Happy and in control: Links between measures of perceived control, happiness, and blood pressure in the Study on global AGEing and adult health (SAGE)

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Elevated blood pressure (BP) is a leading risk factor for cardiovascular disease (CVD) and accounted for an estimated 12.8% of all global deaths in 2008 (WHO, 2011). The burden of hypertension-related disease is greatest among low- and middle-income countries, with the risk of hypertension (systolic BP ≥140mmHg and/or diastolic BP ≥90mmHg) for CVD increasing with age (Lawes et al., 2008; Basu and Millett, 2013). Older adults comprise a growing portion of the national population in virtually every country (Mathers et al., 2015; Prince et al., 2015), and overall global deaths from cardiovascular disease are expected to rise from 16.7 million in 2002 to 23.3 million in 2030 (Mathers and Loncar, 2006). Therefore, understanding factors associated with elevated BP among older adults in low- and middle-income countries is important for improving global health.

One of the various factors that contributes to elevated BP is chronic psychosocial stress (Ice and James, 2007); yet, the relationship between stress and health is complex, and its intricacies vary across cultures and populations (Dressler and Bindon, 2000; Ice and Yogo, 2005). Subjective well-being (SWB) likely plays a key role in the relationship between stress and BP. SWB is defined here as an individual's emotions, moods, and self-evaluation of life satisfaction and fulfillment (Diener et al., 2003) and is typically measured by scaled responses to questions asked by interviewers conducting surveys (Oswald and Wu, 2010). For instance, Ostir et al. (2006) found positive emotions to be inversely associated with both systolic blood pressure (SBP) and diastolic blood pressure (DBP) among 2,564 Mexican American older adults, and Steptoe et al. (2005) found that happier middle-aged adults in London (N=216) had lower heart rates than less happy

middle-aged adults. SWB has also been shown to predict disability and mortality among older adults; however, studies examining SWB in relation to specific health conditions in older populations are limited (George, 2010). Thus, a concerted effort to investigate SWB in relation to specific measures of CVD risk, including hypertension, among older adults in low- and middle-income countries is necessary to inform policies designed to improve the quality of life of aging populations in these contexts.

Happiness, defined here as an individual's overall self-evaluation of their whole life (Veenhoven, 2008), is typically measured from a single survey question and is useful for examining associations between SWB and health. Happiness has been linked with better physical and mental health (Lyubomirsky et al., 2005) as well as longevity (Veenhoven, 2008), but a relatively small number of studies have explicitly investigated relationships between happiness and CVD risk. For example, James et al. (1986) documented an inverse relationship between SBP and happiness arousal states (i.e. participants reported their emotional arousal intensity on a happiness scale) among 90 patients of a hypertension center in New York, and more recent research has demonstrated that wealthy countries, such as Denmark and Sweden, reporting greater happiness have lower levels of hypertension (Blanchflower and Oswald, 2008). However, most studies investigating relationships between happiness and BP are conducted in Western settings (Selin and Davey, 2012). Examining cross-cultural differences in associations between happiness and BP is thus a crucial step towards understanding the role of SWB in the relationship between chronic psychosocial stress and CVD risk.

Along with happiness, investigating additional factors that contribute to SWB such as perceived ability to cope and perceived control is integral to discerning how

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stress impacts cardiovascular health among older populations. For instance, locus of control (i.e. an individual's sense of internal versus external control over their life) was inversely associated with BP and appeared to serve a mediating role between SWB and BP (Steptoe and Willemsen, 2004; Blanchflower and Oswald, 2008). This evidence suggests that people who feel greater control over life events have better cardiovascular health; however, empirically-supported cultural differences in the relationship between locus of control and SWB may further influence BP (Stocks et al., 2012). Previous research has further demonstrated that an individual's physiological response to psychosocial stressors is mediated by behavioral responses or coping, and this mediating role has been documented between psychosocial stress and BP (Lindquist et al., 1997). Examining cross-cultural measures of perceived control and perceived ability to cope in relation to BP is key to further elucidating this relationship.

Actual income is another factor that contributes to SWB (George, 2010), and previous research has documented associations among socioeconomic status (SES), psychosocial stress, and CVD risk (Steptoe and Marmot, 2002). Recent research by Pereira and Coelho (2013) demonstrated that, among 66,070 participants of the European Social Survey, perceived income adequacy mediated the relationship between actual income and SWB. Further, in a study of 14,172 Korean adults, Kim et al. (2014) found that as individuals' actual income and education levels increased, while their perceived SES decreased, their likelihood of having depressive symptoms increased. Among older adults, major life changes associated with aging can drastically alter economic circumstance. The experience of this transition varies both within and between populations, and Chan et al. (2002) demonstrated that changes in perceived income

adequacy after retirement differed significantly between older adults in Singapore and Taiwan. Therefore, further research is needed that explicitly tests for associations between perceived income adequacy and cardiovascular health among older adults in non-Western settings.

Previous research has demonstrated that SWB has a bidirectional relationship with cardiovascular health, such that poor cardiovascular health contributes to decreased SWB and that lower SWB can also contribute to greater CVD risk (Steptoe et al. 2014); yet, little is known about the patterning of this relationship among older populations in low- and middle-income countries. Moreover, few studies have examined SWB in relation to CVD risk among older adults in non-Western settings, and parsing the differences between these measures is key to informing the incorporation of SWB metrics into global health research. To address these research gaps, the current study aims to examine associations between four measures of SWB and CVD risk, as well as variation in mean BP by sex and country, using data gathered from nationally-representative samples of older adults ($\geq$50 years old) in China, Ghana, India, Mexico, Russian Federation, and South Africa as part of the Study on global AGEing and adult health (SAGE). Specifically, this study uses SAGE's unique dataset to test the following hypotheses:

> H_1: Happiness will be negatively associated with SBP and DBP.
>
> H_2: Perceived ability to cope and perceived control will be inversely associated with SBP and DBP.
>
> H_3: Perceived income adequacy will be inversely associated with SBP and DBP.

Methods

SAGE and Study Participants

The World Health Organization's Study on global AGEing and adult health (SAGE; www.who.int/healthinfo/sage) is a multi-country project designed to gather information on the health of adult populations and the aging process from nationally representative samples in China, Ghana, India, Mexico, Russian Federation, and South Africa (Kowal et al., 2012). Data for the present study were collected between 2007 and 2010 from consenting adults using face-to-face interviews. The present study included a sample of 35,325 participants (≥50 years old) (16,180 men; 19,145 women). 2,368 men and 2,727 women were not included in the regression analyses due to the exclusion of physical activity, waist circumference, and BP outliers, as well as missing data.

Blood Pressure

Both systolic BP (SBP) and diastolic BP (DBP) were measured during the interview using a Boso Medistar Wrist Blood Pressure Monitor Model S (Jungingen, Germany). A series of three measures were taken and then averaged; the mean of the three SBP and DBP measures were used in this study.

Happiness

Using the following question, participants were asked about their general level of happiness at their current point in life: "Taking all things together, how would you say you are these days?" Participants then reported their happiness level on a five-point scale

(1="very unhappy"; 2="unhappy"; 3="neither unhappy or happy"; 4="happy"; and 5="very happy").

Ability to Cope and Perceived Control

During the interview, participants were also asked: "How often have you found that you could not cope with all the things that you had to do?" Participants were then provided with a range of response choices on a five-point scale (1="always able to cope"; 2="almost always able to cope"; 3="sometimes unable to cope"; 4="fairly often unable to cope"; and 5="very often unable to cope"). Participants were also asked: "How often have you felt that you were unable to control the important things in your life?" Similarly, participants were provided with five response choices (1="always able to control"; 2="almost always able to control"; 3="sometimes unable to control"; 4="fairly often unable to control"; and 5="very often unable to control").

Income Adequacy

Additionally, participants were asked: "Do you have enough money to meet your needs?" and were then given the choice of five responses denoting their income adequacy (1="not at all adequate"; 2="somewhat"; 3="moderately adequate"; 4="mostly adequate"; and 5="completely adequate").

Control Variables

The analyses outlined below controlled for the effects of waist circumference (proxy measure of body composition), physical activity, smoking, alcohol consumption, and hypertension diagnosis based on measured BP.

Waist circumference was measured using a standardized procedure. Using interview questions based on the Global Physical Activity Questionnaire (GPAQ), self-report physical activity level (hours/day) was calculated by averaging self-reported time spent in vigorous and moderate activity per day for both work and leisure. During the interview, participants were asked if they smoke "daily," "not daily," or "not at all/never" and if they consumed alcohol "not at all," "less than once a month," "one to three days per month," "one to four days per week," or "five days per week." Participants were also asked if they have ever been diagnosed with hypertension.

Statistical Analysis

Individuals with outlying SBP and DBP values (± 3 SD) as well as individuals with age, sex, and country-specific physical activity and waist circumference outliers were excluded from the analyses. Samples from the six SAGE countries, excluding outliers, included: 12,466 (5,793 men; 6,673 women) from China; 4,164 (2,163 men; 2,001 women) from Ghana; 6,425 (3,229 men; 3,196 women) from India; 2,132 (834 men; 1,298 women) from Mexico; 3,787 (1,340 men; 2,447 women) from Russian Federation; and 3,579 (1,520 men; 2,059 women) from South Africa. Descriptive statistics for SBP and DBP were calculated by sex and country. Multiple regressions were used to estimate the effect of the coping, control, happiness, and income adequacy variables on variation in SBP and DBP, while controlling for body composition, physical

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activity, smoking, alcohol consumption, and hypertension diagnosis. All analyses were conducted separately by country and sex, and results were considered statistically significant at $P<0.05$. Analyses were performed using SPSS 21.0.

Results

Mean Blood Pressure by Sex and Country

Average SBP and DBP for men and women in the six SAGE countries are reported in **Table 1**. Among men, mean SBP ranged from 123.3mmHg in India to 147.2mmHg in Mexico, and mean DBP ranged from 80.3mmHg in Mexico to 95.2mmHg in South Africa. Among women, SBP ranged from 125.7mmHg in India to 147.7mmHg in Mexico, and DBP ranged from 79.0mmHg in Mexico to 95.3mmHg in South Africa.

Happiness and Blood Pressure

Multiple regressions were performed by sex to test if higher happiness levels predict a greater likelihood of having lower SBP and DBP compared to the reference group of "very unhappy" across the six SAGE countries, while controlling for the effects of waist circumference, physical activity level, smoking, alcohol consumption, and hypertension diagnosis on SBP and DBP. As expected, Russian women who reported being "happy" had lower SBP than Russian women who reported being "very unhappy" ($P=0.013$). However, for every unit increase in happiness, Mexican women and South African men have significantly greater SBP. That is, Mexican women who report being "unhappy" ($P=0.008$), "neither unhappy or happy" ($P=0.004$), "happy" ($P=0.005$), and "very happy" ($P=0.002$) all have higher SBP than those who are "very unhappy."

Similarly, South African men who report being "unhappy" ($P=0.007$), "neither unhappy or happy" ($P=0.014$), "happy" ($P=0.005$), and "very happy" ($P=0.017$) all have higher SBP than those who are "very unhappy." Among Ghanaian women, those who report being "unhappy" ($P=0.004$), "happy" ($P=0.046$), and "very happy" ($P<0.001$) have higher SBP compared to those who are "very unhappy," and those who report being "unhappy" ($P=0.001$), "neither unhappy or happy" ($P=0.032$), "happy" ($P=0.013$), and "very happy" ($P<0.001$) have higher DBP compared to Ghanaian women who are "very unhappy."

Ability to Cope, Perceived Control, and Blood Pressure

Multiple regressions conducted by sex were performed to test if a decreased ability to cope and a lower level of perceived control predicts a greater likelihood of having increased SBP and DBP compared to the reference groups of "always able to cope" and "always able to control" across the six SAGE countries. These regression models also controlled for the effects of waist circumference, physical activity level, smoking, alcohol consumption, and hypertension diagnosis on SBP and DBP. Among Ghanaian men, those who "very often felt unable to cope" had greater SBP than those who felt "always able to cope" ($P=0.002$), and those who are "almost always able to cope" ($P=0.046$), "sometimes unable to cope" ($P=0.039$), and "fairly often unable to cope" ($P<0.001$) have higher DBP than those who are "always able to cope." Further, Indian women who feel that they are "very often unable to cope" have higher SBP than those who feel that they are "always able to cope" ($P=0.029$), and both Chinese men ($P=0.003$) and women ($P=0.007$) who feel that they are "almost always able to cope" have higher

SBP than those who are "always able to cope." Interestingly, Russian women who are "fairly often unable to cope" have higher SBP than those who are "always able to cope" (P=0.034) as predicted, but those who feel that they are "almost always able to cope" have lower DBP than those who are "always able to cope" (P=0.028).

Among Chinese men and women, SBP significantly increases for every unit decrease in perceived control except for those who report that they very often do not feel in control of the important things in their lives. That is, Chinese men who feel they "almost always have control" (P=0.003), are "sometimes unable to control" (P=0.043), and are "fairly often unable to control" (P=0.009) have greater SBP than those who are "always able to control," and Chinese women who feel they "almost always have control" (P=0.007), are "sometimes unable to control" (P=0.025), and are "fairly often unable to control" (P=0.041) also have greater SBP than those who are always in control. Ghanaian men show a similar pattern, whereby those who "almost always have control" (P=0.026), are "sometimes unable to control" (P=0.013), and are "very often unable to control" (P=0.001) have higher DBP than Ghanaian men who always feel in control.

Income Adequacy and Blood Pressure

To test if a higher level of perceived income adequacy predicts a greater likelihood of having higher SBP and DBP when compared to the reference group "not at all adequate" across the six SAGE countries, multiple regressions were conducted by sex that controlled for the effects of waist circumference, physical activity level, smoking, alcohol consumption, and hypertension diagnosis on the two measures of BP. As predicted, both Indian men and women have lower SBP for every unit increase in income

adequacy. That is, Indian men whose income is "somewhat adequate" (P=0.033), "moderately adequate" (P=0.003), "mostly adequate" (P=0.001), and "completely adequate" (P=0.013) have lower SBP than those whose income is "not at all adequate," and Indian women whose income is "somewhat adequate" (P=0.002), "moderately adequate" (P<0.001), "mostly adequate" (P=0.005), and "completely adequate" (P=0.010) also have lower SBP than those whose income is "not at all adequate." This predicted association was found among Russian men as well. That is, Russian men whose income is "mostly adequate" (P=0.001) and "completely adequate" (P=0.017) have lower SBP than Russian men whose income is "not at all adequate." However, this pattern was not found for men and women across all six countries. Unexpectedly, Ghanaian men whose income is "moderately adequate" had higher SBP (P=0.031) and DBP (P=0.023) than those whose income is "not at all adequate," and Mexican men whose income is "mostly adequate" showed a trend towards having greater SBP than those whose income is "not at all adequate" (P=0.059). Regression coefficients for every unit increase in income adequacy for men and women in China, Ghana, India, Mexico, Russian Federation, and South Africa are reported in **Figures 1-6**.

Discussion

Using SAGE's unique dataset, this study documented substantial variation in the patterning of relationships between measures of well-being and blood pressure among older adults in six low- and middle-income countries. As expected, greater perceived ability to cope and greater perceived control are associated with lower SBP and DBP among Ghanaian men, Indian women, Chinese men, and Chinese women. While Russian

women perceiving a greater coping ability also have lower SBP, they unexpectedly have higher DBP. In terms of happiness, Russian women are the only group to have significantly lower SBP with greater happiness. Mexican women and South African men have higher SBP with increasing happiness, and Ghanaian women have higher SBP and DBP with increasing happiness. Mixed results were also found for links between income adequacy and BP. For instance, Indian men and women have lower SBP for every unit increase in income adequacy, and Russian men who perceive their income to be more adequate also have lower SBP. However, Ghanaian men who report their income to be "moderately adequate" as opposed to "not at all adequate" have both higher SBP and DBP.

Perceptions of life control and ability to cope are key components of the relationship between psychosocial stress and health, with a greater internal locus of control and ability to cope helping to mediate the impacts of stress on health (Ice and James, 2012). The current study provides further evidence for this relationship, but additional research is needed to test whether or not coping ability and perceived control are actually mediating stress and BP rather than directly associated with BP.

Unexpected associations were found between happiness and BP. One potential explanation for the inverse relationships between happiness and BP is that wealth and lifestyle variables not accounted for in this analysis may have confounding effects. That is, happier individuals may be comparatively wealthy and living a more Westernized lifestyle, especially in low- and middle-income countries. While this lifestyle may provide a greater sense of happiness, it may also entail a high stress occupation and unhealthy diet (e.g. high in salt and refined sugars) that contributes to increased BP.

Since these findings are also contrary to previous research conducted among wealthy countries (Blanchflower and Oswald, 2008), they demonstrate the importance of this type of cross-cultural, population-level research on happiness, and documenting such associations is the first step toward understanding the specific factors that explain relationships between BP and happiness. For example, happiness is difficult to quantify, but it can also take on a variety of meanings when translated and operationalized in different cultural settings (Wierzbicka, 2004). How people report happiness may be affected by cultural factors as well, which is distinct from differing ways of experiencing and making sense of happiness. These measurement issues can be particularly challenging in multi-country studies; therefore, further examination and validation of the methods used in happiness studies is paramount to the future of SWB and quality of life research.

Relationships between perceived income adequacy and BP were found to vary greatly across the six countries. One possible explanation for the diversity of associations is that older adults are often in a period of income transition (e.g. entering retirement), and this experience can differ greatly by country (Chan et al., 2002). In some instances, income transition may mean greater financial security than an individual was previously ensured, while in others leaving the work force may result in economic hardship. Either way, older adults face a unique period of income transition wherein their perceptions of income adequacy are in flux, which may result in the greater variability in the link between perceived income adequacy and BP found in the current study. Notably, among men and women in Mexico and among men in Ghana, there is a mixed relationship between perceived income adequacy and SBP. That is, those reporting their income as "a

little adequate" and "completely adequate" have lower SBP compared to those reporting their income as "not at all adequate," while those in the middle two groups ("moderately adequate" and "mostly adequate") have higher SBP compared to those in the "not at all adequate" group. These results indicate that among older adults in Mexico and among older Ghanaian men, being classified as middle-income may be more stressful than being classified as low- or high-income. This type of stress may be due to a sense of economic mobility, meaning that individuals who perceive themselves to be middle-income are either eager to transition into a higher income group or fearful of losing income. More research is needed to further elucidate these relationships in low- and middle-income countries.

The present study demonstrates the utility of SAGE's nationally representative multi-country dataset in documenting cross-cultural variation in the patterns of associations between measures of SWB and cardiovascular health; however, there are some limitations to this study. First, understandings of individual measures of SWB such as happiness can differ greatly both within and between populations, and this variation greatly limits the ability to draw conclusions from research employing such metrics. Second, the current study would further benefit from the incorporation of more socioeconomic variables. For instance, Kim et al.'s (2014) findings among Korean adults indicate that a measure of overall wealth may impact associations between perceived income adequacy and health measures. Future SAGE studies will test for mediation relationships among wealth, perceived income adequacy, and health. Finally, due to the large sample size of the current study (N=35,325), some of predictor variables may have a statistically significant effect in the regression models while not necessarily having a

biologically significant effect on the measures of BP. Despite these limitations, this study contributes to an understanding of the links between SWB and BP among older adults in China, Ghana, India, Mexico, Russian Federation, and South Africa and identifies key areas for future investigation of SWB in relation to health in low- and middle-income countries.

Conclusion

The present study utilized nationally representative data gathered from older adults in six low- and middle-income countries (China, Ghana, India, Mexico, Russian Federation, and South Africa) as part of the World Health Organization's Study on global AGEing and adult health (SAGE) in order to examine associations among happiness, perceived ability to cope, perceived control, perceived income adequacy, and BP. Substantial variation in the patterning of these associations across the six countries was documented, including unexpected links between happiness and BP as well as between perceived income adequacy and BP. This study thus contributes to a more nuanced understanding of the links between SWB and health among older adults across cultures.

Acknowledgements

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Table 1. Mean SBP and DBP by sex and country.

		Men			Women	
		SBP	DBP		SBP	DBP
Country	N	Mean (SD)	Mean (SD)	N	Mean (SD)	Mean (SD)
China	5,793	141.82 (21.91)	85.17 (12.90)	6,673	142.36 (23.76)	84.11 (12.61)
Ghana	2,163	134.48 (22.78)	89.65 (15.61)	2,001	140.22 (25.15)	90.98 (14.94)
India	3,229	123.31 (19.80)	80.76 (13.79)	3,196	125.68 (20.63)	82.27 (12.53)
Mexico	834	147.19 (24.25)	80.30 (11.61)	1,298	147.71 (25.42)	79.01 (11.67)
Russia	1,340	140.11 (19.68)	86.79 (11.68)	2,447	143.76 (21.19)	87.88 (12.31)
South Africa	1,520	143.79 (24.44)	95.24 (15.69)	2,059	145.99 (24.02)	95.31 (15.10)

Figure 1. Regression coefficients for every unit increase in income adequacy compared to "not at all adequate" among Chinese men and women.[a]
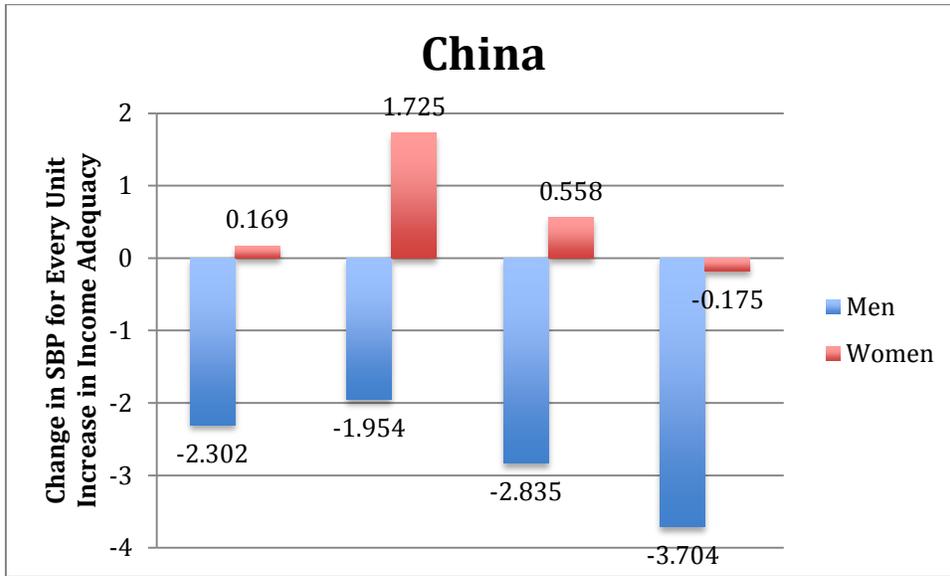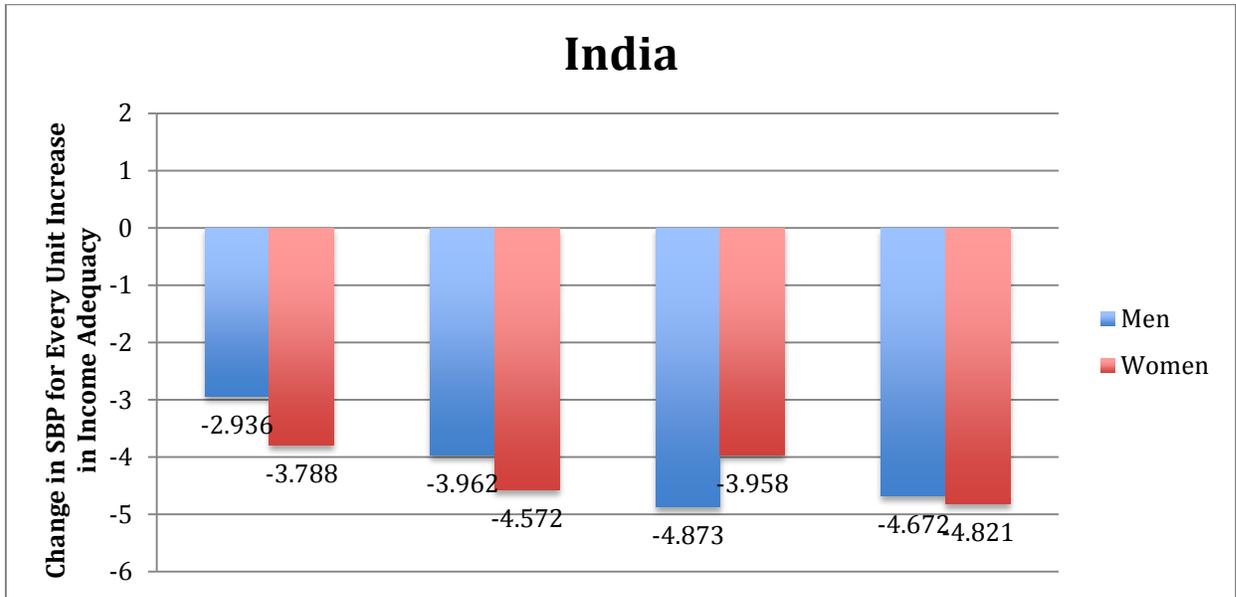

[a]Columns from left to right: "a little adequate," "moderately adequate," "mostly adequate," "completely adequate."

Figure 2. Regression coefficients for every unit increase in income adequacy compared to "not at all adequate" among Ghanaian men and women.[a]
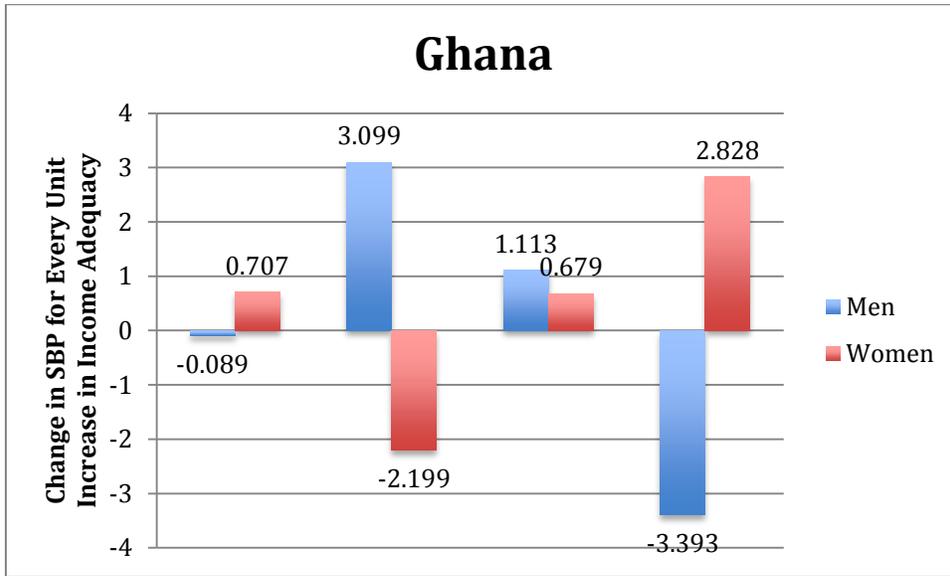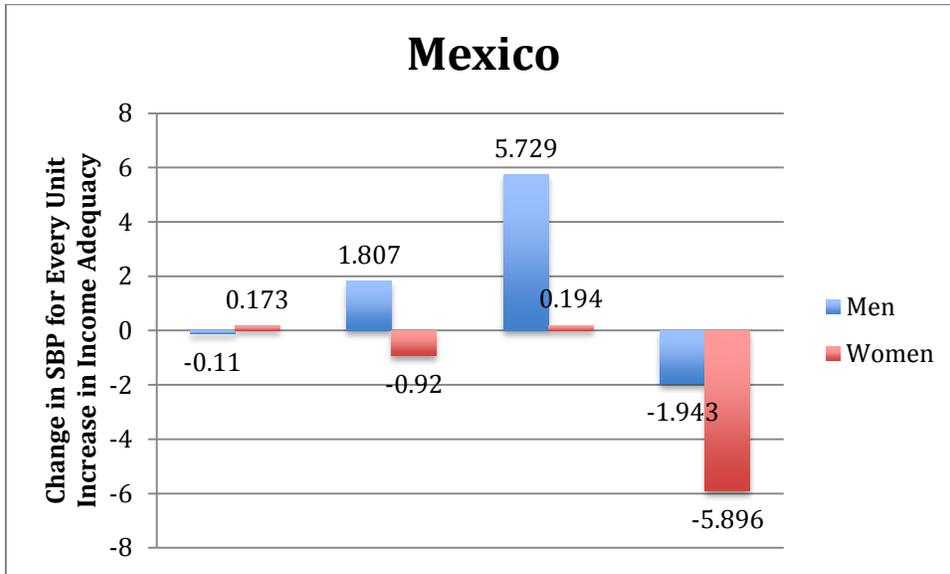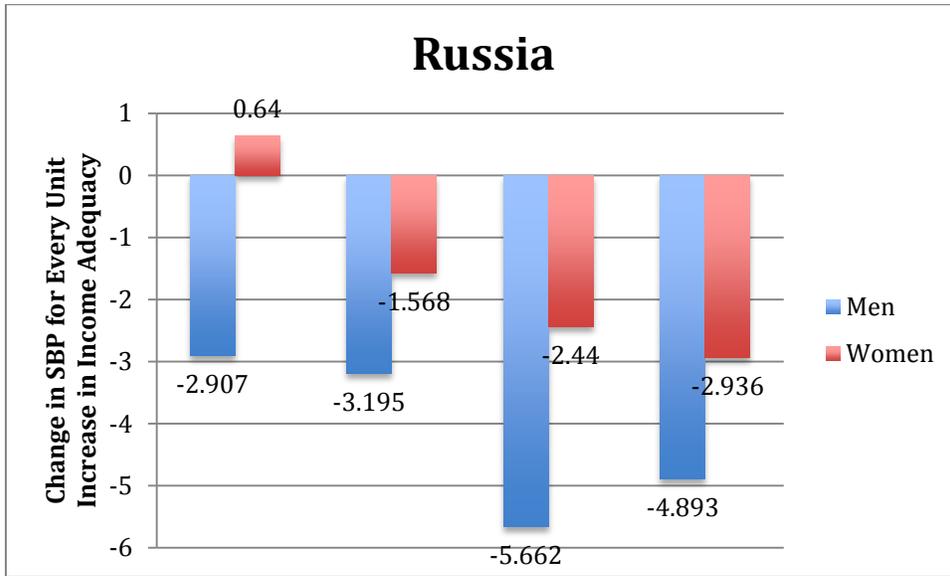

[a]Columns from left to right: "a little adequate," "moderately adequate," "mostly adequate," "completely adequate."

Figure 3. Regression coefficients for every unit increase in income adequacy compared to "not at all adequate" among Indian men and women.[a]

[a]Columns from left to right: "a little adequate," "moderately adequate," "mostly adequate," "completely adequate."

Figure 4. Regression coefficients for every unit increase in income adequacy compared to "not at all adequate" among Mexican men and women.[a]
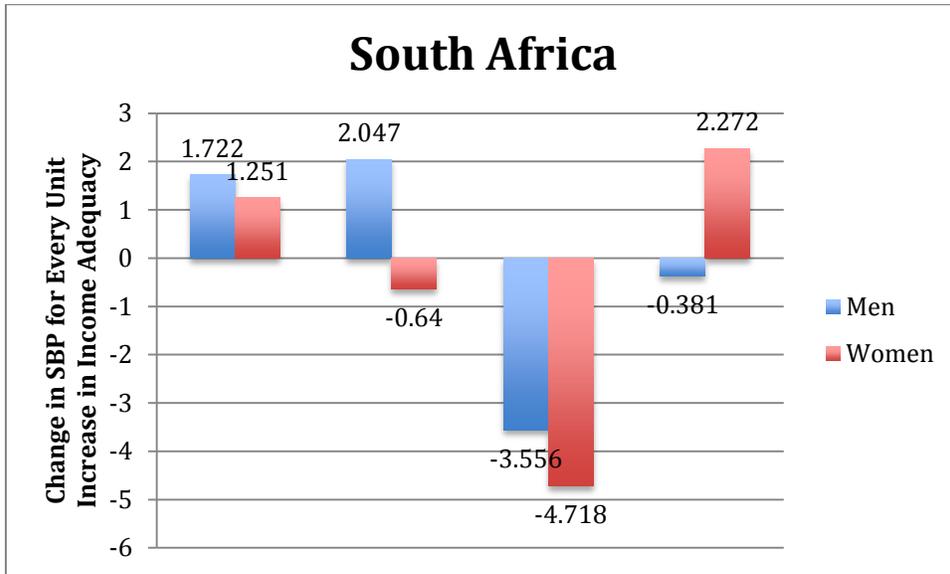

[a]Columns from left to right: "a little adequate," "moderately adequate," "mostly adequate," "completely adequate."

Figure 5. Regression coefficients for every unit increase in income adequacy compared to "not at all adequate" among Russian men and women.[a]

[a]Columns from left to right: "a little adequate," "moderately adequate," "mostly adequate," "completely adequate."

Figure 6. Regression coefficients for every unit increase in income adequacy compared to "not at all adequate" among South African men and women.[a]

[a]Columns from left to right: "a little adequate," "moderately adequate," "mostly adequate," "completely adequate."