Knowledge translation of scholarly publishing impacts on public health

Na Ran
University of Science and Technology Beijing,
30 Xueyuan Road, Haidian District, Beijing 100083, P. R. China
Tel: 86-10-62332539  Fax: 86-10-62332494  E-mail: ranna@ustb.edu.cn

Abstract

BACKGROUND: Although scholarly publishing plays a key role in learning, the role of knowledge translation of scholarly publishing with education and income on public health has not been well established. The objective was to describe how knowledge translation of scholarly publishing impacts on public health.

METHODS: The correlations between the input data and the target data were firstly calculated. After the input data that is not correlated to the target have been removed, the principal component analysis will be performed to avoid multicollinearity problems in the input data. Finally, the multivariate regression method is used to fit the relationship between the principal components and the target data. Thus both dimensionality reduction and personalized optimization oriented a target can be done.

RESULTS: After the public health in China is measured by Life expectancy and Death rate, the Pearson correlation coefficient, principal component analysis, and linear regression method have been performed. It proved that some activities of knowledge translation of scholarly publishing with a focus on health and well-being have the highest correlations with the first principal component. Results are also presented on that the first and the second principal component explain 99.3% of the variation (p<0.01) in Life expectancy and 92.8 % of the variation (p<0.01) in Death rate, respectively.

CONCLUSIONS: Scholarly publishing, education, income, health expenditure, nurses, and midwives appear to have a similarly important effect on public health.

Keywords: Scholarly Communication; Publications; Public Health; Principal Component Analysis; Regression Analysis; Multivariate Analysis
Background

Society can be treated as a system of exchanges that both the parties who make the exchange are benefited [1]. Knowledge plays various functional roles in society. Knowledge can be a basis for action. For example, once the causes of disease are identified, knowledge can be used to find a cure. Knowledge also licenses assertions and it can be used to policymakers, private companies, courts of law, etc. for making a proper decision. Knowledge is stored in papers, journals, books, proceedings, digital repositories, etc. Scientific knowledge came to mean the elimination of surprise and outlawed miracles. The stored knowledge (for example, published in scholarly journals and books, or stored in libraries, optic media, etc.) can be available for retrieval and use by anyone else [2]. The idea of the Invisible College for scholarly communication was originated by a group of scholars at Oxford University in the 1640s. The Invisible College was named as the Royal Society. But as the group grew, the journal became a suitable means to scholarly communication owing to the natural inhibitions, difficulties, and finance of traveling. The first journal named “Philosophical Transactions of the Royal Society of London” was published in March 1665. Now more ways to scholarly communication have been developed due to the advanced technology. However, journals have emerges as more than a device for scholarly communication in modern society [3].

Sustainable development might be described by complex interrelationships between natural and social spheres [4]. An accelerated and sustainable economic growth requires organizations to make proper managerial decisions and realizing actions and behaviors by obtaining the necessary knowledge at a high-quality level and using it with maxim effectiveness [5]. The knowledge of health and well-being is various. The health benefits of physical activity require the necessary knowledge, skills, etc. [6]. Changes in the accuracy of sea ice travel knowledge affect the ability of Inuit to be on the ice safely. These changes are transforming sea ice for Inuit from a place that is ‘theirs’, a place that means cultural and individual freedom and autonomy and is an important source of health [7]. Knowing colorectal cancer screening tests increases the relevant confidence and benefit perception [8]. Increasing knowledge and awareness by training health professionals to communicate and deliver targeted preconception care, which aims to enhance health status before conception to reduce perinatal morbidity and mortality and improve maternal and child health, interventions may be important [9]. Health promotion is not only related to the prevention of diseases, it is essential to invest in health education actions aiming at the sharing of knowledge, as well as the development of knowledge [10]. Lack of knowledge can cause serious health problems. The delays caused by lacking the knowledge to diagnose or suspect breast cancer are likely to
be worse [11]. Better-educated people have lower mortality, experience less often harmful diseases, and feel overall healthier than their less-educated peers [12]. This is because education raises a person’s health knowledge, allowing the educated to choose a more efficient input mix in the health production process, i.e., to make better health decisions, leading to improved health outcomes [13].

Knowledge translation has been defined in various ways but has generally focused on the application of knowledge. For example, it is defined as "a dynamic and iterative process that includes the synthesis, dissemination, exchange and ethically sound application of knowledge to improve the health of populations, provide more effective health services and products and strengthen the health care system". The principles of knowledge translation can be described as ‘dissemination’, ‘utilization’, ‘evidence into practice’ and ‘knowledge transfer’ [14, 15]. Understanding local Indigenous processes of knowledge creation, dissemination, and utilization is a necessary prerequisite to effective knowledge translation in Indigenous contexts [16]. What is and what is not considered to be knowledge translation is the most important [17]. Knowledge translation in some circumstances has been found as effective as complex and multifaceted ones [18]. Definitions of concepts in knowledge translation are unclear [19, 20]. It results that information retrieval is difficult [21]. Making knowledge relevant to the challenges their stakeholders face, the capabilities of their stakeholders, and the expectations the government can make it work [22]. Knowledge translation in the health field strategies involved in public or community prevention orientated coalitions from a range of health and well-being disciplines [23], preventative adolescent substance abuse services [24], healthy body weight promotion [25], immunization and cancer screening prevention [26].

The research utilization theory of knowledge translation suggests that knowledge is a changing set of understandings shaped by those who both generate and use research [27]. It implied that potential users are more likely to do so if there is an identified need or incentive [28]. This is similar to the diffusion of innovations theory [29]. Potential adopters of innovations can be categorized as innovators, early adopters, early majority, etc. [30]. Many theories have varying objectives, which range from information provision individually or to large audiences to achieving behavior change through education or skills acquisition [31]. For example, the successes, challenges, and lessons learned from using social media within health research have been studied [32]. At the same time the knowledge gap have been to affect disseminate information in a social system [33,34]. More importantly, it is often difficult to measure directly the effects of knowledge creation and diffusion on society [35].
Methods

The data have been obtained from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com). One can note that the data used in this article do not include the influence of knowledge gaps. All data of the scholarly publishing (e.g., articles indexed by SCImago, journals indexed by SCImago, etc.), education, health, etc. in this article use the data for the entire Chinese community. This article aims to do a pioneer investigation on the relationship between knowledge translation from the research results published in the scholarly journals and the health and well-being of the whole Chinese society without considering the difference caused by knowledge gaps. In detail, the relationship has been statically analyzed based on the data of the research results published in the scholarly journals and the health and well-being data in recent years.

To check generating theories and hypotheses, it is very important for using data in testing those generating theories and hypotheses. To test most hypotheses, two variables (a proposed cause and a proposed outcome) need to be measured. Variables are things that can vary. After the data of the research have been collected, it is to analyze the data that involves both seeing what the general trends in the data are via graphical data and also fitting the data by using statistical models.

Many researchers have studied issues in the social sciences by using mathematical methods and statistic models. For example, regression and component analysis are so important and frequently used in social science research [36-42]. The principal component analysis, a mathematical method, can help us find relationships between two variables sets (a cause variable set and an outcome variable set) that have been collected for an issue in societies. For example, principal component analysis has been used to get socioeconomic impact [43]; the relationship between academic performance, substance use, sleep quality, and risk of anxiety and depression in young adults have been investigated by principal component analysis [44]; principal component analysis has also been used for analyzing the performance of semiconductor devices [45]; the relationships between some pre- and post-slaughter traits of broilers have been investigated by principal component analysis [46]; principal component analysis has also been used for early disease detection [47]; principal component analysis has also been used to predict ozone concentrations [48].

Multicollinearity is a linear association between two or more explanatory variables. A set of variables is perfectly multicollinear will have the following equation
\[ \alpha_1 x_{1i} + \alpha_2 x_{2i} + \Lambda + \alpha_n x_{ni} = \alpha_0 \]  \tag{1}

where \( n \) is an integer, \( \alpha_n \) is a constant, and \( x_{ni} \) the \( i \)th observation on the \( n \)th explanatory variable. Thus

\[
x_{ni} = \frac{\alpha_0 - \sum_{j=n} x_{ji}}{\alpha_n} \tag{2}
\]

When Eq.2 is valid, there is multicollinearity among explanatory variables.

The principal component analysis is one method to overcome the multicollinearity problem. For an \( n \times p \) matrix:

\[
X = \begin{pmatrix}
x_{11} & x_{12} & \Lambda & x_{1p} \\
x_{21} & x_{22} & \Lambda & x_{2p} \\
\Lambda & \Lambda & \Lambda & \Lambda \\
x_{n1} & x_{n2} & \Lambda & x_{np}
\end{pmatrix} \tag{3}
\]

Its correlation coefficient can be calculated by

\[
r_{ij} = \frac{\sum_{k=1}^n (x_{ki} - \overline{x}_i)(x_{kj} - \overline{x}_j)}{\sqrt{\sum_{k=1}^n (x_{ki} - \overline{x}_i)^2 \sum_{k=1}^n (x_{kj} - \overline{x}_j)^2}} \tag{4}
\]

And, the matrix of correlation coefficient is

\[
R = \begin{pmatrix}
r_{11} & r_{12} & \Lambda & r_{1p} \\
r_{21} & r_{22} & \Lambda & r_{2p} \\
\Lambda & \Lambda & \Lambda & \Lambda \\
r_{n1} & r_{n2} & \Lambda & r_{np}
\end{pmatrix} \tag{5}
\]

Let

\[
\begin{vmatrix}
r_{11} - \lambda & r_{12} & \Lambda & r_{1p} \\
r_{21} & r_{22} - \lambda & \Lambda & r_{2p} \\
\Lambda & \Lambda & \Lambda & \Lambda \\
r_{n1} & r_{n2} & \Lambda & r_{np} - \lambda
\end{vmatrix} = 0 \tag{6}
\]

Eigenvalues \( \lambda_i (i=1,2,\ldots,n) \) and eigenvectors \( \gamma = (\gamma_1, \gamma_2, \ldots, \gamma_p) \) can be obtained by solving Eq.6. Let \( \lambda_1 \geq \lambda_2 \geq \ldots \geq \lambda_n \). The \( i \)th principal component can be written as

\[
Y_i = \gamma_{i1} z_1 + \gamma_{i2} z_2 + \Lambda + \gamma_{ip} z_p \tag{7}
\]
and its variance is

\[ \beta_k = \frac{\lambda_k}{\sum_{i=1}^{n} \lambda_i} \]  

(8)

The cumulative variance is

\[ \sum_{j=1}^{k} \beta_j = \frac{\sum_{j=1}^{k} \lambda_j}{\sum_{i=1}^{n} \lambda_i} \]  

(9)

The load is

\[ l_{ij} = \sqrt{\lambda_i \gamma_{ij}} \]  

(10)

The component scores for all principal components are

\[
\begin{align*}
    z_1 &= l_{11} x_1 + l_{12} x_2 + \Lambda + l_{1p} x_p \\
    z_2 &= l_{21} x_1 + l_{22} x_2 + \Lambda + l_{2p} x_p \\
    \Lambda &= \text{\(\vdots\)} \\
    z_n &= l_{n1} x_1 + l_{n2} x_2 + \Lambda + l_{np} x_p
\end{align*}
\]  

(11)

Results

One can note that principal component analysis is the same for the same input data if input data are not cleaned [49]. To increase interpretability and void the multicollinearity problem by using principal component analysis in the input data-oriented a target, a personalized optimization will be first performed. In other words, the input data will be firstly filtered based on its correlation with the target data. In this article, the correlation coefficient between the input data and target data will be calculated according to Eq.4. After the input data that is not significantly correlated to the target data \((p>0.01)\) have been removed, the principal component analysis will be performed for the selected input data. Finally, the multivariate regression method has been used to justify the relationship between the principal components and the target data. In this article, we do focus on the whole authors in China, whole journals published by China not focus on special types of authors in china. In other
words, the study by using the cites in the Web of science or ORCID to narrow down a list of authors could be a future job.

Table 1 shows the data (1996-2018) of Life expectancy at birth, Death rate, School enrolment (primary), School enrollment (tertiary), Current health expenditure per capita, Adjusted net national income per capita, Adjusted savings: education expenditure, intellectual properties, and Nurses and midwives in China. Because the above data have different scales and units, normalization (Z-score) have first been performed before applications of statistics because it can adjust values measured on different scales to a notionally common scale [36-42]. Life expectancy at birth in China is found to nearly linearly increase with time since 1996, which is shown in Figure 1. Figure 1 also illustrates that Death rate, School enrolment (primary), School enrollment (tertiary), Current health expenditure per capita, Adjusted net national income per capita, Adjusted savings: education expenditure, intellectual properties, and Nurses and midwives in China are found to fluctuate but has a growth trend. School enrolment (primary) is found to fluctuate.

In this article, either the Life expectancy at birth or the Death rate is used to measure health and well-being in China.

Table 1 Life expectancy at birth, Death rate, School enrolment (primary), School enrollment (tertiary), Current health expenditure per capita, Adjusted net national income per capita, Adjusted savings: education expenditure, intellectual properties, and Nurses and midwives in China. The data come from the website of the World Bank (https://data.worldbank.org).

| Year | Life expectancy at birth, total (years) | Death rate, crude (per 1,000 people) | School enrolment, primary (% gross) | School enrolment, tertiary (% gross) | Current health expenditure per capita (constant 2010 US$) | Adjusted net national income per capita (current US$) | Adjusted savings: education expenditure (current US$) | Nurses and midwives (per 1,000 people) |
|------|----------------------------------------|--------------------------------------|------------------------------------|-------------------------------------|-------------------------------------------------------|---------------------------------------------------|--------------------------------------|--------------------------------------|
| 2018 | 76.704                                 | 7.1                                  | 100.2228                           | 50.6044                             | ..                                                    | 5862.628                                          | 2.43E+11                             | ..                                   |
| 2017 | 76.47                                  | 7.11                                 | 99.40481                           | 49.07326                            | 440.8256                                             | 5405.507                                          | 2.17E+11                             | 2.6621                              |
| 2016 | 76.21                                  | 7.09                                 | 97.96192                           | 48.01902                            | 398.3316                                             | 5161.977                                          | 1.99E+11                             | 2.4665                              |
| 2015 | 75.928                                 | 7.11                                 | 96.3186                           | 46.04043                            | 392.846                                              | 4837.549                                          | 1.96E+11                             | 2.2914                              |
| 2014 | 75.629                                 | 7.16                                 | 95.79643                           | 42.43073                            | 361.7244                                             | 4474.737                                          | 1.87E+11                             | 2.1349                              |
| 2013 | 75.321                                 | 7.16                                 | 95.5646                           | 32.43367                            | 328.1849                                             | 4112.281                                          | 1.7E+11                              | 1.9886                              |
| 2012 | 75.013                                 | 7.15                                 | 99.7911                           | 28.72567                            | 283.5222                                             | 3834.553                                          | 1.52E+11                             | 1.7938                              |
| 2011 | 74.708                                 | 7.14                                 | 99.04702                           | 25.64785                            | 237.9336                                             | 3519.379                                          | 1.34E+11                             | 1.6213                              |
| 2010 | 74.409                                 | 7.11                                 | 98.96422                           | 24.19849                            | 187.735                                              | 3362.865                                          | 1.08E+11                             | 1.4881                              |
| 2009 | 74.119                                 | 7.08                                 | 100.0061                           | 22.44306                            | 163.7122                                             | 3088.494                                          | 9.12E+10                             | 1.3552                              |
| 2008 | 73.835                                 | 7.06                                 | 100.7424                           | 20.68412                            | 132.7853                                             | 2740.451                                          | 8.27E+10                             | 1.233                               |
| 2007 | 73.553                                 | 6.93                                 | 100.7071                           | 20.52122                            | 97.74693                                             | 2596.522                                          | 6.37E+10                             | 1.1518                              |
| 2006 | 73.271                                 | 6.81                                 | 100.9933                           | 20.21919                            | 81.79035                                             | 2284.692                                          | 4.92E+10                             | 1.0599                              |
| 2005 | 72.985                                 | 6.51                                 | 100.0033                           | 19.087                              | 72.36211                                             | 2022.022                                          | 4.06E+10                             | 1.0086                              |
| 2004 | 72.689                                 | 6.42                                 | ..                                 | 17.69126                            | 63.699                                               | 1806.959                                          | 3.49E+10                             | 0.9836                              |
| 2003 | 72.381                                 | 6.4                                 | ..                                 | 15.45268                            | 56.03277                                             | 1648.989                                          | 2.95E+10                             | 0.9573                              |
| 2002 | 72.061                                 | 6.41                                 | ..                                 | 12.62848                            | 49.4711                                              | 1492.254                                          | 2.61E+10                             | 0.9483                              |
| 2001 | 71.732                                 | 6.43                                 | 112.3416                           | 9.78911                             | 43.94076                                             | 1345.958                                          | 2.36E+10                             | 1.083                               |
| 2000 | 71.397                                 | 6.45                                 | ..                                 | 7.59041                             | 42.35368                                             | 1223.285                                          | 2.14E+10                             | 0.9763                              |
| 1999 | 71.063                                 | 6.46                                 | ..                                 | 6.39428                             | ..                                                   | 1133.511                                          | 1.93E+10                             | 0.9662                              |
| 1998 | 70.737                                 | 6.5                                  | 105.7694                           | 3.86393                             | ..                                                   | 1052.53                                           | 2.03E+10                             | 0.9531                              |
| 1997 | 70.428                                 | 6.51                                 | 105.5071                           | 5.38011                             | ..                                                   | 978.5956                                          | 1.94E+10                             | 0.9445                              |
| 1996 | 70.14                                  | 6.56                                 | 108.0742                           | 4.91532                             | ..                                                   | 904.9024                                          | 1.45E+10                             | 0.924                               |
Fig. 1 Normalized Life expectancy at birth, Death rate, School enrolment (primary), School enrollment (tertiary), Current health expenditure per capita, Adjusted net national income per capita, Adjusted savings: education expenditure, intellectual properties, and Nurses and midwives in China as a function of time. The raw data come from the website of the World Bank (https://data.worldbank.org).

Table 2 shows the data (1996-2019) of Documents and its citation situation, International Collaboration articles, open access articles, journals, and open access journals published by China. Figure 2 shows that only the number open access articles in China are found to monotonous increases with time since 1996, whereas Documents and its citation situation, International Collaboration articles, journals, and open access journals published by China are found to fluctuates.

Table 2 Documents and its citation situation, International Collaboration articles, open access articles, journals, and open access journals published by China. The data come from the website of SCImago (https://www.scimagojr.com).

| Year | Documents | Cited documents | Cites | External Cites | International Collaboration | Open Access | Journals | Open access journals |
|------|-----------|----------------|-------|----------------|-----------------------------|-------------|----------|---------------------|
| 2019 | 684048    | 199074         | 544310| 164545         | 162050          | 182982     | 662      | 77                  |
| 2018 | 605616    | 378798         | 2161615| 681294        | 140381          | 155037     | 682      | 80                  |
| 2017 | 538162    | 393539         | 3512243| 1209703       | 120602          | 132280     | 683      | 76                  |
| 2016 | 498325    | 382165         | 4308362| 1569550       | 107339          | 107090     | 682      | 77                  |
| 2015 | 460425    | 361010         | 4987119| 1909799       | 95584           | 90105      | 648      | 67                  |
| 2014 | 490859    | 353627         | 5257180| 2093561       | 86391           | 74855      | 635      | 57                  |
| 2013 | 456542    | 324831         | 5145005| 2138702       | 76196           | 64235      | 626      | 51                  |
| 2012 | 415082    | 296107         | 4913231| 2124347       | 65084           | 47028      | 595      | 41                  |
| 2011 | 393879    | 273191         | 4548474| 2000236       | 57939           | 35724      | 612      | 37                  |
| 2010 | 344017    | 246625         | 4229403| 1917681       | 50295           | 23977      | 605      | 33                  |
| 2009 | 308464    | 224807         | 3895162| 1794314       | 44109           | 20173      | 595      | 27                  |
| 2008 | 261264    | 194182         | 3419775| 1587921       | 37961           | 15806      | 577      | 23                  |
| 2007 | 223247    | 166440         | 2961272| 1365609       | 32326           | 13193      | 538      | 21                  |
| 2006 | 201159    | 147615         | 2550868| 1186712       | 28222           | 11325      | 565      | 21                  |
| 2005 | 171226    | 124369         | 2194990| 1032205       | 23663           | 7756       | 537      | 16                  |
| 2004 | 117131    | 89148          | 1752095| 853695        | 19279           | 49070      | 501      | 14                  |
| 2003 | 81740     | 62404          | 1303917| 650898        | 15203           | 3261       | 473      | 13                  |
| 2002 | 68633     | 51546          | 998871 | 495375        | 11049           | 2148       | 449      | 13                  |
| 2001 | 65674     | 45734          | 794033 | 398386        | 8774            | 1648       | 449      | 12                  |
| 2000 | 51443     | 36599          | 636868 | 326461        | 8364            | 1358       | 375      | 12                  |
| 1999 | 43315     | 29580          | 495957 | 267703        | 6839            | 1030       | 367      | 11                  |
| 1998 | 42555     | 26791          | 411332 | 228716        | 6736            | 1055       |         |                     |
| 1997 | 36113     | 22884          | 353338 | 207839        | 6088            | 743        |         |                     |
| 1996 | 30780     | 18698          | 282718 | 164565        | 5331            | 634        |         |                     |
Fig. 2 Normalized Documents and its citation situation. International Collaboration articles, open access articles, journals, and open access journals published by China as a function of time. The raw data come from the website of the website of SCImago (https://www.scimagojr.com).

Table 3 shows the Pearson correlation coefficient $r$. Life expectancy at birth, total (years) has a significant very strong positive linear relationship with Cited documents ($r_{(21)}=0.981$, $p<0.01$), Adjusted net national income per capita (constant 2010 US$) ($r_{(21)}=0.979$, $p<0.01$), Documents ($r_{(21)}=0.977$, $p<0.01$), Journals ($r_{(18)}=0.971$, $p<0.01$), School enrollment at tertiary education (% gross) ($r_{(21)}=0.964$, $p<0.01$), Current health expenditure per capita (current US$) ($r_{(16)}=0.964$, $p<0.01$), Adjusted savings: education expenditure (current US$) ($r_{(21)}=0.95$, $p<0.01$), Open Access journals ($r_{(18)}=0.943$, $p<0.01$), International Collaboration Documents ($r_{(21)}=0.94$, $p<0.01$), Nurses and midwives (per 1,000 people) ($r_{(20)}=0.898$, $p<0.01$), Open Access Documents($r_{(21)}=0.861$, $p<0.01$), and Cites ($r_{(21)}=0.858$, $p<0.01$). Life expectancy at birth, total (years) has a significant strong positive linear relationship with External Cites ($r_{(21)}=0.778$, $p<0.01$). Life expectancy at birth, total (years) has a significant very strong negative linear relationship with School enrollment at primary education (% gross) ($r_{(21)}=-0.824$, $p<0.01$).

Death rate, crude (per 1,000 people) has a significant very strong positive linear relationship with Cited documents ($r_{(21)}=0.916$, $p<0.01$), Documents ($r_{(21)}=0.911$, $p<0.01$), Cites ($r_{(21)}=0.907$, $p<0.01$), Journals ($r_{(18)}=0.879$, $p<0.01$), Adjusted net national income per capita (constant 2010 US$) ($r_{(21)}=0.868$, $p<0.01$), External Cites ($r_{(21)}=0.866$, $p<0.01$), Adjusted savings: education expenditure (current US$) ($r_{(21)}=0.986$, $p<0.01$), International Collaboration Documents ($r_{(21)}=0.808$, $p<0.01$), and Current health expenditure per capita (current US$) ($r_{(16)}=0.800$, $p<0.01$). Death rate, crude (per 1,000 people) has a significant strong positive linear relationship with School enrollment at tertiary education (% gross) ($r_{(21)}=0.793$, $p<0.01$), Nurses and midwives (per 1,000 people) ($r_{(20)}=0.793$, $p<0.01$), Open Access Documents($r_{(21)}=0.752$, $p<0.01$), and Open Access Documents($r_{(21)}=0.694$, $p<0.01$).
Death rate, crude (per 1,000 people) has a significant very strong positive linear relationship with School enrollment at primary education (% gross) \((r(21)=-0.912, p<0.01)\).

Table 3: The output for the Pearson correlation coefficient \((r)\). The raw data come from the website of the World Bank \(\text{https://data.worldbank.org}\) and the website of SCImago \(\text{https://www.scimagojr.com}\).

| Variables                              | Life expectancy at birth, total (years) | Death rate, crude (per 1,000 people) |
|----------------------------------------|----------------------------------------|--------------------------------------|
|                                        | \(r\) | Sig. | \(r\) | Sig. |
| School enrollment, primary (% gross)   | -0.824 | 0.000 | -0.912 | 0.000 |
| School enrollment, tertiary (% gross)  | 0.964  | 0.000 | 0.793  | 0.000 |
| Current health expenditure per capita (current US$) | 0.964  | 0.000 | 0.8   | 0.000 |
| Adjusted net national income per capita (constant 2010 US$) | 0.979  | 0.000 | 0.868  | 0.000 |
| Adjusted savings: education expenditure (current US$) | 0.95   | 0.000 | 0.86   | 0.000 |
| Nurses and midwives (per 1,000 people) | 0.898  | 0.000 | 0.793  | 0.000 |
| Documents                              | 0.977  | 0.000 | 0.911  | 0.000 |
| Cited documents                        | 0.981  | 0.000 | 0.916  | 0.000 |
| Cites                                  | 0.858  | 0.000 | 0.907  | 0.000 |
| External Cites                         | 0.778  | 0.000 | 0.866  | 0.000 |
| International Collaboration Documents  | 0.94   | 0.000 | 0.808  | 0.000 |
| Open Access Documents                  | 0.861  | 0.000 | 0.694  | 0.000 |
| Journals                               | 0.971  | 0.000 | 0.879  | 0.000 |
| Open Access journals                   | 0.943  | 0.000 | 0.752  | 0.000 |

The above collected multidimensional data is likely to be related, in other words, the collected multidimensional data have commonness. To see the utility of various kinds of collected multidimensional information data, it is obvious that this commonness should be removed. However, we cannot roughly remove the relevant information data, because the reduction of relevant information data will inevitably lose a lot of important information, which leads to the existence of no one in the effectiveness and reliability of the target information. Besides, how to simply process these multi-dimensional collected information data into single-dimensional collected information data, then the result of calculating the target information must be independent. Therefore, there is no way to compare the comprehensive conclusion of multidimensional information collection (input information) with the information collected (input information) of each dimension. Factor analysis is a technology to extract common factors from variable groups. It is just right for solving the above problems.

Table 4 shows the principal component analysis results of eigenvalues, individual, and cumulative. According to statistics, the principle components have been defined as those eigenvalues that are larger than 1 [36-42]. In the following, only principle components that are larger than 1 have been discussed. Table 4 demonstrates that two principal components whose eigenvalues are larger than 1. The first principal component accounts for 85.6% of the
total variance. And the second principal component accounts for 11.8% of the total variance. Both principal components account for 97.3% of the total variance. One can note that each principal component is composed of 14 types of input data including education, income, scholarly publishing, etc. and there are two principal components. Such results imply that there will be a complicated relationship between the input data and the target data even there is a simple linear relation between the principal components and the target data. At the same time, the input data of documents, education expenditure, journals, etc. are treated as the data of knowledge services. In other words, the data of knowledge services have a complicated dependent relation with public health. Such conclusions agree well that both the provision of education and good governance and the spread of values, beliefs, and institutions are important to regional development with a complex interplay between technological, social, and geographical factors and a difficult to measure the knowledge services [35, 50].

Table 4 Eigenvalues, individual and cumulative by using the normalized data. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).

| Components | Eigenvalue | Individual, % | Cumulative, % |
|------------|------------|---------------|---------------|
| 1          | 11.981     | 85.576        | 85.576        |
| 2          | 1.648      | 11.769        | 97.345        |
| 3          | 0.267      | 1.908         | 99.253        |
| 4          | 0.071      | 0.505         | 99.758        |
| 5          | 0.020      | 0.144         | 99.902        |
| 6          | 0.006      | 0.043         | 99.945        |
| 7          | 0.003      | 0.024         | 99.969        |
| 8          | 0.002      | 0.015         | 99.984        |
| 9          | 0.002      | 0.011         | 99.995        |
| 10         | 0.000      | 0.003         | 99.999        |
| 11         | 0.000      | 0.001         | 100.000       |
| 12         | 2.651E-5   | 0.000         | 100.000       |
| 13         | 2.737E-16  | 1.955E-15     | 100.000       |
| 14         | -2.107E-16 | -1.505E-15    | 100.000       |

Table 5 demonstrates the principal component analysis results of loading. Loadings indicate the importance of the original variables in the formation of new variables[36-42]. The order from the largest loading to the smallest loading for the first principal component is Open Access Documents, Nurses and midwives (per 1,000 people), Open Access journals, International Collaboration Documents, School enrollment, tertiary (% gross), Current health expenditure per capita (current US$), Adjusted net national income per capita (constant 2010 US$), Adjusted savings: education expenditure (current US$), Cited documents, Documents, Journals, Cites, External Cites, and School enrollment, primary (% gross). The order from the largest loading to the smallest loading for the second principal component is Cites, Documents, Journals, Cited documents, Adjusted savings: education expenditure (current
US$), Adjusted net national income per capita (constant 2010 US$), Current health expenditure, per capita (current US$), International Collaboration Documents, School enrollment, tertiary (% gross), Open Access journals, Nurses and midwives (per 1,000 people), Open Access Documents, and School enrollment, primary (% gross). Obviously, Open Access Documents is the largest loading in the first principal component, and Cites is the largest loading in the second principal component. School enrollment at primary education is the smallest loading for both principal components.

Table 5 The loadings after varimax rotation by using the normalized data. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).

| Variables                                      | The first principal component | The second principal component |
|------------------------------------------------|-------------------------------|--------------------------------|
| School enrollment, primary (% gross)           | -.421                         | -.833                          |
| School enrollment, tertiary (% gross)          | .934                          | .310                           |
| Current health expenditure per capita (current US$) | .916                          | .379                           |
| Adjusted net national income per capita (constant 2010 US$) | .898                          | .435                           |
| Adjusted savings: education expenditure (current US$) | .886                          | .446                           |
| Nurses and midwives (per 1,000 people)         | .965                          | .237                           |
| Documents                                      | .809                          | .574                           |
| Cited documents                                | .836                          | .547                           |
| Cites                                          | .388                          | .908                           |
| External Cites                                 | .109                          | .982                           |
| International Collaboration Documents          | .946                          | .323                           |
| Open Access Documents                          | .909                          | 1.40                           |
| Journals                                       | .781                          | .556                           |
| Open Access journals                           | .961                          | .259                           |

The load of education expenditure that is 0.886 in the first principal components is very high. It can be compared with that of Current health expenditure per capita (0.916) and net national income per capita (0.898). That the level of education seems to exert a very high impact on regional growth has been concluded [51]. It has been found that there is a significant relationship between regional growth and higher education within North European countries [52]. A high load of education expenditure in the principal analysis agrees well with those conclusions drawn in the references [51,52]. At the same time, it was found that school-based programs to promote health knowledge in an area characterized by low levels of income and education may have much smaller payoffs than programs that encourage the investments in time preference made by the more educated [12]. Such a viewpoint can be partly supported by the load education expenditure locate the middle of all 14 factors because it ranks eighth out of 14 factors. Significant non-monetary returns to education concerning health outcomes and not necessarily for health-related behavior have been found [13]. Schooling could be an important factor influencing nonmarket production processes.
associated with fertility and child health [53]. These loads that are shown in Table 5 support the above findings on health promotion in references [12,13,53]. Most loads of the number of documents and journals indexed by SCImago are comparable with those of education expenditure, Current health expenditure per capita, and Nurses and midwives. It agrees well with the conclusion that knowledge plays a crucial role in the process of economic development [54]. That the information and knowledge exercise a decisive impact on the functionality and performance of organizations, assuring the sustainability of the economy in the long term has been found at the global level [5]. And increasing knowledge and developing knowledge can improve public health, for example, increasing knowledge and awareness by training health professionals to communicate and deliver targeted preconception care interventions may be important [9]; it is necessary to develop sustainable strategies for collective health-promoting activities, in addition to strengthening multidisciplinary work and Continuing Education actions [10]. All the above conclusions demonstrate that education, income, knowledge, etc. can have an impact on public health. Most loads that are shown in Table 5 are comparable (loads of 11 input variables change from 0.78 to 0.99 ). It means that all factors can not be neglected for public health promotion.

The component score coefficient matrix is an output product in the principal components analysis [36-42]. The component score coefficient represents the weighting of variables to be used when computing the saved variables of the components. Table 6 shows the principal component analysis results of the component score coefficient. The order from the largest component score coefficient to the smallest loading for the first principal component is Open Access Documents, Nurses and midwives (per 1,000 people), Open Access journals, School enrollment, tertiary (% gross), International Collaboration Documents, Current health expenditure per capita (current US$), School enrollment, primary (% gross), Adjusted net national income per capita (constant 2010 US$), Adjusted savings: education expenditure (current US$), Cited documents, Documents, Journals, Cites, and External Cites. The order from the largest component score coefficient to the smallest loading for the second principal component is External Cites, Cites, Documents, Journals, Cited documents, Adjusted savings: education expenditure (current US$), Adjusted net national income per capita (constant 2010 US$), Current health expenditure per capita (current US$), International Collaboration Documents, School enrollment, tertiary (% gross), Open Access journals, Nurses and midwives (per 1,000 people), Open Access Documents, and School enrollment, primary (% gross).
Table 6 Component score coefficient matrix by using the normalized data. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).

| Variables                                         | The first principal component | The second principal component |
|---------------------------------------------------|------------------------------|-------------------------------|
| School enrollment, primary (% gross)              | 0.099                        | -0.298                        |
| School enrollment, tertiary (% gross)             | 0.132                        | -0.067                        |
| Current health expenditure per capita (current US$) | 0.113                        | -0.067                        |
| Adjusted net national income per capita (constant 2010 US$) | 0.096                        | 0.000                         |
| Adjusted savings: education expenditure (current US$) | 0.091                        | 0.008                         |
| Nurses and midwives (per 1,000 people)            | 0.156                        | -0.108                        |
| Documents                                         | 0.045                        | 0.086                         |
| Cited documents                                   | 0.057                        | 0.068                         |
| Cites                                             | -0.123                       | 0.340                         |
| External Cites                                    | -0.201                       | 0.439                         |
| International Collaboration Documents             | 0.132                        | -0.063                        |
| Open Access Documents                             | 0.183                        | -0.160                        |
| Journals                                          | 0.043                        | 0.084                         |
| Open Access journals                              | 0.150                        | -0.097                        |

The component score coefficients of education expenditure, School enrollment, tertiary (% gross), Current health expenditure per capita (current US$), and Nurses and midwives in the first and second principal components are also very high. Most component score coefficients (9 input variables) vary from 0.09 to 0.18. In these 9 variables, there are factors for education, net national income per capita, scholarly publishing, etc. It further supports that the level of education exerts a very high impact on regional growth [51] and there is a significant relationship between regional growth and higher education [52]. These results also agree well with that school-based programs to promote health knowledge in an area characterized by low levels of income and education may have a small payoff [12], there are Significant non-monetary returns to education concerning health outcomes [13], schooling could be an important factor influencing fertility and child health [53]. Most component score coefficients of the Document and journals published in China are comparable with those of education expenditure, School enrollment, tertiary (% gross), Current health expenditure per capita (current US$), and Nurses and midwives. This might be because knowledge is the most powerful engine for economic development [54], accelerated sustainable economic growth [5], increasing knowledge, and developing knowledge can improve public health [9,10]. That all these input factors can improve health and well-being according to Table 6 is consistent with the above conclusion drawn in the literature.

**Discussion**
According to Table 1 out of 14 components, only those factors whose eigenvalues are larger than 1 have been selected for multiple linear regressions between Life expectancy at birth or Death rate and the principal components.

Table 7 demonstrates the results of multivariate multiple linear regression analysis results based on principal component scores. 71.3 % of the variation in the normalized Life expectancy at birth of China could be explained by the first principal component, which is determined from the stepwise regression analysis. 99.3 % of the variation in the normalized Life expectancy at birth of China could be explained by both the first and second principal components. The above results reveal that the first principal component gives the most contribution to the normalized Life expectancy at birth of China. 15.8 % of the variation in the normalized Death rate of China could be explained by the first principal component, which is determined from the stepwise regression analysis. 92.8 % of the variation in the normalized Death rate of China could be explained by both the first and second principal components. The above results reveal that the second principal component gives the most contribution to the normalized Death rate of China. In other words, the selected data might be enough to explain the Life expectancy at birth of China, but should be not enough to explain the death rate of China.

Table 7: Multivariate multiple linear regression analysis results. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).

| Variable                  | Unstandardized Coefficients | Standardized coefficients | t    | Sig. | R²  |
|---------------------------|-----------------------------|---------------------------|------|------|-----|
| Life expectancy at birth, total (years) | Before stepwise regression analysis |                             |      |      |     |
| Intercept                 | .549                        | .017                      | 32.366 | .000 | .993 |
| PC1                       | .555                        | .018                      | .845  | 31.466 | .000 |
| PC2                       | .348                        | .018                      | .529  | 19.696 | .000 |
| Death rate, crude (per 1,000 people) | Before stepwise regression analysis |                             |      |      |     |
| Intercept                 | .669                        | .052                      | 12.878 | .000 | .928 |
| PC1                       | .254                        | .054                      | .397  | 4.688 | .001 |
| PC2                       | .561                        | .054                      | .878  | 10.368 | .000 |
| Life expectancy at birth, total (years) | After stepwise regression analysis |                             |      |      |     |
| Intercept                 | .549                        | .102                      | 5.381  | .000 | .713 |
| PC1                       | .555                        | .106                      | .845  | 5.232 | .000 |
| Death rate, crude (per 1,000 people) | After stepwise regression analysis |                             |      |      |     |
| Intercept                 | .669                        | .170                      | 3.940  | .002 | .158 |
| PC1                       | .254                        | .177                      | .397  | 1.435 | .179 |
These linear relationships between the principal components and the normalized Life expectancy at birth or Death rate of China demonstrate that public health has a dependent relationship on the principal components. Every principal component is composed of 14 input variables. Most variables have a similar contribution to the principal components. It means that some factors of scholarly publishing, education, income, health expenditure, etc. have a similar contribution to new variables that have been obtained by using the principal component analysis. These linear relationships between the principal components (it includes scholarly publishing, education, income, health expenditure, etc.) and the target data (the data of public health in China) support the well-known conclusions that education can exert a very high impact on regional growth [51,52], and an impact on health promotion[12,13,53]. Such linear relationships between the principal components (it includes scholarly publishing, education, income, health expenditure, etc.) and the target data (the data of public health in China) could originate that knowledge is necessary for the health benefits and the knowledge for health and well-being is various [6], either increasing knowledge or developing knowledge can improve public health [9,10], lack of knowledge can cause serious health problems [11], it needs knowledge for making proper decisions and realizing actions [5], making better health decisions leads to improved health outcomes [13], knowledge is the most powerful engine for economic development [54], knowledge can accelerate sustainable economic growth [5]. In other words, both economic development and regional development can improve health and well-being.

The public health and well-being in China are measured by Life expectancy at birth and Death rate. Tables 1-7 show that the data of Life expectancy at birth or Death rate of China are strong linear dependent on the principal components. Each principal component is composed of the input data related to education, income, and scholarly publishing, etc. Hence, the linear relationships between the principal components including the factors such as scholarly publishing, education, income, health expenditure, etc.) and the data of public health in China imply that there is a strong interdependence between scholarly publishing and public health in China. Scholarly publishing plays a similar role in public health, which has a similar behavior of education, income, health expenditure, etc. The results shown in Tables 1-7 are new. The very good linear relationship between the principal components and the Life expectancy at birth or Death rate of China could result from the well-known conclusions that knowledge is necessary for the health benefits and the knowledge for health and well-being is various [6], either increasing knowledge or developing knowledge can improve public health [9,10], lack of knowledge can cause serious health problems [11], it needs knowledge for
making proper decisions and realizing actions [5], making better health decisions leads to improved health outcomes [13].

**Conclusions**

One can note that the combination method is proposed in this article is not the actual answer. Instead, this model is an example of showing our idea to study the relationship between the input data (knowledge, education, etc.) and the target data (public health). Besides, due to the limited or possible error of the collected data of knowledge, education, etc., the relationship the input data (knowledge, education, etc.) and the target data (public health) based on the proposed method in this paper may be different from the actual situation. However, the proposed method can be used to study the issue of how the target data depends on the input data. This is because the proposed method provides a new idea for the influence of knowledge in future studies.

The proposed method can be treated as a new method introduced to study the correlation between scholarly publishing and health and well-being.

Principal component analysis has been used to avoid the multicollinearity problem in the data used in this article. Through a case study of the data of health and well-being, education, income, and knowledge translation of scholarly publishing in China, explore the effects of the various activities of scholarly publishing on health and well-being. Results obtained from the principal analysis show that two principal components whose eigenvalues are larger than 1. The first principal component accounts for 85.6% of the total variance. And the second principal component accounts for 11.8% of the total variance. Both principal components account for 97.3% of the total variance. It implies that only the first and the second principal components at the most needed to be considered. Multivariate multiple linear regression analysis based on principal component analysis demonstrates that 71.3 % of the variation in the normalized Life expectancy at birth of China could be explained by the first principal component, which is determined from the stepwise regression analysis. On the other hand, 99.3 % of the variation in the normalized Life expectancy at birth of China could be explained by both the first and second principal components. The contribution of the education, the income, and the scholarly publishing to the first principal component can not be neglected. This implies that scholarly publishing especially on open access publishing could be an important factor in improving health and well-being. All results demonstrate that scholarly publishing can give an important contribution to the health and well-being of China. The findings in this paper agree with the former conclusions reported in the literature that that
various knowledge is necessary for health and well-being [6], knowledge can promote public health [9,10], serious health problems could occur due to lack of knowledge can cause [11], knowledge is necessary for making proper decisions and realizing actions [5], health outcomes can be improved by making better health decisions [13]. In conclusion, the combination of the correlation analysis, the principal component analysis, and multivariate regression methods is valid in the study of the correlation between scholarly publishing and health and well-being.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Availability of data and materials
The datasets generated and/or analysed during the current study are available in the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).

Competing interests
The authors declare that they have no competing interests.

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Authors' contributions
Na analyzed and interpreted the data, and wrote the manuscript. All authors read and approved the final manuscript.

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Table
Table 1 Life expectancy at birth, Death rate, School enrolment (primary), School enrollment (tertiary), Current health expenditure per capita, Adjusted net national income per capita, Adjusted savings: education expenditure, intellectual properties, and Nurses and midwives in China. The data come from the website of the World Bank (https://data.worldbank.org).
Table 2 Documents and its citation situation, International Collaboration articles, open access articles, journals, and open access journals published by China. The data come from the website of SCImago (https://www.scimagojr.com).
Table 3: The output for the Pearson correlation coefficient ($r$). The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).
Table 4 Eigenvalues, individual and cumulative by using the normalized data. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).
Table 5 The loadings after varimax rotation by using the normalized data. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).
Table 6 Component score coefficient matrix by using the normalized data. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).
Table 7: Multivariate multiple linear regression analysis results. The raw data come from the website of the World Bank (https://data.worldbank.org) and the website of SCImago (https://www.scimagojr.com).

Captions

Fig. 1 Normalized Life expectancy at birth, Death rate, School enrolment (primary), School enrollment (tertiary), Current health expenditure per capita, Adjusted net national income per capita, Adjusted savings: education expenditure, intellectual properties, and Nurses and midwives in China as a function of time. The raw data come from the website of the World Bank (https://data.worldbank.org).
Fig. 2 Normalized Documents and its citation situation, International Collaboration articles, open access articles, journals, and open access journals published by China as a function of time. The raw data come from the website of SCImago (https://www.scimagojr.com).