Changes in the mental wellbeing among Nigerians due to Ramadan intermittent fasting: A nationwide cross-sectional study

Sahabi Kabir Sulaiman
Yobe State University Damaturu
Fatimah Isma'il Tsiga-Ahmed
Bayero University
Teresa Arora
Zayed University Department of Natural Science and Public Health
MoezAlIslam E Faris
University of Sharjah College of Health Sciences
Muhammad Sale Musa
Yobe State University Damaturu
Yesir Adeyemi Kareem
Federal Neuro Psychiatric Hospital
Farouq Muhammad Dayyab
Aminu Kano Teaching Hospital
Aminu Hussein
Yobe State University Damaturu
Shehu Sale
Federal Neuro Psychiatric Hospital
Moien AB Khan (moien.khan@uaeu.ac.ae)
United Arab Emirates University College of Medicine and Health Sciences https://orcid.org/0000-0003-4970-4618

Research Article

Keywords:

Posted Date: March 29th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1486892/v1

Abstract

This study examined mental wellbeing and associated factors among Nigerian adults who observed Ramadan intermittent fasting (RIF) amid the COVID-19 pandemic. A cross-sectional online study was conducted among 770 adult Nigerians who observed RIF. Using pre-tested, web-based questionnaires, data about mental wellbeing (depression, anxiety), spirituality, and intrinsic religiosity were collected using validated generalised anxiety disorder-2 (GAD-2) and Patient Health Questionnaire-2 (PHQ-2), four-item spiritual wellbeing index (4-ISWBI) and the Muslim intrinsic religiosity questionnaire. Respondents' mental wellbeing before and during Ramadan was compared. The factors associated with the feeling of depression and anxiety were determined using multinomial regression analysis. When compared to mental wellbeing prior to Ramadan, observing RIF by Nigerian adults were associated with improved mental wellbeing.

Introduction

During the annual fasting month of Ramadan (the ninth month of the Islamic *Hijri* calendar), Muslims are required to abstain from eating, drinking, and having sexual intercourse from dawn (*suhoor*) until dusk (*iftaar*)(Jahrami et al., 2020). This Islamic ritual is one of the five tenets of the religion that all Muslims are obliged to observe if they are a healthy (both physically and mentally) adult, not on a distant journey that is exhausting to the body, not pregnant or breastfeeding or menstruating. ('Mo'ez Al-Islam' E. Faris et al., 2020; Trepanowski & Bloomer, 2010) Ramadan is a period devoted to prayers, feeding, alms-giving, and other acts of good that Muslims adhere seeking the proximity to God. This spiritual practice that accelerates faith has also been shown to have a range of positive benefits to mental and physical health and cognition('Mo'ez Al-Islam' E. Faris et al., 2020, 2020; Gilavand & Fatahiasl, 2018; Khan et al., 2018).

A significant number of studies have explored associations between Ramadan intermittent fasting (RIF) and the various components of mental health, with the majority reporting an overall improvement. For example, Ramadan fasting has been shown to significantly lower depression among people observing this ritual compared to other periods outside of the holy month, with no sex disparity (Erdem, 2018; Koushali et al., 2013; Maryam et al., 2010; Yousuf et al., 2021). A significant anxiety reduction has also been linked to RIF (Erdem, 2018; Maryam et al., 2010; Yousuf et al., 2021) although a study has reported non-significant change for females compared to male counterparts (Mohammadi et al., 2001). In addition, RIF has also been shown to significantly improve health through the downstream effect of stress reduction (Erdem, 2018; Yousuf et al., 2021) including psychotism, interpersonal sensitivity, hostility, obsession, phobia and paranoid ideation aspects of mental health (Maryam et al., 2010). An Iranian study conducted on university students in Ramadan found intrinsic religiosity to be a factor associated with improved mental health aspects of the students, mitigating depression, anxiety, and helping in coping with psychological distress (Gilavand & Fatahiasl, 2018). The other forms of fasting such as the voluntary bi-weekly fasting of Mondays and Thursdays encouraged by Islam on Muslims have been reported to be significantly associated with emotional intelligence (Ridho et al., 2021). In this way, RIF exerts a beneficial role on, emotion, self-esteem and mental health.

The relationship between mental health especially feeling anxious and depressed, physical health and religiosity has been extensively explored across different populations and religions. The evidence surrounding this area has led some to suggest a possible role for religiosity within the context of healthcare management(Mishra et al., 2017). A recent meta-analysis which included Arab Muslims and included ten studies found a pooled mean correlation coefficient of -0.22 between religiosity and self-reported anxiety symptoms (Abdel-Khalek et al., 2019). Mechanistically, the authors purported that those with higher levels of religiosity may have enhanced coping strategies which, in turn, can help to better manage anxiety-related symptoms. In line with this study, another group showed that positive religious coping strategies were associated with fewer depressive symptoms and better quality of life outcomes amongst a clinical population of 148 patients diagnosed with bipolar disorder(Stroppa & Moreira-Almeida, 2013). The relationship between religiosity and depressive symptoms appears to be relatively consistent across different populations and religions as reported by multiple groups(Moutinho et al., 2017; Ronneberg et al., 2016; Saunders et al., 2021; Stearns et al., 2018; Stroppa & Moreira-Almeida, 2013). A cross-sectional survey of 38,694 individuals from the French general population found that religious beliefs, as well as religious observance, was a protective factor for self-reported suicide attempts(Brito et al., 2021). However, the results are not homogenous as religious beliefs were positively associated with psychotic symptoms/disorders as well as generalised anxiety disorder and unipolar depression. Moreover, it should be noted that these findings were based on cross-sectional data from two questions, one to assess religious belief and one to assess religious observance. More convincing evidence surrounding the link between religiosity and depressive symptoms has emerged from recent prospective studies amongst adults(Brito et al., 2021; Saunders et al., 2021). One group demonstrated that religiosity predicted reduced depressive symptoms following longitudinal follow up(Brito et al., 2021). In contrast in a a prospective study amongst older adults, consisting of 1,992 depressed elders who were compared to 5,740 non-depressed, healthy controls at baseliner(Ronneberg et al., 2016). The authors assessed religiosity as well as onset of depression amongst the healthy controls and depression recovery amongst the patient group across a two-year time period. They found that religiosity was protective against depression and was also beneficial for those with depression at baseline in terms of recovery. Another key finding of this study was that those in the healthy control group who attended religious services more frequently were more likely to remain free of a depression diagnosis. Furthermore, those who were depressed at baseline and who frequently practised private prayers were less likely to be depressed when followed up two years later(Ronneberg et al., 2016).

At a biological level, religiosity and spirituality appear to activate, and possibly strengthen, specific neurological pathways and regions (Rim et al., 2019). Specifically, the authors of this review found differences between those who were religious/spiritual compared to their non-religious/spiritual counterparts. Differences were detected between the two groups for the medial frontal cortex, which has been previously linked to maintenance of emotional states(Waugh et al., 2014); the orbitofrontal cortex which has multiple functions and plays a key role in executive function and emotional states(Rudebeck & Rich, 2018); and the posterior cingulate cortex which receives information from the orbitofrontal cortex(Rolls, 2019) and forms part of the limbic system, a network of interconnected regions, which is

best known for the role it plays with emotional response. Interestingly, another biological finding related to religiosity is that of telomere length(L. Wang et al., 2020)(Shammas, 2011). In a cross-sectional study of 1,742 Chinese community-dwelling older adults (≥ 55 years), religiosity was negatively correlated with depressive symptoms after adjustment for sociodemographic factors. Moreover, religiosity was significantly, positively correlated with telomere length, a biological predictor of disease and longevity(Shammas, 2011). Thus, there is some evidence for biological differences between those who observe religious beliefs and practices compared to those who do not, which may be driven by activation of different brain pathways and/or differences to specific brain regions, with consequential cognitive, mood and behavioural outcomes.

The evidence supporting the connection between religiosity and mental health is relatively consistent, regardless of age, religion, geographical location, and health status. There are multiple studies demonstrating a cross-sectional link between religiosity and symptoms of anxiety and depression. Thus, in Muslim populations during Ramadan, where religiosity becomes all-encompassing with additional religious practices, it is feasible to propose that mental health will improve during Ramadan when religiosity is likely to be more prominent. We therefore sought to examine potential alterations to some aspects of mental health, precisely anxiety and depression amongst a large sample of Muslims before and during Ramadan in adult Nigerians amidst the COVID-19 pandemic.

Methods

Study design and participants

A cross-sectional web-based survey was conducted from the 9th of May, 2021 (27th of Ramadan) to the 4th of June, 2021(29th of *Shawwal*) among Nigerian adult (at least 18 years old) who are Muslims, residing in the country during the survey period and who fasted during the month of Ramadan.

Sample Size

We estimated a sample size of 687 participants required for the study. If 687 participants were recruited for the study, the study will have an effect size of 0.15, with a power of 0.99 and an alpha error of 0.1.We calculated by using a bivariate correlation analysis model using a two tail student t-tests (Faul et al., 2007).

Study instrument and data collection

Data were collected with anonymity to exclude any identifying information using pre-tested, self-administered, online questionnaires, from previous studies (Arroll et al., 2010; Fisher & Ng, 2017; Plummer et al., 2016); while three other (intrinsic religiosity, spirituality and eating habits)(Al Zaben et al., 2015; Athanasiadis et al., 2021; Fisher & Ng, 2017) were added to the create a questionnaire to suit the study objective. The questions were prepared on google forms (docs.google.com/forms) for the survey. Survey was collected through snow-ball and conveyance sampling. The survey questionnaire elicited information from the respondents about their socio-demographic characteristics, eating habits (before and during

Ramadan)(Athanasiadis et al., 2021), mental wellbeing (in terms of depression and anxiety)(Arroll et al., 2010; Plummer et al., 2016) before and during Ramadan, spirituality (Fisher & Ng, 2017), and Muslim intrinsic religiosity (Al Zaben et al., 2015).

Sociodemographic characteristics

Survey participants were asked about their age, sex, marital status, residence (rural or urban), educational status, occupational status (employed or unemployed), total household income with reference to the country's minimum household expenditure of NGN137,600 (USD 354)(*Nigeria*, n.d.) for families, living status during month of Ramadan (alone, with a friend, or with family), number of days fasted during Ramadan.

Spirituality, Intrinsic Religiosity

Spirituality was assessed using the four-item spiritual wellbeing index (4-ISWBI) The five options [very important (5), important (4), average (3), less important (2), not important (1)] in each question of the 4-ISWBI were later collapsed into a Likert scale of three (very important, less important, not important) during analysis. While the last three items of the 13-item Muslim Religiosity Scale were adapted to assess for intrinsic religiosity of the participants. These three questions (in my life, I experience the presence of Allah/God; my religious beliefs are what really lie behind their whole approach to life; I try hard to carry religion over into all my other dealings in life) were scored on a five-point Likert scale (definitely true, tends to be true, unsure, tends not to be true, definitely not true) and later collapsed into three (true, unsure, not true) during analysis.

Mental wellbeing

Respondents' mental wellbeing were assessed by using the adopted generalised anxiety disorder-2 (GAD-2) and Patient Health Questionnaire-2 (PHQ-2), respectively(Arroll et al., 2010; Plummer et al., 2016). For each question of the two scales, participants were asked to score their responses based on a four-point Likert scale [not at all (0), several days (1), more than half the days (2), nearly every day (3)], which was later collapsed into three (no change, less often, much often) during analysis.

Assessment of weight, height and eating habits

Respondents were asked to self-report their current body weights (in kilograms) and heights (in centimetres) which were used to calculate their corresponding Body Mass Index (BMI) in kg/m^2 during analysis, and classified into four categories: normal (18.5–24.9), underweight (< $18.5kg/m^2$), overweight (25.0-29.9) and obese (> $30kg/m^2$)(Weir & Jan, 2022). Respondents were assessed for eating habits by asking them about snacking, consuming large quantities of food and eating despite not feeling hungry before and during Ramadan based on a seven-point Likert scale [No (0), slightly less often (-1), slightly more often (+ 1), moderately less often (-2), moderately more often (+ 2), much less often (-3), much more often (+ 3)], which were later collapsed into three categories (no, less often, more often) during analysis.

Statistical Analysis

Data collected were appropriately entered into a Microsoft Excel spreadsheet, cleaned and analysed using STATA version 15.0 (StataCorp LLC, College Station, TX, USA). The mean and standard deviation (SD) were used to summarise continuous data. Categorical data were presented using frequencies and percentages. Respondents' psychological health before and during Ramadan were compared using Pearson's Chi-square or Fisher's exact test as appropriate. Factors associated with symptoms of depression and anxiety were determined using multinomial regression analysis. Age, sex and health state were considered as a priori confounding variables in all models. Independent variables with $p < 0.10$ at the bivariate level were included in the multivariate analysis. A backward stepwise regression was used, and the p-values reported were from the likelihood ratio test. Adjusted odds ratios (aORs) and their 95% confidence intervals (CIs) were used to determine the strength and direction of the effect of factors associated with the dependent variables (depression and anxiety). Type I error was fixed at 5% for all tests.

Results

Reliability of the study tools

In terms of reliability, the 4-ISWBI and the intrinsic religiosity showed high internal consistency and high reliability, $\alpha = 0.86$ and $\alpha = 0.75$ respectively. Similarly, Cronbach's alpha of the adapted mental wellbeing scale (GAD-2 and PHQ-2) was 0.84. Cronbach's alpha was also high, 0.84, for the total questionnaire, indicating that our instrument was robust and internally consistent.

Background characteristics of the respondents

A total of 770 respondents filled completed the online questionnaires and were included in the study. The majority (90.9%, n = 700) were between 21 to 40 years with a mean age and SD of 27.7 ± 6.4 years. Almost two-thirds (62.9%, n = 484) were females and the vast majority − 73.0% (n = 562) lived in an urban area. About half were unemployed (51.8%, n = 399), and a fifth (21.3%, n = 164) were educated up to tertiary level. Three quarters (75.6%, n = 582) lived with their family and 83.0% (n = 639) fasted for 21 to 30 days. Full information on all demographic variables is presented in Table 1.

Table 1
Sociodemographic characteristics of the respondents

Variable N = 770	Frequency (n) (%)
Age (in years)	
≤ 20	43 (5.6)
21–40	700 (90.9)
40–60	27 (3.5)
Sex	
Male	286 (37.1)
Female	484 (62.9)
Marital status	
Single	510 (66.2)
Married	249 (32.3)
Divorced	8 (1.0)
Widowed	3 (0.4)
Residence	
Rural	208 (27.0)
Urban	562 (73.0)
Occupation	
Employed	371 (48.2)
Unemployed	399 (51.8)
Highest Educational Level	
Tertiary or higher	164 (21.3)
Undergraduate	508 (66.0)
Secondary	95 (12.3)
Primary	3 (0.4)
Household income relative to National average	
Top 20%	18 (2.3)
Upper 20%	123 16.0)
Middle 20%	435 (56.5)

Variable N = 770	Frequency (n) (%)
Lower 20%	121 (15.7)
Lowest	73 (9.5)
Days fasted	
1–10	5 (0.7)
11–20	105 (13.6)
21–30	639 (83.0)
Living with during Ramadan	
Alone	125
A friend	63 (8.2)
Family	582 (75.6)

Relationships and religiosity

Table 2 describes the spirituality (relationships) and intrinsic religiosity of the respondents. The majority of respondents considered spirituality to be very important in their life. A total of 85.5% (n = 658) agreed that a relationship with God was very important, and 83.9% (n = 646) considered their relationship with themselves very important. Relationships with other people were seen as very important by 74.0% (n = 570) of the respondents and the environment by 71.0% (n = 547). Almost all respondents (96.4%, n = 742) attested to the presence of God in their life (7.0%, n = 54) do not include religion in their life's dealings, and 1.8% (n = 14) were unsure about the role of religious beliefs in their approach to life.

Table 2
Spirituality (relationship) and intrinsic religiosity among the respondents

Factor	Not Important n (%)	Less important n (%)	Very Important n (%)
Importance of relationship with self	52 (6.8)	72 (9.4)	646 (83.9)
Importance of relationship with God	51 (6.6)	61 (7.9)	658 (85.5)
Importance of relationship with other people	46 (6.0)	154 (20.0)	570 (74.0)
Importance of relationship with environment	46 (6.0)	177 (23.0)	547 (71.0)
Factor	True n (%)	Not true n (%)	Unsure n (%)
I experience the presence of God in my life	742 (96.4)	21 (2.7)	7 (0.9)
Religious beliefs are behind my whole approach to Life	714 (92.7)	42 (5.5)	14 (1.8)
I try hard to carry my Religion into all other life's dealings	695 (90.3)	54 (7.0)	21 (2.7)

Psychological wellbeing before and during Ramadan

A higher proportion of respondents felt less depressed during Ramadan (54.7% vs 59.2%).

Interest and pleasure in doing things were better during Ramadan than pre-Ramadan ($p < 0.001$ and respondents felt less nervous and anxious (58.6% Vs 54.9%). Compared to pre-Ramadan, more respondents were able to stop or control worrying during Ramadan; however, more respondents were engaged in behaviours related to mental wellbeing; 59.9% increased their quantity of food compared to 56.8%, 57.8% ate despite not feeling hungry compared to 53.8% Table 3.

Table 3
Respondents mental wellbeing before and during Ramadan

Factor	Before Ramadan	During Ramadan	P-value
Little interest or pleasure in doing things that I enjoy			
No change	184 (23.9)	210 (27.3)	**0.007**
Less often	442 (57.4)	460 (59.7)	
More often	144 (18.7)	100 (13.0)	
Felt down, depressed or hopeless			
No change	260 (33.8)	274 (35.6)	**< 0.001**
Less often	421 (54.7)	456 (59.2)	
More often	89 (11.6)	40 (5.2)	
Felt nervous, anxious or on edge			
No change	247 (32.1)	267 (34.7)	**< 0.001**
Less often	423 (54.9)	451 (58.6)	
More often	100 (13.0)	52 (6.8)	
Unable to stop or control my worrying			
No change	237 (30.8)	257 (33.4)	**< 0.001**
Less often	423 (55.0)	456 (59.2)	
More often	110 (14.3)	577 (7.4)	
Consuming large quantities of food			
Less often	200 (26.0)	198 (25.7)	0.27
More often	437 (56.8)	461 (59.9)	
No	133 (17.3)	111 (14.4)	
Eating despite not feeling hungry			
Less often	219 (28.4)	238 (30.9)	**0.001**
More often	414 (53.8)	445 (57.8)	
No	137 (17.8)	87 (11.3)	
Snacking			**< 0.001**
Less often	485 (63.0)	540 (70.0)	

Factor	Before Ramadan	During Ramadan	P-value
More often	173 (22.5)	67 (8.7)	
No	112 (14.6)	163 (21.2)	

Factors associated with the change in feeling depressed during Ramadan

Respondents' marital status, educational level, physical activity during Ramadan and perceived importance of a relationship with self were independently associated with the feeling of depression during Ramadan. The odds of feeling more depressed during Ramadan were 70% lower in married respondents relative to their single counterparts (aOR:03, 5% CI: 0.1–0.9). Similarly, respondents who were educated up to secondary school had five-fold increased odds of becoming more depressed during Ramadan (aOR:4.7, 95% CI:1.2–17. 9) relative to those without any education. Furthermore, respondents who increased their physical activity during Ramadan were twice more likely to feel less depressed (aOR:1.8, 5% CI:1.3–2.5). Likewise, respondents who considered relationship with themselves very important had a 70% reduction in odds of feeling more depressed (aOR:0.3, 95% CI 0.1–0.7) (Table 4).

Table 4
Factors associated with the change in feeling depressed during Ramadan

Covariate	*Felt depressed less often*	*Felt depressed more often*	P-Value	*Felt depressed less often*	*Felt depressed more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Age (in years)						
≤20	Reference	Reference	0.11	Reference	Reference	0.62
20–40	1.5 (0.8–2.9)	0.5 (0.2–1.5)		1.6 (0.8–3.1)	0.9 (0.3–2.8)	
40–60	1.8 (0.4–4.2)	–		1.9 (0.6-6.0)	–	
Sex						
Male	Reference	Reference	0.06	Reference	Reference	0.07
Female	0.7 (0.5-1.0)	1.1 (0.6–2.2)		0.7 (0.5-1.0)	1.0 (0.5-2.0)	
Marital status						
Single	Reference	Reference	0.09	Reference	Reference	0.02
Married	0.9 (0.7–1.3)	0.3 (0.1–0.8)		1.0 (0.6–1.3)	0.3 (0.1–0.9)	
Divorced	4.1 (0.5–34.0)	–		4.4 (0.5–37.2)	–	
Widowed	1.2 (1.1-2.0	–		1.1 (0.1–13.5)	–	
Residence						
Rural	Residence	Reference	0.65			
Urban	1.1 (0.8–1.6)	0.8 (0.4–1.8)				
Occupation						
Employed	Reference	Reference	0.10	Reference	Reference	0.42
Unemployed	0.9 (0.7–1.2)	1.9 (0.9–3.8)		0.9 (0.6–1.2)	1.4 (0.6–2.9)	
Highest educational level						

**Adjusted for age, sex, marital status, education, occupation, physical activity, perceived health state, consuming large quantities of food, eating despite not feeling hungry, relationship with self, relationship with God, relationship with other people, relationship with environment & Religious beliefs are behind whole approach to life.*

Covariate	*Felt depressed less often*	*Felt depressed more often*	P-Value	*Felt depressed less often*	*Felt depressed more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Tertiary or higher	Reference	Reference	0.04	Reference	Reference	0.02
Undergraduate	1.3 (0.9–1.9)	2.5 (0.9–7.5)		1.5 (1.0-2.3)	1.9 (0.5–5.9)	
Secondary	1.7 (1.0–3.0)	6.6 (1.9–23.0)		1.9 (1.0-3.5)	4.7 (1.2–17.9)	
Primary	0.4 (0.1–4.3)	–		0.3 (0.1–4.7)	–	
Household income relative to National average						
Top 20%	Reference	Reference	0.82			
Upper 20%	0.6 (0.3–1.2)	0.6 (0.2–1.9)				
Middle 20%	0.7 (0.4–1.2)	0.6 (02-1.7)				
Lower 20%	0.7 (0.4–1.4)	0.6 (0.2–1.9)				
Lowest	1.2 (0.4–4.4)	1.6 (0.2–11.4)				
BMI						
Normal	Reference	Reference	*0.10*	Reference	Reference	0.34
Underweight	1.0 (0.6–1.7)	1.6 (0.7–4.2)		1.1 (0.7–1.9)	1.7 (0.5–4.4)	
Overweight	0.8 (0.5–1.2)	0.5 (0.2–1.5)		0.8 (0.6–1.7)	0.7 (0.5–1.9)	
Obese	0.6 (0.2–1.8)	2.2 (1.4–3.3)		0.7 (0.3–1.9)	2.1 (1.0-3.6)	
Perceived health state during Ramadan						
Good	Reference	Reference	0.71	Reference		0.66
Poor	1.0 (0.4–2.5)	0.5 (0.1–2.5)		1.1 (0.4–2.2)	0.6 (0.3-2.0)	
Modified eating habits during Ramadan						
No	Reference	Reference	0.87			
Yes	1.0 (0.7–1.5)	1.2 (0.5–2.9)				

**Adjusted for age, sex, marital status, education, occupation, physical activity, perceived health state, consuming large quantities of food, eating despite not feeling hungry, relationship with self, relationship with God, relationship with other people, relationship with environment & Religious beliefs are behind whole approach to life.*

Covariate	*Felt depressed less often*	*Felt depressed more often*	P-Value	*Felt depressed less often*	*Felt depressed more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Snacking during Ramadan						
No	Reference	Reference	0.77			
More often	0.5 (0.2–3.1)	0.5 (0.2–2.7)				
Less often	1.1 (0.8–1.9	0.7 (0.4–2.2)				
Consuming large quantities of food						
No	Reference	Reference	< 0.001	Reference	Reference	< 0.001
More often	4.3 (2.9–7.2)	1.7 (0.5-5.0)		4.2 (2.7–7.9)	1.8 (0.6–5.1)	
Less often	3.4 (1.9–6.3)	6.9 (3.2–15.4)		3.3 (1.8–6.2)	6.7 (3.0-14.9)	
Eating despite not feeling hungry						
No	Reference	Reference	< 0.001	Reference	Reference	< 0.001
More often	6.4 (3.8–9.4)	2.9 (1.1–7.5)		6.0 (3.3–10.8)	3.2 (1.2–8.2)	
Less often	4.6 (2.5–8.5)	7.3 (3.3–15.9)		4.5 (2.4–8.4)	7.1 (3.2–15.7)	
Physical activity during Ramadan						
Not changed	Reference	Reference	0.06	Reference	Reference	0.04
Increased	1.9 (1.3–2.6)	1.8 (0.9–3.6)		1.8 (1.3–2.5)	2.1 (0.9–4.4)	
Decreased	1.7 (1.1–2.6)	1.7 (0.8–3.7)		1.7 (1.0-2.6)	2.0 (0.8–4.9)	
Relationship with self						
Not important	Reference	Reference	< 0.001	Reference	Reference	0.01
Less important	0.5 (0.2–1.3)	0.7 (0.5–2.6)		0.3 (0.1–1.3)	0.6 (0.5–2.5)	
Very important	0.6 (0.2–0.8)	0.3 (0.1–0.6)		0.8 (0.2–1.1)	0.3 (0.1–0.7)	

**Adjusted for age, sex, marital status, education, occupation, physical activity, perceived health state, consuming large quantities of food, eating despite not feeling hungry, relationship with self, relationship with God, relationship with other people, relationship with environment & Religious beliefs are behind whole approach to life.*

Covariate	*Felt depressed less often*	*Felt depressed more often*	P-Value	*Felt depressed less often*	*Felt depressed more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Relationship with God						
Not important	Reference		< 0.001	Reference		0.35
Less important	0.6 (0.2–1.5)	–		0.7 (0.1-4.0)	–	
Very important	0.3 (0.1–0.6)	–		0.6 (0.1–3.9)	–	
Relationship with other people						
Not important	Reference	Reference	< 0.002	Reference	Reference	0.55
Less important	0.4 (0.2–0.9)	1.2 (0.1–11.0)		0.3 (0.1–2.5)	1.2 (0.1–11.0)	
Very important	0.3 (0.2–0.6)	1.4 (0.2–11.7)		0.2 (0.1-2.0)	1.4 (0.2–11.7)	
Relationship with environment						
Not important	Reference	Reference	0.03	Reference	Reference	0.51
Less important	0.4 (0.2-1.0)	1.0 (0.2–4.5)		1.8 (0.5–6.3)	1.0 (0.2–4.5)	
Very important	0.3 (0.2–0.7)	0.7 (0.2–3.6)		2.3 (0.6-8.0)	0.7 (0.2–3.6)	
Experience the presence of God in life						
True	Reference		0.53			
Untrue	0.8 (0.2–3.6)	–				
Not sure	1.0 (.4-2.4)	–				
Religious beliefs are behind my whole approach to life						
True	Reference	Reference	0.10	Reference	Reference	0.09
Untrue	0.6 (0.2–1.9)	1.9 (0.4–11.5)		0.7 (0.4–2.1)	2.0 (0.4–10.9)	

**Adjusted for age, sex, marital status, education, occupation, physical activity, perceived health state, consuming large quantities of food, eating despite not feeling hungry, relationship with self, relationship with God, relationship with other people, relationship with environment & Religious beliefs are behind whole approach to life.*

Covariate	*Felt depressed less often*	*Felt depressed more often*	P-Value	*Felt depressed less often*	*Felt depressed more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Not sure	1.4 (0.7–2.6)	–		1.1 (0.4–2.4)		
Try hard to carry religion into all other life's dealings						
True	Reference	Reference	0.59			
Untrue	1.0 (0.4–2.4)	–				
Not sure	1.1 (0.6–2.1)	0.7 (0.2–3.3)				

**Adjusted for age, sex, marital status, education, occupation, physical activity, perceived health state, consuming large quantities of food, eating despite not feeling hungry, relationship with self, relationship with God, relationship with other people, relationship with environment & Religious beliefs are behind whole approach to life.*

Factors associated with the change in the feeling of anxiety during Ramadan

Table 5 displays the factors associated with change in anxiety during Ramadan. Educational level and physical activity during Ramadan were found to be independent risk factors for change in anxiety. Respondents that were educated up to secondary level were 8-fold (aOR;7.5, 95% CI: 2.1–27.5) more likely to be more anxious during Ramadan. On the other hand, respondents who decreased their physical activity were twice more likely to have increased anxiety, (aOR: 1.9, 95% CI: 1.2.-4.4).

Table 5
Factors associated with the change in anxiety during Ramadan

Covariate	*Felt anxious less often*	*Felt anxious more often*	P-Value	*Felt anxious less often*	*Felt anxious more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Age (Years)						
≤20	Reference	Reference	0.06	Reference	Reference	0.29
20–40	2.0 (1.0-3.7)	0.8 (0.3–2.2)		1.9 (0.9–3.9)	1.4 (0.4–4.2)	
40–60	2.2 (0.8–6.2)	–		2.7 (0.9–8.6)	–	
Sex						
Male	Reference	Reference	0.04	Reference	Reference	0.13
Female	0.7 (0.5-1.0)	1.1 (0.6-2.0)		0.7 (0.5-1.0)	1.1 (0.6–2.2)	
Marital status						
Single	Reference	Reference	0.04	Reference	Reference	0.31
Married	0.9 (0.6–1.2)	0.3 (0.1–0.7)		1.0 (0.7–1.4)	0.5 (0.2–1.4)	
Divorced	4.0 (0.5–33.0)	–		4.5 (0.5–39.7)	–	
Widowed	1.1 (0.1–12.7)	–		0.2 (0.1–3.7)	–	
Residence						
Rural	Residence	Residence	0.86			
Urban	1.1 (0.8–1.5)	0.9 (0.5–1.9)				
Occupation						
Employed	Reference	Reference	0.10	Reference	Reference	0.54
Unemployed	1.0 (0.8–1.4)	1.9 (0.9–3.8)		0.9 (1.6–1.2)	1.2 (0.6–2.3)	
Highest Educational status						
Tertiary or higher	Reference	Reference	0.004	Reference	Reference	0.01
Undergraduate	1.5 (1.1–2.2)	3.8 (1.3–11.1)		1.8 (0.8–2.7)	3.1 (1.0-9.5)	

**Adjusted for age, sex, marital status, occupation, marital status, perceived health state during Ramadan, relationship with self, relationship with God, relationship with environment and relationship with other people.*

Covariate	*Felt anxious less often*	*Felt anxious more often*	P-Value	*Felt anxious less often*	*Felt anxious more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Secondary	1.7 (1.0-2.9)	8.6 (2.6–28.9)		1.7 (1.0-3.2)	7.5 (2.1–27.5)	
Primary	0.4 (0.1–4.6)	–		0.2 (0.1–3.7)	–	
Household income relative to National average						
Top 20%	Reference	Reference	0.61			
Upper 20%	0.6 (0.3-1.0)	0.3 (0.1-1.0)				
Middle 20%	0.7 (0.4–1.2)	0.5 (02-1.3)				
Lower 20%	0.7 (0.4–1.4)	0.6 (0.2–1.9)				
Lowest	1.0 (0.3–3.2)	0.7 (0.1–6.9)				
BMI						
Normal	Reference	Reference	0.07	Reference	Reference	0.22
Underweight	1.0 (0.6–1.7)	0.6 (0.2–1.3)		1.3 (0.7–2.1)	0.7 (0.2–1.4)	
Overweight	0.9 (0.5–1.6)	0.4 (0.1–1.1)		1.0 (0.6–1.6)	0.4 (0.1–1.9)	
Obese	0.4 (0.2–1.3)	2.2 (0.9–3.9)		0.6 (0.3–1.6)	1.9 (0.9–4.1)	
Perceived health state during Ramadan						
Good	Reference	Reference	0.43	Reference	Reference	0.51
Poor	0.7 (0.2-2.0)	0.2 (0.1–1.9)		0.7 (0.2-2.0)	0.3 (0.1–1.7)	
Modified eating habits during Ramadan						
No	Reference	Reference	0.42			
Yes	1.2 (0.8–1.7)	1.9 (0.6–5.6)				
Snacking during Ramadan						
No	Reference	Reference	0.63			
More often	0.7 (0.3–4.5)	0.5 (0.3–2.7)				
Less often	1.8 (0.8–2.9)	1.3 (0.6–2.6)				

**Adjusted for age, sex, marital status, occupation, marital status, perceived health state during Ramadan, relationship with self, relationship with God, relationship with environment and relationship with other people.*

Covariate	*Felt anxious less often*	*Felt anxious more often*	P-Value	*Felt anxious less often*	*Felt anxious more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Consuming large quantities of food						
No	Reference	Reference	< 0.001	Reference	Reference	< 0.001
More often	5.0 (2.0-8.9)	2.0 (0.8-5.0)		4.6 (2.7–7.4)	2.0 (0.8-5.0)	
Less often	4.0 (2.1–7.4)	7.3 (3.5–15.0)		3.8 (2.0-7.1)	6.9 (3.3–14.2)	
Eating despite not feeling hungry						
No	Reference	Reference	< 0.001	Reference	Reference	< 0.001
More often	7.4 (4.2–25.6)	3.4 (1.4–7.1)		7.5 (4.5–32.9)	3.5 (1.5-8.0)	
Less often	5.6 (2.5–10.9)	6.9 (3.4–13.9)		5.5 (2.9–10.5)	7.0 (3.4–14.5)	
Physical activity during Ramadan						
Not changed	Reference	Reference	0.003	Reference	Reference	**0.02**
Increased	1.9 (1.3–2.6)	2.0 (0.9–4.2)		1.8 (0.9–2.5)	1.7 (0.8–3.5)	
Decreased	1.7 (1.2–2.6)	2.0 (0.8–4.8)		1.6 (0.8–2.5)	1.9 (1.2.-4.4)	
Relationship with self						
Not important	Reference	Reference	< 0.001	Reference		0.07
Less important	0.5 (0.2–1.3)	0.8 (0.2–1.3)		0.5 (0.2–1.9)	1.9 (0.1–41.2)	
Very important	0.3 (0.1–0.6)	0.3 (2.5–11.4)		0.3 (0.1–1.1)	5.9 (0.4–10.4)	
Relationship with God						
Not important	Reference		0.02	Reference		0.24
Less important	0.6 (0.2–1.5)	0.5 (0.1–9.7)		1.2 (0.2–9.2)	0.9 (0.1–8.4)	
Very important	0.3 (0.1–0.6)	1.6 (0.2–13.4)		0.7 (0.1–5.6)	4.1 (0.1–15.9)	

**Adjusted for age, sex, marital status, occupation, marital status, perceived health state during Ramadan, relationship with self, relationship with God, relationship with environment and relationship with other people.*

Covariate	*Felt anxious less often*	*Felt anxious more often*	P-Value	*Felt anxious less often*	*Felt anxious more often*	P-Value
	Crude OR (95% CI)	Crude OR (95% CI)		*Adjusted OR (95% CI)	*Adjusted OR (95% CI)	
Relationship with other people						
Not important	Reference		0.002	Reference	Reference	0.28
Less important	0.4 (0.2-0.)	1.2 (0.2 (11.0)		0.5 (0.1–3.8)	5.0 (0.2–13.7)	
Very important	0.3 (0.1–0.6)	1.4 (0.2–11.7)		0.4 (0.1–3.4)	7.0 (0.2–12.0)	
Relationship with environment						
Not important	Reference		*0.03*	Reference		0.29
Less important	0.4 (0.2-1.0)	–		0.8 (0.5–6.3)	–	
Very important	0.3 (0.2–0.7)	–		0.8 (0.6-8.0)	–	
Experience the presence of God in my life						
True	Reference	Reference	0.95			
Untrue	1.2 (0.2 (6.5)	2.6 (0.2–28.9)				
Not sure	0.9 (.4-2.2	0.6 0(.1-5.3)				
Religious beliefs are behind the whole approach to life						
True	Reference	Reference	0.47			
Untrue	0.6 (0.2–1.9)	1.8 (0.4–9.3)				
Not sure	1.5 (0.7-3.0)	2.0 (0.6–6.5)				
Try hard to carry religion into all other life's dealings						
True	Reference	Reference	0.56			
Untrue	1.6 (0.6–4.6)	3.3 (0.8–14.2)				
Not sure	1.3 (0.7–2.4	1.4 (0.4–4.3)				

**Adjusted for age, sex, marital status, occupation, marital status, perceived health state during Ramadan, relationship with self, relationship with God, relationship with environment and relationship with other people.*

Discussion

Our study seeks to determine the effects of RIF on mental health and factors associated with changes in depression and anxiety among fasting Nigerians during the month of Ramadan. To the best of our knowledge, this is the first study that looked at the factors influencing mental wellbeing during Ramadan fasting in Nigeria. We found a significant improvement in mental wellbeing among the participants, and symptoms of depression and anxiety were found to be more prevalent before the Ramadan fasting period. Interest and pleasure in doing things were also better during the month. The mental wellbeing was found to be independently associated with some sociodemographic characteristics, physical activity, and perceived relationships.

Our results suggest that RIF promotes psychological wellbeing, and this is consistent with the results of several previous studies. A prospective study examining the effect of RIF on depression among people with type 2 diabetes found significant reduction in depression among the participants(Al-Ozairi et al., 2019). Another research conducted among Iranian general population demonstrated that fasting has positive effects on psychological wellbeing, with reduced depression and anxiety (Mousavi et al., 2014). A recent meta-analysis that included 11 studies with a total of 1436 participants examined effectiveness of fasting interventions on mental health (Berthelot et al., 2021). The result showed that RIF has a positive effect on anxiety and depression. In addition to the its positive effects on depression and anxiety, RIF has also been shown to have a diminishing effect on stress(Berthelot et al., 2021; Erdem, 2018; Koushali et al., 2013) and positive effects on mood and self-esteem (Fond et al., 2013). These effects of RIF on mental wellbeing have been attributed to the reductions in serum cortisol and brain-derived neurotrophic factor (BDNF) of fasting Muslims brought about by this Islamic ritual (Riat et al., 2021). These and other neurobiological factors have as well been reported to account for the observed effects of diet restriction and intermittent fasting even in non-Ramadan fasting subjects.

The therapeutic role of Ramadan on mental health can be explained by many mechanisms, one of which is its lowering effect on body weight (for both obese and non-obese people)('Mo'ez Al-Islam' E. Faris et al., 2020; Fernando et al., 2019; Jahrami et al., 2020). This is because obesity/overweight have been positively correlated to increased incidence of both anxiety and depression even in recent studies (Fulton et al., 2022; Sharafi et al., 2020). This was earlier buttressed in a prospective cohort study of 25, 180 men and women aged 19 to 55 years, which found anxiety and depression to be associated with increased body weight and increased incidence of obesity (Brumpton et al., 2013). Earlier than this study, a five-year observational study of 2123 people aged 50 years and older found obesity at baseline to be associated with increased risk of depression five years later(Roberts et al., 2003). On one hand, a reciprocal association between obesity/overweight with depression and/or anxiety has been reported;(de Wit et al., 2010; Strine et al., 2008) while on the other hand, contrary findings were reported for depression(Roberts et al., 2003), and anxiety(Ejike, 2013). Furthermore, sex disparity has been observed in terms of obesity association with anxiety and depression. This was reported in an Australian study of 2.280 subjects aged 20 to 64 years, wherein obesity in women was found to be associated with greater anxiety and depression and less positive affect, but not in men (Jorm et al., 2003). Biological/molecular mechanisms have also been used to explain the beneficial effect of RIF on mental health. In a recent study, these therapeutic effects on mood-related symptoms have been attributed to the reductions in serum cortisol

and brain-derived neurotrophic factor (BDNF) of fasting Muslims brought about by RIF;(Riat et al., 2021) although one study reported an increase in serotonin, BNDF and nerve growth factor (NGF) in a cohort of “22 women” fasting during Ramadan(Bastani et al., 2017). Similarly, RIF has been found to lower the serum levels of pro-inflammatory cytokine IL-1, IL-6, tumour necrosis factor α (TNF-α)(M. a. I. E. Faris et al., 2019; M. A.-I. E. Faris et al., 2012), which have been shown to be elevated in the serum of depressed people(Young et al., 2014). These and other neurobiological factors have as well been reported to account for the observed effects of “diet restriction and intermittent fasting” even in non-Ramadan fasting subjects(Fond et al., 2013; Igwe et al., 2021); there is yet to be any consensus to perfectly explain the precise nature of depression(Yang et al., 2020). In spite of these vastly reported benefits of Ramadan on aspects of mental health, some studies have reported none or insignificant change(Hsouna et al., 2019; Nugraha et al., 2017). This disparity could be explained by cultural and lifestyle variations between populations.

Furthermore, a large proportion of the respondents reported good mental health during COVID-19 lockdown and nearly half of them agreed that execution of their routine activities was good, despite the tremendous impact of the pandemic on global mental health (Rajkumar, 2020), which resulted in high levels of depression, stress and anxiety in different parts of the world (Ahmad et al., 2020; Shi et al., 2020; C. Wang, Pan, Wan, Tan, Xu, Ho, et al., 2020; C. Wang, Pan, Wan, Tan, Xu, McIntyre, et al., 2020), including Nigeria (Nri-Ezedi et al., 2020; Olaseni et al., 2020). This could be explained by the role of religiousness and spirituality that characterized the study population (Carranza Esteban et al., 2021). This could further be explained by the Islamic faith and its role of alleviating the adverse effect of the pandemic, and the Prophet Mohamed (Peace be upon him) teachings and directions regarding how to deal with the pandemics (BinTaleb & Aseery, 2022).

It is not surprising that nearly three-fifths of the participants had increased their quantity of food during Ramadan. People usually eat two meals during Ramadan, one before dawn (Sahur) and another immediately after sunset (Iftar) but some individuals take an additional meal just before sleeping. Many fasting Muslims believe that deliberate ingestion of extra amounts of food at night helps in reducing the effects of hunger during the daytime. This is not just limited to food but also drinks, as fasting people drink nearly half more amount of fluids than those that are not fasting within the fasting period (Kerimoglu et al., 2010). These habits (dietary restriction during the daytime and or excessive eating at night) may seem to be a risk for later development of eating disorders, which have been found to affect mental wellbeing (Köster & Mojet, 2015). However, most of the studies that examine the effects of Ramadan fasting on disordered eating behaviour showed no significant relationship between the two. Recent studies that examined the relationship between Ramadan fasting and disordered eating behaviours found no correlation between them.

This study found significant associations between psychological wellbeing and some sociodemographic characteristics (such as marital status and educational level), physical activity as well as religiosity and spirituality. While all these were independently associated with the feeling of depression during Ramadan, only education and physical activity were found to have significant association with anxiety during the

month. The relation between depression and marital status in this study is highly significant which is consistent with results of several previous studies. For instance, a study that examined the relationship between socioeconomic status indicators and depression among African women reported that women who have never married present with relatively higher levels of depression compared to those that were married (Scarinci et al., 2002). Similar result was found by another study conducted in the province of Ontario, Canada (Akhtar-Danesh & Landeen, 2007). However, these are in contrast to the finding of an earlier similar study conducted in Northern Nigeria where the author found that depression was diagnosed more frequently in married women than single women (Ifabumuyi, 1983). There are evidences highlighting that the beneficial effect of marriage is mainly to males than females (Brown et al., 2000; Weissman et al., 1996).

It is generally believed that education has a protective effect on mental health. However, our result showed a positive correlation, as respondents who were educated up to secondary school were five and eight times more likely to be more depressed and anxious respectively. Conflicting results have been reported regarding the association between education and depression and anxiety with many researchers reporting inverse relationship (Andrews et al., 2001; Bjelland et al., 2008; Scarinci et al., 2002), and others proving the opposite (Akhtar-Danesh & Landeen, 2007; Fryers et al., 2003). The protective effects of higher education on mental health vary across population subgroups. Generally, it has a more beneficial effect for women than for men, for whites than for blacks, and for people growing up in families with limited socioeconomic resources (Bjelland et al., 2008). Depression was noted to reduce with increasing levels of education, particularly for people who are highly educated (Bjelland et al., 2008). However, anxiety is mostly associated with low education, and the relationship between them might be determined by genetic factors common to both (Tambs et al., 2012).

In the current research we found an inverse relationship between physical activity and mental health status. Individuals that increased their physical activity during the period were noted to have reduced the likelihood of being depressed or hopeless by nearly a half. This supports the findings of many previous studies. A recent study conducted among Spanish adult population during COVID-19 lockdown found that consistent physical activity was associated with reduction in perceived anxiety and depression (López-Bueno et al., 2020). Another study also obtained negative correlation between physical activity and anxiety (Legey et al., 2017). Furthermore, regular moderate physical activity has been reported to protect against the development of depression (Raglin, 1990) and in fact, sedentary lifestyle has been shown to be an important risk factor for depression (Yates et al., 2020).

Another important finding of the current research was the negative correlation between perceived relationships, which define individuals' spirituality, and improved mental wellbeing. It is worth mentioning that beside the physical aspect of Ramadan fasting, the month provides an avenue for improving relationships as fasting individuals are encouraged to re-assess and re-establish meaningful relationships with other people, the community and the Creator. It teaches people to share the responsibilities of people, especially those that are less privileged, through showing mercy and humility as well as giving charity. These foster unity in the society and strengthen interpersonal relationships, and

could explain why the majority of the respondents believe that relationships are essential in their lives. These results are consistent with the findings of Kim et al who highlighted that interpersonal relationship along with other factors could lessen the symptoms of depression and anxiety (Kim et al., 2011). Surprisingly, we found no significant influence of intrinsic religiosity on either depression or anxiety. This finding is indeed unexpected because religiosity has been described to have a profound impact on both physical health and psychological wellbeing, and it contradicts the findings of some studies that found that intrinsic religiosity was strongly associated with fewer depressive symptoms and improved quality of life (Stroppa & Moreira-Almeida, 2013) as well as with faster remission of depression (Koenig et al., 1998).

Strengths and Limitations

To our knowledge this is the first study in Nigeria reviewing the impact of Ramadan intermittent fasting on mental wellbeing. We also correlated the impact of intrinsic religiosity and found to have no effect on mental well- being. The study is not without limitations, as it is a cross-sectional study, it is challenging to establish causality in the relationships that we have identified. Furthermore, with the self-reporting nature of the study there is a risk of social -desirability bias. We emphasise further prospective research with large samples in patients with established mental health and normal individuals to compare the impact of religiosity and spirituality and RIF

Conclusion

This study found significant improvement in mental wellbeing during Ramadan fasting compared to pre-Ramadan period despite the ongoing COVID- 19 pandemic. While marital status, education, physical activity and spirituality was independently associated with the feeling of depression during Ramadan, only education and physical activity were found to have significant association with feeling of anxiety. All these factors were negatively correlated with both depression and anxiety, except education which appeared to have a direct relationship with anxiety.

Statements And Declarations

Acknowledgments: The authors would like to thank all the participants who participated in the study. We are thankful to the following people for their contribution: Dr Aminu Yusuf Abubakar (Federal Medical Center Birnin Kudu, Jigawa), Dr Najib Jamal AbdulNasir (Federal Medical Center, Katsina), Dr Saidu Idris Ahmad (Murtala Muhammad Specialist Hospital, Kano), Abubakar Yakubu (College of Health Sciences, Bayero University, Kano), RN Saadiya Usman (ART Clinic, YSSH, Gashua, Yobe), Dr Abubakar Garba Ismail (Yobe State Specialist Hospital, Damaturu), Dr Saeed Suleiman (College of Health Science. Bayero University, Kano).

Funding: No funding was obtained for this research

Competing Interest: The authors have no relevant financial or non-financial interests to disclose.

Author Contributions: Conceptualization, Moien AB Khan, Sahabi K. Sulaiman, Fatima I. Tsiga-Ahmad, Yesir A. Kareem; Data collection (survey link dissemination): Sahabi K. Sulaiman, Aminu H., Yesir A. Kareem, Farouq M. Dayyab; Methodology, Sahabi K. Sulaiman, Moien AB Khan ; Formal Analysis, Fatima I. Tsiga-Ahmad (lead), Sahabi K. Sulaiman (support); Data curation, Sahabi K. Sulaiman, Moien AB Khan, Fatima I. Tsiga-Ahmad ; Writing—original draft preparation, Sahabi K. Sulaiman, Fatima I. Tsiga-Ahmad, Mohammad Sale Musa, Teresa A., Yesir A. Kareem; Writing—review and editing Shehu S., Moien AB Khan, Fatima I. Tsiga-Ahmad, Sahabi K. Sulaiman, MoezAlIslam E. Faris, Teresa A., Mohammad S. Musa, Farouq M. Dayyab, Aminu H; Supervision, Shehu S., MoezAlIslam E. Faris, Teresa A., Sahabi K. Sulaiman; Project administration, Moien AB Khan; Ethics approval acquisition, Sahabi K Sulaiman. All authors have revised the manuscript for intellectual content. All authors have read and approved the final version of the manuscript.

Ethics Approval: This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the research ethics committee of the Yobe State University Teaching Hospital, Damaturu, Nigeria (YSUTH/MAC/EC/02). Informed consent was obtained from the patient prior to conducting study.

References

1. Abdel-Khalek, A. M., Nuño, L., Gómez-Benito, J., & Lester, D. (2019). The Relationship Between Religiosity and Anxiety: A Meta-analysis. *Journal of Religion and Health*, 58(5), 1847–1856. https://doi.org/10.1007/s10943-019-00881-z
2. Ahmad, A., Rahman, I., & Agarwal, M. (2020). Early psychosocial predictors of mental health among Indians during coronavirus disease 2019 outbreak. *Journal of Health Sciences*, 10(2), 147–156. https://doi.org/10.17532/jhsci.2020.950
3. Akhtar-Danesh, N., & Landeen, J. (2007). Relation between depression and sociodemographic factors. *International Journal of Mental Health Systems*, 1(1), 4. https://doi.org/10.1186/1752-4458-1-4
4. Al Zaben, F., Khalifa, D. A., Sehlo, M. G., Shohaib, A., Binzaqr, S., Badreg, S. A. … Koenig, H. G. (2015). Religious involvement and health in dialysis patients in Saudi Arabia. *Journal of Religion and Health*, 54(2), 713–730. https://doi.org/10.1007/s10943-014-9962-8
5. Al-Ozairi, E., AlAwadhi, M. M., Al-Ozairi, A., Taghadom, E., & Ismail, K. (2019). A prospective study of the effect of fasting during the month of Ramadan on depression and diabetes distress in people with type 2 diabetes. *Diabetes Research and Clinical Practice*, 153, 145–149. https://doi.org/10.1016/j.diabres.2019.05.006
6. Andrews, G., Henderson, S., & Hall, W. (2001). Prevalence, comorbidity, disability and service utilisation. Overview of the Australian National Mental Health Survey. *The British Journal of Psychiatry: The Journal of Mental Science*, 178, 145–153. https://doi.org/10.1192/bjp.178.2.145

7. Arroll, B., Goodyear-Smith, F., Crengle, S., Gunn, J., Kerse, N., Fishman, T. … Hatcher, S. (2010). Validation of PHQ-2 and PHQ-9 to screen for major depression in the primary care population. *Annals of Family Medicine*, 8(4), 348–353. https://doi.org/10.1370/afm.1139
8. Athanasiadis, D. I., Hernandez, E., Hilgendorf, W., Roper, A., Embry, M., Selzer, D., & Stefanidis, D. (2021). How are bariatric patients coping during the coronavirus disease 2019 (COVID-19) pandemic? Analysis of factors known to cause weight regain among postoperative bariatric patients. *Surgery for Obesity and Related Diseases*, 17(4), 756–764. https://doi.org/10.1016/j.soard.2020.11.021
9. Bastani, A., Rajabi, S., & Kianimarkani, F. (2017). The Effects of Fasting During Ramadan on the Concentration of Serotonin, Dopamine, Brain-Derived Neurotrophic Factor and Nerve Growth Factor. *Neurology International*, 9(2), 7043. https://doi.org/10.4081/ni.2017.7043
10. Berthelot, E., Etchecopar-Etchart, D., Thellier, D., Lancon, C., Boyer, L., & Fond, G. (2021). Fasting Interventions for Stress, Anxiety and Depressive Symptoms: A Systematic Review and Meta-Analysis. *Nutrients*, 13(11), 3947. https://doi.org/10.3390/nu13113947
11. BinTaleb, A., & Aseery, A. (2022). What Can the Prophet Muhammad Teach Us about Pandemics? *Journal of Religious & Theological Information*, 0(0), 1–13. https://doi.org/10.1080/10477845.2021.2017552
12. Bjelland, I., Krokstad, S., Mykletun, A., Dahl, A. A., Tell, G. S., & Tambs, K. (2008). Does a higher educational level protect against anxiety and depression? The HUNT study. *Social Science & Medicine (1982)*, 66(6), 1334–1345. https://doi.org/10.1016/j.socscimed.2007.12.019
13. Brito, M. A., Amad, A., Rolland, B., Geoffroy, P. A., Peyre, H., Roelandt, J. L. … Pignon, B. (2021). Correction to: Religiosity and prevalence of suicide, psychiatric disorders and psychotic symptoms in the French general population. *European Archives of Psychiatry and Clinical Neuroscience*, 271(8), 1559. https://doi.org/10.1007/s00406-021-01304-5
14. Brumpton, B., Langhammer, A., Romundstad, P., Chen, Y., & Mai, X. M. (2013). The associations of anxiety and depression symptoms with weight change and incident obesity: The HUNT Study. *International Journal of Obesity (2005)*, 37(9), 1268–1274. https://doi.org/10.1038/ijo.2012.204
15. Carranza Esteban, R. F., Turpo-Chaparro, J. E., Mamani-Benito, O., Torres, J. H., & Arenaza, F. S. (2021). Spirituality and religiousness as predictors of life satisfaction among Peruvian citizens during the COVID-19 pandemic. *Heliyon*, 7(5), e06939. https://doi.org/10.1016/j.heliyon.2021.e06939
16. de Wit, L. M., Fokkema, M., van Straten, A., Lamers, F., Cuijpers, P., & Penninx, B. W. J. H. (2010). Depressive and anxiety disorders and the association with obesity, physical, and social activities. *Depression and Anxiety*, 27(11), 1057–1065. https://doi.org/10.1002/da.20738
17. Ejike, C. E. (2013). Association between anxiety and obesity: A study of a young-adult Nigerian population. *Journal of Neurosciences in Rural Practice*, 4(Suppl 1), 13–18. https://doi.org/10.4103/0976-3147.116429

18. Erdem, Ö. (2018). The investigation of the effects of Ramadan fasting on the mood state of healthy volunteer persons. *Aile Hekimliği ve Palyatif Bakım*, 3, 1–6. https://doi.org/10.22391/fppc.398323
19. Faris, M. a. I. E., Jahrami, H. A., Obaideen, A. A., & Madkour, M. I. (2019). Impact of diurnal intermittent fasting during Ramadan on inflammatory and oxidative stress markers in healthy people: Systematic review and meta-analysis. *Journal of Nutrition & Intermediary Metabolism*, *15*, 18–26. https://www.cabdirect.org/globalhealth/abstract/20193232951
20. Faris, M. A. I. E., Kacimi, S., Al-Kurd, R. A., Fararjeh, M. A., Bustanji, Y. K., Mohammad, M. K., & Salem, M. L. (2012). Intermittent fasting during Ramadan attenuates proinflammatory cytokines and immune cells in healthy subjects. *Nutrition Research (New York, N.Y.)*, 32(12), 947–955. https://doi.org/10.1016/j.nutres.2012.06.021
21. Faris, M. A. I. E., Jahrami, H. A., Alsibai, J., & Obaideen, A. A. (2020). Impact of Ramadan diurnal intermittent fasting on the metabolic syndrome components in healthy, non-athletic Muslim people aged over 15 years: A systematic review and meta-analysis. *British Journal of Nutrition*, 123(1), 1–22. https://doi.org/10.1017/S000711451900254X
22. Faul, F., Erdfelder, E., Lang, A. G., & Buchner, A. (2007). G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, 39(2), 175–191. https://doi.org/10.3758/bf03193146
23. Fernando, H. A., Zibellini, J., Harris, R. A., Seimon, R. V., & Sainsbury, A. (2019). Effect of Ramadan Fasting on Weight and Body Composition in Healthy Non-Athlete Adults: A Systematic Review and Meta-Analysis. *Nutrients*, 11(2), E478. https://doi.org/10.3390/nu11020478
24. Fisher, J., & Ng, D. (2017). Presenting a 4-Item Spiritual Well-Being Index (4-ISWBI). *Religions*, 8(9), 179. https://doi.org/10.3390/rel8090179
25. Fond, G., Macgregor, A., Leboyer, M., & Michalsen, A. (2013). Fasting in mood disorders: Neurobiology and effectiveness. A review of the literature. *Psychiatry Research*, 209(3), 253–258. https://doi.org/10.1016/j.psychres.2012.12.018
26. Fryers, T., Melzer, D., & Jenkins, R. (2003). Social inequalities and the common mental disorders: A systematic review of the evidence. *Social Psychiatry and Psychiatric Epidemiology*, 38(5), 229–237. https://doi.org/10.1007/s00127-003-0627-2
27. Fulton, S., Décarie-Spain, L., Fioramonti, X., Guiard, B., & Nakajima, S. (2022). The menace of obesity to depression and anxiety prevalence. *Trends in Endocrinology and Metabolism: TEM*, 33(1), 18–35. https://doi.org/10.1016/j.tem.2021.10.005
28. Gilavand, A., & Fatahiasl, J. (2018). Studying Effect of Fasting during Ramadan on Mental Health of University Students in Iran: A Review. *Undefined*. https://www.semanticscholar.org/paper/Studying-Effect-of-Fasting-during-Ramadan-on-Mental-Gilavand-Fatahiasl/89ed126a367dd9c8e9569de711765a6f437fd64b
29. Hsouna, H., Abdessalem, R., Boukhris, O., Trabelsi, K., Chtourou, L., Tahri, N. … Chtourou, H. (2019). Short-term maximal performance, alertness, dietary intake, sleep pattern and mood states of

physically active young men before, during and after Ramadan observance. *PloS One*, 14(6), e0217851. https://doi.org/10.1371/journal.pone.0217851

30. Ifabumuyi, O. I. (1983). Demographic characteristics of depressives in northern Nigeria. *Acta Psychiatrica Scandinavica*, 68(4), 271–276. https://doi.org/10.1111/j.1600-0447.1983.tb07007.x
31. Igwe, O., Sone, M., Matveychuk, D., Baker, G. B., & Dursun, S. M. (2021). A review of effects of calorie restriction and fasting with potential relevance to depression. *Progress in Neuro-Psychopharmacology & Biological Psychiatry*, 111, 110206. https://doi.org/10.1016/j.pnpbp.2020.110206
32. Jahrami, H. A., Alsibai, J., Clark, C. C. T., & Faris, M. A. I. E. (2020). A systematic review, meta-analysis, and meta-regression of the impact of diurnal intermittent fasting during Ramadan on body weight in healthy subjects aged 16 years and above. *European Journal of Nutrition*, 59(6), 2291–2316. https://doi.org/10.1007/s00394-020-02216-1
33. Jorm, A. F., Korten, A. E., Christensen, H., Jacomb, P. A., Rodgers, B., & Parslow, R. A. (2003). Association of obesity with anxiety, depression and emotional well-being: A community survey. *Australian and New Zealand Journal of Public Health*, 27(4), 434–440. https://doi.org/10.1111/j.1467-842x.2003.tb00423.x
34. Kerimoglu, H., Ozturk, B., Gunduz, K., Bozkurt, B., Kamis, U., & Okka, M. (2010). Effect of altered eating habits and periods during Ramadan fasting on intraocular pressure, tear secretion, corneal and anterior chamber parameters. *Eye*, 24(1), 97–100. https://doi.org/10.1038/eye.2009.96
35. Khan, M. M. A., Nor, M., Mamat, N., Mohd-Shukri, N. M., N. A., & Bakar, W. A. M. A. (2018). Fasting in Islam: A Combination of Spiritual Elevation and Prevention of Diseases. *IIUM Medical Journal Malaysia*, 17(2), Article 2. https://doi.org/10.31436/imjm.v17i2.955
36. Kim, S., Kim, H. L., Woo, C., Park, S., & Keum, R. (2011). Communication abilities, Interpersonal Relationship, Anxiety, and Depression in Korean Soldiers. *Journal of Korean Academy of Psychiatric and Mental Health Nursing*, 20(1), 81–90. https://doi.org/10.12934/jkpmhn.2011.20.1.81
37. Koenig, H. G., George, L. K., & Peterson, B. L. (1998). Religiosity and Remission of Depression in Medically Ill Older Patients. *American Journal of Psychiatry*, 155(4), 536–542. https://doi.org/10.1176/ajp.155.4.536
38. Köster, E. P., & Mojet, J. (2015). From mood to food and from food to mood: A psychological perspective on the measurement of food-related emotions in consumer research. *Food Research International*, 76, 180–191. https://doi.org/10.1016/j.foodres.2015.04.006
39. Koushali, A. N., Hajiamini, Z., Ebadi, A., Bayat, N., & Khamseh, F. (2013). Effect of Ramadan fasting on emotional reactions in nurses. *Iranian Journal of Nursing and Midwifery Research*, 18(3), 232–236. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3748544/
40. Legey, S., Aquino, F., Lamego, M. K., Paes, F., Nardi, A. E., Neto, G. M. … Machado, S. (2017). Relationship Among Physical Activity Level, Mood and Anxiety States and Quality of Life in Physical Education Students. *Clinical Practice and Epidemiology in Mental Health: CP & EMH*, 13, 82–91. https://doi.org/10.2174/1745017901713010082

41. López-Bueno, R., Calatayud, J., Ezzatvar, Y., Casajús, J. A., Smith, L., Andersen, L. L., & López-Sánchez, G. F. (2020). Association Between Current Physical Activity and Current Perceived Anxiety and Mood in the Initial Phase of COVID-19 Confinement. *Frontiers in Psychiatry*, 11, 729. https://doi.org/10.3389/fpsyt.2020.00729
42. Maryam, J., Alireza, Z. S., Mehran, H. S., & Ali, R. (2010). *Effect Of Ramadan Fasting On Self-Esteem And Mental Health Of Students*. *11*(444), 266–273. https://www.sid.ir/en/Journal/ViewPaper.aspx?ID=197135
43. Mishra, S. K., Togneri, E., Tripathi, B., & Trikamji, B. (2017). Spirituality and Religiosity and Its Role in Health and Diseases. *Journal of Religion and Health*, 56(4), 1282–1301. https://doi.org/10.1007/s10943-015-0100-z
44. Mohammadi, M., Larijani, B., Sanjari, M., & Jalili, R. (2001). Effects of Ramadan Of Anxiety & Depression. *IJEM*, 3(0), 27–27. https://www.sid.ir/en/journal/ViewPaper.aspx?id=498471
45. Mousavi, S., Rezaei, M., Baghni, S. A., & Seifi, M. (2014). *Effect of fasting on mental health in the general population of Kermanshah, Iran.* https://doi.org/10.22038/JFH.2014.3143
46. Moutinho, I. L. D., Maddalena, N., de Roland, C. P., Lucchetti, R. K., Tibiriçá, A. L. G., Ezequiel, S. H. C., O. da S., & Lucchetti, G. (2017). Depression, stress and anxiety in medical students: A cross-sectional comparison between students from different semesters. *Revista Da Associacao Medica Brasileira (1992)*, *63*(1), 21–28. https://doi.org/10.1590/1806-9282.63.01.21
47. Nigeria (2022). : *Monthly living wage 2020*. (n.d.). Statista. Retrieved February 8, from https://www.statista.com/statistics/1119087/monthly-living-wage-in-nigeria/
48. Nri-Ezedi, C. A., Nnamani, C. P., Ezeh, N. I., Okechukwu, C., Fasesan, O., & Ulasi, T. O. (2020). Psychological Distress among Residents in Nigeria during the COVID-19 Pandemic. *International Neuropsychiatric Disease Journal*, 8–21. https://doi.org/10.9734/indj/2020/v14i330129
49. Nugraha, B., Ghashang, S. K., Hamdan, I., & Gutenbrunner, C. (2017). Effect of Ramadan fasting on fatigue, mood, sleepiness, and health-related quality of life of healthy young men in summer time in Germany: A prospective controlled study. *Appetite*, 111, 38–45. https://doi.org/10.1016/j.appet.2016.12.030
50. Olaseni, A. O., Akinsola, O. S., Agberotimi, S. F., & Oguntayo, R. (2020). Psychological distress experiences of Nigerians during Covid-19 pandemic; the gender difference. *Social Sciences & Humanities Open*, 2(1), 100052. https://doi.org/10.1016/j.ssaho.2020.100052
51. Plummer, F., Manea, L., Trepel, D., & McMillan, D. (2016). Screening for anxiety disorders with the GAD-7 and GAD-2: A systematic review and diagnostic metaanalysis. *General Hospital Psychiatry*, 39, 24–31. https://doi.org/10.1016/j.genhosppsych.2015.11.005
52. Raglin, J. S. (1990). Exercise and mental health. Beneficial and detrimental effects. *Sports Medicine (Auckland, N.Z.)*, 9(6), 323–329. https://doi.org/10.2165/00007256-199009060-00001
53. Rajkumar, R. P. (2020). COVID-19 and mental health: A review of the existing literature. *Asian Journal of Psychiatry*, 52, 102066. https://doi.org/10.1016/j.ajp.2020.102066

54. Riat, A., Suwandi, A., Ghashang, S. K., Buettner, M., Eljurnazi, L., Grassl, G. A. … Nugraha, B. (2021). Ramadan Fasting in Germany (17–18 h/Day): Effect on Cortisol and Brain-Derived Neurotrophic Factor in Association With Mood and Body Composition Parameters. *Frontiers in Nutrition*, *8*. https://www.frontiersin.org/article/10.3389/fnut.2021.697920
55. Ridho, S., Hasan, H., Futihandayani, A. K. A., Islamiati, A., D., & Suralaga, F. (2021, January 1). *The Relation between Monday and Thursday Fasting towards Emotional Intelligence (EI): A Preliminary Report*. https://doi.org/10.4108/eai.20-10-2020.2305136
56. Rim, J. I., Ojeda, J. C., Svob, C., Kayser, J., Drews, E., Kim, Y. … Weissman, M. M. (2019). Current Understanding of Religion, Spirituality, and Their Neurobiological Correlates. *Harvard Review of Psychiatry*, 27(5), 303–316. https://doi.org/10.1097/HRP.0000000000000232
57. Roberts, R. E., Deleger, S., Strawbridge, W. J., & Kaplan, G. A. (2003). Prospective association between obesity and depression: Evidence from the Alameda County Study. *International Journal of Obesity and Related Metabolic Disorders: Journal of the International Association for the Study of Obesity*, 27(4), 514–521. https://doi.org/10.1038/sj.ijo.0802204
58. Rolls, E. T. (2019). The cingulate cortex and limbic systems for emotion, action, and memory. *Brain Structure & Function*, 224(9), 3001–3018. https://doi.org/10.1007/s00429-019-01945-2
59. Ronneberg, C. R., Miller, E. A., Dugan, E., & Porell, F. (2016). The Protective Effects of Religiosity on Depression: A 2-Year Prospective Study. *The Gerontologist*, 56(3), 421–431. https://doi.org/10.1093/geront/gnu073
60. Rudebeck, P. H., & Rich, E. L. (2018). Orbitofrontal cortex. *Current Biology: CB*, 28(18), R1083–R1088. https://doi.org/10.1016/j.cub.2018.07.018
61. Saunders, D., Svob, C., Pan, L., Abraham, E., Posner, J., Weissman, M., & Wickramaratne, P. (2021). Differential Association of Spirituality and Religiosity With Rumination: Implications for the Treatment of Depression. *The Journal of Nervous and Mental Disease*, 209(5), 370–377. https://doi.org/10.1097/nmd.0000000000001306
62. Scarinci, I. C., Beech, B. M., Naumann, W., Kovach, K. W., Pugh, L., & Fapohunda, B. (2002). Depression, socioeconomic status, age, and marital status in black women: A national study. *Ethnicity & Disease*, 12(3), 421–428
63. Shammas, M. A. (2011). Telomeres, lifestyle, cancer, and aging. *Current Opinion in Clinical Nutrition and Metabolic Care*, 14(1), 28–34. https://doi.org/10.1097/MCO.0b013e32834121b1
64. Sharafi, S. E., Garmaroudi, G., Ghafouri, M., Bafghi, S. A., Ghafouri, M., Tabesh, M., & Alizadeh, Z. (2020). *Prevalence of anxiety and depression in patients with overweight and obesity*. https://doi.org/10.1016/j.obmed.2019.100169
65. Shi, L., Lu, Z. A., Que, J. Y., Huang, X. L., Liu, L., Ran, M. S. … Lu, L. (2020). Prevalence of and Risk Factors Associated With Mental Health Symptoms Among the General Population in China During the Coronavirus Disease 2019 Pandemic. *JAMA Network Open*, 3(7), e2014053. https://doi.org/10.1001/jamanetworkopen.2020.14053

66. Stearns, M., Nadorff, D. K., Lantz, E. D., & McKay, I. T. (2018). Religiosity and depressive symptoms in older adults compared to younger adults: Moderation by age. *Journal of Affective Disorders*, 238, 522–525. https://doi.org/10.1016/j.jad.2018.05.076

67. Strine, T. W., Mokdad, A. H., Dube, S. R., Balluz, L. S., Gonzalez, O., Berry, J. T. … Kroenke, K. (2008). The association of depression and anxiety with obesity and unhealthy behaviors among community-dwelling US adults. *General Hospital Psychiatry*, 30(2), 127–137. https://doi.org/10.1016/j.genhosppsych.2007.12.008

68. Stroppa, A., & Moreira-Almeida, A. (2013). Religiosity, mood symptoms, and quality of life in bipolar disorder. *Bipolar Disorders*, 15(4), 385–393. https://doi.org/10.1111/bdi.12069

69. Tambs, K., Kendler, K. S., Reichborn-Kjennerud, T., Aggen, S. H., Harris, J. R., Neale, M. C. … Røysamb, E. (2012). Genetic and environmental contributions to the relationship between education and anxiety disorders – a twin study. *Acta Psychiatrica Scandinavica*, 125(3), 203–212. https://doi.org/10.1111/j.1600-0447.2011.01799.x

70. Trepanowski, J. F., & Bloomer, R. J. (2010). The impact of religious fasting on human health. *Nutrition Journal*, 9, 57. https://doi.org/10.1186/1475-2891-9-57

71. Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., & Ho, R. C. (2020). Immediate Psychological Responses and Associated Factors during the Initial Stage of the 2019 Coronavirus Disease (COVID-19) Epidemic among the General Population in China. *International Journal of Environmental Research and Public Health*, 17(5), E1729. https://doi.org/10.3390/ijerph17051729

72. Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R. S. … Ho, C. (2020). A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain, Behavior, and Immunity*, 87, 40–48. https://doi.org/10.1016/j.bbi.2020.04.028

73. Wang, L., Koenig, H. G., Shohaib, A., S., & Wang, Z. (2020). Religiosity, depression and telomere length in Chinese older adults. *Journal of Affective Disorders*, 260, 624–628. https://doi.org/10.1016/j.jad.2019.09.066

74. Waugh, C. E., Lemus, M. G., & Gotlib, I. H. (2014). The role of the medial frontal cortex in the maintenance of emotional states. *Social Cognitive and Affective Neuroscience*, 9(12), 2001–2009. https://doi.org/10.1093/scan/nsu011

75. Weir, C. B., & Jan, A. (2022). BMI Classification Percentile And Cut Off Points. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK541070/

76. Yang, T., Nie, Z., Shu, H., Kuang, Y., Chen, X., Cheng, J. … Liu, H. (2020). The Role of BDNF on Neural Plasticity in Depression. *Frontiers in Cellular Neuroscience*, *14*. https://www.frontiersin.org/article/10.3389/fncel.2020.00082

77. Yates, B. E., DeLetter, M. C., & Parrish, E. M. (2020). Prescribed exercise for the treatment of depression in a college population: An interprofessional approach. *Perspectives in Psychiatric Care*, 56(4), 894–899. https://doi.org/10.1111/ppc.12508

78. Young, J. J., Bruno, D., & Pomara, N. (2014). A review of the relationship between proinflammatory cytokines and major depressive disorder. *Journal of Affective Disorders*, 169, 15–20.

https://doi.org/10.1016/j.jad.2014.07.032

79. Yousuf, S., Syed, A., & Ahmedani, M. Y. (2021). To explore the association of Ramadan fasting with symptoms of depression, anxiety, and stress in people with diabetes. *Diabetes Research and Clinical Practice*, 172, 108545. https://doi.org/10.1016/j.diabres.2020.108545