]. The USA’s food consumption trends are often implicated as the leading drivers of the epidemic. Given that malnutrition (including over and under nutrition) is largely preventable, it is of interest to assess and compare the research energy devoted to these issues, in the form of research outputs (i.e. publications).

METHODS

We used three measures of research output: (a) the total number of nutrition publications for India, China and USA in the last decade (using PubMed); (b) contribution in the top ten nutrition journals (using Journal Citation Reports); and (c) quality of those published papers (using country wise aggregated Impact factor) in the top 10 nutrition journals.
To tally the number of publications during each five-year period (2000 – 2005) and (2006 – 2010), we performed a search of all “nutrition” categories in the Medical Subject Headings (MeSH) database under the Pubmed homepage (http://www.ncbi.nlm.nih.gov/mesh). This yielded 31 MeSH terms out of which those relevant to humans only (n=27) were selected (Box 1). The results yielded were then categorized into the 3 countries of interest (India, China and US) based on the corresponding author’s affiliation/country provided in the address bar. The rest (other than those from the 3 countries) were excluded. Using Excel 2007 and EndNote X4, a dataset was created which compiled, tabulated and summarized all extracted publications. Even though the same terms may have been differently weighted in terms of research priorities in the 3 countries, for consistency and fair comparability, the same search terms and criteria were used to compare the number of publications across the three countries. The obtained results (number of publications) country wise are tabulated.

### Box 1

**Search strategy and selection criteria**

**Database:** PubMed

**Date search done:** 30 Nov 2010


To measure the relative quality of India’s nutrition research, we assessed each country’s research output in the top ten nutrition journals in the world according to the 2009 impact factor rankings by Journal Citation Reports (JCR) citation index (JCR Science Edition, 2009). (Table 1) Under JCR Science edition 2009, the most appropriate subject category available was selected to represent the field of nutrition (“Nutrition & Dietetics”). The top 10 journals under this category based on the impact factor ratings were selected. Each journal name was then added to the existing search builder (Box 1). The number of articles in each journal from each country in the specified duration was multiplied by the journal’s most recent individual impact factor (2009) to get each country’s “Journal Impact Factor” (JIF). These JIFs were totaled to determine each overall “Country Impact Factor” (CIF). Thus for each country, we computed two CIFs – one for 2000–2005 and 2006–10. An example is illustrated below (Box 2). The computation of aggregated CIF can be seen as a superior measure than reporting overall mean impact factor of all journals because the former allowed taking the number of publications too into account. This is important because summing the product of both quantity (number of publications) and quality (Impact factor of the journal) for each country gave a comparable picture and allowed to make inter-country comparisons for the same journal and across the top 10 journals.

**Box 2**

An example to illustrate computation of Country Impact factor (CIF)

Calculation for one country, one journal - India:

American Journal of Clinical Nutrition- Impact Factor=6.307

India’s contribution (nos.)

(2000–5) = 24

(2006–10) = 20

JIF (2000–5)= 6.307* 24

Similar calculation for each journal (ie no of articles retrieved in that journal in the specified duration * impact factor of that journal). Add all JIFs and we get the CIF (2000–5)

Similarly for 2006–10….

JIF (2006–10)=6.307*20

Add all JIFs and we get the CIF (2006–10)
To account for the fact that country-specific journals may be more likely to publish articles from their own country, and since many of the top nutrition research journals are USA-based, we also examined selected common nutrition journals from other regions: the European Journal of Clinical Nutrition (EJCN), Asia Pacific Journal of Clinical Nutrition (APJCN), and the British Journal of Nutrition (BJN).

RESULTS

Figure 1 shows the nutrition research output and JIFs and CIFs for India, China and the USA. Together, the countries produced approximately one-third of global nutrition research output. India produced 2,712 articles (1.9% of the global total) in 2000–2005 and 3,999 articles (2.1% of the global total) in 2006–2010. In comparison, China produced 5,146 articles (4.7% of global total) in 2000–2005 and 10,982 (5.8% of global total) in 2006–2010 and the USA published 42,089 articles (26% of global total) in 2000–2005 and 47,408 articles (25.2% of global total) in 2006–2010. (Table 1)

Similarly, the CIF for the USA was far higher than that for China or India. India’s CIF was 191 in 2000–2005 and 174 in 2006–2010, while China’s was 96 and 360 and the USA was 10,675 and 11,293 in 2000–2005 and 2006–2010, respectively.

Table 2 shows the contributions from India, China and the USA in the top ten nutrition journals in the world (based on 2009 JCR ranking). The USA contributed a much larger percentage than either India or China to the top ten nutrition journals. Of note, while India’s contribution stayed roughly the same between 2000–2005 and 2006–2010, China’s contribution tripled (from 0.3% to 1.4%). A similar pattern was found when examining the European and British nutrition journals. The USA contributed approximately 10% of articles (11% in EJCN 6.9% in BJN), while India and China contributed significantly lower proportions (1.6% and 2.2% of articles in EJCN; 2.1% and 2.4 % of articles in BJN, respectively). Interestingly, in APJCN, China contributed a larger percentage (13.9%) while India only contributed 4.7%, as compared to the USA’s contribution of 9.2% of articles.

DISCUSSION

Our data reveal that India’s nutrition research output is small and has remained relatively unchanged over the past decade. In 2000–2005 and 2006–2010, India contributed only 1% of global nutrition research, while China rose from a mere 0.3% (2000–2005) to 1.4% (2006–2010). In comparison, the USA contributed roughly one-third of global research in nutrition during both time periods.

Our analysis has several limitations. First, measuring research output in terms of number of research publications may ignore other forms of output, such as training students and building capacity, implementing community interventions, engaging in advocacy, or working with stakeholders to implement policy and change practice. However, publications are often viewed as a key marker of academic success and productivity. Second, PubMed archives few Indian journals. Thus, our analysis may have underestimated the actual number of publications from India. However, the fact that only a few Indian journals are indexed in PubMed may suggest limited existing research infrastructure, quality, and output, and

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inadequate integration of Indian researchers into the global nutrition field. Third, selection of the top ten nutrition journals based on 2009 impact factor alone may also induce some bias. However, comparing the same parameters for all three countries using same methodology may provide some balance to this approach. The measure of an overall impact factor for each country computed by adding up the products of number of publications and JIF may not be the only approach, but broadly presents a comparable picture. Few other limitations to be noted while interpreting our results include the publication bias in the compared countries, time points selected and the attempt to address research efficiency with mere scientific publications.

Based on our understanding, there are several reasons for India’s limited nutrition research. Poor allocation of resources, infrastructural issues, hierarchical and non-progressive education system, vested interests and bureaucracy and an overall lack of research culture may all play a role. In particular, low allocation of resources to education and research is a major problem in India [17,18]. For example, India only allocates 0.8% of its GDP to research and development (R&D), while developed countries generally budget more than 2.7% to such endeavors [19]. Despite efforts by the Indian Government to promote higher education, the percentage of India’s GDP spent on higher education remains low at 0.37%, compared to 1.41% in the USA and 0.50% in China [20]. India’s meager financial investment can be seen in its small number of public health schools (4 schools in 2008). In contrast, there are 72 established public health schools in China and 147 in the USA. Even in Indian academic institutes of higher education that do exist, research infrastructure in libraries, information technology, laboratories and classrooms tend to be inadequate. These inadequacies can create a cycle of under-investment in research, in which the most talented (and productive) students and professionals seek opportunities abroad, and the institutions, faced with a dwindling student body and a shrinking research output, simply cannot afford to attract – or retain – quality researchers [21–24]. As a result, Indian nutrition and public health institutions simply cannot compete with institutions abroad, and thus have limited presence in global rankings [11, 21, 25].

Additionally, India’s educational style remains a barrier to promoting research output [20]. Teaching styles remain didactic and non-progressive, with little encouragement for students to think independently, creatively, or critically, or to question the status quo [23,24]. Curricula fail to infuse interdisciplinary approach, analytical strengths, and effective written and verbal communication skills, which together form the basis of sound research and good quality publications [26–31]. Paucity of skilled mentors, and the absence of a “research culture” that can provide protected time for fostering research and writing skills also contributes to poor research output. Fear of criticism, lack of confidence and language barriers may also play a role [7,8]. India’s Prime Minister, an economist by training, lamented the control that vested interests have on scientific innovation in India, and highlighted excessive bureaucracy and in-house favoritism as the two main reasons, preventing Indians from becoming leaders in science and technology [32].

Current curricula in India reflects a disconnect between educational priority-setting and real-world health challenges, whereby current students are not actively exposed to the links between research and policy, nor to the real-world application of research to improving the
health status of the population. This may lead to student ambivalence about researching and publishing. In reality, research is fundamental to raising the quality of service delivery and can lead to public policies that significantly impact the population’s health. For example, Denmark’s “6-a-Day” campaign to promote consumption of six portions of fruits and vegetables per day was the direct outcome of several publications in the late 1990s that demonstrated a clear link between increased consumption of fruits and vegetables and reduced risk of cancer and ischemic heart disease [33]. Similarly, research studies in the USA have shown that consumption of fruits and vegetables substantially lowers health risks; as a result, recommendations to consume sufficient fruits and vegetables (“five-a-day”) have been incorporated into population-based dietary guidelines [32,34]. Another example of research-to-policy in the USA is the Active Living Research program, which aims to reduce physical inactivity through evidence-based strategies to prevent obesity in children by making changes at environment and policy levels [19].

Our findings have important implications for policy changes to guide improvements in public health nutrition training. First, reforms in education and employment sector are needed [35]. Nutrition education should span the entire spectrum from dietetics to research and teaching. Interdisciplinary education that highlights how nutrition fits into broader issues of medicine, agriculture, economics and policy should be encouraged and incorporated in the existing nutrition curriculum [26,36]. A diverse array of different aspects of nutrition from maternal-child health to micronutrient deficiencies to NCD prevention could allow students to appreciate the links between different sectors and gear up to public health challenges in a holistic manner [37–40]. Nutrition research should be raised in status and made attractive to bright young investigators. Better mentoring opportunities (either in form of short term trainings or fellowships in institutions outside India) can go a long way in nurturing the evolving young pool of talent. Strong synergistic collaborations/partnerships with developed countries should be encouraged to catalyze solutions to emerging and/or existing threats to public health [41]. A recent commission of global experts from various fields recommended designing new instructional and institutional strategies to combat multiple looming health challenges [25,42]. The recommendations include aligning national efforts through joint planning, especially in the education and health sectors, engaging all stakeholders in the reform process and developing global collaborative networks for mutual strengthening. They also advocate developing competency-based curriculum of globally recognized high academic standards [34].

There is some promise that these changes are underway. One example is the online post graduate diploma in public health nutrition started by the Public Health Foundation of India [43]. This well received peer-reviewed program rises beyond the existing clinical/therapeutic scope of the nutrition education, by adding new dimensions of epidemiology and research methods integrated with core nutrition modules. Another example is the increase in the number of national and international fellowships for public health, science and technology research including public health nutrition over the last decade [44–46]. These clearly indicate the rising demand and highlight the urgent need to invest in more such endeavors.

We found that India’s nutrition research output is disproportionately low, considering its large population and its huge dual nutritional challenges and public health concerns.
Investment in nutrition policy research in India could help to guide appropriate modifications in policy strategy and programs for tackling the existing and emerging nutrition problems [2, 6]. While some commentators project that India will become a great academic power by 2025 [47, 48], our findings highlight the urgent need for India to invest in research infrastructure and innovation culture to realize this dream.

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Figure 1.
Trends in Nutrition Research Output and Impact Factor.
Source: PubMed database, author’s calculations.
Note: Number of Research Articles is the number of nutrition research articles from the
country in the time period, according to the PubMed database search. The Country Impact
Factor was calculated as the weighted sum of all articles in the top 10 nutrition research
journals globally, according to 2009 ranking on Journal Citation Reports (JCR), available at
http://thomsonreuters.com/products_services/science/science_products/a-z/
journal_citation_reports/. The number of articles in each journal was multiplied by the
journal’s most recent individual impact factor (2009) to get each country’s “journal impact
factor”, and then all of the “journal impact factors” were totaled to get the overall country
impact factor.
### Table 1

Total number of articles from China, India and US, 2000–2005 and 2006–2010

<table>
<thead>
<tr>
<th>Years</th>
<th>India</th>
<th>China</th>
<th>USA</th>
<th>Rest of the World</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 – 2010</td>
<td>6711</td>
<td>16128</td>
<td>89497</td>
<td>232089</td>
<td>344425</td>
</tr>
<tr>
<td>2000 – 2005</td>
<td>2712</td>
<td>5146</td>
<td>42089</td>
<td>106715</td>
<td>156662</td>
</tr>
<tr>
<td>2006 – 2010</td>
<td>3999</td>
<td>10982</td>
<td>47408</td>
<td>125374</td>
<td>187763</td>
</tr>
<tr>
<td>Journal</td>
<td>Rank</td>
<td>Impact Factor</td>
<td>China</td>
<td>India</td>
<td>United States</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------</td>
<td>---------------</td>
<td>--------</td>
<td>-------</td>
<td>---------------</td>
</tr>
<tr>
<td>Annual Review of Nutrition</td>
<td>1</td>
<td>8.783</td>
<td>0</td>
<td>1.3</td>
<td>85.7</td>
</tr>
<tr>
<td>Progress in Lipid Research</td>
<td>2</td>
<td>8.167</td>
<td>0</td>
<td>0</td>
<td>31.3</td>
</tr>
<tr>
<td>American Journal of Clinical Nutrition</td>
<td>3</td>
<td>6.307</td>
<td>0.2</td>
<td>0.7</td>
<td>39.5</td>
</tr>
<tr>
<td>International Journal of Obesity</td>
<td>4</td>
<td>4.343</td>
<td>0</td>
<td>2.0</td>
<td>21.3</td>
</tr>
<tr>
<td>Proceedings of the Nutrition Society</td>
<td>5</td>
<td>4.321</td>
<td>0</td>
<td>0</td>
<td>10.2</td>
</tr>
<tr>
<td>Current Opinion in clinical nutrition and metabolic care</td>
<td>6</td>
<td>4.291</td>
<td>0</td>
<td>0</td>
<td>21.9</td>
</tr>
<tr>
<td>Journal of Nutritional Biochemistry</td>
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<td>4.288</td>
<td>0.6</td>
<td>5.3</td>
<td>38.4</td>
</tr>
<tr>
<td>Journal of Nutrition</td>
<td>8</td>
<td>4.091</td>
<td>0.7</td>
<td>1.5</td>
<td>54.7</td>
</tr>
<tr>
<td>Critical Reviews in Food Science and Nutrition</td>
<td>9</td>
<td>3.725</td>
<td>1.4</td>
<td>2.0</td>
<td>32.2</td>
</tr>
<tr>
<td>Nutritional Metabolism and Cardiovascular</td>
<td>10</td>
<td>3.517</td>
<td>0</td>
<td>0.8</td>
<td>5.4</td>
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<tr>
<td>Country average</td>
<td></td>
<td>0.3</td>
<td>1.4</td>
<td>0.9</td>
<td>34.1</td>
</tr>
</tbody>
</table>

Note: Rank is based on 2009 rank, from Journal Citation Reports (JCR), available at [http://thomsonreuters.com/products_services/science/science_products/a-z/journal_citation_reports/](http://thomsonreuters.com/products_services/science/science_products/a-z/journal_citation_reports/).