Cross-country variation in additive effects of socio-economics, health behaviors, and comorbidities on subjective health of patients with diabetes

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Abstract

Purpose: This study explored cross-country differences in the additive effects of socio-economic characteristics, health behaviors and medical comorbidities on subjective health of patients with diabetes.

Methods: The study analyzed data from the Research on Early Life and Aging Trends and Effects (RELATE). The participants were 9,179 adults with diabetes who were sampled from 15 countries (i.e. China, Costa Rica, Puerto Rico, United States, Mexico, Argentina, Barbados, Brazil, Chile, Cuba, Uruguay, India, Ghana, South Africa, and Russia). We fitted three logistic regressions to each country. Model I only included socio-economic characteristics (i.e. age, gender, education and income). In Model II, we also included health behaviors (i.e. smoking, drinking, and exercise). Model III included medical comorbidities (i.e. hypertension, respiratory disease, heart disease, stroke, and arthritis), in addition to the previous blocks.

Results: Our models suggested cross-country differences in the additive effects of socio-economic characteristics, health behaviors and comorbidities on perceived health of patients with diabetes. Comorbid heart disease was the only condition that was consistently associated with poor subjective health regardless of country.

Conclusion: Countries show different profiles of social and behavioral determinants of subjective health among patients with diabetes. Our study suggests that universal programs that assume that determinants of well-being are similar across different countries may be over-simplistic. Thus instead of universal programs that use one protocol for health promotion of patients in all countries, locally designed interventions should be implemented in each country.

Keywords: Subjective health, Socio-economics, Health behaviors, Comorbidity, Cross country study

Introduction

It has been consistently shown that individuals with diabetes report poorer well-being and subjective health, compared to people without diabetes [1-5]. A question that is not answered yet is whether poor subjective health of patients with diabetes is the consequence of diabetes - per se - or factors associated with diabetes. We know that low socio-economic status [6], health compromising behaviors [7] and chronic medical conditions [8-12] frequently co-occur with diabetes and also influence the well-being of individuals.

Low socio-economic status may be associated with poor subjective health [6]. The protective effect of high social class on well-being has been partially attributed to better access to financial and material resources available in the community [13]. Unfortunately, most of our knowledge about the effect of socio-economic status on health and well-being of individuals has originated from studies conducted within one country [14,15]. Thus, it is not known if there are cross-country differences in the
effect of socio-economic status on subjective health or not.

Comorbid conditions are associated with poor subjective health among patients with an index disease [6]. Patients who suffer from a higher number of chronic conditions tend to report lower physical and mental health related quality of life [16-18]. In the United States, each comorbid chronic condition has been estimated to reduce 3–4 decrements in mental quality of life [19]. Chronic conditions are closely associated with deterioration in physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role and mental health [20].

Although research has consistently shown cross-country differences in objective and subjective measures of health [21-26], limited knowledge exists on causes of such variations. The World Values Survey, European Values Study, Eurobarometer, and Latinobarometer, have all reported cross-country variations in self-rated health and well-being of individuals [21-33]. It is, however, not known if determinants of well-being also vary based on country. According to our knowledge, there are not many–if any–studies that have compared the effects of social and behavioral determinants of subjective health among individuals with an index chronic medical condition across countries.

The current study aimed to compare countries in the effects of socio-economic characteristics (i.e. age, gender, education and income), health behaviors (i.e. smoking, drinking and exercise), and comorbid conditions (i.e. hypertension, respiratory disease, heart disease, stroke, and arthritis) on the subjective health of a community sample of adults with diabetes.

Methods

Study design & participants

Research on Early Life and Aging Trends and Effects (RELATE) is a cross-national survey in 15 countries located in North America, South America, Asia, and Africa [34,35]. The RELATE composed of the following national surveys: 1) China Health and Nutrition Study (CHNS), 2) Chinese Longitudinal Healthy Longevity Survey (CLHLS), 3) Costa Rican Study of Longevity and Healthy Aging (CRELES), 4) Puerto Rican Elderly: Health Conditions (PREHCO), 5) Study of Aging Survey on Health and Well Being of Elders (SABE), 6) WHO Study on Global Ageing and Adult Health (SAGE), and 7) Wisconsin Longitudinal Study (WLS). [34,35] All studies were approved by an institutional review board. Written consent was provided by all participants. Data were collected in an anonymous fashion.

The current analysis included 9,179 adults with diabetes. Participants were sampled in the following 15 countries: China (n = 3,024), Puerto Rico (n = 1,197), the United States (n = 887), Mexico (n = 687), Costa Rica (n = 542), India (n = 478), Brazil (n = 380), South Africa (359), Russia (n = 350), Barbados (n = 325), Cuba (n = 290), Uruguay (n = 188), Chile (n = 173), Ghana (n = 167), and Argentina (n = 132).

The RELATE project represents countries from a diverse range in national income levels. The United States, Puerto Rico, and Barbados represent high income countries; Argentina, Cuba, Uruguay, Chile, Costa Rica, Brazil, Mexico, and Russia represent upper middle income countries; China and India represent lower middle income countries; and China and India represent lower middle income countries; and Ghana represents low income countries.

Measures

Socio-economic characteristics

The study measured socio-economic data such as age (continuous variable), gender (dichotomous variable), education level (a four level categorical variable composed of no schooling, primary to elementary, secondary to intermediate, and higher), and income (continuous variable).

Comorbid conditions

We measured five different chronic medical conditions including hypertension, respiratory disease, heart disease, stroke, and arthritis, using self-report of physician diagnoses. Agreement between self-report and physician diagnosis of comorbid conditions has been shown to be high (kappa: 0.74-0.92) [36].

Main outcome

The outcome was a single item measure of subjective health. Overall perceived health was measured using a five-item Likert scale (i.e. very bad, bad, moderate, good, and very good). Single items have been frequently used to measure subjective health and well-being [27,28,37-42]. The test retests reliability of single items for measuring subjective health range from 0.7 to 0.8 [41]. Results of these single item measures of subjective health are highly correlated with standard scales [41,43]. Single item measures of subjective health have shown high predictive validity for prediction of mortality, even after controlling for other risk factors [29].

Data analysis

Data analysis was conducted using SPSS 20.0 for Windows. We transformed our five-item Likert scale to a dichotomous outcome, as poor health (i.e. very bad health and bad health) versus good health (i.e. moderate health, good health, and very good health). Odds Ratios (OR) and 95% confidence intervals (95% CI) were reported. P less than 0.05 was considered as significant.

We fitted country specific logistic regressions to determine if the associations between socio-economic factors (i.e age, gender, education, and income), health behaviors
(i.e. smoking, drinking, and exercise) and chronic conditions (i.e. hypertension, respiratory disease, heart disease, stroke, and arthritis), and subjective health vary across countries. Although most country specific surveys had sampling weights, sampling weights were not applicable to surveys from the United States (Wisconsin) and China (CHNS). Thus, the current study did not apply sampling weights.

We took a hierarchical approach for our regression analysis. Model I only included socio-economic characteristics (i.e. age, gender, education and income). In Model II, health behaviors (i.e. smoking, drinking, and exercise) were added to the model. Model III also included comorbidities (i.e. hypertension, respiratory disease, heart disease, stroke, and arthritis).

Changes in the odds ratios from Model I (socio-economic factors) to Model II (socio-economic factors and health behaviors) suggest that health behaviors may mediate the effect of socio-economic factors on subjective health. Changes in the odds ratios from Model II (socio-economic factors and health behaviors) to Model III (full model) suggest that comorbid conditions may mediate the effect of socio-economic factors and health behaviors on subjective health.

Results

This study included 9,179 adults with diabetes. Participants were sampled in the following 15 countries: China (n = 3,024), Puerto Rico (n = 1,197), the United States (n = 887), Mexico (n = 687), Costa Rica (n = 542), India (n = 478), Brazil (n = 380), South Africa (359), Russia (n = 350), Barbados (n = 325), Cuba (n = 290), Uruguay (n = 188), Chile (n = 173), Ghana (n = 167), and Argentina (n = 132).

Model I (socio-economics)

With the exception of Costa Rica, the United States, Mexico, Brazil, and South Africa, in all 10 other countries, female patients had significantly poorer subjective health than male patients [Table 1].

In six countries (i.e. Mexico, Barbados, India, Ghana, South Africa, and Russia), older patients had poorer subjective health than younger patients. In China and Costa Rica, older patients reported better subjective health. In the other seven countries (i.e. Puerto Rico, the United States, Brazil, Chile, Cuba, Argentina, and Uruguay), age was not associated with subjective health [Table 1].

In all countries other than South Africa, high education was associated with better subjective health. This association was marginally significant in South Africa [Table 1].

In six countries (i.e. Argentina, Chile, Cuba, Uruguay, Ghana, and South Africa), high income was not associated with subjective health. High income was predictive of better subjective health in the other nine countries [Table 1].

Model II (socio-economics and health behaviors)

In all countries but Mexico, exercise was predictive of better subjective health. In Mexico, exercise was associated with worse subjective health [Table 2].

In India and South Africa, drinking was marginally associated with poor subjective health. In Ghana, and Russia, drinking was not associated with subjective health. In all other 12 countries, drinking was associated with better subjective health [Table 2].

In Ghana, smoking was marginally associated with poor subjective health. In Costa Rica, Barbados, Chile, Uruguay, and South Africa, smoking was not associated with subjective health. In all other nine countries, smoking was associated with poor subjective health [Table 2].

Model III (socio-economics, health behaviors and comorbidities)

With no exception, comorbid heart disease was associated with poor subjective health in all countries. With an exception of South Africa, in all other countries, comorbid hypertension was associated with poor subjective health. Arthritis was associated with poor subjective health in all countries but Ghana. In countries other than China and Ghana, comorbid lung disease was associated with poor subjective health. With an exception of China, Argentina and Ghana, in all other countries, stroke was associated with poor subjective health. In Ghana, the association between stroke and subjective health was marginally significant [Table 3].

Discussion

The purpose of this study was to explore cross-country differences in the associations between socio-economic characteristics, health behaviors and comorbid medical conditions with subjective health among individuals with diabetes. The study showed that low socio-economic status, smoking, lack of exercise, and medical comorbidities are predictive of poor subjective health of patients with diabetes in most countries. The study, however, documented several cross-country differences in the links between socio-economics, health behaviors and chronic conditions, and subjective health of individuals with diabetes. The only factor with a consistent effect on subjective health of patients with diabetes was comorbid heart disease. These findings suggest that the link between social and behavioral determinants of health and subjective health may vary across countries.

With exception of the United States, Costa Rica, Mexico, Brazil, and South Africa, in all ten other countries, female gender was associated with poor subjective health among individuals with diabetes. According to
another study among the general population, in 6 of 15 countries (i.e., China, Costa Rica, Puerto Rico, Barbados, Cuba and Uruguay) women reported poorer subjective health than men [44]. Among individuals with at least one chronic medical condition in Uruguay, Ghana and South Africa, female gender was associated with worse subjective health. Gender was not associated with subjective health in other countries [45]. These findings explain the complex role of gender in shaping the well-

| Country   | Gender | B     | S.E.   | Wald  | Sig.   | Exp (B)  | 95% C.I. for EXP (B) |
|-----------|--------|-------|--------|-------|--------|----------|---------------------|
|           |        |       |        |       |        | Lower    | Upper              |
| China     | Female | .183  | .028   | 41.44 | <.001  | 1.201    | 1.136 1.269        |
|           | Age    | −.016 | .001   | 334.03| <.001  | .984     | .982  .986          |
|           | Education | −.211 | .016   | 176.77| <.001  | .810     | .785   .835          |
|           | Income | .000  | .000   | 178.85| <.001  | 1.000    | 1.000  1.000        |
| Costa Rica| Female | .121  | .083   | 2.116 | .146   | .959     | .959  1.328         |
|           | Age    | −.014 | .004   | 12.23 | <.001  | .986     | .984  .994          |
|           | Education | −.378 | .068   | 31.28 | <.001  | .685     | .600   .782          |
|           | Income | .000  | .000   | 10.24 | <.001  | 1.000    | 1.000  1.000        |
| Puerto Rico| Female | .487  | .075   | 42.08 | <.001  | 1.628    | 1.405  1.886        |
|           | Age    | −.004 | .005   | .630  | .427   | .996     | .987   1.005        |
|           | Education | −.462 | .050   | 85.79 | <.001  | .630     | .572   .695          |
|           | Income | .000  | .000   | 17.88 | <.001  | 1.000    | 1.000  1.000        |
| United States | Female | −.105 | .082   | 1.636 | .201   | .901     | .766   1.057        |
|           | Age    | .060  | .055   | 1.198 | .274   | 1.062    | .953   1.183        |
|           | Education | −.517 | .102   | 25.58 | <.001  | .596     | .488   .728          |
|           | Income | .000  | .000   | 23.91 | <.001  | 1.000    | 1.000  1.000        |
| Mexico    | Female | .105  | .080   | 1.691 | .193   | 1.110    | .948   1.300        |
|           | Age    | .016  | .005   | 12.28 | <.001  | 1.016    | 1.007  1.025        |
|           | Education | −.305 | .054   | 32.47 | <.001  | .737     | .664   .819          |
|           | Income | .000  | .000   | 17.66 | <.001  | 1.000    | 1.000  1.000        |
| Argentina | Female | .363  | .155   | 5.494 | .019   | 1.438    | 1.061  1.494        |
|           | Age    | −.013 | .010   | 1.718 | .190   | .987     | .967   1.007        |
|           | Education | −.763 | .104   | 53.39 | <.001  | .466     | .380   .572          |
|           | Income | .000  | .000   | 2.467 | .116   | 1.000    | 1.000  1.000        |
| Barbados  | Female | .407  | .120   | 11.42 | <.001  | 1.502    | 1.186  1.901        |
|           | Age    | .041  | .007   | 31.86 | <.001  | 1.042    | 1.027  1.057        |
|           | Education | −.290 | .099   | 8.62 | <.001  | .748     | .617   .908          |
|           | Income | .000  | .000   | 4.121 | .042   | 1.000    | 1.000  1.000        |
| Brazil    | Female | .040  | .090   | 1.92  | .661   | 1.040    | .872   1.241        |
|           | Age    | .001  | .005   | .045  | .832   | 1.001    | .991   1.012        |
|           | Education | −.279 | .063   | 19.37 | <.001  | .756     | .668   .856          |
|           | Income | .000  | .000   | 17.58 | <.001  | 1.000    | 1.000  1.000        |
Table 2 Socio-economics, behaviors, and number of chronic conditions as predictors of poor subjective health among patients with diabetes in 15 countries (Continued)

|                | B     | S.E.  | Wald | Sig.  | Exp (B) | 95% C.I. for EXP (B) |
|----------------|-------|-------|------|-------|---------|----------------------|
|                |       |       |      |       |         | Lower    | Upper    |
| **Argentina**  |       |       |      |       |         |          |          |
| Female         | .374  | .182  | .422 | .040  | 1.453   | .101    | 2.075    |
| Age            | -.014 | .011  | 1.657| .198  | .986    | .966    | 1.007    |
| Education      | -.756 | .108  | 49.389| <.001 | .470    | .380    | .580    |
| Income         | .000  | .000  | 2.127| .145  | 1.000   | 1.000   | 1.000    |
| Smoking        | .415  | .172  | 5.853| .016  | 1.515   | 1.082   | 2.120    |
| Drinking       | -.528 | .160  | 10.903| .001  | .590    | .431    | .807    |
| Exercising     | -.622 | .243  | 6.541| .011  | .537    | .333    | .865    |
| **Barbados**   |       |       |      |       |         |          |          |
| Female         | .330  | .147  | 5.028| .025  | 1.390   | 1.042   | 1.855    |
| Age            | .032  | .008  | 17.359| <.001 | 1.032   | 1.017   | 1.048    |
| Education      | -.273 | .103  | 7.082| .008  | .761    | .622    | .931    |
| Income         | .000  | .000  | 3.758| .053  | 1.000   | 1.000   | 1.000    |
| Smoking        | .154  | .160  | .921 | .337  | 1.166   | .852    | 1.597    |
| Drinking       | -.564 | .143  | 15.517| <.001 | .569    | .429    | .753    |
| Exercising     | -.503 | .124  | 16.409| <.001 | .605    | .474    | .771    |
| **Brazil**     |       |       |      |       |         |          |          |
| Female         | .012  | .108  | .012 | .913  | 1.012   | .819    | 1.250    |
| Age            | -.007 | .006  | 1.470| .225  | .993    | .982    | 1.004    |
| Education      | -.196 | .065  | 9.063| .003  | .822    | .723    | .934    |
| Income         | .000  | .000  | 11.466| .001  | 1.000   | 1.000   | 1.000    |
| Smoking        | .397  | .104  | 14.675| <.001 | 1.488   | 1.214   | 1.823    |
| Drinking       | -.788 | .105  | 56.162| <.001 | .455    | .370    | .559    |
| Exercising     | -.680 | .111  | 37.302| <.001 | .507    | .407    | .630    |
| **Chile**      |       |       |      |       |         |          |          |
| Female         | .253  | .136  | 3.475| .062  | 1.288   | .987    | 1.682    |
| Age            | .001  | .008  | .021 | .885  | 1.001   | .986    | 1.016    |
| Education      | -.323 | .064  | 25.809| <.001 | .724    | .639    | .820    |
| Income         | .000  | .000  | 9.891 | .002  | 1.000   | 1.000   | 1.000    |
| Smoking        | .179  | .128  | 1.943| .163  | 1.196   | .930    | 1.537    |
| Drinking       | -.395 | .130  | 9.271 | .002  | .674    | .523    | .869    |
| Exercising     | -.408 | .146  | 7.809 | .005  | .665    | .499    | .885    |
| **Cuba**       |       |       |      |       |         |          |          |
| Female         | .472  | .119  | 15.580| <.001 | 1.603   | 1.268   | 2.025    |
| Age            | -.008 | .006  | 1.389| .239  | .992    | .980    | 1.005    |
| Education      | -.264 | .076  | 12.158| <.001 | .768    | .662    | .891    |
| Income         | .000  | .000  | 1.217| .270  | 1.000   | 1.000   | 1.000    |
| Smoking        | .251  | .115  | 4.785 | .029  | 1.285   | 1.026   | 1.609    |
| Drinking       | -.434 | .127  | 11.570| .001  | .648    | .505    | .832    |
| Exercising     | -.382 | .119  | 10.371| .001  | .682    | .541    | .861    |
| **Uruguay**    |       |       |      |       |         |          |          |
| Female         | .201  | .149  | 1.805| .179  | 1.222   | .912    | 1.639    |
| Age            | -.006 | .008  | .581 | .446  | .994    | .978    | 1.010    |
being of individuals. These studies collectively suggest that there are variations in the effect of gender on well-being between various populations, and sometimes even within a single country. The effect of gender on health and well-being among patients with medical conditions may be different from gender’s effects among the general population. Interestingly, the role of gender on the well-being of patients with medical conditions may depend on type of chronic illness.

Literature suggests that women tend to report a higher number of self-reported chronic medical conditions and poorer self-reported health [46]. Women also report worse subjective health and well-being, compared to men [46]. Due to gender differences in longevity, a larger part of a woman’s life is spent with illness and disabilities [47]. Although women require more care later in life than men, women tend to have less access to health resources [48,49]. In Ghana and Uruguay, among individuals with one chronic medical condition, women were more vulnerable to the effect of education on subjective health [45]. In a study on patients with chronic heart disease from Iran, women were more prone to the effect of income and education on sleep quality [50].

Pinquart and Sörensen proposed a number of mechanisms that may explain gender differences in subjective well-being. First, due to gender inequities and gendered social power, women may have lower material resources. In several countries, the gendered labor market may result in a lower level of stable employment among women [51]. Even among those who are employed, women’s pensions may be lower than men’s [52]. Among elderly, women more frequently live in poverty compared to men [53]. In addition, older women are more likely to be widowed than men [53]. In the United States, nearly four times as many older women than men live alone [49]. Finally, gender differences in response sets may explain worse self-reported health among women, as women may have more tendencies to report negative feelings and emotions [54].

Our results suggested that age and subjective well-being of patients with diabetes may be differently linked across countries. While in a number of countries (i.e. Mexico, Barbados, India, Ghana, South Africa, and Russia) high age is predictive of poor subjective health, age may not be associated with subjective health of patients with diabetes in other countries (i.e. Puerto Rico, United States, Brazil, Chile, Cuba, Argentina, and Uruguay). Interestingly, in China and Costa Rica, high age was associated with better subjective health among patients with diabetes. A recent study of general populations showed that in three countries (i.e. China, Costa Rica and Argentina), high age is predictive of poor subjective health, age may not be associated with subjective health of patients with diabetes in other countries (i.e. Puerto Rico, United States, Brazil, Chile, Cuba, Argentina, and Uruguay).

Table 2 Socio-economics, behaviors, and number of chronic conditions as predictors of poor subjective health among patients with diabetes in 15 countries (Continued)

|                | Education | Drinking | Smoking | Income | Age | Gender | Education | Drinking | Smoking | Income | Age | Gender |
|----------------|-----------|----------|---------|--------|-----|--------|-----------|----------|---------|--------|-----|--------|
| India          |           |          |         |        |     | Female |           |          |         |        |     | Female |
| Female         | .293      | .080     | .1323   | <.001  | .874| .005   | .256      | .075     | .179    | <.001  | .867| .372   |
| Age            | .404      | .004     | 129.415 | <.001  | 1.041| 1.004  | 1.010     | .814     | .750    | .084  | .988  | .131   |
| Education      | −.205     | .042     | .23824  | <.001  | 1.025| 1.010  | 1.006     | .950     | .925    | .033  | .971  | .075   |
| Income         | .000      | .000     | .15854  | <.001  | 1.000| 1.000  | 1.000     | 1.000    | 1.000   |     | 1.074 | .111   |
| Smoking        | .337      | .072     | 21.774  | <.001  | 1.401| 1.216  | 1.614     |          |         |       |       |        |
| Drinking       | .166      | .095     | .0307   | .081   | .118| .980   | .142      |          |         |       |       |        |
| Exercising     | −.613     | .077     | 63.331  | <.001  | .542| .466   | .630      |          |         |       |       |        |
| Ghana          |           |          |         |        |     | Female |           |          |         |        |     | Female |
| Female         | .284      | .119     | 5.655   | .017   | 1.328| 1.051  | 1.679     |          |         |       |       |        |
| Age            | .052      | .005     | 115.199 | <.001  | 1.053| 1.043  | 1.063     |          |         |       |       |        |
| Education      | −.188     | .056     | 11.171  | .001   | .829| .742   | .925      |          |         |       |       |        |
| Income         | .000      | .000     | .160    | .689   | 1.000| 1.000  | 1.000     |          |         |       |       |        |
| Smoking        | .236      | .135     | 3.037   | .081   | 1.266| .971   | .651      |          |         |       |       |        |
| Drinking       | .165      | .109     | 2.307   | .129   | .118| .953   | .460      |          |         |       |       |        |
| Exercising     | −.587     | .108     | 29.316  | <.001  | .556| .449   | .687      |          |         |       |       |        |
| South Africa   |           |          |         |        |     | Female |           |          |         |        |     | Female |
| Female         | .064      | .108     | .348    | .555   | 1.066| .863   | 1.316     |          |         |       |       |        |
| Age            | .025      | .005     | 22.845  | <.001  | 1.025| 1.015  | 1.035     |          |         |       |       |        |
| Education      | −.052     | .036     | 2.075   | .150   | .950| .885   | 1.019     |          |         |       |       |        |
| Income         | .000      | .000     | 2.049   | .152   | 1.000| 1.000  | 1.000     |          |         |       |       |        |
| Smoking        | .156      | .122     | 1.643   | .200   | 1.169| .921   | 1.484     |          |         |       |       |        |
| Drinking       | .219      | .131     | 2.816   | .093   | 1.245| .964   | 1.608     |          |         |       |       |        |
| Exercising     | −.665     | .179     | 13.800  | <.001  | .515| .362   | .731      |          |         |       |       |        |
| Russia         |           |          |         |        |     | Female |           |          |         |        |     | Female |
| Female         | .372      | .131     | 8.002   | .005   | 1.450| 1.121  | 1.876     |          |         |       |       |        |
| Age            | .070      | .005     | 175.456 | <.001  | 1.073| 1.062  | 1.084     |          |         |       |       |        |
| Education      | −.256     | .075     | 11.785  | .001   | .774| .669   | .896      |          |         |       |       |        |
| Income         | .000      | .000     | 14.406  | <.001  | 1.000| 1.000  | 1.000     |          |         |       |       |        |
| Smoking        | .417      | .140     | 8.907   | .003   | 1.518| 1.154  | 1.996     |          |         |       |       |        |
| Drinking       | −.146     | .111     | 1.725   | .189   | .864| .695   | 1.074     |          |         |       |       |        |
| Exercising     | −.746     | .118     | 40.223  | <.001  | .474| .377   | .597      |          |         |       |       |        |

Assari Journal of Diabetes & Metabolic Disorders 2014, 13:36
http://www.jdmdonline.com/content/13/1/36
Table 3 Socio-economics, behaviors and chronic conditions as predictors of poor subjective health among patients with diabetes in 15 countries (Continued)

| Country     | Female B  | S.E. | Wald  | Sig.  | Exp (B) | 95% C.I. for EXP (B) |
|-------------|-----------|------|-------|-------|---------|-----------------------|
|             |           |      |       |       |         | Lower       | Upper       |
| United States |          |      |       |       |         |            |            |
| Female      | .020      | .108 | .033  | .855  | 1.020   | .825       | 1.260       |
| Age         | .033      | .071 | .220  | .639  | 1.034   | .900       | 1.187       |
| Education   | -.273     | .124 | 4.809 | .028  | .761    | .596       | .971        |
| Income      | .000      | .000 | 12.312| .001  | 1.000   | 1.000      | 1.000       |
| Smoking     | .417      | .110 | 14.458| .001  | 1.517   | 1.224      | 1.881       |
| Drinking    | -.527     | .106 | 24.865| .001  | .590    | .480       | .726        |
| Exercising  | -1.086    | .212 | 26.201| .001  | .337    | .223       | .511        |
| Hypertension| .489      | .104 | 21.986| .001  | 1.630   | 1.329      | 1.999       |
| Lung Disease| .759      | .118 | 41.048| .001  | 2.135   | 1.693      | 2.693       |
| Heart Disease| 1.361    | .109 | 157.177| .001  | 3.902   | 3.154      | 4.827       |
| Stroke      | 1.035     | .195 | 28.045| .001  | 2.816   | 1.920      | 4.131       |
| Arthritis   | .685      | .104 | 43.091| .001  | 1.984   | 1.617      | 2.435       |
| Mexico      |          |      |       |       |         |            |            |
| Female      | -.201     | .107 | 3.517 | .061  | .818    | .663       | 1.009       |
| Age         | .013      | .005 | 6.592 | .010  | 1.013   | 1.003      | 1.024       |
| Education   | -.310     | .058 | 28.134| .001  | .734    | .654       | .823        |
| Income      | .000      | .000 | 15.857| .001  | 1.000   | 1.000      | 1.000       |
| Smoking     | .385      | .101 | 14.426| .001  | 1.469   | 1.205      | 1.792       |
| Drinking    | -.192     | .105 | 129.940| .001  | .303    | .247       | .373        |
| Exercising  | .587      | .106 | 30.569| .001  | 1.799   | 1.461      | 2.215       |
| Hypertension| .349      | .089 | 15.502| .001  | 1.418   | 1.192      | 1.687       |
| Lung Disease| .734      | .161 | 20.753| .001  | 2.083   | 1.519      | 2.857       |
| Heart Disease| .285     | .137 | 4.331 | .037  | 1.329   | 1.017      | 1.738       |
| Stroke      | .443      | .189 | 5.485 | .019  | 1.557   | 1.075      | 2.256       |
| Arthritis   | 1.018     | .111 | 84.795| .001  | 2.768   | 2.229      | 3.438       |
| Argentina   |          |      |       |       |         |            |            |
| Female      | .172      | .201 | .732  | .392  | 1.188   | .801       | 1.760       |
| Age         | -.024     | .012 | 4.206 | .040  | .976    | .954       | .999        |
| Education   | -.736     | .116 | 40.039| .001  | .479    | .381       | .602        |
| Income      | .000      | .000 | 2.969 | .085  | 1.000   | 1.000      | 1.000       |
| Smoking     | .446      | .187 | 5.701 | .017  | 1.562   | 1.083      | 2.251       |
| Drinking    | -.519     | .173 | 9.005 | .003  | .595    | .424       | .835        |
| Exercising  | -.394     | .259 | 2.302 | .129  | .675    | .406       | 1.122       |
| Hyper.      | .548      | .161 | 11.643| .001  | 1.729   | 1.263      | 2.369       |
| Lung Disease| 1.283     | .289 | 19.658| .001  | 3.607   | 2.046      | 6.358       |
| Heart Disease| .956     | .194 | 24.405| .001  | 2.603   | 1.781      | 3.804       |
| Stroke      | .428      | .383 | 1.248 | .264  | 1.534   | .724       | 3.248       |
| Arthritis   | .999      | .169 | 34.967| .001  | 2.716   | 1.950      | 3.782       |
| Barbados    |          |      |       |       |         |            |            |
| Female      | .021      | .161 | .016  | .898  | 1.021   | .744       | 1.400       |
| Age         | .032      | .008 | 15.068| .001  | 1.032   | 1.016      | 1.049       |


| Country | Diagnosis | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising | Smoking | Income | Exercising |
|---------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|---------|--------|-----------|
| Brazil  | Arthritis | .810    | .129   | .3923    | .001   | .2247  | .145    | .592    | .142   | .174     | .129   | .705   | .083    | .189   | .166    | .001   | .573   | .057    | .991   | .174    | .111    | .988   | .075    | .979   | .094   | .904    | .092    | .075    | .979   |
| Algeria | Arthritis | .555    | .087   | .4030    | .001   | .1567  | .086    | .393    | .099   | .223     | .106   | .530   | .083    | .163   | .068    | .001   | .419   | .068    | .792   | .075    | .979   | .094   | .904    | .092    | .075    | .979   |
| India   | Arthritis | .676    | .106   | .4033    | .001   | .1958  | .145    | .592    | .142   | .174     | .129   | .705   | .083    | .189   | .166    | .001   | .573   | .057    | .991   | .174    | .111    | .988   | .075    | .979   | .094   | .904    | .092    | .075    | .979   |
| Ghana   | Arthritis | .555    | .087   | .4030    | .001   | .1567  | .086    | .393    | .099   | .223     | .106   | .530   | .083    | .163   | .068    | .001   | .419   | .068    | .792   | .075    | .979   | .094   | .904    | .092    | .075    | .979   |

(Continued)
Argentina. In that study, high age was associated with poor subjective health in India, Ghana, South Africa and Russia. Age and subjective health were not significantly associated in other countries [44]. There are studies suggesting that there is an improvement in well-being as age increases among older individuals [55,56]. A study among patients with heart disease showed that patients older than 65 years had better health-related quality of life than those younger [45].

Based on Model I, low education was consistently associated with higher risk of poor subjective health among patients with diabetes. Based on a recent study among general populations, education was not associated with subjective health in the United States, Ghana or South Africa [44]. Among patients with chronic conditions, education was not associated with subjective health in the United States, Mexico, Barbados, Brazil, Uruguay, Ghana, South Africa, or Russia. [45] The effect of education on health and well-being might be due to income or marital status [57]. Other reasons that highly educated people may stay healthier include social support and health protective behaviors [57].

Based on our study, in nine countries, income had an effect on subjective health of patients with diabetes, above and beyond the effect of education and other socio-economic factors. In Argentina, Chile, Cuba, Uruguay, Ghana, and South Africa, income did not have an effect on subjective health of patients with diabetes while the effect of education was controlled. Similar results were reported on the residual effect of income after controlling education in nine of 15 countries by a study that included a general population [44]. Among patients with at least one chronic medical condition, income was not predictive of poor subjective health in Argentina, Chile, Cuba, India, Ghana, or South Africa [45]. In India, the effect of income on subjective health of patients with chronic medical conditions was larger among women than men [45]. In Iran, among patients with chronic heart disease, the effect of income on well-being was larger for women than men [50]. These findings suggest that the links between country, gender, education, income and well-being are very complex.

A recent study suggested that the complex interplay between socio-economic status, chronic conditions and subjective health varies from setting to setting. In the United States, chronic conditions may explain the effect of marital status on health, while in Puerto Rico, the effect of income on subjective health was attributed to chronic conditions. In Costa Rica, Argentina, Barbados, Cuba, and Uruguay, chronic conditions explained gender disparities in subjective health. In China, Mexico, Brazil, Russia, Chile, India, Ghana and South Africa, the effect of socio-economic status was not due to chronic conditions [44].

Based on our study, comorbid heart disease was consistently predictive of poor subjective health among patients with diabetes. The effects of other chronic conditions on subjective health, however, were moderated by country. A study among 21,133 individuals on the association between number of chronic somatic conditions and quality of life showed an association between presence of a chronic condition and lower well-being across all domains of subjective health including physical function, fatigue, pain, emotional distress, and social function. Presence of two or more conditions was associated with larger decrements in quality of life, compared to a single condition [58]. Another large study among adults showed that after adjustments for socio-economic status and health behaviors (i.e.

Table 3 Socio-economics, behaviors and chronic conditions as predictors of poor subjective health among patients with diabetes in 15 countries (Continued)

|                      | Lung Disease | Heart Disease | Stroke | Arthritis |
|----------------------|--------------|---------------|--------|-----------|
| South Africa         |              |               |        |           |
| Female               | .045         | .116          | .151   | .698      |
| Age                  | .023         | .006          | 16.941 | <.001     |
| Education            | −.054        | .038          | 2.024  | .155      |
| Income               | .000         | .000          | 1.156  | .282      |
| Smoking              | .068         | .130          | .273   | .601      |
| Drinking             | .299         | .140          | 4.564  | .033      |
| Exercising           | −.663        | .192          | 11.969 | .001      |
| Hypertension         | .028         | .118          | .057   | .812      |
| Lung Disease         | 1.205        | .267          | 20.325 | <.001     |
| Heart Disease        | .706         | .162          | 18.995 | <.001     |
| Stroke               | 1.279        | .236          | 29.486 | <.001     |
| Arthritis            | .738         | .120          | 37.630 | <.001     |

Russia

|                      | Lung Disease | Heart Disease | Stroke | Arthritis |
|----------------------|--------------|---------------|--------|-----------|
| Female               | .331         | .159          | 4.314  | .038      |
| Age                  | .050         | .006          | 60.756 | <.001     |
| Education            | −.277        | .088          | 10.041 | .002      |
| Income               | .000         | .000          | 16.812 | <.001     |
| Smoking              | .509         | .169          | 9.072  | .003      |
| Drinking             | −.306        | .132          | 5.355  | .021      |
| Exercising           | −.670        | .138          | 23.611 | <.001     |
| Hypertension         | .296         | .128          | 5.345  | .021      |
| Lung Disease         | .376         | .137          | 7.508  | .006      |
| Heart Disease        | 1.140        | .119          | 91.247 | <.001     |
| Stroke               | .846         | .206          | 16.849 | <.001     |
| Arthritis            | .690         | .114          | 36.867 | <.001     |
smoking, alcohol consumption, and physical activity), people with 3 or more chronic medical conditions were more likely to report poor general health, mental distress, physical distress, and activity limitations compared to individuals who had one or two chronic conditions [59,60].

Our study may have important implications for global public health policy and practice. As countries show different sets of determinants of subjective health among individuals, we suggest that country should be considered as the context that shapes social and behavioral determinants of health. Comorbid heart disease, however, has a consistent effect and should be universally diagnosed and treated among patients with diabetes. Thus, we do not recommend universal programs for health promotion of patients with diabetes across countries. Based on our findings, tailored health promotion programs should be designed specific to each country.

Universal programs focusing on comorbid heart disease among patients with diabetes may be important. In addition, our results suggested clusters of countries with similar patterns of social and behavioral determinants of health. Patients in such countries may benefit from similar health promotion interventions. Our findings discourage policy makers and public health practitioners from implementing universal programs that assume social and behavioral determinants of well-being are the same across different settings. Our results may also explain why the same programs may have different effects on well-being of patients with diabetes across countries. Locally designed interventions may be superior to such rigid programs.

Limitations
The current study had several limitations. Due to the cross sectional design, causative associations are not plausible from this study. In addition, cross-country differences in the validity of self-report of subjective health and chronic conditions cannot be ruled out. The study did not measure glucose control, type of diabetes, or mental health as other factors associated with subjective health of participants with diabetes. The study also ignores duration or complications of diabetes.

Conclusion
Our study revealed major cross-country differences in social and behavioral determinants of well-being among patients with diabetes. Only comorbid heart disease was consistently associated with poor subjective health across all countries. The findings advocate for design and implementation of country-specific health promotion programs for patients with diabetes. Further research is needed on causes and consequences of cross-country variations in social and behavioral determinants of well-being among patients with chronic conditions.

Competing interests
The author declares that he has no competing interests.

Acknowledgment
Research on Early Life and Aging Trends and Effects (RELATE): A Cross-National Study (ICPSR 34241) was conducted by Mary McEniry, who serves as a Research Affiliate at the University of Michigan’s Population Studies Center and as the Director of the DSDR project at ICPSR. The RELATE study compiles several cross-national surveys.

Received: 15 October 2013 Accepted: 6 January 2014 Published: 21 February 2014

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