Associations between longevity and subjective well-being by country

Ge Qian

This study examines the relationships between longevity and subjective well-being from the social science perspective, using global data, by employing epidemiological methods and data from the Human Development Report 2010. For all countries as a whole and of all the subjective well-being variables in this study, the overall life satisfaction had the strongest positive association with longevity. At this point, the situations are similar for very high and medium human development countries, but quite different for high and low human development countries. The effects of various control variables seemed relatively limited. Path analyses showed that the overall life satisfaction had the strongest effect on life expectancy, while the effect of income was indirect. The number of physicians per 10,000 people, which was the main medical indicator, had neither direct nor indirect effects on life expectancy. In conclusion, the cognitive component of subjective well-being had a stronger impact than the emotional component did on life expectancy. However, subjective and psychological factors play more important roles in prolonging lifespans than objective factors such as economic and medical indicators do.

Keywords: Correlation, human development, longevity, path analysis, subjective well-being.

CONFUCIUS said, 'The wise are joyful; the virtuous are long-lived'[1]. He perhaps realized that there were some associations between longevity and happiness or subjective well-being. A commonly accepted notion in modern society is that happier people tend to live longer. However, relatively few empirical studies could substantiate this claim until the advent of so-called positive psychology. For example, Diener and Chan[2] concluded from previous literature that seven types of evidence indicated that high subjective well-being causes better health and increased longevity.

All research on factors related to the extension of human life is important. However, the present study makes a contribution to existing knowledge as it employs global data, epidemiological methods, and a social science perspective to examine the relationships between personal longevity and subjective well-being.

Data

This study uses data of all 169 nations in the Human Development Report (HDR) 2010 (ref. 3). Table 1 describes the variables.

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Considering that most of the data in HDR 2010 are second-handed, further information about the primary sources of the indices is available in HDR 2010 and associated websites and publications, including: life expectancy at birth[3,4]; gross national income per capita[5,6]; mean years of schooling[7]; income Gini coefficient[8]; deaths due to indoor and outdoor air and water pollution[4,9]; physician per 10,000 people[10]; and population[3,4]. As to the 5 subjective well-being indices in HDR 2010 used in this study, e.g., overall life satisfaction, negative experience index and elements of happiness, all came from the Gallup World Poll database[11].

In this article, the word 'longevity' is used as a synonym for 'life expectancy' demographically; however, 'longevity' can also refer only to especially long-lived members of a population. Subjective well-being refers to how people perceive the quality of their lives. This concept includes both emotional reactions and cognitive judgments. Similarly, psychologists have defined happiness as a combination of life satisfaction and relative frequency of positive and negative effect[12]. In the present study, emotional reactions are measured through the Negative Experience Index (NEI), and this index is compiled by asking questions such as whether the respondent had experienced anger, pain, or worry for much of the previous day. While the cognitive judgments are represented by overall life satisfaction (OLS), the measures of this index are based on ladder-of-life questions, which ask respondents to rate their life from the worst (0) to the

Table 1. Study variables

Life expectancy at birth		Years		LEB
Gross national income per capita		US$	2010	GNI
Mean years of schooling		Years		MYS
Income Gini coefficient		0–100	2000–2010	IGC
Deaths due to indoor and outdoor air and water pollution		Per million people	2004	DDP
Physician		Per 10,000 people	2000–2009	PHY
Population		Million	2010	POP
Overall life satisfaction		0–10		OLS
Elements of happiness	Purposeful life	%	2006–2009	PUL
	Treated with respect			TWR
	Social support network			SSN
Negative experience index		0–100		NEI

Figure 1. World map by quartiles of Human development index in the Human Development Report 2010.

best (10) level. In addition, data on all respondents who reported having one of the three elements of happiness (purposeful life [PUL], treated with respect [TWR], and social support network [SSN]) are analysed by the country[3,11].

Social scientists have always been plagued by problems of data accuracy and comparability. The accuracy of the data in this study depends on that in HDR 2010; similarly, some data in this study are treated comparably, such as data from different years, because they are compared in the HDR 2010.

Another data problem we may encounter is one of heterogeneity, for, the data we used here are from 169 nations with different conditions and situations; so analysis on complete dataset of all countries or subset of data including certain types of countries seem both necessary. In the field of sustainable development, there exist two universally recognized methods which have well-defined classificatory mechanisms to places in each country in specific groups. One is as per the World Bank[13] segregated by economies, while the other is as per the United Nations Development Programme[3] segregated by the level of human development. The latter nomenclature seems more suitable to this study which addresses an important public health issue.

The Human Development Index (HDI) was created by the United Nations Development Programme[3] as a summary measure of average achievement in key dimensions of human development: health, education and income. Figure 1 shows the world map by quartiles (very high, high, medium, low) of HDI based on data from HDR 2010.

Method

The present study utilized data from HDR 2010, as mentioned above in the data section, and applies epidemiological methods to derive associations between longevity and subjective well-being of the country. Epidemiology, according to the World Health Organization[14], is the study of the distribution and determinants of health-related states or events, and the application of this study to the control of diseases and other health problems. The concepts of epidemiology are developed using examples involving real data from published studies, and the relevant statistical methods are developed systematically to provide an integrated approach to observational and experimental studies[15].

This study used SPSS 16.0 for data processing. The statistical/epidemiological methods used included measures of correlation and path analyses, and the analysis process was divided into three main steps. First, we computed Pearson correlation coefficients between longevity and subjective well-being both for all countries as a whole and for countries in specific groups with very high, high, medium, and low levels of human development as per HDR 2010. Second, from the social science perspective, there are many factors affecting average life expectancy. Thus, we computed partial correlation coefficients between longevity and subjective well-being by controlling for income (gross national income per capita, GNI), education (mean years of schooling, MYS), inequality (income Gini coefficient, IGC), environment (deaths due to indoor and outdoor air and water pollution per million people, DDP), medical (physicians per 10,000 people,

Table 2. Pearson correlation coefficients

LEB		OLS	PUL	TWR	SSN	NEI
Pearson correlation (N)	All countries	0.783**	–0.377**	0.269**	0.586**	0.121
		(144)	(133)	(147)	(146)	(144)
	Very high human development countries	0.541**	–0.013	0.106	0.129	–0.182
		(38)	(33)	(38)	(38)	(38)
	High human development countries	0.294	0.334*	0.222	0.117	0.319*
		(39)	(37)	(40)	(39)	(39)
	Medium human development countries	0.553**	0.083	0.289	0.155	0.064
		(31)	(28)	(31)	(31)	(30)
	Low human development countries	0.140	0.054	–0.255	0.023	0.058
		(36)	(35)	(38)	(38)	(37)

*Significant at the 0.05 level (2-tailed). **Significant at the 0.01 level (2-tailed). OLS, Overall life satisfaction; PUL, Purposeful life; TWR, Treated with respect; SSN, Social support network; NEI, Negative experience index; LEB, Life expectancy at birth.

PHY), and demographic (population, POP) factors. Third, we applied path analyses, which usually consist of two or more multiple regression equations, to reveal how the above major social factors interacted with subjective well-being in affecting life expectancy.

Since the use of Pearson correlation coefficients and multiple regression equations may be statistically problematic for nations with extremely different systems, economies, and medical treatment levels, analysis on both complete dataset of all countries and subsets of data including certain types of countries are necessary. And according to the taxonomy of the countries mentioned above, there is altogether one complete dataset and nine sub-datasets, i.e.: sub-dataset 1 (very high human development, 42 countries), sub-dataset 2 (high human development, 43 countries), sub-dataset 3 (medium human development, 42 countries), sub-dataset 4 (low human development, 42 countries), sub-dataset 5 (very high + high human development, 85 countries), sub-dataset 6 (high + medium human development, 85 countries), sub-dataset 7 (medium + low human development, 84 countries), sub-dataset 8 (very high + high + medium human development, 127 countries), sub-dataset 9 (high + medium + low human development, 127 countries). However, in the first step, to avoid redundant computations, we only computed Pearson correlation coefficients between longevity and subjective well-being based on the complete dataset and sub-datasets 1, 2, 3, 4. And in the third step, according to the theory of statistics[16], for the purpose of making multiple linear regression equations more robust, the sample size should be at least 5–10 times, even 20 times as large as the number of independent variables. And here the number of independent variables is 10, so the sample size should be at least 50–100, even 200. With exploratory modelling, we found that computational results based on the sub-datasets 1, 2, 3, 4, 5, 6, 7 are rather unstable; this may suggest that at least 10 times are needed here and thus we only report the results of path analyses on the complete dataset and the sub-datasets 8, 9.

Results

Table 2 lists the computational results on the Pearson correlation coefficients between longevity and subjective well-being both for all countries as a whole and for countries in specific groups with very high, high, medium, and low human development level as per HDR 2010. Our empirical results based on data from all countries showed that, of all the subjective well-being variables in this study, OLS had the strongest positive association with personal longevity, followed by SSN and TWR. It is unusual that our empirical study showed that a purposeful life is negatively associated with longevity; this may be because rigidity is not conducive to good health. Situations generally were quite similar in the very high and medium human development countries, for in these countries, OLS continued to have the strongest positive association with personal longevity. But in the low human development countries, no subjective well-being variable was significantly associated with life expectancy at birth (LEB). However, in high human development countries, NEI and PUL but not OLS are significantly associated with LEB.

Table 3 lists the computational results on the partial correlation coefficients between longevity and subjective well-being by controlling for income, education, inequality, environment, medical and demographic factors, and shows that the effects of various control variables are relatively limited. We found that IGC, DDP, and POP have little impact on the correlation between longevity and subjective well-being. As possible intermediary variables, GNI, MYS, and PHY may cause significant negative correlation between LEB and PUL, while GNI may also cause significant positive correlation between LEB and TWR.

We then applied path analyses to reveal how the above major social factors interacted with subjective well-being in affecting life expectancy. In the following path analyses, we placed the variables into three levels. At the bottom was the dependent variable in this study: LEB. The

Table 3. Partial correlation coefficients

LEB	Control variables	OLS	PUL	TWR	SSN	NEI
Correlation	GNI	0.574** (128)	–0.161 (128)	0.097 (128)	0.325** (128)	0.115 (128)
	MYS	0.610** (128)	–0.056 (128)	0.259** (128)	0.272** (128)	0.141 (128)
	IGC	0.777** (122)	–0.301** (122)	0.289** (122)	0.559** (122)	0.100 (122)
	DDP	0.580** (128)	–0.261** (128)	0.199* (128)	0.228** (128)	–0.097 (128)
	PHS	0.683** (115)	–0.006 (115)	0.215* (115)	0.353** (115)	0.112 (115)
	POP	0.773** (128)	–0.376** (128)	0.250** (128)	0.571** (128)	0.075 (128)

*Significant at the 0.05 level (2-tailed). **Significant at the 0.01 level (2-tailed).
GNI, Gross national income per capita; MYS, Mean years of schooling; IGC, Income Gini coefficient; DDP, Deaths due to indoor and outdoor air and water pollution; PHY, Physician; POP, Population.

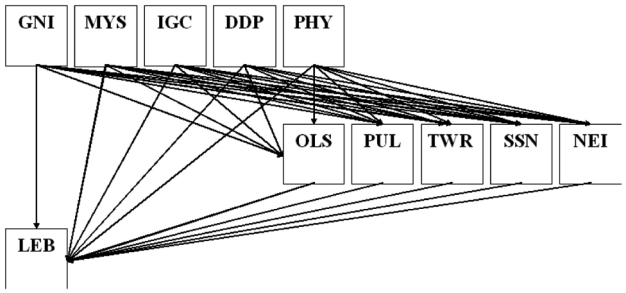

Figure 2. Assumed paths of influence. GNI, Gross national income per capita; MYS, Mean years of schooling; IGC, Income Gini coefficient; DDP, Deaths due to indoor and outdoor air and water pollution; PHY, Physician; OLS, Overall life satisfaction; PUL, Purposeful life; TWR, Treated with respect; SSN, Social support network; NEI, Negative experience index; LEB, Life expectancy at birth.

middle level contained a variety of subjective variables, including OLS, NEI, and the three elements of happiness. In the upper level, there were various social factors, including income, education, inequality, environment, and medicine; these factors affect people's life expectancy not only directly but also indirectly, via subjective well-being. Considering the large variations in populations between countries, we used POP to weigh the variables. Figure 2 shows the assumed paths from various social factors to subjective well-being and then to life expectancy.

In this study, stepwise multivariate linear modelling was used, with SPSS 16.0. Independent variables for which the direct and indirect effects on the dependent variable were both non-significant were excluded. Figure 3 shows the empirical results of the path analysis respectively on the complete dataset, the sub-dataset 8 and the sub-dataset 9. We treat the path analysis model based on the complete dataset as the main model, while the other two path analysis models are quite similar to the main model, except for education factor that no longer has a significant effect on the dependent variable, and the *R*-squares of the multiple linear regression equations are relatively low in the other two models based on sub-datasets.

The main path analysis model based on the complete dataset actually includes two multiple linear regression equations: the *R*-squares of these two equations are all

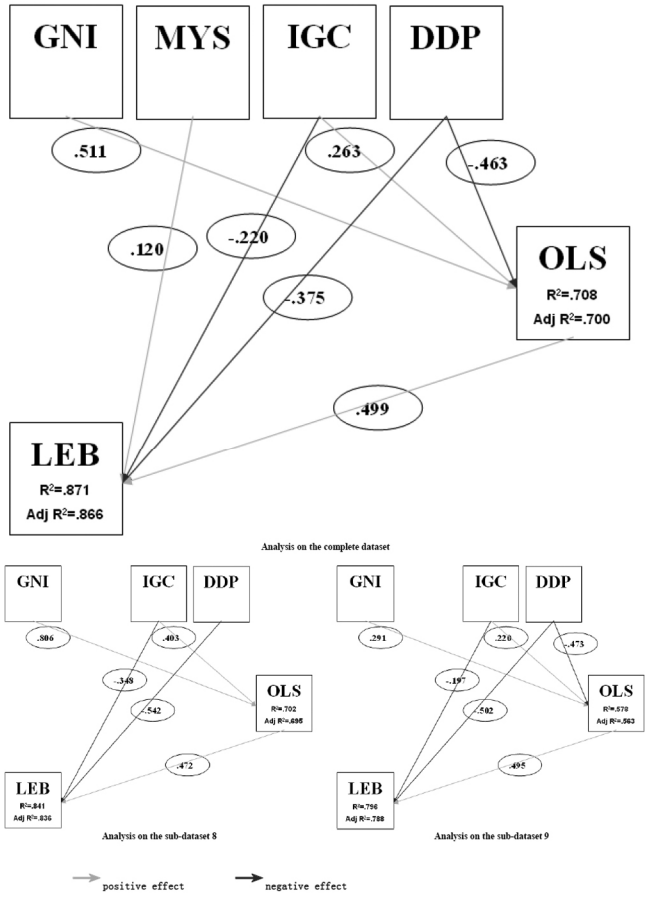

Figure 3. Path analysis results. GNI, Gross national income per capita; MYS, Mean years of schooling; IGC, Income Gini coefficient; DDP, Deaths due to indoor and outdoor air and water pollution; OLS, Overall life satisfaction; LEB, Life expectancy at birth.

over 0.700 and appear satisfactory. OLS had the strongest effect ($\beta = 0.499$) on life expectancy, followed by environment ($\beta = -0.375$), inequality ($\beta = -0.220$), and education ($\beta = 0.120$). Though the direct effect of income on life expectancy was not significant, income affected life expectancy indirectly through its significant effect ($\beta = 0.511$) on OLS. A somewhat surprising finding is that PHY, which was the main health indicator, had neither direct nor indirect effects on life expectancy.

Discussion

A methodological strength of this study is the use of the largest existing data set of nations with representative sampling; thus, it has a far more representative and extensive sample than most previous studies. The main conclusions of this study are as follows. First, the cognitive component of subjective well-being has a greater impact than its emotional component on life expectancy, perhaps because this is just a fact or because emotion measurement has low accuracy. The former explanation is consistent with other research results; for example, Blazer and Hybels[17] found that the negative effect is not statistically related to longevity. Since there is no direct index of positive effect in HDR 2010, NEI was considered an indicator of the emotional component of subjective well-being in the present study. Second, subjective and psychological factors play more important roles in prolonging lifespans than objective factors such as economic and medical indicators do. This finding is supported by the results of Wright *et al.*[18], who determined that neighbourhood poverty, income, and education exerted negligible or no influence on physical functioning and emotional well-being among Medicare-Medicaid enrollees.

Another finding of this study discussed here is: for all countries as a whole and of all the subjective well-being variables, OLS had the strongest positive association with personal longevity; and it seems quite similar at this point in the very high and medium human development countries. But no subjective well-being variable was significantly associated with life expectancy at birth in low human development countries. This seems to be logical because in these countries, actual physical conditions, rather than subjective sense of happiness, are crucial for extending people's lives. There is no simple explanation why NEI and PUL but not OLS are significantly associated with LEB in high human development countries. One reason may be that some countries in this group are former Soviet and socialist republics, such as the Russian Federation and Ukraine; countries with only petrodollars, such as Kuwait and Saudi Arabia; or 'trapped in Latin America' nations, such as Brazil and Argentina, although this type of country group is not restricted to Latin America. All these nations may be called transition countries. The drastic social changes in these countries have upset the mental and psychological status of their citizens, and how people respond to such upsets also affects the length of their lives. (Note that on the NEI, 0 = most negative, while 100 = least negative.)

1. Confucius, *The Analects of Confucius*, W. W. Norton, New York, 1997.
2. Diener, E. and Chan, M. Y., Happy people live longer: Subjective well-being contributes to health and longevity. *Appl. Psychol.: Health Well-Being*, 2011, **3**, 1–43.
3. United Nations Development Programme. Human Development Report 2010: The Real Wealth of Nations – Pathways to Human Development, Palgrave Macmillan, New York, 2010.
4. United Nations Department of Economic and Social Affairs. World Population Prospects: The 2008 Revision, United Nations, New York, 2009.
5. World Bank, *World Development Indicators 2010*, World Bank, Washington, DC, 2010.
6. International Monetary Fund. *Government Finance Statistics*, International Monetary Fund, Washington, DC, 2010.
7. http://laborsta.ilo.org/ (accessed on 22 April 2016).
8. World Bank, International Income Distribution Database, World Bank, Washington, DC, 2010.
9. http://www.who.int/healthinfo/global_burden_disease/en/ (accessed on 22 April 2016).
10. http://www.who.int/whosis/whostat/2010/en/ (accessed on 22 April 2016).
11. http://www.gallup.com/home.aspx (accessed on 22 April 2016).
12. Diener, E., Subjective well-being. *Psychol. Bull.*, 1984, **95**, 542–575.
13. World Bank, *World Development Report 2010: Development and Climate Change*, World Bank, Washington, DC, 2009.
14. http://www.who.int/topics/epidemiology/en/ (accessed on 22 April 2016).
15. Mcneil, D. R., *Epidemiological Research Methods*, John Wiley, New York, 1996.
16. Weisberg, S., *Applied Linear Regression*, John Wiley, New York, 1985.
17. Blazer, D. G. and Hybels, C. F., What symptoms of depression predict mortality in community-dwelling elders? *J. Am. Geriatrics Soc.*, 2004, **52**, 2052–2056.
18. Wright, K. D. *et al.*, Factors that influence physical function and emotional well-being among Medicare-Medicaid enrollees. *Geriatric Nursing*, 2015, **36**, S16–S20.

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