

Cognitive and Socio-emotional Correlates of Psychological Well-being and Mental Health in Guatemalan Adults

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Abstract

Background: Little is known about associations of psychological and mental well-being with cognitive and socioemotional factors in low and middle-income countries, particularly among vulnerable populations born in adverse environments that may restrict developmental potential.

This study aimed to examine the cognitive and socioemotional correlates of psychological well-being and mental health in a cohort of Guatemalan adults born in contexts of adversity.

Methods: From Dec 2017 to Apr 2019, data were collected from 704 women and 564 men ages 40-57 y living in four rural villages in eastern Guatemala and Guatemala City. We measured latent domains of psychological well-being, spirituality and religion, emotional support, and executive function using Confirmatory Factor Analysis (CFA). Under a Structural Equation Modeling framework, we examined intercorrelations among latent domains and observed measures of intelligence and mental health.

Results: CFA supported the construct validity of factor structures in this population. Correlations of psychological well-being with spirituality and religion were moderate in women ($r=0.68$, $p<0.001$) and strong in men ($r=0.70$, $p<0.001$). Executive function was weakly correlated with psychological well-being in men ($r=0.23$, $p<0.001$) and showed no association in women. Correlations of psychological well-being with emotional support and IQ were weak in women ($r=0.34$, and $r=0.15$, respectively; $p<0.001$ for both) and men ($r=0.35$, and $r=0.25$, respectively; $p<0.001$ for both). Mental health and IQ were weakly correlated in men ($r=0.09$, $p<0.05$) and showed no association in women. Mental health showed weak correlations with emotional support ($r=0.18$, $p<0.001$ in women; $r=0.09$, $p<0.05$ in men), psychological well-being ($r=0.32$ and $r=0.35$, in women and men respectively; $p<0.001$ for both) and showed no association with executive function in both sexes.

Conclusions: Our findings lay the foundation for advancing the understanding of factors that could contribute to strengthening psychological well-being and mental health in populations living in contexts of adversity. The extent to which spiritual and religious involvement may promote higher levels of psychological well-being merits further investigation.

1. Background

Psychological well-being is a multidimensional construct that refers to optimal psychological functioning and experience (1). The use of subjective well-being as the overall measure of prosperity has gained prominence over the last few years, moving away from traditional macro-economic indicators like GDP (2). Much evidence suggests that the skills that contribute to achieving psychological well-being rely on higher-order cognitive processes of general intelligence and executive function. General intelligence, usually measured using intelligence quotient (IQ) tests, is the ability to acquire knowledge and use it in novel ways (3). Executive function refers to the cognitive process responsible for controlling and regulating thoughts, emotions, and behaviors in pursuit of personal goals (4). The positive association of IQ and executive function with psychological, social, and mental health outcomes are well documented:

studies have consistently shown that higher IQ predicts better income (5), decreased vulnerability to mental illness, (6) and reduced criminal and delinquent involvement (7, 8).

Similarly, higher self-control (one aspect of inhibitory control) has been associated with protective health-related behaviors and feelings of happiness and life satisfaction (9–11). Moreover, childhood self-control predicts better physical health, higher income, lower substance abuse, and criminal offending outcomes (12, 13). Executive function has also been linked to mental health outcomes (14), with studies suggesting that it serves as an important cognitive resource, involved in the ability to cope with stressful events and regulate mood and thoughts (15).

A substantial body of research has examined the influence of coping resources (i.e., social support, religion, and spirituality) on promoting psychological well-being and mental health. Social support has been positively linked with subjective well-being and mental health, with some mixed evidence indicating that these associations vary across gender and life stage (16, 17). Similarly, studies have found that people with strong spiritual or religious faith report higher levels of happiness, life satisfaction, have fewer psychosocial consequences of traumatic life events (18, 19), lower levels of depression and substance abuse (20), adapt better to stressful life events (21), and have higher levels of social support (22).

While much about the association of well-being and mental health with cognitive and socioemotional factors has been investigated, most studies have been conducted in developed countries and populations experiencing psychiatric and medical conditions or among the elderly. Very little research has been conducted in low and middle-income countries (LMICs), particularly among populations born in resource-limited environments that may restrict developmental potential. It is well established that childhood adversities leave long-lasting imprints on the neural mechanisms of cognition and emotion (23, 24). Thus, it is important to examine the factors that could influence psychological well-being and mental health in these populations. This information could provide valuable data to inform the future development of targeted intervention programs.

The objective of this study was to examine the cognitive and socioemotional correlates of psychological well-being and mental health in a cohort of Guatemalan adults who were born into resource-limited environments.

2. Methods

2.1 Study population and setting

The population in our study had participated in a community-randomized food supplementation trial in early childhood. The intervention was implemented between 1969–1977 by the Institute of Nutrition of Central America and Panama (INCAP) in 4 rural communities in eastern Guatemala (n = 2392). At the time of the intervention, child undernutrition and infectious diseases were endemic in the study villages, and most adults were illiterate (25). The nutritional trial was designed to assess the impact of improved

nutrition on child growth and cognitive development. Complete details of the original trial and subsequent follow-up studies are published elsewhere (26, 27).

2.2 Training and data collection

This paper utilizes data collected from Dec 2017 to Apr 2019 in 1268 participants, with a mean age of 47 years. In the 2017-19 follow-up, out of the 1643 cohort members presumed alive and living in Guatemala (68.7% of the original cohort), 261 declined or were physically unable to participate, and 114 could not be contacted after multiple attempts. Apart from sex, characteristics of participants who were lost to follow-up were similar to those who participated in the 2017-19 study (**Supplemental Table 1**).

All survey instruments (details below) were tested before the commencement of the study. Participants were interviewed in a research facility established in a rented building in each village or at INCAP headquarters in Guatemala City. Survey instruments were administered by trained enumerators. Details on training, adaptation, and administration of the cognitive tests are published elsewhere (28).

The Institutional Review Boards of Emory University (Atlanta, GA) and INCAP (Guatemala City, Guatemala) gave ethical approval for this study. All methods were carried out in accordance with relevant guidelines and regulations and all participants gave written informed consent.

2.3 Measurements

2.3.1 Psychological Well-being

We adopted a model that captures both hedonic and eudaimonic aspects of psychological well-being. The hedonic approach defines well-being in terms of pleasure attainment and pain avoidance (e.g., happiness; life satisfaction), and the eudaimonic approach defines well-being in terms of psychosocial functioning (e.g., meaning and purpose; self-efficacy) (1, 29, 30).

We measured happiness using the Lyubomirsky Scale of Global Subjective Happiness (31). Participants were asked to rate four items on a 5-point Likert scale ranging from 1 (*Very unhappy or not at all*) to 5 (*Very happy or a great deal*). A total score was calculated by computing the mean of the four items, with higher scores signifying greater happiness (31).

We assessed life satisfaction using the NIH Toolbox General Life Satisfaction Survey consisting of five items assessing global feelings and attitudes about one's life (32). Participants rated these items on a 5-point Likert scale ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*). Final scores were computed as the sum of item scores, with higher scores signifying higher life satisfaction.

Meaning and purpose in life was measured using the NIH Toolbox Meaning and Purpose Survey. Participants rated nine items on a 5-point Likert scale ranging from 1 (*Strongly disagree*) to 5 (*Strongly agree*) (32). Final scores were computed as the sum of item scores, with higher scores signifying greater meaning and purpose.

Self-efficacy is defined as a person's belief in his/her capacity to manage, function, and have control over meaningful events (33). We assessed self-efficacy using the NIH Toolbox Self-Efficacy Survey (34). Participants rated ten items on a 5-point Likert scale ranging from 1 (*Never*) to 5 (*Very often*). Final scores were computed as the sum of item scores, with higher scores signifying greater self-efficacy.

2.3.2 Socio-emotional measures

Emotional support

Emotional support is one component of social support that refers to the experience of being cared about, valued, and loved by people in one's social network (35). We assessed emotional support using the fixed 8-item form of the NIH Toolbox Emotional Support Survey (36). Each item administered has a 5-point Likert scale. Total scores were the sum of all items, with higher scores signifying higher emotional support.

Spirituality and religion

While the terms spirituality and religion are used interchangeably, they have different meanings. Religion functions in the context of an organized institution that places spirituality under a specific set of beliefs, values, and practices. On the other hand, spirituality is a subjective experience that involves a sense of connection and transcendence with a greater force (37). Thus, religion can be considered a specific form of spirituality, while spirituality is a broader concept.

We assessed spirituality and religion using the faith and hope facets of the World Health Organization Quality of Life Spirituality, Religiousness, and Personal Beliefs WHOQOL-SRPB questionnaire (38). The WHOQOL-SRPB questionnaire does not tie spirituality to religion, and questions are phrased in ways that apply to individuals with a wide range of religious and non-religious beliefs. Each facet included 4-items on a 5-point Likert scale and was scored through summative scaling, with each item contributing equally to the facet score. Mean scores were then calculated, where higher values reflect higher levels of spirituality and religion (38).

2.3.3 Mental health

We used the WHO Self-Reporting Questionnaire (SRQ-20) to assess mental health. The SRQ-20 is a screening tool for mental disorders specifically designed for developing countries, consisting of 20 *yes/no* questions, with a maximum score of 20 (39). Higher values are indicative of worse symptomology. For consistency with the other measures collected, we reverse-scored the items so that higher mean values are indicative of greater mental health.

2.3.4 Cognitive measures

Non-verbal fluid intelligence (IQ)

We assessed non-verbal fluid intelligence using the Raven's Progressive Matrices Test (40). The test consists of a series of increasingly-complex patterns, for each of which there is a piece missing.

Participants were asked to select which piece completes the pattern from several options. Three of the five scales (A, B, and C, with 12 questions each) were administered since previous administrations of the instrument in this population showed that only few participants could progress beyond the third scale. Scores were computed as the sum of correct responses, for a maximum total score of 36.

Executive Function

We measured executive function as a latent construct that includes working memory, inhibitory control, and cognitive flexibility as building blocks (41, 42). We administered computerized Spanish-language tests of the National Institutes of Health (NIH) Toolbox cognition battery. To assess working memory capacity, we used the List Sorting Working Memory Test (43). The task requires participants to remember information that is visually and auditorily presented with illustrated pictures (either foods, animals, or both) in size order from the smallest to the largest. Item substitutions were made to the List Sorting Working Memory test to increase cultural appropriateness. Specifically, pumpkin was substituted with papaya, cherry with nispero (loquat), and blueberry with nance (a small tropical fruit). These adaptations were approved and implemented by the NIH Toolbox development team. Final scores were computed as the sum of correct responses for a maximum score of 26. Inhibitory control was assessed using the Flanker Inhibitory Control and Attention Test (44). The task requires participants to indicate the left-right orientation of a centrally presented stimulus while inhibiting potentially irrelevant information from the flanking stimuli (45). We used the Dimensional Change Card Sort (DCCS) Test to assess cognitive flexibility. Participants were asked to switch between matching pictures by color and matching pictures by shape (44). For Flanker Inhibitory Control and Attention and DCCS Tests, we used the NIH toolbox computed scores, which uses a two-vector algorithm that combines accuracy and reaction time (46). Higher values indicate greater cognitive flexibility and inhibitory control. Computed scores range from 0–10, and a score between 0 and 5 indicates that the participant did not score high enough in accuracy (80% correct or less).

2.4 Statistical analysis

In all scales with missing items (< 1%), we applied a two-way imputation approach (47). We used Structural Equation Modelling (SEM) techniques to examine the factor-loadings patterns of studied domains and to assess their intercorrelations. Under the SEM framework, we used first-order Confirmatory Factor Analysis (CFA) to investigate whether the established dimensionality and factor-loadings patterns for executive function and scales assessing happiness, life satisfaction, meaning and purpose, self-efficacy, emotional support, faith and hope fitted our sample population. For second-order factor structures (i.e., psychological well-being and spirituality and religion), we used hierarchical CFA to determine the degree to which factors loaded on their underlying sub-constructs.

Our final model included the individual Likert-item responses from the scales assessing happiness, life satisfaction, meaning and purpose, and self-efficacy as latent sub-domains of “psychological well-being.” Likert-item responses from the NIH Emotional Support Scale were used to model emotional support. Likert-item scale responses from the faith and hope facets of the WHOQOL-SRPB scale were modeled as

latent sub-domains of "spirituality and religion." Mental health and IQ were modeled as observed variables using computed scores. List Sorting Working Memory, Flanker Inhibitory Control and Attention, and DCCS Tests scores were modeled as latent "executive function." (Fig. 1).

Additionally, for comparison purposes, we tested a model in which the hope and faith facets were modeled together with happiness, life satisfaction, meaning and purpose, and self-efficacy as additional subdomains of psychological well-being.

We assessed model fit using the root mean square error of approximation (RMSEA), Comparative Fit Index (CFI), and Tucker-Lewis index (TLI). A good model fit is indicated by RMSEA < 0.08, CFI > 0.90 and TLI > 0.95.

We interpreted the strength of correlation coefficients ≥ 0.70 as strong, between 0.69 and 0.40 as moderate, and ≤ 0.39 as weak.

Our analysis accounted for clustering of subjects within family, and models were sex-stratified. All analysis was conducted using MPLUS 8.0 using the Weighted Least Square Mean and Variance (WLSMV) estimator for categorical and ordinal responses using pairwise deletion of missing values (48).

3. Results

Study participants (704 women; 564 men) had a mean age of 47 years. Table 1 shows means and SD of the scores of completed tests. Models in women and men showed adequate fit (RMSEA = 0.04; CFI = 0.95, TLI = 0.95, and RMSEA = 0.04, CFI = 0.95, TLI = 0.94, respectively).

Table 1

Demographic, cognitive, and socioemotional characteristics of the study population, by sex¹

	n	Women	n	Men	P-value
Age, y	704	47.5 ± 4.3	564	47.4 ± 4.1	0.61
Area of residence, % rural	704	71.6	564	74.6	0.23
Psychological well-being					
Lyubomirsky Happiness (out of 5)	700	4.0 ± 1.0	553	4.1 ± 0.9	0.25
NIH Life Satisfaction (out of 25)	699	18.5 ± 3.5	553	18.9 ± 3.4	0.07
NIH Meaning and Purpose (out of 45)	698	36.2 ± 4.1	552	37.2 ± 4.0	< 0.01
NIH Self-efficacy (out of 40)	698	30.9 ± 7.1	552	31.4 ± 6.4	0.25
Socio-emotional scores					
NIH Emotional support (out of 40)	703	31.0 ± 9.3	559	32.5 ± 7.7	< 0.01
WHOQOL-SRPB Hope facet (out of 5)	698	3.2 ± 0.8	552	3.3 ± 0.7	< 0.05
WHOQOL-SRPB Faith facet (out of 5)	698	3.9 ± 0.7	552	3.9 ± 0.7	0.79
Mental health					
SRQ-20 (out of 20) ²	700	± 4.0	558	17.7 ± 2.9	< 0.01
Cognitive tests scores					
Intelligence					
Raven's Progressive Matrices, (# correct out of 36)	686	15.3 ± 4.9	537	17.8 ± 6.0	< 0.01
Executive function					

	n	Women	n	Men	P-value
List Sorting Working Memory, (# correct out of 26)	670	11.3 ± 3.8	541	12.7 ± 3.9	< 0.01
Flanker Inhibitory Control and Attention, (NIH score) ³	671	5.4 ± 1.1	542	5.8 ± 1.2	< 0.01
Cognitive flexibility - DCCS, (NIH score) ³	677	5.1 ± 1.9	546	5.4 ± 1.9	< 0.01
<p>¹ Values are means ± SD or percentages. ² For interpretation purposes items were reverse scored so that higher mean values are indicative of greater mental health. ³ Computed scores range from 0–10, but if the score is between 0 and 5, it indicates that the participant did not score high enough in accuracy (80% correct or less).</p> <p>Abbreviations: NIH National Institutes of Health; DCCS Dimensional Change Card Sort; WHOQoL SRPB World Health Organization Quality of Life Spirituality, Religiosity, and Personal Beliefs; SRQ-20 Self-Reported Questionnaire-20.</p>					

Models combining the hope and faith facets with the psychological well-being components indicated a small decrease in goodness-of-fit indices (RMSEA = 0.05, CFI = 0.94, TLI = 0.93 in women, and RMSEA = 0.04, CFI = 0.94 and TLI = 0.93 in men). Thus, we decided to keep the model that differentiates spirituality and religion from psychological well-being.

First-order factor loadings for scales assessing happiness, life satisfaction, meaning and purpose, self-efficacy, emotional support, hope, and faith are presented in **Supplemental Table 2**. Second-order CFA showed that the theorized subcomponents for spirituality and religion and psychological well-being were highly loaded into their underlying constructs. We also found computed scores for List Sorting Working Memory, Flanker Inhibitory Control and Attention, and DCCS tests loaded onto the executive function latent construct (Table 2).

Table 2
Factor loadings for psychological well-being, spirituality, and religion, and executive function latent constructs.¹

	Women	Men
<i>Psychological well-being scales</i>		
Lyubomirsky Happiness	0.73	0.69
NIH Life Satisfaction	0.86	0.86
NIH Meaning and purpose	0.83	0.83
NIH Self-efficacy	0.55	0.53
<i>Spirituality and religion²</i>		
Faith	0.79	0.73
Hope	0.91	0.88
<i>Executive function</i>		
List sorting working memory test	0.60	0.66
Flanker Inhibitory control and attention test	0.59	0.69
Cognitive flexibility - DCCS ³ test	0.82	0.70
1. All factor loadings are statistically significant ($p < 0.01$)		
2. Measured using the hope and faith facets of the World Health Organization Quality of Life Spirituality, Religiosity and Personal Beliefs (WHOQoL SRPB).		
3. DCCS Dimensional Change Card Sort (DCCS)		

Intercorrelation matrices between latent domains and observed variables in women and men are presented in Table 3 and Table 4, respectively. In women, psychological well-being was moderately associated with spirituality and religion ($r = 0.68, p < 0.001$), weakly correlated with emotional support ($r = 0.34, p < 0.001$), mental health ($r = 0.32, p < 0.001$) and IQ ($r = 0.15, p < 0.001$), and showed no association with executive function. Mental health was weakly correlated with emotional support ($r = 0.18, p < 0.001$), spirituality, and religion ($r = 0.16, p < 0.001$), and showed no association with IQ and executive function. We also found moderate correlations between executive function and IQ ($r = 0.63, p < 0.001$) (Table 3).

Table 3

Correlation matrix of cognitive and socioemotional domains among adult women in Guatemala (n = 704)

	Psychological well-being	Emotional support	Spirituality and religion	Mental health	IQ	Executive function
Psychological well-being	-					
Emotional support	0.34**	-				
Spirituality and religion	0.68**	0.19**	-			
Mental health	0.32**	0.18**	0.16**	-		
IQ	0.15**	0.09*	0.27**	0.08	-	
Executive function	0.08	0.15**	0.38**	0.08	0.63**	-
*p < 0.05; **p < 0.001						

Table 4

Correlation matrix of cognitive and socioemotional domains among adult men in Guatemala (n = 564)

	Psychological well-being	Emotional support	Spirituality and religion	Mental health	IQ	Executive function
Psychological well-being	-					
Emotional support	0.35**	-				
Spirituality and religion	0.70**	0.32**	-			
Mental health	0.35**	0.09*	0.12*	-		
IQ	0.25**	0.11*	0.32**	0.09*	-	
Executive function	0.23**	0.22**	0.43**	0.08	0.70**	-
*p < 0.05; **p < 0.001						

The correlation matrix in men showed similar results. We observed a strong association between psychological well-being and spirituality and religion ($r=0.70$, $p<0.001$). Psychological well-being was weakly correlated with emotional support ($r=0.35$, $p<0.001$), mental health ($r=0.35$, $p<0.001$), IQ ($r=0.25$, $p<0.001$) and executive function ($r=0.23$, $p<0.001$). Mental health was weakly associated with

emotional support ($r = 0.09, p < 0.05$), spirituality and religion ($r = 0.12, p < 0.05$), and IQ ($r = 0.09, p < 0.05$), and showed no association with executive function. We also found strong correlations between executive function and IQ ($r = 0.70, p < 0.001$) (Table 4).

4. Discussion

We investigated associations of psychological well-being and mental health with executive function, IQ, spirituality and religion, and emotional support in a population of Guatemalan adults born in contexts of adversity. Our results derived from CFA support the use of the applied measures in this context. Our findings demonstrate the construct validity of first-order (i.e., happiness, life satisfaction, meaning and purpose, self efficacy, emotional support, faith, hope and executive function) and second-order (i.e., psychological well-being and spirituality and religion) factor structures. In both sexes, spirituality and religion was moderately to strongly correlated with psychological well-being and weakly correlated with mental health. Much debate has revolved around whether there is a meaningful differentiation between spirituality and religion from psychological well-being components. In agreement with previous studies (49), our findings support differentiation between these two constructs.

The relationship of psychological well-being with spirituality and religion is well documented (50, 51). The mechanism by which spirituality and religion could influence psychological well-being has been suggested to involve psychosocial factors such as providing a sense of identity and social support and promoting an active and socially engaged lifestyle (22). Our study found a weak association between emotional support (our measure of social support) and psychological well-being in both sexes. However, our social support measure was limited to emotional aspects and did not include components of instrumental support or social networks, and therefore may underestimate the associations. The religious landscape in Guatemala may provide additional insights into the observed associations. Pentecostal congregations rose in popularity in Guatemala during the late 1970s, turning it into one of the most Protestant countries in Latin America (52). This is relevant because pentecostal churches are very supportive of their adherents, providing them with various social services. The extent to which social support mediates the association of spirituality and religion with psychological well-being remains to be further investigated.

We measured three core executive functions (working memory, inhibitory control, and cognitive flexibility) that facilitate higher-order executive function: problem-solving, reasoning, and planning. It is well established that the cognitive processes involved in executive function are critical to mental health and psychological well-being. Research has shown that people show better executive function capacities when they feel happy, socially supported, and healthy (53). Conversely, deficits in executive function have been associated with depression, and various psychopathologies (54). Our findings suggest that in this population of Guatemalan adults executive function had little if any association with psychological well-being and mental health constructs. The mechanisms through which greater executive function positively influence various aspects of well-being (e.g., good relationships, health, and academic achievement) have been shown to involve the ability to inhibit automatic responses (i.e., self-control) and delay of

gratification (55). These proposed mechanisms have been derived from studies conducted on children and adolescents in developed countries (56–59). More research in different populations and contexts is needed to understand the underlying mechanisms influencing better outcomes among those with higher executive function.

We also found that executive function was moderately correlated with spirituality and religion. These findings are in line with previous studies documenting associations of spiritual and religious involvement with better inhibitory control and lower cognitive decline (60). Proposed mechanisms include the stimulation of higher cortical functions related to abstract thinking (61) and promoting a stimulating and socially engaged lifestyle that may help prevent cognitive decline (60).

We also found in this population that executive function was strongly and positively correlated with general intelligence measures (IQ). These findings are consistent with previous studies indicating that performance on executive function tests, particularly on tasks assessing working memory capacity, is associated with intelligence measures (62, 63).

Our findings are limited by the data's cross-sectional nature, which does not allow for directionality or causality to be inferred. Another limitation is the limited generalizability of our findings, which may only apply to populations with similar characteristics to those of our study sample. Despite these limitations, our study has several strengths. We applied cognitive and socio-emotional measures with good psychometric properties in a large sample of men and women living in rural areas of Guatemala or Guatemala City. Moreover, structural equation modeling techniques allow examining interrelationships among factors and observed variables while accounting for measurement error.

Conclusions

Our findings indicate strong and positive correlations of psychological well-being with spirituality and religion. We also found that psychological well-being was weakly correlated with emotional support, IQ, and executive function. We found weak associations of mental health with emotional support, spirituality and religion, and IQ.

Our findings lay the foundation for advancing the understanding of factors that could contribute to strengthen individual well-being and positive mental health outcomes in populations living in adversity contexts in LMICs. The extent to which spiritual and religious involvement may play an important role in promoting higher psychological well-being and executive function needs to be further investigated.

Abbreviations

CFA: Confirmatory Factor Analysis; CFI: Comparative Fit Index; DCCS: Dimensional Change Card Sort; INCAP: Institute of Nutrition of Central America and Panama; IQ: Intelligence quotient; LMICs: Low-and middle-income countries; NIH: National Institutes of Health;

RMSEA: Root mean square error of approximation; SEM: Structural Equation Modelling;

SRQ-20:WHO Self-Reporting Questionnaire; TLI: Tucker-Lewis index; WHOQOL-SRPB: World Health Organization Quality of Life Spirituality, Religiousness and Personal Beliefs questionnaire; WLSMV: Weighted Least Square Mean and Variance.

Declarations

Our findings indicate strong and positive correlations of psychological well-being with spirituality and religion. We also found that psychological well-being was weakly correlated with emotional support, IQ, and executive function. We found weak associations of mental health with emotional support, spirituality and religion, and IQ.

Our findings lay the foundation for advancing the understanding of factors that could contribute to strengthen individual well-being and positive mental health outcomes in populations living in adversity contexts in LMICs. The extent to which spiritual and religious involvement may play an important role in promoting higher psychological well-being and executive function needs to be further investigated.

References

1. Ryff CD, Keyes CL. The structure of psychological well-being revisited. *J Pers Soc Psychol.* 1995;69(4):719-27.
2. Diener E, Oishi S, Lucas RE. National accounts of subjective well-being. *Am Psychol.* 2015;70(3):234-42.
3. Spearman C. "General Intelligence," objectively determined and measured. *The American Journal of Psychology.* 1904;15(2):201-92.
4. Diamond A. Executive functions. *Annu Rev Psychol.* 2013;64:135-68.
5. Strenze T. Intelligence and socioeconomic success: A meta-analytic review of longitudinal research. *Intelligence.* 2007;35(5):401-26.
6. Melby L, Indredavik MS, Løhaugen G, Brubakk AM, Skranes J, Vik T. Is there an association between full IQ score and mental health problems in young adults? A study with a convenience sample. *BMC Psychology.* 2020;8(1):7.
7. Beaver KM, Wright JP. The association between county-level IQ and county-level crime rates. *Intelligence.* 2011;39(1):22-6.
8. Beaver KM, Schwartz JA, Nedelec JL, Connolly EJ, Boutwell BB, Barnes J. Intelligence is associated with criminal justice processing: Arrest through incarceration. *Intelligence.* 2013;41(5):277-88.
9. de Ridder DT, Lensvelt-Mulders G, Finkenauer C, Stok FM, Baumeister RF. Taking stock of self-control: a meta-analysis of how trait self-control relates to a wide range of behaviors. *Pers Soc Psychol Rev.* 2012;16(1):76-99.

10. Duckworth A. The significance of self-control. *Proceedings of the National Academy of Sciences*. 2011. p. 2639-40.
11. Cheung TT, Gillebaart M, Kroese F, De Ridder D. Why are people with high self-control happier? The effect of trait self-control on happiness as mediated by regulatory focus. *Front Psychol*. 2014;5:722.
12. Moffitt TE, Arseneault L, Belsky D, Dickson N, Hancox RJ, Harrington H, et al. A gradient of childhood self-control predicts health, wealth, and public safety. *Proceedings of the National Academy of Sciences*. 2011;108(7):2693-8.
13. Schlam TR, Wilson NL, Shoda Y, Mischel W, Ayduk O. Preschoolers' delay of gratification predicts their body mass 30 years later. *J Pediatr*. 2013;162(1):90-3.
14. Lund JI, Toombs E, Radford A, Boles K, Mushquash C. Adverse Childhood Experiences and Executive Function Difficulties in Children: A Systematic Review. *Child abuse & neglect*. 2020;106:104485.
15. Zelazo PD, Cunningham WA. Executive Function: Mechanisms Underlying Emotion Regulation. *Handbook of emotion regulation*. New York, NY, US: The Guilford Press; 2007. p. 135-58.
16. Holden L, Dobson AJ, Ware RS, Hockey R, Lee C. Longitudinal trajectory patterns of social support: correlates and associated mental health in an Australian national cohort of young women. *Quality of Life Research*. 2015;24(9):2075-86.
17. Siedlecki KL, Salthouse TA, Oishi S, Jeswani S. The Relationship Between Social Support and Subjective Well-Being Across Age. *Social indicators research*. 2014;117(2):561-76.
18. Ellison CG. Religious involvement and subjective well-being. *Journal of health and social behavior*. 1991;32(1):80-99.
19. Laudet AB, Morgen K, White WL. The Role of Social Supports, Spirituality, Religiousness, Life Meaning and Affiliation with 12-Step Fellowships in Quality of Life Satisfaction Among Individuals in Recovery from Alcohol and Drug Problems. *Alcohol Treat Q*. 2006;24(1-2):33-73.
20. Moreira-Almeida A, Lotufo Neto F, Koenig HG. Religiousness and mental health: a review. *Brazilian Journal of Psychiatry*. 2006;28(3):242-50.
21. Pargament KI, Smith BW, Koenig HG, Perez L. Patterns of positive and negative religious coping with major life stressors. *Journal for the scientific study of religion*. 1998:710-24.
22. Elliott M, Hayward R. Religion and the search for meaning in life. *Journal of Counselling Psychology*. 2007;53(1):80-93.
23. Roth TL, Lubin FD, Funk AJ, Sweatt JD. Lasting epigenetic influence of early-life adversity on the BDNF gene. *Biological psychiatry*. 2009;65(9):760-9.
24. Ridout KK, Khan M, Ridout SJ. Adverse Childhood Experiences Run Deep: Toxic Early Life Stress, Telomeres, and Mitochondrial DNA Copy Number, the Biological Markers of Cumulative Stress. *BioEssays : news and reviews in molecular, cellular and developmental biology*. 2018;40(9):e1800077.
25. Bergeron G. Social and economic development in four Ladino communities of eastern Guatemala: a comparative description. *Food and Nutrition Bulletin*. 1992;14(3):1-17.

26. Martorell R, Habicht JP, Rivera JA. History and design of the INCAP longitudinal study (1969-77) and its follow-up (1988-89). *The Journal of nutrition*. 1995;125(4 Suppl):1027S-41S.
27. Stein AD, Melgar P, Hoddinott J, Martorell R. Cohort Profile: the Institute of Nutrition of Central America and Panama (INCAP) Nutrition Trial Cohort Study. *International journal of epidemiology*. 2008;37(4):716-20.
28. Wray C, Kowalski A, Mpondo F, Ochaeta L, Belleza D, DiGirolamo A, et al. Executive functions form a single construct and are associated with schooling: Evidence from three low- and middle- income countries. *PloS one*. 2020;15(11):e0242936.
29. Ryan RM, Deci EL. On happiness and human potentials: a review of research on hedonic and eudaimonic well-being. *Annu Rev Psychol*. 2001;52:141-66.
30. Diener E. Subjective well-being: The science of happiness and a proposal for a national index. *American psychologist*. 2000;55(1):34.
31. Lyubomirsky S, Lepper HS. A measure of subjective happiness: Preliminary reliability and construct validation. *Social indicators research*. 1999;46(2):137-55.
32. Salsman JM, Lai J-S, Hendrie HC, Butt Z, Zill N, Pilkonis PA, et al. Assessing psychological well-being: self-report instruments for the NIH Toolbox. *Quality of Life Research*. 2014;23(1):205-15.
33. Bandura A. Self-efficacy. *The Corsini encyclopedia of psychology*. 2010:1-3.
34. Salsman JM, Butt Z, Pilkonis PA, Cyranowski JM, Zill N, Hendrie HC, et al. Emotion assessment using the NIH Toolbox. *Neurology*. 2013;80(11 Supplement 3):S76-S86.
35. Gurung R. Coping and social support. *Health Psychology: A Cultural Approach Belmont, CA: Thomson Wadsworth*. 2006:131-71.
36. Cyranowski JM, Zill N, Bode R, Butt Z, Kelly MA, Pilkonis PA, et al. Assessing social support, companionship, and distress: National Institute of Health (NIH) Toolbox Adult Social Relationship Scales. *Health Psychology*. 2013;32(3):293.
37. Fontana D. *Psychology, religion, and spirituality: Bps Blackwell Oxford*; 2003.
38. A cross-cultural study of spirituality, religion, and personal beliefs as components of quality of life. *Social science & medicine (1982)*. 2006;62(6):1486-97.
39. Beusenbergh M, Orley JH, Organization WH. *A User's guide to the self reporting questionnaire (SRQ)*. Geneva: World Health Organization; 1994.
40. Raven J. The Raven's progressive matrices: change and stability over culture and time. *Cognitive psychology*. 2000;41(1):1-48.
41. Friedman NP, Miyake A, Young SE, DeFries JC, Corley RP, Hewitt JK. Individual differences in executive functions are almost entirely genetic in origin. *Journal of experimental psychology: General*. 2008;137(2):201.
42. Miyake A, Friedman NP, Emerson MJ, Witzki AH, Howerter A, Wager TD. The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive psychology*. 2000;41(1):49-100.

43. Tulsy DS, Carlozzi N, Chiaravalloti ND, Beaumont JL, Kisala PA, Mungas D, et al. NIH Toolbox Cognition Battery (NIHTB-CB): List sorting test to measure working memory. *Journal of the International Neuropsychological Society*. 2014;20(6):599-610.
44. Zelazo PD, Anderson JE, Richler J, Wallner-Allen K, Beaumont JL, Weintraub S. II. NIH Toolbox Cognition Battery (CB): Measuring executive function and attention. *Monographs of the Society for Research in Child Development*. 2013;78(4):16-33.
45. Zelazo PD, Anderson JE, Richler J, Wallner-Allen K, Beaumont JL, Conway KP, et al. NIH Toolbox Cognition Battery (CB): Validation of executive function measures in adults. *Journal of the International Neuropsychological Society*. 2014;20(6):620-9.
46. Heaton RK, Akshoomoff N, Tulsy D, Mungas D, Weintraub S, Dikmen S, et al. Reliability and validity of composite scores from the NIH Toolbox Cognition Battery in adults. *Journal of the International Neuropsychological Society*. 2014;20(6):588-98.
47. Bernaards CA, Sijtsma K. Influence of imputation and EM methods on factor analysis when item nonresponse in questionnaire data is nonignorable. *Multivariate Behavioral Research*. 2000;35(3):321-64.
48. Muthén L, Muthén B. Mplus. The comprehensive modelling program for applied researchers: user's guide. 1998;5.
49. Hammer JH, Wade NG, Cragun RT. Valid assessment of spiritual quality of life with the WHOQOL-SRPB BREF across religious, spiritual, and secular persons: A psychometric study. *Psychology of Religion and Spirituality*. 2019.
50. Vosloo C, Wissing MP, Temane QM. Gender, spirituality and psychological well-being. *Journal of Psychology in Africa*. 2009;19(2):153-9.
51. Ivtzan I, Chan CP, Gardner HE, Prashar K. Linking religion and spirituality with psychological well-being: Examining self-actualisation, meaning in life, and personal growth initiative. *Journal of religion and health*. 2013;52(3):915-29.
52. Steigenga TJ. The politics of the spirit: The political implications of pentecostalized religion in Costa Rica and Guatemala: Lexington Books; 2002.
53. Diamond A, Ling DS. Conclusions about interventions, programs, and approaches for improving executive functions that appear justified and those that, despite much hype, do not. *Developmental cognitive neuroscience*. 2016;18:34-48.
54. Farruggia MC, Laird AR, Mattfeld AT. Common default mode network dysfunction across psychopathologies: A neuroimaging meta-analysis of the n-back working memory paradigm. *bioRxiv*. 2020:2020.01.30.927210.
55. Luerssen A, Ayduk O. Executive functions promote well-being: Outcomes and mediators. *The Happy Mind: Cognitive Contributions to Well-Being*: Springer; 2017. p. 59-75.
56. Mischel W, Shoda Y, Peake PK. The nature of adolescent competencies predicted by preschool delay of gratification. *Journal of personality and social psychology*. 1988;54(4):687.

57. von Hippel W, Gonsalkorale K. "That is bloody revolting!" Inhibitory control of thoughts better left unsaid. *Psychological Science*. 2005;16(7):497-500.
58. Yovetich NA, Rusbult CE. Accommodative behavior in close relationships: Exploring transformation of motivation. *Journal of Experimental Social Psychology*. 1994;30(2):138-64.
59. Finkel EJ, Campbell WK. Self-control and accommodation in close relationships: an interdependence analysis. *Journal of personality and social psychology*. 2001;81(2):263.
60. Hill TD. Religious involvement and healthy cognitive aging: patterns, explanations, and future directions. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*. 2008;63(5):478-9.
61. Koenig HG. Religion, spirituality, and health: The research and clinical implications. *ISRN psychiatry*. 2012;2012.
62. Miyake A, Friedman NP, Rettinger DA, Shah P, Hegarty M. How are visuospatial working memory, executive functioning, and spatial abilities related? A latent-variable analysis. *Journal of experimental psychology: General*. 2001;130(4):621.
63. Engle RW, Tuholski SW, Laughlin JE, Conway AR. Working memory, short-term memory, and general fluid intelligence: a latent-variable approach. *Journal of experimental psychology: General*. 1999;128(3):309.

Figures

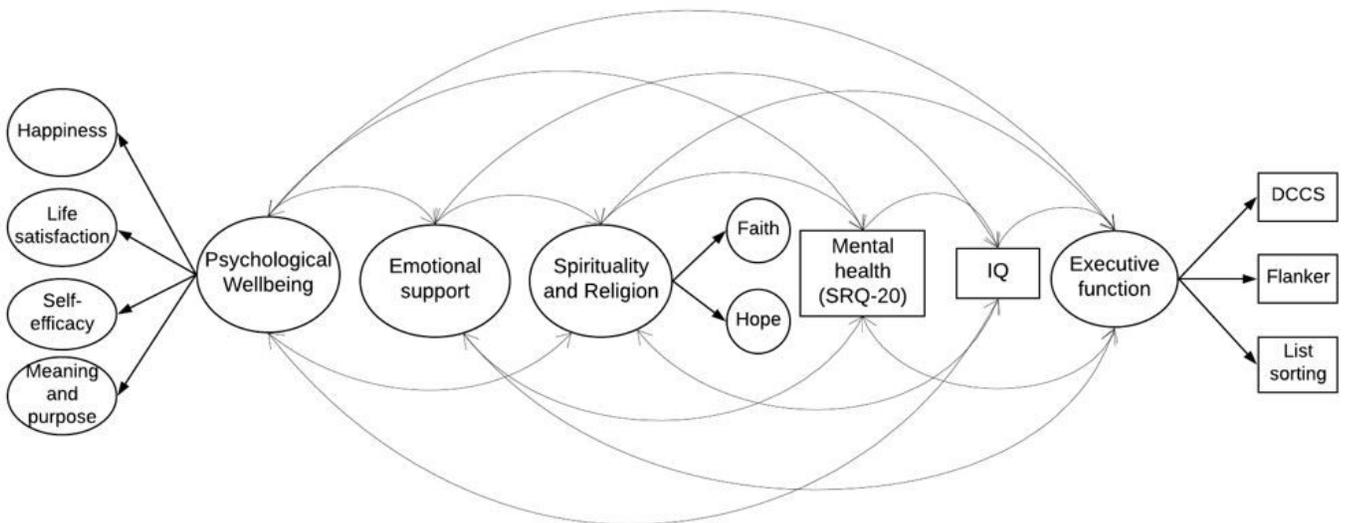


Figure 1

Hypothesized model

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