

**CORRELATION BETWEEN HEALTH INNOVATION AND EXPENDITURE
FOSTERING HEALTH REFORM IN INDIA: A DESCRIPTIVE ANALYSIS**

Dissertation

Submitted to



The IIHMR University, Jaipur

for the partial fulfilment for the award of the degree of

Master of Business Administration (MBA)

in

Hospital and Health Management

by

Vinit Yadav

Under the Supervision and Guidance of

Dr. Pallavi Choudhary Agarwalla

2021

**CORRELATION BETWEEN HEALTH INNOVATION AND EXPENDITURE
FOSTERING HEALTH REFORM IN INDIA: A DESCRIPTIVE ANALYSIS**

Dissertation

Submitted to



The IIHMR University, Jaipur

for the partial fulfilment for the award of the degree of

Master of Business Administration (MBA)

in

Hospital and Health Management

by

Vinit Yadav

Under the Supervision and Guidance of

Dr. Pallavi Choudhary Agarwalla

2021

DECLARATION BY STUDENT

I hereby declare that this dissertation titled “A correlation between health innovation and expenditure fostering health reform in India: a descriptive analysis” is the bonafide record of my original research work. I declare that it has not been submitted to any other university or institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been duly acknowledged in the text.

Name of Student- Vinit Yadav

Student_id - 1037

Date- 03/07/21

CERTIFICATE

This is to certify that dissertation titled “Correlation between health innovation and expenditure fostering health reform in India: a descriptive analysis” is a record of the research work undertaken by Mr. Vinit Yadav in partial fulfilment of the requirements for the award of the degree of MBA Hospital and Health Management from the IIHMR University, Jaipur under my guidance and supervision and his approach to the research study has been sincere, scientific, and analytical.

Faculty Guide

Dr. Pallavi Choudhary Agarwalla

School Dean

Dr. Dharendra Kumar

IIHMR University, Jaipur

Date- 03/07/21

IIHMR University, Jaipur

Date-03/07/21

CORRELATION BETWEEN HEALTH INNOVATION AND EXPENDITURE FOSTERING HEALTH REFORM IN INDIA: A DESCRIPTIVE ANALYSIS

ABSTRACT

Currently, developing countries encountering increased health expenditure. Increased geriatric population and life expectancy enhanced health costs. Along these lines, policymakers execute health reform to overcome health expenditure. These health expenditures can be reduced by medical or health innovation, hence this article focus on how health innovation and health expenditure are correlated post and prior to health reform. A set of medical and health expenditure variables are assessed in which dataset are taken from database of various health economic organization like Organization for Economic Co-operation and Development (OECD) and World Intellectual Property Organization (WIPO) both Pre and post health care reform i.e. for time slot 2000 to 2010 (pre-health reform) and 2011 to 2019 (post- health reform). The numerous publications and journals related to biotechnology, pharmaceuticals and biomedical technology were reviewed as measure of health innovation. Health care expenditure index can be determined as a sum or share of health GDP which is directly insight of health care expenditure per capita and public health expenditure. This study correlates the database for South East Asian countries where the health reform came into existence during 2010 to 2015. Data from other dataset like WHO, NFHS and MoHFW are also compared in context of India. The relation between health innovation and expenditure is carried out using correlation and covariance in terms to determine degree of association and freedom. A graphical and tabulated data analysis is done to support data. The dataset supports a highly correlated data set or positive (strong) correlation for health innovation and expenditure both expenditure before ($r_c, b = 0.91; p < 0.001$) and after ($r_c, a = 0.94; p < 0.001$) health care reforms. These results depict a high degree of correlation for post reform period and low degree of covariance (2011-2019). Based on results various policy making and discussion proposed.

Additionally, health care reform is one of the crucial factors which determine relationship direction in contrast with correlation. Enhanced channels between health innovation and cost benefit analysis for health can proceed to improved health services and accessibility. In context,

this study will enhance a reformist direction for policymakers to for development of novel and people centric approach to enhance medical innovation and decrement in health expenditure. Additionally, many research studies can also be supported by this study where a combat relation between health innovation and expenditure proves to be significant which is beneficial for developing countries to enhance the health care system. This is central in finding out whether the targets of insurance change can be accomplished all the time, alongside controlling expenses and improving health.

Keywords: Health Expenditure, Medical Innovation, Health Reform, Correlation, Policy Makers.

Acknowledgement

The satisfaction and euphoria that accompany the successful completion of the project would be incomplete without the mention of the people who made it possible.

Firstly, I would like to express my sage sense of gratitude and indebtedness to our President Dr PR Sodani, The IIHMR University, Dr Dhirendra Kumar, Dean, The IIHMR University and Dr Arindam Das HOD, School of Health Management, The IIHMR University.

I would also like to thank to my guide at The IIHMR University, Dr Pallavi Choudhary Agarwalla for being available whenever I needed for guidance and support.

I would also like to extend my sincere thanks to my Industry mentors Dr. Avani Dodiya and Dr. Ravisha Bharati at PD Hinduja Hospital for providing their valuable guidance at all stages of the study, their advice, constructive suggestions, positive and supportive attitude and continuous encouragement, without which it would not have been possible to complete the project.

The compilation of this undertaking would not have been possible without the wholehearted support of the all the people in Procurement team at PD Hinduja Hospital for being a constant source of knowledge, support and guidance throughout the span of time.

I hope that I can build upon the experience and knowledge that I have gained and make a valuable contribution towards the industry in coming future.

Table of Content

Chapter	Content	Pg. No.
1	Introduction	10
2	Review of Literature	13
3	Material & Methodology 3.1 Research Design 3.2 Study Design Process 3.3 Study Indicator 3.4 Data Set 3.5 Data analysis	19
4	Results & Interpretations 4.1 Descriptive Statistics 4.2 Bivariate analysis	22
5	Evidence based strategies & Discussion	26
6	Conclusion	29
7	Policy Recommendation	30
	Reference	31

List of Figures

Figure No.	Title	Pg.no.
------------	-------	--------

4.1	Summary Results of Canonical Roots Between Medical Innovation and Health Expenditure Variables pre health reform	24
4.2	Summary Results of Canonical Roots Between Medical Innovation and Health Expenditure Variables post health reform	25

List of Tables

Table No.	Title	Pg. no.
2.1	A brief rundown on the health care reform policy in various OECD nations.	13
3.1	Study Variables	20
4.1	Descriptive Statistics	22
4.2	Bivariate analysis	23

Abbreviations

OECD	Organization for Economic Co-operation and Development
WIPO	World Intellectual Property Organisation
NFHS	National Family Health Survey
CA	Correlation Analysis

CORRELATION BETWEEN HEALTH INNOVATION AND EXPENDITURE FOSTERING HEALTH REFORM IN INDIA: A DESCRIPTIVE ANALYSIS

Chapter 1: Introduction

Healthcare costing is getting high in developed countries during previous years. As life expectancy and population age increased the health expenditures are also accelerated [1]. Because of these policies should be implemented to restructure the costing and healthcare output [2]. Major objective is to consider 3A's in healthcare and control healthcare expenditures because only cost control is not responsible to give shape to the funded healthcare system for public [5]. Major recognised area of increased expenditure on healthcare is innovation and technology [4] and providing support to technology and encourage innovation are the bones to restructure the health policies for future planning [3].

There is rapid increase in expenditure for technology in medical field since late 90's [6, 7]. This growth is in corresponding with public health expenditure slant in western economics [2]. Population maturing is one of the significant explanations behind expanded public health spending on the grounds that an expanded number of dependent elders fundamentally build healthcare expenditure [7]. Besides, variable of lifestyle, for example, smoking, lack of physical movement, and bad dietary habit are profoundly related with financial burden, and there is little enthusiasm for econometric demonstrating of their healthcare services cost, which is the reason policymakers want to battle them [3]. Discussions on healthcare costs and new medical innovations have concentrated on shaping the pharmaceutical industry and the quality of public healthcare [7].

The effect of innovation on healthcare costs varies across various sorts of innovations, illnesses, and medications, including anticancer medications and invasive instrument. Medical innovation, biotechnology, and pharmaceuticals are the significant zones of healthcare innovations. Healthcare innovation incorporates drugs, vaccines, and health instrument. Which are fundamental for public health [8]. It has been contended that the expanding cost and utilization

of medical innovation is adding to the raising human care costs [9]. Expenditure and supportability of the healthcare sector depend upon benefits to subsidize future advancements [10]. Development in medicinal innovation is emphatically influenced by monetary emergencies and value disintegrations [11]. Financial emergencies cause organizations to diminish their interest in development [12]. Then again, monetary emergencies can be drivers of development as for giving progressively imaginative other options. Be that as it may, past examinations guarantee that monetary emergencies lead the way to a centralization of innovative exercises by new organization, and those organizations are exceptionally inventive even before an emergency begins [12]. The troubling impact of monetary emergency on medicinal advancement in Greece was analysed, and decay was seen in relative biomedical-investigate efficiency beginning not long after the monetary emergency started [13]. Although empowering advancement is key in the improvement of the healthcare segment, advancing development needs genuine appraisal to look at the effect of current financial emergencies [13].

Biotechnology is another expensive territory comparable to healthcare innovation. It for the most part concerns the use of cell and sub-atomic science techniques to make or adjust items or procedures [14]. Pharmaceuticals identify with the generation of medications and have assumed a key job in diminishing mortality because of disease and improving the general health of individuals all over [15]. Also, pharmaceuticals are vital to medical innovation.

The pharmaceutical sector is the most innovative sector among all sectors [16]. The quantity of patent published by the sector encourages us comprehend its tendency, determinants, and the degree of medical innovation. Also, the patents encourage us comprehend the global examples in medical development because health care innovation firms, research centres, and people can apply for a patent to ensure innovation and to demonstrate their mechanical innovation and creativity [17]. The significance of patent as supporters of innovation has gotten support by different studies; furthermore, patent action has seen a sharp ascent generally [18]. Various past examinations have concentrated on the quantity of patent productions, which is impacted by the need given to intercessions and the measure of research action [19]. Although protecting in pharmaceuticals furthermore, biotechnology requires tedious research and formative procedures, the field of pharmaceuticals assumes a significant job in patent assurance [20], and patenting energizes mechanical advancement in social insurance. Additionally, medical innovation

diminishes emergency hospital use and the number of hospital stays, consequently expanding life expectancy [21].

Policymakers are feeling the squeeze to control the rising health care use. Thusly, the policymakers have gotten increasingly keen on costly regions like, medical innovation than the policymakers attempt to find harmony between the expenses furthermore, the advantages of medical innovation [22]. As expenses of medical innovation keep on rising, the policymakers become progressively keen on managing them. The key inquiry becomes how do the advantages compare and the expenses [23]? This expects us to survey whether and under which conditions invest in medicinal innovation provide good incentive in health care [4]. We should, in this manner, look at the connection between medical innovation and healthcare expenditure. It is broadly accepted that new innovations have been a significant reason for expanding health expenses in a few nations [24]. Past investigations recommend that although pharmaceutical innovation is costly, the advantages of embracing the innovation exceed the costs [24]. It is likewise notable that innovative medications can be beneficial [25]. Besides, the significant expenses of medical advances, biotechnologies, and pharmaceutical innovation are shown in the significant expenses due to the patent framework [24], and we have just talked about how patent applications have assumed a significant job in the improvement of health care innovation [25].

A steady domain for inter organizational systems impacts the creative yield of pharmaceutical associations. Be that as it may, worldwide union among pharmaceutical companies, which is estimated utilizing the thickness of the general system among pharmaceutical firms, negatively affects the creative execution of a firm [26]. Progression in medicinal innovation is corresponding to the improvement level of nations; also, some created nations assume a synergetic job in the advancement of wellbeing innovations [27]. It is notable that the Organization for Economic Co-operation and Development (OECD) nations are profoundly created and industrialized. Since these nations have political, financial, demographic, and health status factors, the degree of innovation and health innovations vary among the created OECD nations [27].

In the expenditure on innovative work and the quantity of patent applications among OECD nations during 1981 to 2001 [28]. The examination found that the share of health care expenditure as percent of GDP comparable to add up to public use has expanded essentially in 30

years. Various OECD nations presented health care changes to control costs during that period, and endeavours to present human health care reform have been embraced by OECD nations somewhere in the range of 2000 and 2012.

OECD Countries	Discription of Health Reform	Year (reform started)
Austria	To change reimbursement for cost containment motives and to improve coordination of health care	2005
Canada	To change primary care system in order to promote cost containment and for better coordination of health care	2000
Chile	To increase accessibility of health care with chronic diseases, and to improve treatment outcomes, hospitalization rates, medical leave rates for chronic diseases	2010
Denmark	To revamp the hospital sector, and to improve coordination across different public areas	2010
Estonia	To improve hospitals and long-term care and to improve quality of care	2000
Germany	To increase cost sharing and to promote care coordination	2004
Japan	To promote care coordination, to improve quality of care in hospitals, create an informative pharmaceutical market and cost containment	2006
Mexico	To expand insurance coverage	2001
Netherlands	To manage competition among insurers and promote cost containment	2006
Norway	To develop primary care and hospital care and to promote care coordination and cost containment	2002
Portugal	To reform primary care with the aim to promote care coordination and cost containment	2009
Brazil	To provide compulsory social health insurance and decentralize hospitals	2009
India	To widen health insurance coverage to change delivery and reimbursement models/To promote 3A's	2010
United states	To widen health insurance coverage to change delivery and reimbursement models	2010

Table 2.1: A brief rundown on the health care reform policy in various OECD nations. The table shows that cost control, care coordination, evolving instalment, and repayment models were the major techniques basic health care change policies of the OECD nations from 2000 to 2012 [27].

Here, we present a concise diagram of healthcare reform in a portion of the OECD nations. Austria is one of the nations that have presented reform since 2005. The significant points of these changes were to handle expanding expenses and social imbalances, along with improving the use of medical innovation. Because of this reform, pay related disparity corresponding to medicinal services get to have diminished since 2005. It ought to be noted, be that as it may, that it remains lower than that in different nations [29]. In 2013, Austria acquainted enactment with improve effectiveness through adjusting care arrangement across health care suppliers by advancing new essential consideration models and better coordination of care. Since change goals ought to be accomplished by bound together basic leadership across key partners, it will be important to have a submitted government equipped for improving social protection through focusing on overcapacity, advancing proficiency, and accomplishing further progress, which is upheld up by past examinations [30]. Canada has presented health reform since 2000. Health reform in Canada has moulded well the general healthcare association and has created a proficient framework. Although considerable innovation has been accomplished throughout the most recent 10 years of health care reform, Canadians right now can't get to data on sit tight occasions for vital medical consideration [32]. Health reform began in Chile toward the start of 2005 [33]. Their outcomes demonstrated that the reform have positively affected access to care, treatment results, hospitalization rates, and medical leaves as for six chronic diseases. Current examinations on the impact of health reform, which incorporates widespread inclusion, show that financial disparities have diminished after the presentation of health reform [34]. Denmark started its health reform in 2007, which incorporates four significant territories: hospital admission procedure, rehabilitation, health promotion and disease prevention furthermore, psychological sicknesses. Regardless of these endeavours, considers have indicated that health reform was most certainly not appropriately executed in Denmark in view of the absence of political help [35]. In addition, gives an account of health change demonstrate that patients frequently whine about the absence of coherence of care in Denmark [36]. Estonia experienced health change since 2000 [37] their decisions support the hypothesis that despite reform, disparities in health status and health results remain. In addition, after the health reform, out-of-pocket health expenditure of family units is still dispersed among poor population gatherings.

Germany is an OECD nation with an extremely high expectation for everyday comforts and an extremely gifted and beneficial society [38].

This study explores the relationship between a group of medical innovations and a set of health care expenditure variables before the introduction of health reform and after.

Chapter 2: Review of Literature

S.No	Author	Article	Salient Features
1.	Ikegami N, Campbell JC.	Japan's health care system: containing costs and attempting reform.	In Japan, the medical innovation capacity of the health industry is high; in any case, there is a generally held conviction that innovative headway is the essential driver of increments in healthcare costs. The Japanese framework attempts to keep costs low, especially in the region of diagnostics. This arrangement makes diagnostics, particularly, accessible. In 2006, Japan charged the Medical Law Reform and Pharmaceutical Affairs Act, which was administered in 2009. Significant changes presented by the updated law are tending to and ordering over-the-counter medications as indicated by the hazard in question, requiring authorized drug specialists or enrolled deals people to sell them, and setting up an educational pharmaceutical condition. Researchers propose that Japan needs a healthcare framework intended to conquer imbalances about age, business status, and family circumstance. The Japan Vision: Health Care 2035 has offered a future point of view on improving healthcare. [40]
2.	Nigenda G, Wirtz VJ, Gonzalez-Robledo LM, Reich MR.	Evaluating the implementation of Mexico's Health Reform: The Case of Seguro	In Mexico, the poor are most certainly not secured by standardized savings. Moreover, a high extent of the population funds healthcare all through of-pocket costs. Mexican health reform began in 2001; it delivered sustainable development in people in general assets gave to healthcare and expanded health inclusion. In 2012, the Mexican government presented a general medical coverage framework called Seguro Popular, which covers a wide scope of administrations. Nonetheless, investigations show that the usage of Seguro Popular confronted difficulties, for example, restricted institutional limit, constrained data frameworks, and insufficient utilization of money related assets. Mexico's involvement in the usage of health reform may offer a few experiences for different nations to broaden health inclusion [44].
3.	Schafer W, Kroneman M,	The Netherlands	The Netherlands performs well in healthcare contrasted and most other OECD nations. The Netherlands human

	Boerma W et al.	Health System Review. Health Systems in Transition 2010	services framework has been experiencing change since 2006. New medical innovations have been utilized in the Netherlands with the help of judicious policymaking under a health reform arrangement since the 1990s. Global correlations show that the Netherlands has lower anti-microbial use, a smaller number of avoidable hospitalizations, and a lower avoidable mortality. Nonetheless, development has eased back extensively in the wake of returning to progressively conventional segment concurrences on burning through [47].
4.	Ringard A, Sagan A., Saunes IS. et al.	Norway: Health system review: Health reform.	Among the European nations, Norway can be set at the top according to the innovation level of its healthcare framework. Norway has the most elevated level of doctor thickness among the OECD nations. Be that as it may, protracted holding up times have been a major issue in the Norwegian healthcare framework, and a few endeavours have been attempted to lessen them. The new treatment decision change was actualized in 2015. In prior changes, less consideration was paid to tolerant rights, while current changes strengthen understanding decision and increment the stock of both open and private administrations. It may be prudent for other OECD nations to handle high holding up times by following the innovations in Norway [49].

Chapter 3: Materials & Methodology

3.1 Research design

- **Study Question:** To study the relationship between group of medical innovation and a set of healthcare expenditure variable before the introduction of health reform and after health reform.
- **Study Type:** Descriptive Study
- **Study Design:** Correlation analysis
- **Study population:** Population can't be calculated as entire data was taken from official websites.
- **Research Data:** OECD, WIPO, NFHS
- **Research Location/Time:** India & Data time period 2000-2009 for pre health reform and 2010-2019 for post health reform

3.2 Study Design Process

Correlation analysis (CA) was utilized to quantify the level of relationship between the arrangement of medical innovation variable and the arrangement of health expenditure variable for two distinct periods addressing the time of pre and post health reform. As examined before, the quantity of patent distributions comparable to medical innovation, biotechnology, and drugs was viewed as a marker of medical innovation. Additionally, three unique elements of health expenditure were developed as health expenditure variables. These were public health expenditure (current; US\$), health expenditure per capita (current; US\$), and total health expenditure as share of the GDP (%). Complete public health expenditure included central government expenditure, state government health expenditure, and mandatory contributory health insurance expenditure. A correlation structure for a group of medical innovations and a set of health expenditure variable was analysed for two diverse study periods, addressing pre (2000–2009) and post (2010–2019) health change for 14 OECD nations. These nations went

through change somewhere in the range of 2000 and 2012, while 20 nations did not [27]. The correlation result of the two variable sets were analysed and compared. Prior to performing CA, logarithmic change was applied to both arrangements of variable to linearize the relationship. A multivariate ordinariness appropriation presumption has been accommodated the two arrangements of factors. Besides, Spearman correlation coefficients (rs) showed that there was no multicollinearity in one or the other arrangement of factors and for all factors in the dataset.

3.3 Study Indicators:

Health Innovation includes Number of patent or publication & Expenditure includes 3 variables constructed before performing CA, logarithmic transformation was applied to both sets of variables to linearize the relationship. A multivariate normality distribution assumption has been provided for the two sets of variables. Furthermore, Spearman correlation coefficients (rs) showed that there was no multicollinearity in either set of variables and for all variables in the dataset.

3.4 Dataset:

3.5 The data came from the World Intellectual Property Organization (WIPO) and OECD statistics for the years 2000–2019 Total 14 OECD countries were selected for the study; India went under health reform in 2010. NFHS data is also included in the study variable account for public health expenditure, for pre health reform NFHS data 1 & 2 is recorded and for post health reform NFHS data 3 & 4 was recorded.

Study variables		
variable group	Resource	Variable
Health innovation	WIPO	Advancement in medical technology, pharmaceuticals
Health expenditure	OECD	Health expenditure (per capita) (As a share of GDP) %
Innovation and Expenditure	NFHS	Health expenditure(public)

Table 3.1: Study Variables

3.4 Data Analysis (Statistical Interpretation)

Correlation Analysis CA was performed to inspect the connection between two arrangements of factors, clinical innovation, and health use. CA was performed for these two variable gatherings for two diverse time spans independently (i.e., 2000–2009 and 2010–2019). CA is a strategy used to discover the arrangements of vectors that boost the connection between bunches of factors. This examination was created by Hotelling (1936) [63] to inspect the connection between various gatherings of factors. CA is one of the normal techniques for insights, design acknowledgment, and information mining [64]. It's anything but a notable strategy for measurement decrease, grouping, and arrangement [65]. The primary standard of CA is to discover an answer for a straight blend of two arrangements of factors, with the structure: $X_i = a_1 (\text{indicator } 1) + a_2 (\text{indicator } 2) + \dots + a_m (\text{indicator } m)$ and $Y_i = b_1 (\text{result } 1) + a_2 (\text{result } 2) + \dots + a_m (\text{result } m)$. The principal objective of this strategy is to recognize the coefficients that amplify the relationship between a bunch of X_i and Y_i . After the investigation, the primary relationship shows the most elevated connection between the two arrangements of factors. The outcomes show the relationship between the two variable gatherings [66]

Along with that we estimated the canonical roots and Bartlett's chi-square test and first score plots to strengthen the study.

Chapter 4: Results & Interpretation

4.1. Descriptive Statistics

We present two sets of estimates of 14 OECD countries for two time periods (i.e., 2000-2009 and 2010–2019). The median scores of the variables for medical innovation before health reform were as follows: number of patent publications with respect to medical technology (min. 1; max. 18,885; median 392.5), biotechnology (min. 1; max. 9764; median 360), and pharmaceuticals (min. 3; max. 8461; median 480). For the period after health reform, they were as follows: medical technology (min. 2; max. 39,836; median 410.5), biotechnology (min. 1; max. 26,542; median 471), and pharmaceuticals (min. 1; max. 30,447; median 293). Descriptive statistics for health expenditure before reform were as follows: health expenditure (public; min. 532; max. 768,159; median 12,786), health expenditure (per capita; min. 144; max. 5,559; median 1,799), and health expenditure (% of total GDP; min. 2.21; max. 4.51; median 4.18). For the period after health reform, they were as follows: health expenditure (public; min. 549; max. 2,229,400; median 28,139), health expenditure (per capita; min. 434; max. 3,171; median 2,727), and health expenditure (% of total GDP; min. 4.73; max. 8.41; median 6.74).

Observation period								
2000-2009					2010-2019			
Variable	N	Min	Max	Median	N	Min	Max	Median
Medical Technology	154	1	18885	392	154	2	39836	410
Biotechnology	154	1	9764	360	154	1	26542	471.5
Pharmaceuticals	154	3	8461	480	154	3	30447	293
Health expenditure - Public	154	532	768159	12786	154	549	2229400	28139
Health expenditure - Per capita	154	144	5559	1799	154	434	3171	2727
Health	154	2.21	4.51	4.18	154	4.73	8.41	6.74

expenditure - %
of total GDP

Table 4.1: Descriptive Statistics

4.2. Bivariate analysis

During the analysis, logarithmic transformation showed that the distribution became symmetric, and a multivariate normality assumption was provided for both the set of variables and for both time periods ($p < 0.001$). Spearman correlation coefficients of the two sets of variables indicated that there was no multicollinearity problem between ($r_s < 0.70$) the two sets of variables for both time periods (i.e., 2000–2009 and 2010–2019). The results also showed a strong positive canonical correlation between medical innovation and health expenditure according to the observations representing before health reform ($r_{cb} = 0.91$; $p < 0.001$) and after ($r_{ca} = 0.94$; $p < 0.001$). A summary of the results on the statistical significance of canonical correlations is presented in Table 3. The null hypothesis is that there is no relationship between medical innovation and health expenditure for both the time periods. Bartlett's chi-squared test was used to test the null hypothesis. The results showed that the null hypothesis was rejected for the first roots of the two sets of variables for the two time periods, 2000–2009 ($= 281.48$; $p < 0.001$; $\lambda = 0.152$) and 2010–2019 ($= 342.14$; $p < 0.001$; $\lambda = 0.101$). Figure 1 shows the number of canonical roots and canonical score plots for the first set of canonical roots. The first set of roots has high statistical and practical significance in understanding the relationship between medical innovation and health expenditure for before and after health reform. Scatterplots indicate a stronger positive linear relationship between medical innovation and health expenditure after health reform ($r_{ca} = 0.94$) than before ($r_{cb} = 0.91$)

2000-2009 (pre-health reform)

No of roots removed	r_{cb}	X^2	Degree of freedom	Probability	Lambda
0	0.91	281.5	9	0.001	0.152
1	0.26	10.9	4	0.0027	0.929

2010-2019(post-health

reform)

No of roots removed	r_{cb}	X^2	Degree of freedom	Probability	Lambda
0	0.94	342.1	9	0.001	0.102
1	0.26	11.7	4	0.0019	0.924

Table 4.2: r_{cb} : Canonic correlation coefficient before health reform, r_{ca} : Canonic correlation coefficient after health reform, X^2 : Bartlett's Chi-square test

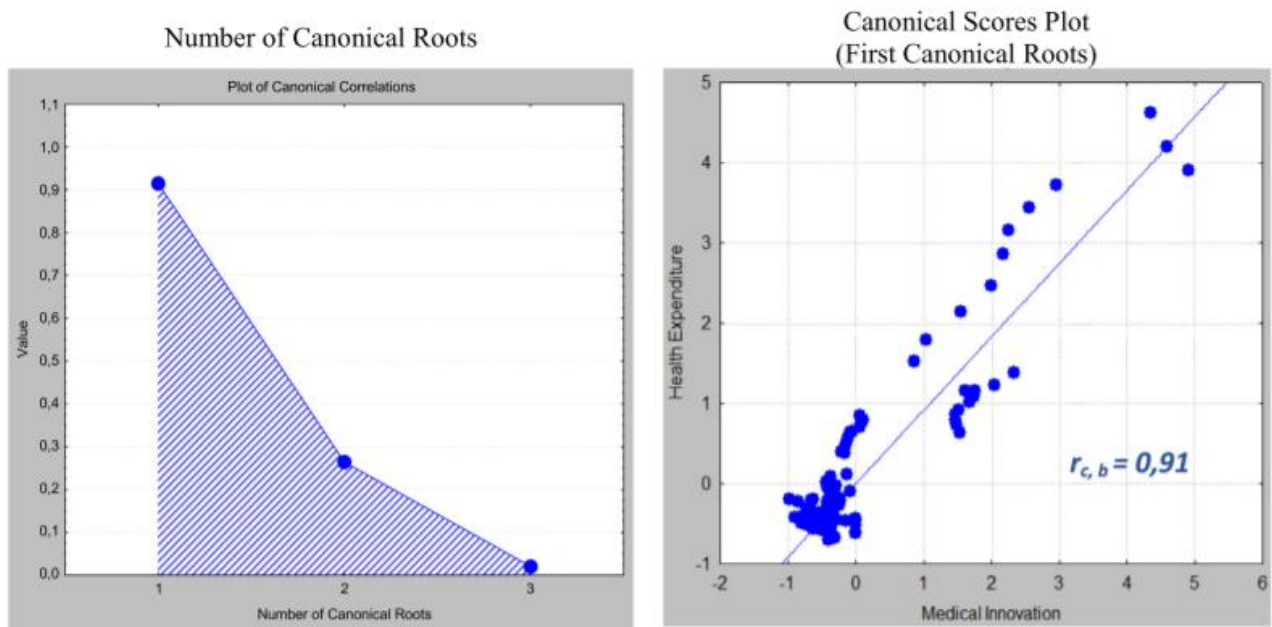


Figure 4.1 Summary Results of Canonical Roots Between Medical Innovation and Health Expenditure Variables pre health reform

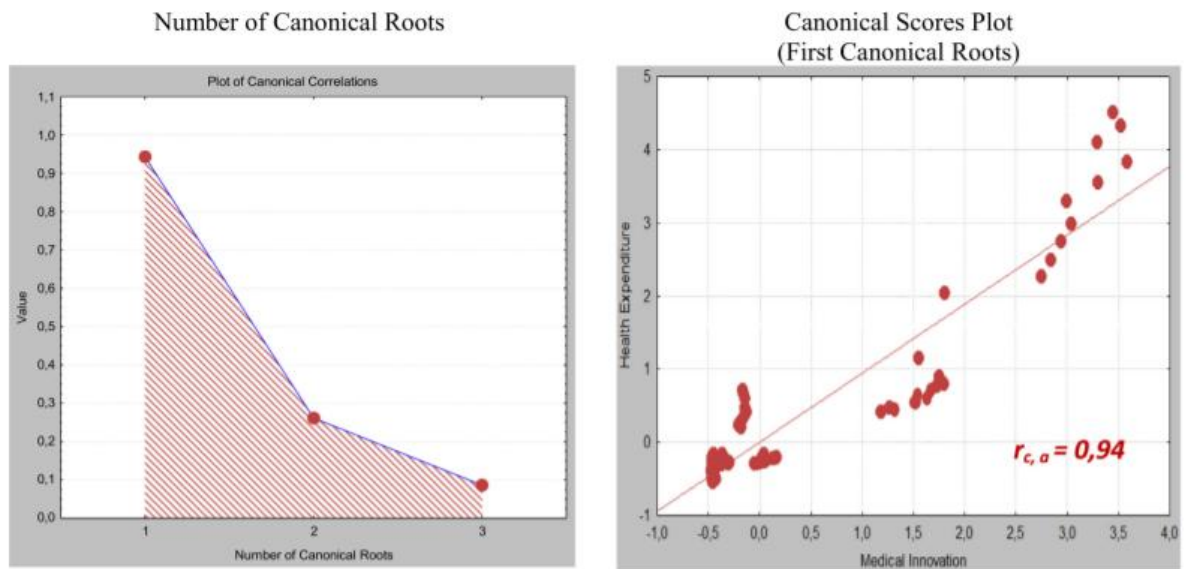


Figure 4.2: Summary Results of Canonical Roots Between Medical Innovation and Health Expenditure Variables post health reform

Chapter 5: EVIDENCE-BASED STRATEGIES & DISCUSSION

Medical innovation and mechanical progression have empowered huge advances in tolerant consideration and improvement in health results [67]. Besides, medical innovation and enhancements in general health are crucial for the flourishing of any country. As such, the innovation biological system of the medical business can possibly further develop general health [68]. Lichtenberg (2014) presents a created country experience and shows that drug innovation expanded mean age at death by 0.29 years (3.43 months) from 2000 to 2009 [69]. Even though innovation makes extra advantages to the public, it is expensive and doesn't generally bring about development or productivity [70]. In this manner, cost regulation is one of the essential policy spaces of monetary administration to battle rising drug costs [71]. The quantity of patent distributions is one of the pointers of medical innovation and perhaps the costliest space of innovation. These are policy instruments that are utilized to energize innovation. They urge health chiefs to make new information. [72]. Additionally, licenses impact the innovation of and admittance to new meds for both the created and non-industrial nations. The quantity of licenses distributed is subject to various regular, logical, and innovative variables [73].

McCormack et al. (2015) [67] note that cultivating an open innovation climate is one of the procedures for further developing innovation capacities and sharing inventive thoughts in the medical market. Hence, partners, values, encounters, aptitude, and exact information shape and advise policy banter on the quantity of licenses. Nonetheless, the absence of a freely accessible dataset to assess medical innovation is one of the significant impediments for concentrates on medical innovation. Global associations like the WIPO distribute covers patent applications in the health area. These reports pursue new directions in policy, business, and innovation overall [74]. Examination on the unique idea of medical innovation shows that innovation and

innovation in health care don't follow a straight model however rather comprises a powerful cycle [75]. Such a vulnerability of the result of the cycle, notwithstanding, can make it hard for policymakers to comprehend and deal with the interrelated interaction of medical innovation and innovation in health care [70]. Likewise, the far and wide dissemination of new medical innovation overpowers the endeavours of policymakers to control expanding costs [61]. Accordingly, cost control is one of the promising and famous techniques of overseeing drug market and health reform approaches [4]. Albeit medical and drug organizations put forth innovation attempts more accessible, moderate, and open in created nations, it's anything but the situation with non-industrial nations, where the organizations are attempting to grow their market. These endeavours need support for addressing the requirements of low-pay gatherings and for working on the openness to drugs [76]. It is broadly accepted that medical innovation is costly and questionable [77]. The quantities of patent distributions for various sorts of medical advances are markers of a steady climate for the improvement of health advances and a strong world of politics in health care. A climate that elevates far reaching admittance to powerful medical innovations is one of the essential difficulties for policymakers. It is broadly acknowledged that medical innovation includes a few costly exercises and is a critical driver of rising health expenditure [68]. To handle this intricacy and the expanding costs in the drug business, a significant assemblage of writing tends to the expense adequacy of prescriptions and the drug market [78]. Despite the fact that there is an immense writing about controlling expenses and policy endeavors help to survey and further develop health advances, there isn't a lot of data concerning the connection between medical innovation and innovation and health expenditure [23]. Policymakers in the created nations are keen on deciding if extra health care expenditure will bring about better health results [79]. The OECD nations are among the most profoundly evolved and richest nations on the planet. Magnussen et al. (2007) [80] conjecture that lately, monetary, and political force has been utilized to further develop health results and health expenditure in a few European nations. These approaches could be the consequence of stylish policy patterns and change programs in health care. To follow this style, various European nations have encountered health reforms lately. The OECD nations that have encountered health reforms have assorted health care and monetary frameworks. Subsequently, the degree of health results and health expenditure is diverse in these nations. Besides, seeing how to handle expanding costs is one of the essential points of health reforms. Ozcan and

Khushalani (2016) [27] report that among the 34 OECD nations, 14 nations went through health reforms somewhere in the range of 2000 and 2012, while the excess 20 didn't. Austria, Canada, Chile, Denmark, Estonia, Germany, Japan, Mexico, the Netherlands, Norway, Portugal, Slovakia, Turkey, and the U.S. are the nations that accomplished health reforms during this period. Anderson and Hussey (2001) [79] express that the policymakers in OECD nations are profoundly keen on deciding if extra health care expenditure will bring about better results. Sorenson et al. (2013) [4] recommend that the policymakers should zero in on the expenses as well as on whether medical innovation brings about a superior worth in health care and diminishes in imbalances. The inspiration driving this centre is to expand the mindfulness on how the cash spent on medical innovation, innovation, doctors, drugs, and other health administrations further develops the general health status of the populace. Also, cross-public correlations and investigations will assist us with understanding whether extra health expenditure brings about better health results over the long run [79]. Underline that health expenditure isn't something similar for all OECD nations. Contrasted and other OECD nations, the U.S. spends a bigger measure of cash on health care. In addition, the OECD nations encountering monetary development witness a relatively quick expansion in health expenditure [79]. These outcomes in an increment in the quantity of studies on the productivity of health frameworks in the OECD nations. Thus, this expanding interest delivers an extensive amount of exploration on the effectiveness of health frameworks in the OECD nations [2]. Hakkinen and Joumard (2007) [81] broke down the effectiveness of health frameworks and inferred that the OECD nations should zero in on further developing health results while at the same time controlling expenses to have proficient health care frameworks. Willeme and Dumont (2015) [7] agree with Hakkinen and Jourmard (2007) [81] and express that the degree of pay and expenses are the deciding components in the openness to health care administrations. Besides, there is huge writing evaluating the proficiency of health care frameworks and the impact of health reform strategies on the framework effectiveness in created nations. Ozcan and Khushalani (2016) [27] showed that the OECD nations that further developed their general health frameworks were probably going to show improvement in productivity following a time of health reforms.

Chapter 6: Conclusion

Advancement and innovation in medical technology used to consider as a health growth indicator for a developing country over a period. However, the study signifies the attempt to correlate the health innovation and expenditure as a variable for health care system which proven as a strongly correlated.

It is imperative to remember that the accomplishment of health reform exertion relies upon practical objectives to policy trends. Moreover, health care reform is one of the major factors which determines relationship direction in contrast with correlation.

Enhanced channels between health innovation and cost benefit analysis for health can proceed to improved health services and accessibility.

In context, this study will enhance a reformist direction for policymakers to for development of novel and people centric approach to enhance medical innovation and decrement in health expenditure.

Additionally, many research studies can also be supported by this study where a combat relation between health innovation and expenditure proves to be significant which is beneficial for developing countries to enhance the health care system. This is central in finding out whether the targets of insurance change can be accomplished all the time, alongside controlling expenses and improving health.

Chapter 7: Policy Recommendation

Obviously, medical innovation and innovation are the significant drivers of expanding health care costs [23]. Understanding the consequences of medical innovation and the connection among innovation and health expenditure is basic in completely evaluating the effect of health reform arrangements [67]. Regardless of this lucidity, there is a requirement for an itemized examination on the connection between medical innovation and health care expenditure under a reformist climate. This paper endeavours to fill this deficiency in the writing by contrasting the connection between a bunch of medical innovation and a gathering of health expenditure factors when health reform periods independently. Our outcomes show a solid positive connection between a gathering of medical innovation factors and a bunch of health expenditure factors pre (2000–2009) and post (2010–2019) health reform periods. Besides, we tracked down that the strength of the connection between medical innovation and health expenditure is higher after health reform period than previously. As per our insight, this investigation underscored the solid linkage between a gathering of medical innovation and a bunch of health expenditure factors and noticed this relationship while considering two free time spans that are when health reform. Study results learn that the connections between two gatherings of factors are more grounded for after health reform period than previously. Considering this investigation, it is recommended for health policymakers to decide health approaches to deal with the solid connection between medical innovation and health expenditure variable gatherings while thinking about reformist climate. The core of this exhortation is to encourage a strong climate to work on medical innovation and health innovation while controlling expenses. The consequences of this examination make a stride further and notice a high connection between factor bunches after health reform period than previously. This outcome affirms the possibility that a steady climate

and strategies to further develop medical innovation are acceptable pointers of expanding health expenditure. Besides, under reformist climate, a solid connection between factor bunches is seen than previously. In this paper, we add to the comprehension of the connection between medical innovation and health expenditure, which has been a central question of discussion for quite a long time. It is expected that further examinations will add to a superior comprehension of the connection among innovation and expenditure under the impact of health reform strategies utilizing various types of markers and zeroing in on nations that have diverse improvement levels.

Reference:

1. Meijer C, Wouterse B, Polder J, Koopmanschap M. The effect of population aging on health expenditure growth: a critical review. *EJA* 2013;10(4):353-61.
2. Hadad S, Hadad Y, Simon-Tuval T. Determinants of health care system's efficiency in OECD countries. *Eur J Health Econ* 2013;14(2):253–65.
3. Fielding JE, Teutsch S, Koh H. Health reform and healthy people initiative. *Am J Public Health* 2012;102(1):30-3.
4. Sorenson C, Drummond M, Khan BB. Medical technology as a key driver of rising health expenditure: disentangling the relationship. *Clinicoecon Outcomes Res.* 2013;5:223–34.
5. Werle J, Dobbelsteyn L, Feasel AL, Hancock B, Job B, Makar L, Manning H, Quigley S, Teppler A, Smith C, Kelly S, Wasylak T. A study of the effectiveness of performance-focused methodology for improved outcomes in Alberta Public Health care. *HMF* 2010;23(4):169-74.
6. DiMasi JA, Hansen RW, Grabowski HG. The price of innovation: new estimates of drug development costs. *J Health Econ* 2003;22(2):151–85.
7. Willeme P, Dumont M. Machines that go —ping! Medical technology and health expenditures in OECD countries. *Health Econ* 2015;25(3):387-88.
8. Torbica A, Cappellaro G. Uptake and diffusion of medical technology innovation in Europe: what role for funding and procurement policies? *J. of Med. Market* 2010;10(1):61–9.
9. Kumar RK. Technology and healthcare costs. *Ann Pediatr Cardiol* 2011;4(1):84-6.

10. Drummond MF, Griffin A, Tarricone R. Economic evaluation for devices and drugs – same or different? *Value in Health* 2009;12(4):402-4.
11. Smith BD, Tarricone R, Vella V. The role of product life cycle in medical technology innovation. *J. of Med. Market* 2013;13(1):37–43.
12. Archibugi D, Filippetti A, Frenz M. The impact of the economic crisis on innovation: evidence from Europe. *Technol Forecast Soc Change* 2013;80(7):1247-60.
13. Falagas ME, Bardakas V, Mavros MN. Biomedical research productivity in Greece: effect of the financial crisis. *Int J Epidemiol* 2012;41(4):1206-7.
14. Bartholomew S. National systems of biotechnology innovation: complex interdependence in the global system. *JIBS* 1997;28(2):241–66.
15. Lichtenberg FR. The impact of pharmaceutical innovation on premature mortality, cancer mortality and hospitalization in Slovenia, 1997–2010. *Appl Health Econ Health Policy* (2015-a);13(2):207–22.
16. Grabowski H, Vernon J. Innovation and structural change in pharmaceuticals and biotechnology. *Ind Corp Change* 1994;3(2):435–49.
17. Ramani SV, Looze MA. Using patent statistics as knowledge base indicators in the biotechnology sectors: an application to France, Germany and the U.K. *Scientometrics* 2002;54(3):319–46.
18. Roper S, Hewitt-Dundas N. Knowledge stocks, knowledge flows and innovation: Evidence from matched patents and innovation panel data. *RP* 2015;44(7):1327-40.
19. Cecere G, Corrocher N, Gossart C, Ozman M. Technological pervasiveness and variety of innovators in Green ICT: A patent-based analysis. *RP* 2014;43(10):1827-39.
20. Harhoff D, Reitzig M. Determinants of opposition against EPO patent grants-the case of biotechnology and pharmaceuticals. *Int J Ind Organ* 2004;22(4):443-80.
21. Linchtenberg FR, Pettersson B. The impact of pharmaceutical innovation on longevity and medical expenditure in Sweden, 1997–2010: Evidence from longitudinal, diseaselevel data. *EINT* 2014;23(3):239–73.

22. Wahlster P, Goetghebeur M, Kriza C et al. Balancing costs and benefits at different stages of medical innovation: a systematic review of multi-criteria decision analysis (MCDA) BMC Health Serv Res. 2015;15:1–12.
23. Baker L, Birnbaum H, Geppert J. et al. The relationship between technology availability and health care spending. Health Aff (Millwood). Web Exclusives 2003;W3-537–51.
24. Hsieh CR, Sloan FA. Adoption of pharmaceutical innovation and the growth of drug expenditure in Taiwan: is it cost effective? Value Health. 2008;11(2):334–44.
25. Jayadev A, Stiglitz J. Two ideas to increase innovation and reduce pharmaceutical costs and prices. Health Aff (Millwood) 2009;28(1):165–68.
26. Guler I, Nerkar A. The impact of global and local cohesion on innovation in the pharmaceutical industry. SMJ 2012;33(5):535–49.
27. Ozcan YA, Khushalani J. Assessing efficiency of public health and medical care provision in OECD countries after a decade of reform. CEJOR 2016;25(2):325-43.
28. Prodan I. Influence of research and development expenditures on number of patent applications: Selected case studies in OECD Countries and Central Europe, 1981– 2001. AEID 2005;5-4:5–22.
29. Hofmarcher MM. Austria health system review. Health System in Transition 2013;15:1–331.
30. Hofmarcher MM. The Australian health reform 2013 is promising but requires continuous political ambition. Health Pol 2014;118(1):8-13.
31. Deber RB. Health care reform: Lessons from Canada. Am J Public Health 2003;93(1):20-4.
32. Simms C. Health reform in Canada. IJCP 2010;64(4):426-28.
33. Bitran R, Escobar L, Gassibe P. After Chile’s health reform: increase in coverage and access, decline in hospitalization and death rates. Health Aff (Millwood) 2010;29(12):2161-70.
34. Cornejo-Ovalle M, Paraje G, Vasquez-Lavin F, Perez G, Palencia L, Borrell C. Changes in socioeconomic inequalities in the use of dental care following major healthcare reform in Chile,

- 2004-2009. *Int. J. Environ. Res. Public Health* 2015;12(3):2823-36.
35. Andersen PT, Jensen JJ. Healthcare reform in Denmark. *Scand J Public Health* 2010;38(3):246-52.
36. Braithwaite J, Matsuyama Y, Mannion R, Johnson J, Bates DW, Hughes C. How to do better health reform: a snapshot of change and improvement initiatives in the health systems of 30 countries. *IJQHC* 2016;28(6):843-46.
37. Lai T, Habicht T, Kahur K et al. Estonia: Health system review. *Health System Transition*. 2013;15:1–196.
38. Müller-Jentsch W. Formation, development and current state of industrial democracy in Germany. *Transfer: European Review of Labour and Research* 2016;22(1):45-62.
39. Busse R, Blümel M. Germany health system review. *Health Systems in Transition* 2014;16(2):1–296.
40. Ikegami N, Campbell JC. Japan's health care system: containing costs and attempting reform. *Health Aff (Millwood)* 2004;23(3):26–36.
41. Matsuo D. Effect of amendment to Japan's Pharmaceutical Affairs Law. Nomura Research Institute (NRI) Papers, No. 149, 2009. Retrieved from: <http://www.nri.com/global/opinion/papers/2009/pdf/np2009149.pdf>. Accessed on: 16.2.2018.
42. Miyata H, Ezoe S, Hori M, Inoue M, Oguro K, Okamoto T, Onishi K, Onozaki K, Sakakibara T, Takeuchi K, Tokuda Y, Yamamoto Y, Yamazaki M, Shibuya K. (2015) Japan's vision for health care in 2035. *Lancet* 385(9987):2549-50.
43. Frenk J, Gonzalez-Pier E, Gomez-Dantes O. et al. Comprehensive reform to improve health system performance in Mexico. *Lancet* 2006(9546);368:1524–34.
44. Nigenda G, Wirtz VJ, Gonzalez-Robledo LM, Reich MR. Evaluating the implementation of Mexico's Health Reform: The Case of Seguro Popular. *HS&R* 2015;1(3):217-28.
45. OECD Better Life Index, Netherlands, Retrieved from: <http://www.oecdbetterlifeindex.org/countries/netherlands/>, Accessed on: 22.07.2016.
46. Schafer W, Kroneman M, Boerma W et al. The Netherlands Health System Review. *Health Systems in Transition* 2010;12(1):1–267.

47. Kroneman M, Boerma W, van den Berg M, Groenewegen P, de Jong J, van Ginneken E. Netherlands: Health Systems in Transition. 2016;18(2):1-240.
48. Ringard A, Saunes IS, Sagan A. The 2015 hospital treatment choice reform in Norway: Continuity or change? Health Pol 2016;120(4):350-5.
49. Ringard A, Sagan A., Saunes IS. et al. Norway: Health system review. Health Systems in Transition 2013;15(8):1–162.
50. Barros PP. Health policy reform in tough times: the case of Portugal. Health Pol 2012;106(1):17–22.
51. Szalay T, Pazitny P, Szalayova A. et al. Slovakia: Health system review. Health System in Transition 2011;13(2):1–203.
52. Dlouhy M. Mental health policy in Eastern Europe: a comparative analysis of seven mental health systems. BMC Health Serv Res 2014;14(42):1-8.
53. Aktan AO, Pala K, Ilhan B. Health-care reform in Turkey: far from the perfect. The Lancet (London, England) 2014;383:25–6.
54. Tatar M, Mollahaliloglu S, Sahin B et al. Turkey: health system review. Health system in Transition 2011;13(6):1–186.
55. Blank RH. Transformation of the US Health System: Why is change so difficult? Current Sociology 2012;60(4):415–26.
56. Rice T, Rosenau P, Unruh LY et al. United States of America: Health system review Health System in Transition 2013;15(3):1–431.
57. McDonough JE. The United States Health System in Transition. HS&R 2015;1(1):39- 51.
58. Lichtenberg FR. The impact of biomedical innovation on longevity and health. Nordic Journal of Health Economics (2015-b) <http://dx.doi.org/10.5617/njhe.1290>, Accessed on: 21.07.2016.
59. Essen A, Lindblad S. Innovation as emergence in health care: unpacking change from within. Soc Sci Med 2013;93:203-11.

60. Newhouse JP. Medical care costs: how much welfare loss? *J Econ Perspect* 1992;6(3):3-21.
61. Bodenheimer T. High and rising health care costs. Part 2: Technological innovation. *Ann Intern Med* 2005;142(11):932-7.
62. Djellal F, Gallouj F. Innovation in hospitals: a survey of the literature. *Eur J Health Econ* 2007;8(3):181-93.
63. Hotelling H. Relations between two sets of variates. *Biometrika* 1936;28(3/4):321–77.
64. Avron H, Boutsidis C, Toledo S. et al. Efficient dimensionality reduction for canonical correlation analysis. *The 30th International Conference on Machine Learning*, 2013; 1–9.
65. Sun L, Ceran B, Ye J. A scalable two-stage approach for a class of dimensionality reduction techniques. *16th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining*. 2010:313–22.
66. Razavi AR, Gill H, Ahlfeldt H. et al. Canonical correlation analysis for data reduction in data mining applied to predictive models for breast cancer recurrence. *STHI*. 2005;116:175–80.
67. McCormack B, Fallon EF, Cormican K. An analysis of open innovation practices in medical technology sector in Ireland. *Procedia Manufacturing* 2015;3:503–09.
68. Daniel GW, Caze A, Romine MH et al. Improving pharmaceutical innovation by building a more comprehensive database on drug development and use. *Health Aff (Millwood)* 2015;34(2):319–27.
69. Lichtenberg FR. The impact of pharmaceutical innovation on longevity and medical expenditure in France, 2000-2009. *Econ Hum Biol*. 2014;13:107-27.
70. Zuckerman B, Margolis PA, Mate KS. Health services innovation the time is now. *JAMA* 2013;309(11):1113-4.
71. Almarsdottir AB, Traulsen JM. Cost-containment as part of pharmaceutical policy. *Pharm World Sci* 2005;27(3):144-8.
72. Gupta H, Kumar S, Kumar RS, et al. Patent protection strategies. *J Pharm Bioallied Sci* 2010;2(1):2-7.

73. Grabowski H. Patents, innovation and access to new pharmaceuticals. *JIEL* 2002;5(4):849-60.
74. WIPO, WTO (2012) Promoting access to medical technologies and innovation World Health Organization, World Intellectual Property Organization and World Trade Organization, Geneva, Switzerland.
75. Neumann PJ, Sandberg EA. Trends in health care R&D and technology innovation. *Health Aff (Millwood)* 1998;17(6):111–9.
76. Hogerzeil HV. Big Pharma and social responsibility-the Access to Medicine Index. *N Engl J Med* 2013;369(10):896–9.
77. DiMasi JA, Grabowski HG, Hansen RW. Innovation in the pharmaceutical industry: New estimates of R&D costs. *J Health Econ* 2016;47:20–33.
78. Barbieri M, Drummond M, Willke R. et al. Variability of cost-effectiveness estimates for pharmaceuticals in Western Europe: Lessons for inferring generalizability. *Value Health* 2005;8(1):10–23.
79. Anderson G, Hussey PS. Comparing health system performance in OECD countries. *Health Aff (Millwood)* 2001;20(3):219–32.
80. Magnussen J, Hagen TP, Kaarboe OM. Centralized and decentralized? A case study of Norwegian hospital reform. *Soc Sci Med* 2007;64(10):2129–37.
81. Hakkinen U, Joumard I. Cross-country analysis of efficiency in OECD health care sectors. OECD Economics Department Working Papers, No. 554, ECO/WKP; 2007.