Do physicians still direct nursing workforce? A profession striving for autonomy since mid- 1900's

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Article

Keywords: Physician healthcare, Nursing healthcare, Life expectancy at birth, Overall population health, Physician's dominance, Nursing autonomy

Posted Date: October 18th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-2166336/v1

Additional Declarations: No competing interests reported.

Version of Record: A version of this preprint was published at Scientific Reports on July 25th, 2023. See the published version at https://doi.org/10.1038/s41598-023-38945-6.

Abstract

Background

This study highlights the contribution of nurses is secondary to physicians to overall population health (indexed with life expectancy at birth, $e_{(0)}$).

Methods

All data were extracted from the World Bank. The potential competing effects of affluence, urbanization and obesity were fully considered when scatter plots, bivariate correlation and partial correlation models were performed to analyse the correlations between $e_{(0)}$ and physician healthcare and nursing healthcare respectively. The Fisher Z-Transformation was conducted for comparing the correlations between $e_{(0)}$ and physician healthcare and nursing healthcare. Multiple linear regression analyses were implemented for modelling that physicians' contributions to $e_{(0)}$ explain nurses'.

Results

Physician healthcare correlates to $e_{(0)}$ significantly more strongly than nursing healthcare (z= 2.83, 2.95 and 2.01 in scatterplots, Pearson's r and nonparametric respectively, $p< 0.05$). Physician healthcare remains significantly correlational to $e_{(0)}$ when nursing healthcare alone was controlled or when the 3 confounders (economic affluence, obesity and urbanization) were controlled ($r=0.380$, $p <0.001$ and $r=0.444$, $p < 0.001$ respectively). Nursing healthcare was in weak or negligible correlation to $e_{(0)}$ when physician healthcare was controlled individually or together with the 3 control variables. Linear regression reveals that nursing healthcare was a significant predictor for $e_{(0)}$ when physician healthcare was "not added" for modelling, but this significance became negligible when physician healthcare was "added".

Conclusions

Physician healthcare correlated to $e_{(0)}$ extension significantly more than nurses. Statistically, physicians may explain the role of nurses in extending $e_{(0)}$.

Background

Life expectancy at birth ($e_{(0)}$) integrates the mortality patterns across all age groups [1, 2] and therefore it is defined as how many years a newborn can expect to live, on average ,if current mortality rates at different developmental stages do not change [1-3]. In epidemiology studies, $e_{(0)}$ has been commonly considered as the statistical measure of overall population health [4]. The limited available data published by the World Bank data shows that, worldwide, $e_{(0)}$ was 72.75 years old, a 20 years improvement from 52.58 years old in 1960 [5]. The rapid increase of $e_{(0)}$ has been attributable to epidemiological transitions which have remarkably improved human health though decreasing morbidity rates during whole human life span [6, 7]. Nurses and physicians are the two major practitioner groups in the healthcare workforce, and have significantly contributed to reducing mortality and morbidity rates to improve overall population health leading to the extension of $e_{(0)}$ [8-25].

Nursing has been a female dominated profession [26, 27]. Historically, nurses were considered as handmaidens or subordinates to a male-dominated medical profession. It is commonly accepted that modern nursing started in mid-1900's an outcome of Nightingale's Environmental Theory published in 1859. This doctrine established principles that required nurses to work under the supervision and direction of medical staff. From that time modern nursing has continued to strive for autonomy and recognition that nursing is a discipline equally important as medicine [28, 29]. This recognition however, from the perspective of sociology, psychology and nursing history has consistently revealed that where there is a hierarchical physician- nurse relationship there is often less effective team collaboration [30]. This hierarchical relationship contributes to nurses' tension and stress a significant contributing factors for nurses' job dissatisfaction, burnout and attrition [31, 32].

Fortunately, the importance of the nursing role, higher education and feminist perspectives have promoted the value of professional autonomy recognising nurses capacity to think independently about their healthcare services [33, 34]. Despite such advances however ongoing studies have revealed continued structural and professional inequalities between physicians and nurses [35, 36]. For example, in many countries physicians still hold absolute power in determining holistic healthcare services to patients through prescribing medications, deciding treatment options and referral pathways. These structural and professional inequalities enable physicians to maintain the traditional dominant role in current healthcare system and therefore maintain the invisibility of nurses healthcare services to the public [37].

At the population level, the overall responsibilities of medicine and nursing for providing healthcare may lead to different magnitudes of contributions to measures of health. In other words, the contributions of physicians and nurses to overall population health ($e_{(0)}$) may not be viewed or documented as equally important. This inference has been supported by several studies which concluded that, in the last decades, although physicians and nurses have been collaborating in different ways, overall, physicians remain dominant in healthcare services [38-42].

There has been no study calculating and comparing the two different levels of healthcare effects on overall population health. To fill this knowledge gap, we calculated the correlations of physicians and nursing healthcare to overall population health, we then compared the two associations in multiple data analysis models. Finally, we analysed statistical explanatory effects of one another in terms of their contributions to overall population health. These statistical analysis results were applied to support our 2 hypotheses: 1) globally, physician healthcare contribute significantly more to overall population health than nurse healthcare; and 2) nurses' contribution to overall population health may be statistically explained by the role of the physicians.

Study Materials

All the 6 variables included in this study were extracted from the database of the World Bank:

1. Dependent variable, life expectancy at birth ($e_{(0)}$) [5].

The $e_{(0)}$ reflects the overall mortality level of a population. It has been the most commonly used measure to describe overall population health. In this manuscript, $e_{(0)}$ and overall population health are interchangeably.

2. Physician healthcare level measured with the physician density, i.e. the number of physicians per 1,000 population [43]

3. Nursing healthcare level indexed with the nurse density (the number of nurses per 1,000 population) [44]

The numbers of physicians and nurses per 1,000 population in each country between 2014 and 2018 were averaged respectively for reducing possible errors when the World Bank collected and integrated the data.

Physician healthcare level and nursing healthcare level are interchangeably written as physicians and nurses respectively in this article.

Gross Domestic Product (GDP), urban advantage and obesity have been postulated as the major factors influencing overall population health [45]. Therefore, they were considered as the potential confounders when we analysed and compared the relationships between $e_{(0)}$ and physician and nurses healthcare levels respectively.

4. GDP purchasing power parity (GDP PPP) measures life quality and wellbeing of individuals at population level which has constantly extended $e_{(0)}$ of each individual country [46-49].

5. Obesity increases the risk for developing health challenges which might lead to early mortality, and subsequently reduction of $e_{(0)}$ [50-52].

6. Urbanization represents the level of advantages for urban residents to access better healthcare services provided by physicians and nurses and healthcare education opportunities [12, 53, 54].

In total, a list of 215 countries with GDP PPP was downloaded and then the other 5 variables were matched with this list. Some populations did not have all the data for all the 5 variables. Therefore, the numbers of populations included in our data analysis models may differ as such. Politically speaking, not all the populations from which the international organisations collected data should be called “country”. For instance, the data from Hong Kong and Macau are included in this study, but neither of them has a sovereign title. To facilitate the author’s writing and follow sound reading habits, in this paper, the territory with or without sovereign is called a country, and it is interchangeable with the population.

Ethical approval

All the population level data for this study were freely downloaded from the official website of the World Bank [55]. There are no individual people or communities which were involved in were identifiable in the study. The health information involved in this study is not traceable to any individual, their family and their community. Ethical clearance was obtained from the Office of Research Ethics, Compliance and Integrity (ORECI) of the University of Adelaide (Ethics Approval Number: 36289).

Data analysis models

The relationships between $e_{(0)}$ and physicians and nurses were calculated and compared in 4 common data analysis models, which were adopted in previous studies [56-61].

1. Scatter plots were conducted with the raw data in Microsoft Excel 2016®.

This does not only allow us to check the data quality, for instance checking if there is any outlier, but also allows us to calculate and visualize the strengths and directions of correlation of $e_{(0)}$ with physicians and nurses respectively.

The square roots of the 2 R square values were obtained for comparing the correlations of $e_{(0)}$ to physician healthcare and nursing healthcare.

2. Pearson’s r and nonparametric correlations were performed for evaluating the strengths and directions of the bivariate correlations between all the 6 variables.

3. Partial correlation of Pearson’s moment-product model were conducted to reveal the independent correlations between different pairs of variables. Firstly, we controlled for GDP PPP, obesity prevalence and urban advantages for calculating the correlations between $e_{(0)}$ and physician healthcare and nursing healthcare respectively. This allows us to explore if and how much the potential competing effects of GDP PPP, obesity prevalence and urbanization make on the significantly correlations between $e_{(0)}$ and physician healthcare and nursing workforce. And then we alternated nursing healthcare and physician healthcare as a potential confounder, and controlled together with affluence, obesity and urbanization for examining the correlation between the one another’s correlation with $e_{(0)}$. Further to this, we alternated each of the 5 variables (independent and confounders) as the predictor for assessing the correlation between $e_{(0)}$ and each of the 5 variables while all the rest of 4 variables were considered as the potential confounders.

Finally, we alternated each of the 5 individual variables (physicians, nurses, affluence, obesity and urban advantages) as the potential competing variable to reveal the correlations of $e_{(0)}$ to the other 4 individual variables respectively.

The Fisher r-to-z transformation was conducted to demonstrate that $e_{(0)}$) was a significantly stronger correlation to physician healthcare than to nurses in the data analysis models, Pearson's r nonparametric and partial correlation.

4. Standard multiple linear regression (enter) was performed to reveal the correlations between $e_{(0)}$ and the predicting variables (physician and nurses). In order to reveal if and how much physicians can statistically explain the individual correlations of $e_{(0)}$ to nurses, affluence, obesity and urban advantages, the enter multiple linear regression model was conducted to reveal the correlations of $e_{(0)}$ to these individual variables when physicians was "not added" and "added" as an independent/predicting variable respectively. Subsequently, stepwise standard multiple linear regression model was conducted to select the predicting variable(s) which had the most significant effects on $e_{(0)}$ when physician healthcare was "not added" and "added" as an independent/predicting variable respectively.

We alternated physicians and nurses and repeated the above linear regression models for observing if and how much nursing can statistically explain physician, GDP PPP, obesity prevalence and urbanization.

We log transformed the variables for increased homoscedasticity for data correlation analyses. SPSS IBM v. 28® was conducted for exploring the bivariate correlations (Pearson's r and nonparametric), partial correlation and multiple linear regression analyses. The significance of the correlation was set at the 0.05, but the levels of 0.01 and 0.001 were reported as well. The analysis criteria of standard multiple linear regression (enter and stepwise) were kept at probability of F to enter ≤ 0.05 and probability of F to remove ≥ 0.10.

Results

The relationships revealed in the scatterplots between $e_{(0)}$ and physician healthcare and nurses were both noted to be power with strong correlations (R^2= 0.6849, p<0.001, n= 189 and R^2= 0.5037, p< 0.001, n=189 respectively, Figure 1). There was no outlier in either physician healthcare, nursing healthcare or $e_{(0)}$. Worldwide, physician healthcare and nursing healthcare explained 68.49% and 50.37% of $e_{(0)}$ respectively. When the above two R^2's were calculated into coefficient r's for revealing the significance of difference, it was found that physician healthcare was in significantly stronger correlation to $e_{(0)}$ than nursing healthcare (z= 2.83, p< 0.01).

Figure 1: The relationships between life expectancy at birth and physician and nurse healthcare respectively

The significant predicting effects of physician healthcare and nursing healthcare on $e_{(0)}$ and their significant difference revealed in the scatterplots were consistent with the subsequent bivariate correlation analyses with log-transformed data.

Worldwide, both physician healthcare and nursing healthcare significantly correlated to $e_{(0)}$ (r= 0.822 and r= 0.695, p<0.001 in Pearson respectively). Fisher r-to-z transformation identifies that physician healthcare was in significantly stronger correlation to $e_{(0)}$ than nursing healthcare (z= 2.95, p< 0.01). Similarly, in non-parametric model, both physician healthcare and nursing healthcare significantly correlated to $e_{(0)}$ as well (r= 0.807 and r= 0.721, p<0.001 respectively). Fisher r-to-z transformation also identifies that physician healthcare was in significantly stronger correlation to $e_{(0)}$ than nursing healthcare (z= 2.01, p< 0.05) (Table 1).

Table 1 Matrix for reporting Pearson's r (above diagonal) & non-parametric (below diagonal) correlations between all variables

When the 3 potential confounders were controlled, both physician and nurse healthcare correlated to $e_{(0)}$ significantly (r= 0.471, p< 0.001 and r= 0.181, p< 0.05 respectively). Fisher r-to-z transformation revealed that physician healthcare was in significantly stronger correlation to $e_{(0)}$ than nursing healthcare (z= 3.03, p< 0.01) (Table 2-1). When physician healthcare and nursing healthcare were alternated as the potential confounders together with GDP PPP, obesity and urbanization for exploring one another's correlation to $e_{(0)}$, nurses showed nil correlation to $e_{(0)}$ (r= 0.001, p= 0.985), but physician healthcare showed moderately strong correlation to $e_{(0)}$ (r= 0.444, p < 0.001, Table 2-2). GDP PPP also showed the moderately strong correlation with $e_{(0)}$ when all the 4 variables were included as potential confounders (Table 2-3).

When physician healthcare, nurse healthcare, GDP PPP, obesity and urbanization were individually controlled, physician healthcare is moderately strong and significant correlation with $e_{(0)}$ independent of nursing healthcare (r= 0.621, p< 0.001, Table 2-4). However, when physician healthcare was kept constant, nursing healthcare only showed very weak and insignificant correlation to $e_{(0)}$ (r= 0.142, p= 0.053, Table 2-4).

These results suggested that nursing healthcare significantly contributes to $e_{(0)}$, but the magnitude became insignificant when physician healthcare was also considered.

Table 2 Partial correlations of life expectancy at birth to physician and nurse healthcare with different combinations of controlled variables

When physician healthcare was "not added" as one of the predicting variables, Standard multiple linear regression (enter) analysis revealed that GDP PPP and nursing healthcare were the only 2 significant predicting variables for $e_{(0)}$ (β= 0.698, p<0.001 and β= 0.174, p<0.05 respectively Table 3). Obesity and urbanization showed almost nil contribution to $e_{(0)}$. Together with GDP PPP, physician healthcare was selected as a significant contribution to $e_{(0)}$ (β= 0.527

and 0.426 respectively, p<0.001) when physician healthcare was “added” as one of the predicting variables in the enter model. Obesity prevalence and urban advantages showed nearly nil correlation to $e_{(0)}$ (Table 2).

Similarly, in the stepwise model, when physician healthcare was “not added” as one of the predictors, GDP PPP and nurse healthcare were the only 2 significant predictors for $e_{(0)}$ (R^2= 0.627 and 0.638 respectively). However, physician healthcare was selected as the most influential contributor to $e_{(0)}$ (R^2= 0.668) when it was “added” as an independent/predicting variable. In this model, GDP PPP was placed as the 2nd most influential predictor for $e_{(0)}$ with the R^2 increment of 0.038 (Table 3). In this data analysis model (stepwise), totally, 70.60% of $e_{(0)}$ was explained by physician healthcare, nursing healthcare, GDP PPP, obesity prevalence, urbanization.

When nursing healthcare was “not added” as a predicting variable in linear regression enter model, physician healthcare and GDP PPP significantly correlated to $e_{(0)}$ (β= 0.527 and β= 0.426, p<0.001 respectively, Table 3). When nursing healthcare was “added”, this did not change the correlations between $e_{(0)}$ and each of 4 predicting variables (physician healthcare, GDP PPP, obesity prevalence, urbanization). Similarly, in two stepwise models, when nursing healthcare was “not added” and “added” in the analyses, physician healthcare and GDP PPP were the only 2 variables showing most influential predicting effects on $e_{(0)}$, and the addition of nursing healthcare did not affect how much the $e_{(0)}$ was explained (both 70.60%, Table 3).

These results appeared in linear regression models were consistent with those reported in Table 2. The statistical relationships reported in Tables 2 and 3 suggested that nursing healthcare significantly contributed to $e_{(0)}$, which was dependent on physicians’ contribution.

Table 3 Multiple linear regression results to show predicting effects of independent variables and identify the significant predictors of life expectancy at birth

Discussion

The findings above illustrate that while nurses account for the bulk of the health care workforce their contribution to discrete indices such as life expectancy are difficult to identify. The lack of nursing interventions with clear metrics reflects the evolution of the modern health system and the role that physicians and nurses play in the delivery of health. Lal suggests this is a critical time in the evolution of nursing and that nurses have an opportunity to ‘find unique challenges’ to some of the most pressing public health care issues [62]. Allard and Conroy describe that the role of the Nurse Navigator, tested in acute care settings, has potential to expand and positively influence population health in a much more visible and cost-effective manner than previously possible [63, 64]. The challenge however lies in the nursing profession becoming visible as an equal contributor to the physician- nurse relationship which in some circumstanced remains characterized by physicians' dominance in providing healthcare services [38, 39]. Our research findings confirm the overt recognition physicians’ receive in healthcare service delivery, when comparing physicians’ and nurses’ contributions to healthcare overall population health:

1) Physician healthcare contribute to $e_{(0)}$ significantly more than nurses, and this significant disparity remains although we ruled out the competing effects of the common confounding factors associated with $e_{(0)}$, such as economic affluence, urbanization, and obesity.

2) Physician healthcare service may contribute to $e_{(0)}$ independent of nursing healthcare service. However, nursing healthcare appears to play a very minor role in maintaining and improving $e_{(0)}$, when physician’s contribution to $e_{(0)}$ is controlled.

3) Physicians’ role may explain/cover nurses’ responsibility for contributing to $e_{(0)}$ when both physician healthcare and nurses, economic affluence, urbanization, and obesity are incorporated for analysing their relationships with $e_{(0)}$. In contrary, nursing healthcare shows its negligible explanation for physicians’ healthcare for maintaining and improving $e_{(0)}$.

These findings illustrate the lack of visibility of nursing autonomy for which nursing industry has been striving since 1845 [65]. Nursing autonomy grants nurses the power to determine the non-medical related aspects of a patient’s care without having to consult physicians. Nurses should rightfully expect equity in decision-making processes and a reciprocal exchange with physicians while developing and implementing the patient’s healthcare plan [37]. The reality of many health care systems however is that physicians are situated to hold final responsible and decision making for patients’ healthcare, [66]. Therefore, it has been suggested that physicians perceive they are the controlling partner in physician- nurse collaborations [67], and nurses should be readily available to assist them or answer questions regarding ‘their’ patients [37]. Physicians and nurses however may have different expectations from their collaborations which may lead to conflict, tension, bullying and stress, factors which lead to job dissatisfaction and, subsequently, burnout for nurses [68, 69] therefore contributing to reducing the nursing workforce. The underlying structures that overtly recognise elements of care such as overall population health care are reflected in the statistical differences between physician healthcare and nurses identified in our study [70]. Such elements have been noted before as the imbalanced power between physicians and nurses which encourages physicians to take a role, authoritative to that of the nurse [71].

While noting that medicine education for physicians is typically longer than for other health professions [72], nurses’ educational level and status usually affords less authority in healthcare contexts.

2) Different expectations from medical and nursing graduates lead to different levels of responsibilities for patients’ healthcare during their clinical practices [73].

Traditionally, physicians are focused on diagnosing and treating diseases and curing the patient. However, nurses are expected to carry out physicians’ order and focus on much broader and wholistic goals along the continuum from health promotion, illness prevention, caring for the unwell and dying patient while also supporting the patients family [70, 74]. May et al note that health care systems are facing a paradigmatic shift from isolated interactions with people to longer term relationships [75, 76]. Critically, this shift should be accompanied by the collection of more refined and discrete measures of nurses’ contribution to population health. If this does not happen an extension of the ubiquitous culture of nurse and doctor will continue. The findings from this study suggest that,

while physicians who often bear primary legal responsibility for their patients, may also make critical decisions about patients' medical diagnosis and subsequent treatment without nursing input.

3) Nursing industry with lower staff retention causing an issue in nursing workforce sustainability [77, 78].

Nursing work is physically and mentally demanding [79-81], an issue which has been responsible for nurses' poor physical and mental health leading to burnout and job dissatisfaction [80, 82, 83], and eventually exit from a nursing career [79-81, 84]. The professional impact of such exits is that the nurses may not gain as much experience as their physician counterparts further reducing the opportunity to collect and influence measures of health such as life expectancy...

When analysing the literature and the underlying causes for the conflicts, the responsibilities of physician healthcare and nurses were quantitatively compared in terms of improving patient outcomes: 1) Nursing healthcare might be as good as physicians' care, and this suggested in a number of studies into primary care healthcare services [85-88]. 2) While nurses play a complementary role to physicians [89-91], their contribution needs to be more visible when considering patients' healthcare plan and patient satisfaction [92-94]. These studies were conducted in specific health care settings, for example, hospitals and primary healthcare facilities where governance and responsibility remain largely hierarchical and often rigid. However, in our study, we compared the comprehensive healthcare effects of total physicians and nurses on overall population health at primary, secondary and tertiary levels.

As the two major healthcare groups, the contribution of the nursing workforce to population health is less visible when compared to physicians. This lack of visibility reflects the existing hierarchy and history of nurse physician relationships. Further compounding this issue is the ambiguity in nurse–physician roles and responsibilities may have arisen from the fact that the role of the nurse has been less autonomous, while the role of the physician has been one of independence [95, 96]. These has already reported in a number of studies that the contemporary "physician- nurse game" has been just played differently, but, essentially, the results remain the same that physicians still direct nursing workforce for delivering physician measures of healthcare services [39-42]. Without explicit and substantial professional awareness, development of educational content [97] and attention to more clearly defining and expanding scope of practice, notions of autonomy and independence will remain vague, political slogans within the nursing industry.

Limitation and strength

Firstly, this is an ecological study, and the results are somehow dependent on the nature of the ecological fallacy. The at population level correlational relationships revealed in our data analyses might not hold true at the individual level. However, considering the number and distribution of people involved in the study, this may not be achievable in the individual based study.

Secondly, the relationships revealed in this data analysis-based study are not causal, but correlational.

Thirdly, the data included in this study may be fairly crude and they may have some random errors when the population level data were collected and aggregated by the United Nations agencies. However, these data were collected and integrated in a more objective manner, which is different from how the data collect for the individual studies.

Finally, there is high validity of the variables involved in this study. Physicians, nurses, GDP PPP, urbanization and obesity explain a majority of overall population health 70.6%. Although not 100%, or still residual to be explained, considering the data availability, we cannot locate more data for the analysis.

Conclusion

Our study suggests that, presently, the contribution of the nursing workforce to population health is much less visible than physicians. This phenomenon reflects the inequity of power due to less visible measures of nursing influence, different levels of education, the perceived value of care as a job, historical hierarchies and subservient workplace structures. Nursing autonomy and independence needs to be more explicit, supported and recognised. Without correction, newer models of care will simply transmit the invisibility of nursing from one generation of nurses to another.

Declarations

Authors' contributions

Wenpeng You: Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Resources; Software; Validation; Visualization; Roles/Writing - original draft; Writing.

Lynette Cusack: Conceptualization; Funding acquisition; Investigation; Methodology; Project administration; Resources; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing.

Frank Donnelly: Conceptualization; Funding acquisition; Investigation; Methodology; Project administration; Resources; Supervision; Validation; Visualization; Roles/Writing - original draft; Writing - review & editing.

Data availability

The sources of all the data have been described in detail in the "Study Materials". The formal permission to download and apply the data for non-commercial purpose is not required as per the protocol of the World Bank. All the data for this study are freely downloaded from the official website of the World Bank.

Conflicts of Interest

The authors declare they have no conflict of interest.

Funding sources

There is no specific funding to this study.

References

1. Jen, M.H., et al., *International Variations In Life Expectancy: A Spatio-Temporal Analysis*. Tijdschrift voor economische en sociale geografie, 2010. **101**(1): p. 73–90.
2. AIHW. *Deaths in Australia*. Life expectancy & deaths 2021 25 Jun 2021 04 April 2022]; Available from: https://www.aihw.gov.au/reports/life-expectancy-death/deaths-in-australia/contents/life-expectancy.
3. WHO. *WHO stat 2006 Definitions And Metadata* Life expectancy at birth 2021 04 April 2022]; Available from: https://www.who.int/whosis/whostat2006DefinitionsAndMetadata.pdf.
4. Jaba, E., C.B. Balan, and I.-B. Robu, *The relationship between life expectancy at birth and health expenditures estimated by a cross-country and time-series analysis*. Procedia Economics and Finance, 2014. **15**: p. 108–114.
5. The World Bank. *Life expectancy at birth, total (years)*. 2022 05 April 2022]; Available from: https://data.worldbank.org/indicator/SP.DYN.LE00.IN.
6. McKeown, R.E., *The Epidemiologic Transition: Changing Patterns of Mortality and Population Dynamics*. Am J Lifestyle Med, 2009. **3**(1 Suppl): p. 19S-26S.
7. McKeown, R.E., *The epidemiologic transition: changing patterns of mortality and population dynamics*. American journal of lifestyle medicine, 2009. **3**(1_suppl): p. 19S-26S.
8. Braveman, P. and L. Gottlieb, *The social determinants of health: it's time to consider the causes of the causes*. Public health reports, 2014. **129**(1_suppl2): p. 19–31.
9. Low, L.F., et al., *Community care for the E lderly: N eeds and Service U se S tudy (CENSUS): Who receives home care packages and what are the outcomes?* Australasian Journal on Ageing, 2015. **34**(3): p. E1-E8.
10. Gu, D., Z. Zhang, and Y. Zeng, *Access to healthcare services makes a difference in healthy longevity among older Chinese adults*. Social science & medicine, 2009. **68**(2): p. 210–219.
11. Oladimeji, O., H. Access, and G. Quality Collaborators, *Measuring performance on the healthcare access and quality index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study* 2016. 2018.
12. Basu, S., et al., *Association of primary care physician supply with population mortality in the United States, 2005–2015*. JAMA internal medicine, 2019. **179**(4): p. 506–514.
13. Basu, S., et al., *Estimated effect on life expectancy of alleviating primary care shortages in the United States*. Annals of Internal Medicine, 2021. **174**(7): p. 920–926.
14. Aiken, L.H., et al., *Hospital nurse staffing and patient mortality, nurse burnout, and job dissatisfaction*. Jama, 2002. **288**(16): p. 1987–1993.
15. Aiken, L.H., et al., *Effects of nurse staffing and nurse education on patient deaths in hospitals with different nurse work environments*. The Journal of nursing administration, 2012. **42**(10 Suppl): p. S10.
16. Estabrooks, C.A., et al., *The impact of hospital nursing characteristics on 30-day mortality*. Nursing research, 2005. **54**(2): p. 74–84.
17. Van den Heede, K., et al., *The relationship between inpatient cardiac surgery mortality and nurse numbers and educational level: analysis of administrative data*. International journal of nursing studies, 2009. **46**(6): p. 796–803.
18. Cho, E., et al., *Effects of nurse staffing, work environments, and education on patient mortality: an observational study*. International journal of nursing studies, 2015. **52**(2): p. 535–542.
19. Manojlovich, M., *Increasing nurse staffing levels and a higher proportion with bachelor's degrees could decrease patient mortality risk*. Evidence-based nursing, 2015. **18**(2): p. 62–62.
20. Oliver, G.M., et al., *Impact of nurse practitioners on health outcomes of Medicare and Medicaid patients*. Nursing Outlook, 2014. **62**(6): p. 440–447.
21. Aiken, L.H., et al., *Hospital nurse staffing and patient outcomes*. Revista Médica Clínica Las Condes, 2018. **29**(3): p. 322–327.
22. Rafferty, A.M., et al., *Outcomes of variation in hospital nurse staffing in English hospitals: cross-sectional analysis of survey data and discharge records*. International journal of nursing studies, 2007. **44**(2): p. 175–182.
23. Aiken, L.H., et al., *Patient safety, satisfaction, and quality of hospital care: cross sectional surveys of nurses and patients in 12 countries in Europe and the United States*. Bmj, 2012. **344**.
24. Suhonen, R., et al., *Patient satisfaction as an outcome of individualised nursing care*. Scandinavian journal of caring sciences, 2012. **26**(2): p. 372–380.
25. Cho, E., et al., *Nurse staffing level and overtime associated with patient safety, quality of care, and care left undone in hospitals: a cross-sectional study*. International journal of nursing studies, 2016. **60**: p. 263–271.
26. Statistic Stats. *Male Nursing Statistics 2019*. 2022 05 July 2022]; Available from: https://www.statisticstats.com/health/male-nursing-statistics/.
27. Ghebreyesus, T.A. *Female health workers drive global health*. 2022 [cited 2022 June 8 2022]; Available from: https://www.who.int/news-room/commentaries/detail/female-health-workers-drive-global-health.

28. Karimi, H. and N.M. Alavi, *Florence Nightingale: the mother of nursing*. Nursing and midwifery studies, 2015. **4**(2).
29. Gilbert, H.A., *Florence Nightingale's Environmental Theory and its influence on contemporary infection control*. Collegian, 2020. **27**(6): p. 626–633.
30. Rosen, M.A., et al., *Teamwork in healthcare: Key discoveries enabling safer, high-quality care*. American Psychologist, 2018. **73**(4): p. 433.
31. Tang, C., et al., *Collaboration between hospital physicians and nurses: an integrated literature review*. International nursing review, 2013. **60**(3): p. 291–302.
32. Poghosyan, L., et al., *Nurse burnout and quality of care: Cross-national investigation in six countries*. Research in nursing & health, 2010. **33**(4): p. 288–298.
33. Entwistle, V.A., et al., *Supporting patient autonomy: the importance of clinician-patient relationships*. Journal of general internal medicine, 2010. **25**(7): p. 741–745.
34. Skår, R., *The meaning of autonomy in nursing practice*. Journal of Clinical Nursing, 2010. **19**(15-16): p. 2226–2234.
35. Cordon, C., *Structural inequality and diversity in nursing*. Minority Nurse, 2012: p. 30–35.
36. Cottingham, M.D., *The missing and needed male nurse: Discursive hybridization in professional nursing texts*. Gender, Work & Organization, 2019. **26**(2): p. 197–213.
37. House, S. and D. Havens, *Nurses' and physicians' perceptions of nurse-physician collaboration: a systematic review*. JONA: The Journal of Nursing Administration, 2017. **47**(3): p. 165–171.
38. Vazirani, S., et al., *Effect of a multidisciplinary intervention on communication and collaboration among physicians and nurses*. American Journal of Critical Care, 2005. **14**(1): p. 71–77.
39. Radcliffe, M., *Doctors and nurses: new game, same result*. Bmj, 2000. **320**(7241): p. 1085.
40. BMJ, *Doctors and nurses: a new dance?* BMJ, 2000. **320**(7241): p. A-A.
41. Stein, L.I., *The doctor-nurse game*. Archives of general psychiatry, 1967. **16**(6): p. 699–703.
42. Stein, L.I., D.T. Watts, and T. Howell, *The doctor–nurse game revisited*. 1990, Mass Medical Soc. p. 546–549.
43. The World Bank. *Physicians (per 1,000 people)*. 2020 April 3 2022]; Available from: https://data.worldbank.org/indicator/SH.MED.PHYS.ZS.
44. The world Bank. *Nurses and midwives (per 1,000 people)*. 2014 2022 January 18 2022]; Available from: https://data.worldbank.org/indicator/SH.MED.NUMW.P3.
45. You, W. and F. Donnelly, *Physician care access plays a significant role in extending global and regional life expectancy*. European Journal of Internal Medicine, 2022.
46. Becker, G.S., T.J. Philipson, and R.R. Soares, *The quantity and quality of life and the evolution of world inequality*. American economic review, 2005. **95**(1): p. 277–291.
47. Deaton, A., *Income, health, and well-being around the world: Evidence from the Gallup World Poll*. Journal of Economic perspectives, 2008. **22**(2): p. 53–72.
48. Preston, S.H., *The changing relation between mortality and level of economic development*. Population studies, 1975. **29**(2): p. 231–248.
49. The world Bank. *GDP per capita, PPP (current international $)*. 2014 December 28 2021]; Available from: https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD.
50. Peeters, A., et al., *Obesity in adulthood and its consequences for life expectancy: a life-table analysis*. Annals of internal medicine, 2003. **138**(1): p. 24–32.
51. Di Angelantonio, E., et al., *Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents*. The Lancet, 2016. **388**(10046): p. 776–786.
52. The world Bank. *Prevalence of obesity (% of population ages 18+)*. 2022 22 May 2022]; Available from: https://genderdata.worldbank.org/indicators/sh-sta-ob-18-zs/.
53. Gorman, D.F. and P.M. Brooks, *On solutions to the shortage of doctors in Australia and New Zealand*. Medical Journal of Australia, 2009. **190**(3): p. 152–156.
54. Kain, J.F. and K. Singleton, *Equality of educational opportunity revisited*. New England Economic Review, 1996(Special issue): p. 87.
55. The World Bank. *DataBank*. World Development Indicators (Public) 2022 May 18 2022]; Available from: https://databank.worldbank.org/home.aspx.
56. You, W. and M. Henneberg, *Relaxed natural selection contributes to global obesity increase more in males than in females due to more environmental modifications in female body mass*. PloS one, 2018. **13**(7): p. e0199594.
57. You, W. and M. Henneberg, *Meat in modern diet, just as bad as sugar, correlates with worldwide obesity: an ecological analysis*. J Nutr Food Sci, 2016. **6**(517): p. 4.
58. You, W. and M. Henneberg, *Cereal crops are not created equal: wheat consumption associated with obesity prevalence globally and regionally*. AIMS public health, 2016. **3**(2): p. 313.
59. You, W., et al., *Decreasing birth rate determining worldwide incidence and regional variation of female breast Cancer*. Advances in Breast Cancer Research, 2018. **7**(01): p. 1–14.
60. You, W. and M. Henneberg, *Prostate Cancer incidence is correlated to Total meat intake–a cross-National Ecologic Analysis of 172 countries*. Asian Pacific journal of cancer prevention: APJCP, 2018. **19**(8): p. 2229.
61. You, W., et al., *Gluten consumption may contribute to worldwide obesity prevalence*. Anthropological Review, 2020. **83**(3): p. 327–348.
62. Lal, M.M., *Innovative Nurse-Led Initiatives Improve Population Health*. The Journal of Nursing Administration, 2020. **50**(2): p. 59–60.

63. Allard, B.L. and C.A. Conroy, *Our Nursing Profession at a Crossroads: Time to Chart a Course for the Future*. Nursing Administration Quarterly, 2022. **46**(3): p. 208–217.
64. Gwon, S.H., et al., *Public health nurses' workforce factors and population health outcomes in the United States*. Public Health Nursing, 2020. **37**(6): p. 829–836.
65. Nightingale, F., *Sick-nursing and health-nursing*, in *Nursing the Sick – 1893*, I. Hampton, Editor. 1974: New York: McGraw-Hill. p. 24–43.
66. Lancaster, G., et al., *Interdisciplinary communication and collaboration among physicians, nurses, and unlicensed assistive personnel*. Journal of Nursing Scholarship, 2015. **47**(3): p. 275–284.
67. Krogstad, U., D. Hofoss, and P. Hjortdahl, *Doctor and nurse perception of inter-professional co-operation in hospitals*. International Journal for Quality in Health Care, 2004. **16**(6): p. 491–497.
68. Zhang, L., et al., *Nurse–physician collaboration impacts job satisfaction and turnover among nurses: A hospital-based cross-sectional study in Beijing*. International Journal of Nursing Practice, 2016. **22**(3): p. 284–290.
69. Nelson, G.A., M.L. King, and S. Brodine, *Nurse-physician collaboration on medical-surgical units*. Medsurg Nursing, 2008. **17**(1): p. 35.
70. University of Missouri. *Physician and nurse relationships* 2020 June 5 2022]; Available from: https://medicine.missouri.edu/centers-institutes-labs/health-ethics/faq/physician-nurse-relationships.
71. Georgiou, E., E.D. Papathanassoglou, and A. Pavlakis, *Nurse-physician collaboration and associations with perceived autonomy in Cypriot critical care nurses*. Nursing in critical care, 2017. **22**(1): p. 29–39.
72. Thompson, A.E., *A physician's education*. JAMA, 2014. **312**(22): p. 2456–2456.
73. Ferrell, B. and N. Coyle, The nature of suffering and the goals of nursing. 2008.
74. Fix, G.M., et al., *Patient-centred care is a way of doing things: How healthcare employees conceptualize patient-centred care*. Health Expectations, 2018. **21**(1): p. 300–307.
75. May, N., et al., *Preparing Nurse Leaders for Value-Based Care: A Toolkit to Guide Practice Transformation.* JONA: The Journal of Nursing Administration, 2021. **51**(7/8): p. 355–358.
76. Shirey, M.R., et al., *Sustainability of an interprofessional collaborative practice model for population health*. Nursing Administration Quarterly, 2020. **44**(3): p. 221–234.
77. Fasbender, U., B.I. Van der Heijden, and S. Grimshaw, *Job satisfaction, job stress and nurses' turnover intentions: The moderating roles of on-the-job and off-the-job embeddedness*. Journal of advanced nursing, 2019. **75**(2): p. 327–337.
78. Yang, H., et al., *Validation of work pressure and associated factors influencing hospital nurse turnover: a cross-sectional investigation in Shaanxi Province, China*. BMC health services research, 2017. **17**(1): p. 1–11.
79. Moseley, A., L. Jeffers, and J. Paterson, *The retention of the older nursing workforce: A literature review exploring factors that influence the retention and turnover of older nurses*. Contemporary Nurse, 2008. **30**(1): p. 46–56.
80. Duffield, C., et al., *Why older nurses leave the workforce and the implications of them staying*. Journal of clinical nursing, 2015. **24**(5–6): p. 824–831.
81. Uthaman, T., T.L. Chua, and S.Y. Ang, *Older nurses: A literature review on challenges, factors in early retirement and workforce retention.* Proceedings of Singapore Healthcare, 2016. **25**(1): p. 50–55.
82. Leners, D.W., et al., *Mentorship: increasing retention probabilities*. Journal of nursing management, 2006. **14**(8): p. 652–654.
83. Van Bogaert, P., et al., *Predictors of burnout, work engagement and nurse reported job outcomes and quality of care: a mixed method study*. BMC nursing, 2017. **16**(1): p. 1–14.
84. Sousa-Ribeiro, M., P. Lindfors, and K. Knudsen, *Sustainable Working Life in Intensive Care: A Qualitative Study of Older Nurses*. International Journal of Environmental Research and Public Health, 2022. **19**(10): p. 6130.
85. Laurant, M., et al., *Substitution of doctors by nurses in primary care*. Cochrane database of systematic reviews, 2005(2).
86. Horrocks, S., E. Anderson, and C. Salisbury, *Systematic review of whether nurse practitioners working in primary care can provide equivalent care to doctors*. Bmj, 2002. **324**(7341): p. 819–823.
87. Martínez-González, N.A., et al., *Substitution of physicians by nurses in primary care: a systematic review and meta-analysis*. BMC health services research, 2014. **14**(1): p. 1–17.
88. Htay, M. and D. Whitehead, *The effectiveness of the role of advanced nurse practitioners compared to physician-led or usual care: A systematic review*. International Journal of Nursing Studies Advances, 2021. **3**: p. 100034.
89. Elsous, A., M. Radwan, and S. Mohsen, *Nurses and physicians attitudes toward nurse-physician collaboration: a survey from Gaza Strip, Palestine.* Nursing research and practice, 2017. **2017**.
90. Baggs, J.G., et al., *Nurse-physician collaboration and satisfaction with the decision-making process in three critical care units.* American Journal of Critical Care, 1997. **6**(5): p. 393–399.
91. Ahmed, L.B. and A. Kitson, *Complementary roles of nurse and health-care assistant*. Journal of Clinical Nursing, 1993. **2**(5): p. 287–297.
92. Hoeve, Y.t., G. Jansen, and P. Roodbol, *The nursing profession: Public image, self-concept and professional identity. A discussion paper.* Journal of Advanced Nursing, 2014. **70**(2): p. 295–309.
93. Öhlén, J. and K. Segesten, *The professional identity of the nurse: concept analysis and development*. Journal of advanced nursing, 1998. **28**(4): p. 720–727.

94. Takase, M., P. Maude, and E. Manias, *Impact of the perceived public image of nursing on nurses' work behaviour*. Journal of advanced Nursing, 2006. **53**(3): p. 333–343.
95. Morse, B.W. and R.N. Piland, *An assessment of communication competencies needed by intermediate-level health care providers: A study of nurse-patient, nurse-doctor, nurse-nurse communication relationships*. Journal of Applied Communication Research, 1981. **9**(1): p. 30–41.
96. El-Hanafy, E.Y., *Nurse physician work-related relationship as perceived by both of them*. Egyptian Nursing Journal, 2018. **15**(2): p. 188.
97. Lasater, K., I.M. Atherton, and R.G. Kyle, *Population health as a 'platform'for nurse education: A qualitative study of nursing leaders*. Nurse education today, 2020. **86**: p. 104313.

Tables

Table 1 Pearson (above diagonal) & non-parametric (below diagonal) correlation matrix for all variables

	Nursing healthcare	Physician healthcare	Life expectancy at birth	GDP PPP	Urbanization	Obesity prevalence
Nursing healthcare	1.000	0.784***	0.695***	0.774***	0.547***	0.508***
Physician healthcare	0.810***	1.000	0.822***	0.839***	0.626***	0.500***
Life expectancy at birth	0.721***	0.807***	1.000	0.801***	0.528***	0.427***
GDP PPP	0.797***	0.831***	0.842***	1.000	0.720***	0.502***
Urbanization	0.600***	0.630***	0.620***	0.757***	1.000	0.546***
Obesity prevalence	0.465***	0.445***	0.437***	0.483***	0.584***	1.000
Fisher r-to-z transformation identifies life expectancy at birth is in significantly stronger correlation with physician healthcare than with nursing healthcare in Pearson r (z= 2.95, p< 0.01) and non-parametric (z= 2.01, p< 0.05) models.						

Significance level: ***p 0.001; n ranges between 176 and 194.

Data source and definition: Nursing healthcare, the number of nurses and midwives per 1,000 population (the Word Bank); Physician healthcare, the number of nurses and midwives per 1,000 population (the Word Bank); Life expectancy at birth, the average number of years that a newborn could expect to live (the World Bank); GDP PPP, the per capita purchasing power parity (PPP) value of all final goods and services produced within a territory in a given year (the Word Bank); Urbanization, the percentage of population living in urban area (the Word Bank); Obesity prevalence, the percentage of population with BMI ≥30 prevalence (WHO Global Health Observatory).

All the data were log-transformed for correlation analysis.

Table 2 Partial correlation coefficients between life expectancy at birth and Nursing healthcare and Physician healthcare with different combinations of controlled variables

Variables	2-1: Nursing healthcare and Physician healthcare to predict life expectancy at birth respectively while GDP PPP, obesity and urbanization were kept statistically constant.						2-2: Nursing healthcare and Physician hea respectively while one another, GDP PPP, o constant.		
	Life expectancy at birth			Life expectancy at birth			Life expectancy at birth		
	r	p	df	r	p	df	r	p	df
Nursing healthcare	0.181	< 0.05	170	Not added			0.001	0.985	169
Physician healthcare	Not added			0.471	<0.001	176	-	-	-
Life expectancy at birth	-	-	-	-	-	-	-	-	-
GDP PPP	-	-	-	-	-	-	-	-	-
Urbanization	-	-	-	-	-	-	-	-	-

Fisher r-to-z transformation identifies that physician healthcare is in significantly stronger correlation to LEB than nursing healthcare (z= 3.03, p< 0.01).

Variables	2-3. Nursing healthcare, Physician healthcare, GDP PPP, obesity and urbanization are alternated as the predicting variable for calculating its r other four independent variables are kept statistically constant.										
	Life expectancy at birth			Life expectancy at birth			Life expectancy at birth			Life expectancy at b	
	R	P	df	r	P	df	r	p	df	r	p
Nursing healthcare	0.001	0.985	169	-	-	-	-	-	-	-	-
GDP PPP	-	-	-	-0.344	<0.001	169	-	-	-	-	-
Obesity prevalence	-	-	-	-	-	-	-0.003	0.966	169	-	-
Physician healthcare	-	-	-	-	-	-	-	-	-	0.444	<0.001
Urbanization	-	-	-	-	-	-	-	-	-	-	-

Variables	2-4. Nursing healthcare, Physician healthcare, GDP PPP, obesity and urbanization were alternated as the individual potential confounder for e expectancy at birth and the other four individual independent variables.											
	Life expectancy at birth			Life expectancy at birth			Life expectancy at birth			Life expectancy at b		
	R	P	df	r	p	df	r	p	df	r	p	c
Nursing healthcare	-	-	-	0.198	< 0.01	180	0.613	<0.001	180	0.142	0.053	1
GDP PPP	0.621	<0.001	185	-	-	-	0.750	<0.001	173	0.360	<0.001	1
Obesity prevalence	0.590	<0.001	180	0.048	0.526	173	-	-	-	0.032	0.670	1
Physician healthcare	0.380	<0.001	188	0.460	<0.001	180	0.777	<0.001	180	-	-	-
Urbanization	0.191	<0.010	181	-0.117	0.111	184	0.389	<0.001	180	0.029	0.690	1

- Controlled variable All the data were log-transformed for correlation analysis.

Data source and definition: Nursing healthcare, the number of nurses and midwives per 1,000 population (the Word Bank); Physician healthcare, the number of nurses and midwives per 1,000 population (the Word Bank); Life expectancy at birth, the average number of years that a newborn could expect to live (the World Bank); GDP PPP, the per capita purchasing power parity (PPP) value of all final goods and services produced within a territory in a given year (the Word Bank); Urbanization, the percentage of population living in urban area (the Word Bank); Obesity prevalence, the percentage of population with BMI ≥30 prevalence (WHO Global Health Observatory).

Table 3 Multiple linear regression results to show predicting effects of independent variables and identify the significant predictors of life expectancy at birth

Enter					Stepwise				
	Life expectancy at birth				Life expectancy at birth			Life expectancy at birt	
	Physician healthcare (Not added)		Physician healthcare(added)		Physician healthcare (Not added)			Physician healthcare (added)	
Variable	Beta	Sig.	Beta	Sig	Rank	Variable	Adjusted R^2	Rank	Variable
Nursing healthcare	0.174	<0.05	0.001	0.985	1	GDP PPP	0.627	1	Physician hea
GDP PPP	0.698	<0.001	0.425	< 0.001	2	Nursing healthcare	0.638	2	GDP PPP
Obesity prevalence	0.012	0.839	-0.002	0.966		Obesity prevalence	Insignificant		Nursing healt
Urbanization	-0.062	0.385	-0.099	0.121		Urbanization	Insignificant		Obesity preva
Physician healthcare	Not added		0.527	< 0.001		Physician healthcare	Not added		Urbanization

Enter					Stepwise				
	Life expectancy at birth				Life expectancy at birth			Life expectancy at birth	
	Nursing workforce (Not added)		Nurse number (added)		Nursing workforce (Not added)			Nursing workforce (added)	
Variable	Beta	Sig.	Beta	Sig	Rank	Variable	Adjusted R^2	Rank	Variable
Physician healthcare	0.527	<0.001	0.527	<0.001	1	Physician healthcare	0.668	1	Physician healthcare
GDP PPP	0.426	<0.001	0.001	0.985	2	GDP PPP	0.706	2	GDP PPP
Obesity prevalence	-0.002	0.968	0.425	<0.001		Obesity prevalence	Insignificant		Nursing healthcare
Urbanization	-0.099	0.117	-0.002	0.966		Urbanization	Insignificant		Obesity prevalence
Nursing healthcare	Not added		-0.099	0.121		Nursing healthcare	Not added		Urbanization

Significance level: * p<0.05; ** p 0.01; ***p 0.001; All the data were log-transformed for correlation analysis.

Data source and definition: Nursing healthcare, the number of nurses and midwives per 1,000 population (the Word Bank); Physician healthcare, the number of nurses and midwives per 1,000 population (the Word Bank); Life expectancy at birth, the average number of years that a newborn could expect to live (the World Bank); GDP PPP, the per capita purchasing power parity (PPP) value of all final goods and services produced within a territory in a given year (the Word Bank); Urbanization, the percentage of population living in urban area (the Word Bank); Obesity prevalence, the percentage of population with BMI ≥30 prevalence (WHO Global Health Observatory).

Figures

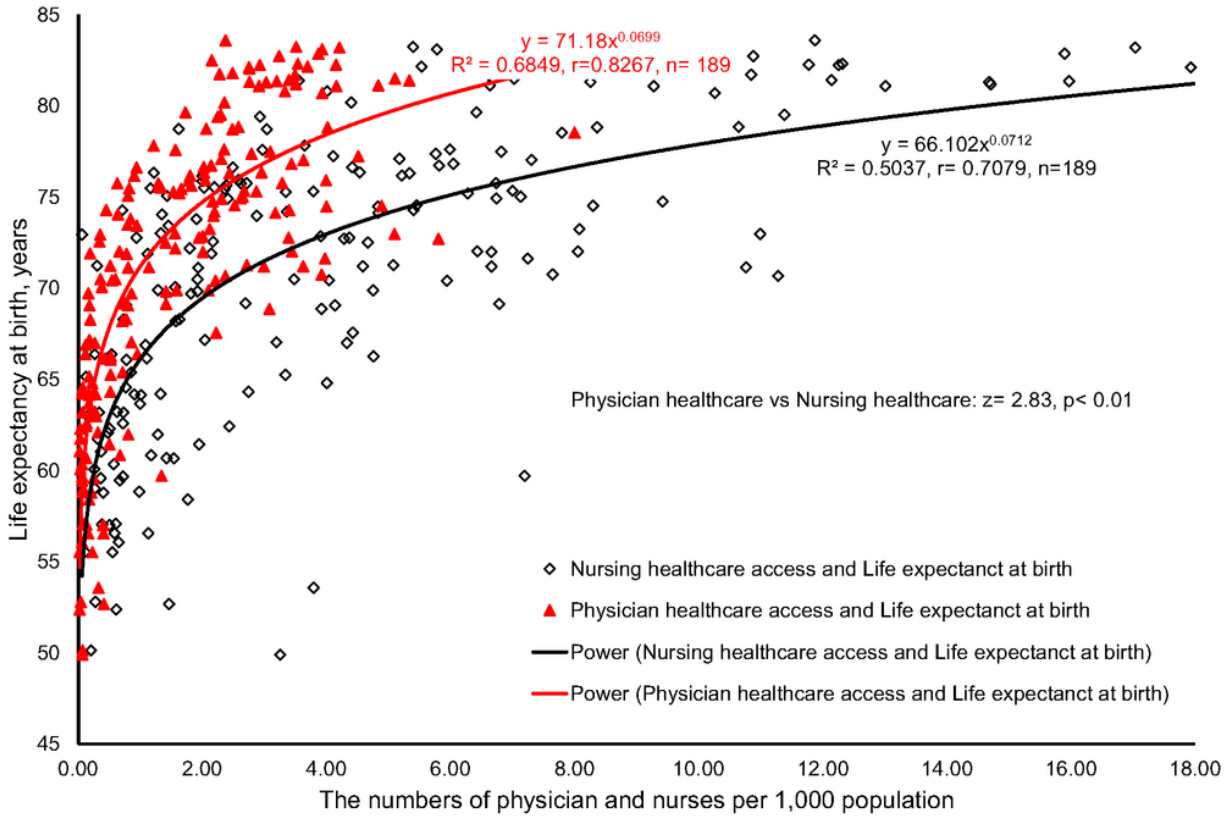

Figure 1

The relationships between life expectancy at birth and physician and nurse healthcare respectively