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The impact of Ramadan during COVID-19 confinement on weight, dietary, and lifestyle habits in the Kingdom of Saudi Arabia: a cross-sectional study

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Abstract

Severe procedures were undertaken globally because of the COVID-19 pandemic to overcome the spread of the disease and to prevent catastrophic results affecting the health care system including social distancing, lockdowns, and quarantines. Despite the widely known health benefits of Ramadan fasting, there was a general concern regarding the lifestyle of people during Ramadan 2020 that accompanied the period of COVID-19 pandemic and the home confinement applied. The main objective for the current cross-sectional investigation was to investigate the influence of Covid-19 lockdown during Ramadan fasting on weight change on 481 participants in Saudi Arabia. Identifying the contributing risk factors to weight gain were also addressed. Around 42% of the participants had gained weight and around 38% of the participants had lost weight. Physical activity level was shown to be considered as a protective factor against weight gain (OR = 1.03 with $P = 0.008$), while increasing the number of meals and not adapting healthy cooking methods can both be considered as contributing factors to weight gain (OR = 1.03 with $P = 0.009$, and OR = 1.03 with $P = 0.004$, respectively). Assessing these changes during Ramadan of COVID-19 quarantine provided valuable perspective on the health and wellbeing of Saudi Arabia citizens. These findings should be considered in future studies to explore the persistence of Covid-19 related weight status and habit change.

Keywords: Weight, Ramadan, Covid-19, Confinement, Saudi Arabia

Introduction

Severe procedures were undertaken globally because of the COVID-19 pandemic to overcome the spread of the disease to prevent catastrophic results affecting the health care system including social distancing, lockdowns, and quarantines. The health status of a particular population is a global public health concern, especially with these restrictive policies that limited access to health care systems, transportation to worksites, changed

physical activity level, and changed the quality of dietary intake [1, 2]. Yet, the influence of these confining procedures on weight is not fully elucidated, with various findings were shown globally [3–6]. Examining obesity risk factors during this critical period of pandemic-related lockdown is important, especially with the lack of weight management treatment worldwide [7]. Identifying obesity contributors on the population level is essential from a policy perspective, to help determine effective strategies targeted against weight gain when such restrictive procedures are intended to be applied again in the future.

A series of curtailments on individual movements have been applied by the Saudi Arabian government. During the partial lockdown, people were permitted to leave

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their homes only from 06:00 to 19:00, whereas permission to leave homes for reported causes such as grocery shopping in the neighbourhood was only from 06:00 to 15:00 during total lockdown. The home quarantine period started on the 23rd of March and ended on the 21st of June 2020 [8], during which the holy month of Ramadan is. Ramadan fasting is considered in the scientific literature as a type of intermittent fasting, which is an obligatory spiritual practice for Muslims that involves abstaining from eating, drinking, intercourse, and other activities from sunrise to sunset [9, 10].

Lockdown can alter nutritional habits, and cause lifestyle disturbances such as increased daily sitting time [1, 2, 11, 12]. On the other hand, Ramadan month is considered as a good chance by Muslims to have lifelong influences by making meaningful modifications to their lifestyle in general that empower them to live a happier and healthier life with their beloved ones [13]. In addition, it improves an individual's self-discipline and self-control [13]. Despite the widely known health benefits of Ramadan fasting, there was a general concern regarding the lifestyle of people during Ramadan 2020 that accompanied the period of the home confinement applied because of the COVID-19 pandemic. The present study highlighted the cross-sectional effect of the lockdown and home confinement applied during Ramadan 2020 on weight status and lifestyle changes among people living in the Kingdom of Saudi Arabia (KSA). Therefore, the main aim of the current research was to investigate the influence of Covid-19 confinement during Ramadan fasting on weight change. Secondary objectives were to identify the most preventive and contributing risk factors to weight loss and/or weight gain, if any.

Methods

Design of the study and study participants

The present cross-sectional study took place between May 17 and May 23, 2020, which was the last week of Ramadan holy month (April 23-May 23, 2020). Within this period of time in KSA, number of confirmed cases of

Covid-19 has more than doubled to 98,869 from 41,014 (John Hopkins Corona Center; <https://coronavirus.jhu.edu/>) [14]. The restrictions imposed in Saudi Arabia with respect to timeline of events are shown in Table 1. Eligibility to voluntarily participate in the study was considered if participants were adults (>18 years old) of Saudi and non-Saudi nationalities who resided in the country and were with access to internet. Participants' email addresses were collected to avoid duplication of data entry. Additionally, volunteered participation was accepted after obtaining written informed consent from all respondents. The Ethics Committee for Post Graduate Studies and Scientific Research at the College of Applied Medical Sciences, King Abdulaziz University, KSA, has approved the research design and protocol (reference number FAMS-EC2020-004). All methods were applied according to relevant regulations and guidelines.

Questionnaire

Collection of data was done via an online electronic survey and all of the included participants completed filling the electronic survey within Ramadan (100%). The questionnaire included 26 questions and started with a cover letter in Arabic language that explained the purpose of the study, information to reach out for the principal investigator, and the consent form. Questions were included based on what was mentioned in the literature and according to study objectives. The electronic survey consisted of demographic and social information, and multiple-choice questions to determine the dietary habits changes related to COVID-19, and lifestyle in general, including physical activity, screen time, smoking, and sleeping habits among participants. Moreover, changes in weight in kg since COVID-19 quarantine started and on-time of questionnaire collection was also requested to be filled, subjectively. Questions were summarised in Table 2 and were attached to [supplementary material](#). Experts of medical background who were resided in the country critically appraised the electronic survey and various revisions were done to add to the scientific

Table 1 Restrictions applied in Saudi Arabia with respect to timeline of events

Event	Dates	Curfew hours	Exception
Suspension of non-essential work	Mar 15	None	None
Nationwide curfew	Mar 23–Apr 5	6AM–7PM	Makkah/Madinah
Enhanced curfew	Apr 6–25	6AM–3PM	None
Ramadan ^a	Apr 26–May 22	9AM–5PM	Makkah
Eid Al Fitr	May 23–27	24 h	None
Phase 1 partial easing	May 28–30	6AM–3PM	Makkah
Phase 2 partial easing	May 31–Jun 20	6AM–6PM	Makkah

^a Denotes events happened throughout data collection timeline (May 17–May 23, 2020). Table adapted from Alfawaz and their colleagues [15].

Table 2 Characteristics of the studied population ($n = 481$)

Parameters		Frequency (%)
Gender	Female	297 (61.7)
	Male	184 (38.2)
Age	18–25 years	53 (11.0)
	26–35 years	153 (31.8)
	36–45 years	90 (18.7)
	> 45 years	205 (42.6)
Body Mass Index (at the time of data collection)	Underweight	12 (2.49)
	Normal weight	162 (33.67)
	Overweight	159 (33.05)
	Obese	148 (30.76)
Sociodemographic parameters		
Education level	High school	62 (12.4)
	Diploma	6 (1.2)
	Bachelor's degree	323 (64.5)
	Master's degree	67 (13.4)
	PhD degree	43 (8.6)
Employment status	Student	47 (9.4)
	Employed	237 (49.2)
	Unemployed	30 (6.0)
	Own business	8 (1.6)
	Retired	82 (16.4)
Family members	House wife	77 (15.4)
	single	12 (2.4)
	2	36 (7.4)
	3–4	110 (22.0)
> 4	327 (67.9)	
COVID-19 pandemic related parameters		
Change in family income	Yes	147 (30.5)
	No	334 (69.4)
Weight change since quarantine started	Yes, increased	202(41.9)
	Yes, decreased	178 (37.0)
	No change, weight is stable	101 (20.9)
Change in dietary habits	Quantity of meal increased	171 (35.6)
	Quantity of meal decreased	102 (21.2)
	Dependent on home cooking for main meals	277 (57.6)
	Dependent on outside foods for main meals (e.g., takeaway from restaurants)	13 (2.7)
	Frying is the main cooking method	117 (24.3)
Boiling, broiling, and grilling are the main cooking methods	163 (33.9)	

Table 2 (continued)

Parameters	Frequency (%)	
Change in lifestyle habits	Water consumption has increased	184 (38.3)
	Water consumption has decreased	91 (18.9)
	Tea and coffee consumption have increased	128 (26.6)
	Tea and coffee consumption have decreased	46 (9.6)
	Physical activity has increased	84 (17.4)
	Physical activity has decreased	209 (43.4)
	Sleeping hours have increased	147 (30.5)
	Sleeping hours have decreased	122 (25.3)
	Time spent on screens has increased	292 (60.7)
	Time spent on screens has decreased	28 (5.8)
	Number of cigarettes smoked has increased	29 (6.0)
	Number of cigarettes smoked has decreased	22 (4.5)

value of the data to be collected along with increasing the validity and reliability of the survey questions. Both the language and the cultural correspondence were reviewed for all questions and answers. Whenever answers were not applicable or not mentioned, notes were taken and edited form was revised in the original survey. The validity and reliability of the electronic questionnaire was confirmed with the aid of a pilot study ($n=5$), the results of which were not included in the larger scale study. Afterwards, the electronic survey was distributed to several social media portals to reach different and the furthest areas of KSA.

Calculation of sample size

Calculating the size of the study sample was done using the Epi Info online calculator to identify the total study subjects required to reach the chosen confidence level [16]. Based on the Saudi Arabian General Authority for Statistics in 2019 [17] and earlier research done in Saudi Arabia [18], 468 participants were minimally required to achieve the study objectives, given that the estimated dropout rate was 20%, with a confidence level of 99%, a margin error of 5%, and a design effect of 1.

Statistical analysis

Reporting categorical parameters was as frequencies (N) and percentages (%) and reporting continuous parameters was as mean \pm standard deviation (SD). Parameters were compared between baseline (since quarantine started) and at the end of the study. Determining the differences in parameters within weight loss and weight gain groups was done using paired sample T-test (normal continuous parameters) and

Wilcoxon-signed rank test (non-normal continuous parameters). Determining the differences in parameters between weight gain and weight loss groups was done using independent sample T-test (normal continuous parameters) and Mann–Whitney U-test (non-normal continuous parameters). To determine the effect of different categorical parameters of interest on weight change, Chi-Square test was applied. To identify potential risk factors for weight change, multinomial logistic regression analysis was used for different categorical parameters of interest as independent predictors to weight change, with either weight loss or gain as the dependent parameter and stable weight as a reference category. Determining significance level was done if P value was less than 0.05. Statistical analysis was undertaken with the help of IBM SPSS statistical software, Version 27 (Armonk, NY, USA).

Results

General characteristics

A total of 502 respondents completed this cross-sectional study, however, only 481 were included in the analysis (mean age of the respondents is 41.9 ± 14.2 , of which 184 (38.2%) were male, and 297 (61.7%) were females), while 21 (4.1%) were excluded for either being living outside KSA, or for being younger than the inclusive age group (i.e., < 18 years old). Table 2 displays the characteristics of the studied population.

Weight change related to Covid-19 pandemic and Ramadan fasting

Since the quarantine started and during Ramadan, 42.4% of the participants had gained weight (mean weight

79.9 ± 20.8 kg (was 76.1 ± 19.5 kg at baseline), $p < 0.0001$), 38.4% of the participants had lost weight (mean weight 73.9 ± 16.6 kg (was 77.6 ± 17.7 kg at baseline), $p < 0.0001$), and 23.4% had no weight change (Fig. 1). When comparing the weight differences between groups, a statistical significance difference was found between people who lost weight and those who gained weight (mean weight lost 3.7 ± 3.0 kg, mean weight gained 3.8 ± 7.8 kg, $p < 0.0001$) (Fig. 1).

Dietary habits change related to Covid-19 pandemic

Of the participants who lost weight and the participants who gained weight, 64.6% and 52.9% have considered home cooking during lockdown and Ramadan, respectively. None of the participants who lost weight and only 4.5% of participants who gained weight have considered food from outside home (i.e., takeaways). When analysing the relationship between home-cooking and weight status, it was found that home cooking has significantly associated with weight loss ($P = 0.01$), but not with weight gain ($P = 0.96$).

Of participants who lost weight and the participants who gained weight, 44.4% and 36.1% have considered not to change the quantity of their meals (i.e., not to increase nor decrease) during lockdown and Ramadan, respectively. Moreover, 21.9% of the participants who lost weight and 51% of participants who gained weight have increased their quantity of food consumption either during their regular meals or by adding extra meals. When analysing the relationship between quantity of food consumed and weight status, it was found

that not changing the quantity of meals consumed has significantly associated with weight loss ($P = 0.006$). On the other hand, increasing quantity of food consumption either during regular meals or by adding extra meals has associated significantly with weight gain ($P < 0.001$).

Of participants who lost weight and the participants who gained weight, 54.5% and 18.3% have considered dominating boiling and grilling as the main cooking methods during lockdown and Ramadan, respectively. Moreover, 33.1% of the participants who lost weight and 44.1% of participants who gained weight have considered not to change their cooking method during lockdown and Ramadan. When analysing the relationship between dominated cooking method and weight status, it was found that dominating boiling and grilling as the main cooking methods has associated significantly with weight loss ($P < 0.001$). On the contrary, not changing the cooking method has associated significantly with weight gain ($P = 0.003$) (Table 3, Fig. 2).

Lifestyle habits change related to Covid-19 pandemic

Of participants who lost weight and the participants who gained weight, 46.6% and 35.1% have considered increasing their water intake during lockdown and Ramadan, respectively. When analysing the relationship between water intake and weight status, it was found that increasing water intake has significantly associated with weight loss ($P = 0.006$). On the other hand, the amount of water intake did not associate with weight gain ($P = 0.54$).

Of participants who lost weight and the participants who gained weight, 63.5% and 59.9% have not changed

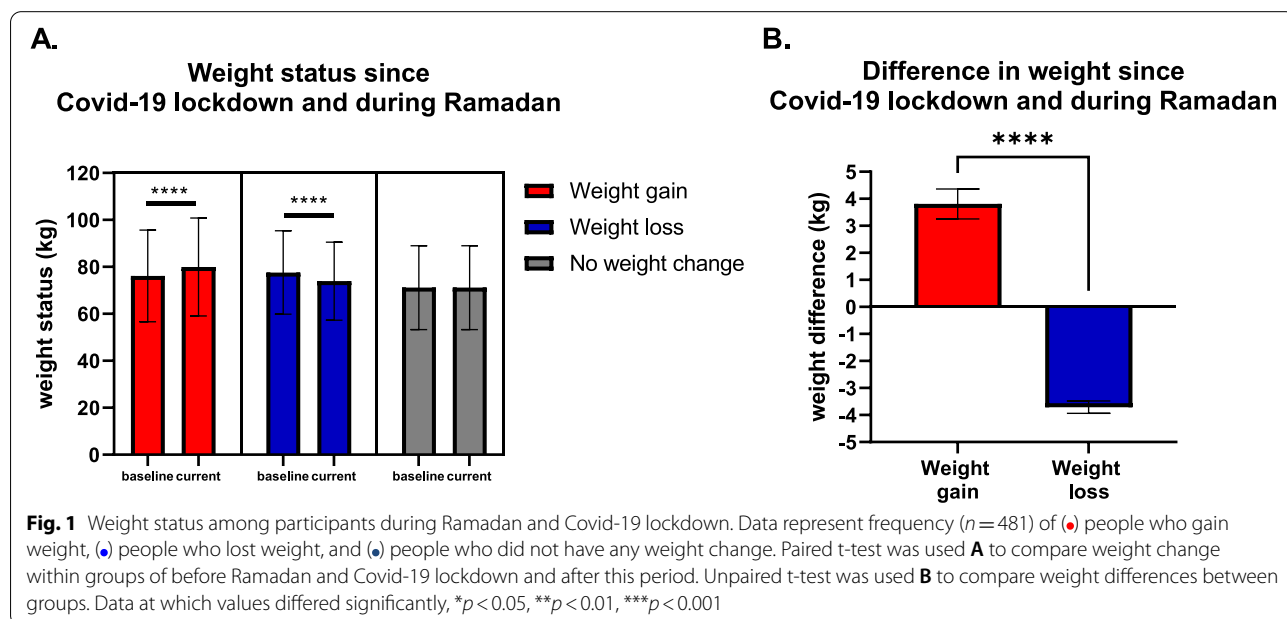
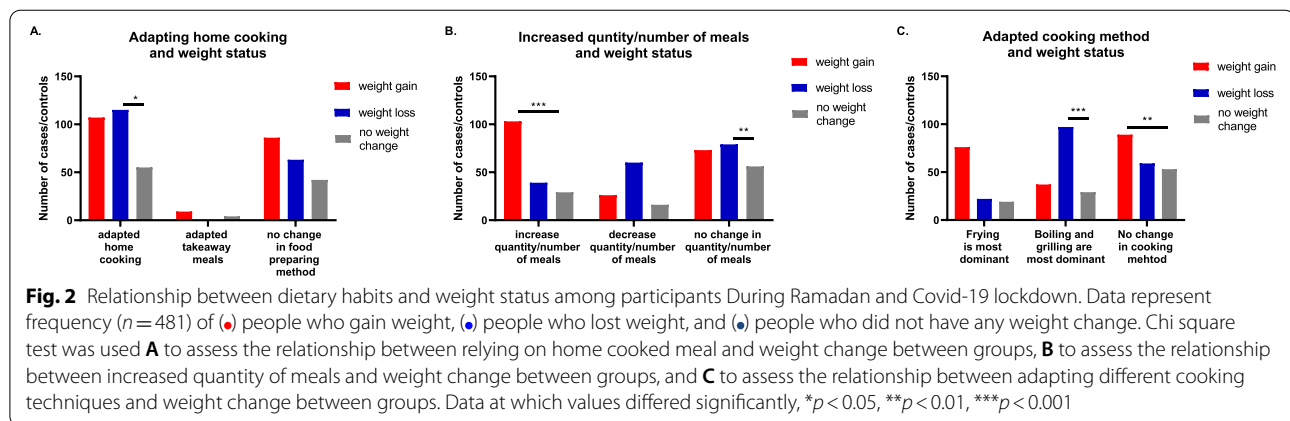


Table 3 Changes in dietary habits related to Covid-19 pandemic in their correspondence weight group ($n = 481$)

	weight gain ($n = 202$), n(%)	weight loss ($n = 178$), n(%)	no weight change ($n = 101$), n(%)
Dependent on home cooking versus takeaway meals			
Dependent on home cooking	107 (52.97)	115 (64.60)	55 (54.45)
Dependent on takeaway meals	9 (4.45)	0	4 (3.96)
No change in food preparation	86 (42.57)	63 (35.39)	42 (41.58)
Increase versus decrease quantity/number of meals			
increase quantity/number of meals	103 (50.99)	39 (21.91)	29 (28.71)
decrease quantity/number of meals	26 (12.87)	60 (33.70)	16 (15.84)
no change in quantity/number of meals	73 (36.13)	79 (44.38)	56 (55.44)
Frying versus boiling and grilling as dominant cooking methods			
Frying is most dominant	76 (37.62)	22 (12.35)	19 (18.81)
Boiling and grilling are most dominant	37 (18.31)	97 (54.49)	29 (28.71)
No change in cooking method	89 (44.05)	59 (33.14)	53 (52.47)



their amount of caffeine intake during lockdown and Ramadan than before these periods, respectively. When analysing the relationship between caffeine intake and weight status, no significant association was found with weight loss ($P = 0.29$) neither with weight gain ($P = 0.08$).

Of participants who lost weight and the participants who gained weight, 37.1% and 34.2% have not changed their physical activity level during lockdown and Ramadan, respectively. Moreover, 33.1% of participants who lost weight and 56.4% of participants who gained weight have decreased their level of physical activity during lockdown and Ramadan. When analysing the link between physical activity level and weight status, it was found that continuing on the same physical activity level as before lockdown and Ramadan has associated significantly with weight loss ($P = 0.002$). On the contrary, decreasing the level of physical activity has associated significantly with weight gain ($P = 0.003$).

Of participants who lost weight and the participants who gained weight, 41.0% and 40.6% have not changed their sleep habits during lockdown and Ramadan than before these periods, respectively. When analysing the relationship between sleep habits and weight status, no significant association was found with weight loss ($P = 0.46$) neither with weight gain ($P = 0.33$).

Of participants who lost weight and the participants who gained weight, 56.2% and 65.3% have increased their screen time/habit during lockdown and Ramadan than before these periods, respectively. When analysing the relationship between screen time/habit and weight status, no significant association was found with weight loss ($P = 0.15$) neither with weight gain ($P = 0.38$).

Of participants who lost weight and the participants who gained weight, 89.3% and 87.6% have not changed their smoking habits during lockdown and Ramadan than before these periods, respectively. When analysing

Table 4 Changes in lifestyle habits related to Covid-19 pandemic in their correspondence weight group ($n = 481$)

	weight gain ($n = 202$), n(%)	weight loss ($n = 178$), n(%)	no weight change ($n = 101$), n(%)
Increased versus decreased water drinking			
Increased water drinking	71 (35.14)	83 (46.62)	30 (29.70)
Decreased water drinking	38 (18.8)	35 (19.66)	18 (17.82)
No change in water drinking	93 (46.03)	60 (33.70)	53 (52.47)
Increased versus decreased caffeine drinking			
Increased caffeine drinking	58 (28.71)	48 (26.96)	22 (21.78)
Decreased caffeine drinking	23 (11.38)	17 (9.55)	6 (5.94)
No change in caffeine drinking	121 (59.90)	113 (63.48)	73 (72.27)
Increased versus decreased level of physical activity			
Increased level of physical activity	19 (9.40)	53 (29.77)	12 (11.88)
Decreased level of physical activity	114 (56.43)	59 (33.14)	36 (35.47)
No change in level of physical activity	69 (34.15)	66 (37.07)	53 (52.47)
Increased versus decreased sleep time			
Increased sleep time	66 (32.67)	57 (32.02)	24 (23.76)
Decreased sleep time	54 (26.73)	48(26.96)	20 (19.80)
No change sleep time	82 (40.59)	73 (41.01)	57 (56.40)
Increased versus decreased screen time			
Increased screen time	132 (65.34)	100 (56.17)	60 (59.40)
Decreased screen time	9 (4.45)	16 (8.98)	3 (2.97)
No change screen time	61 (30.19)	62 (34.83)	38 (37.62)
Increased versus decreased smoking			
Increased smoking	16 (7.92)	9 (5.61)	4 (3.96)
Decreased smoking	9 (4.45)	10 (5.61)	3 (2.97)
No change smoking	177 (87.62)	159 (89.32)	94 (93.06)

the relationship between smoking habits and weight status, no significant association was found with weight loss ($P=0.53$) neither with weight gain ($P=0.33$) (Table 4, Fig. 3).

Multivariate regression analysis to identify the most probable risk factor for weight change

In order to identify the most probable risk factors that directly influence weight status, multivariate regression analysis was done. The analysis showed that physical activity is one factor that can protect against weight gain (OR = 1.03 with $P=0.008$), while increasing the quantity of meals and not adapting healthy cooking methods can both be considered as contributing factors to weight gain (OR = 1.03 with $P=0.009$, and OR = 1.03 with $P=0.004$, respectively).

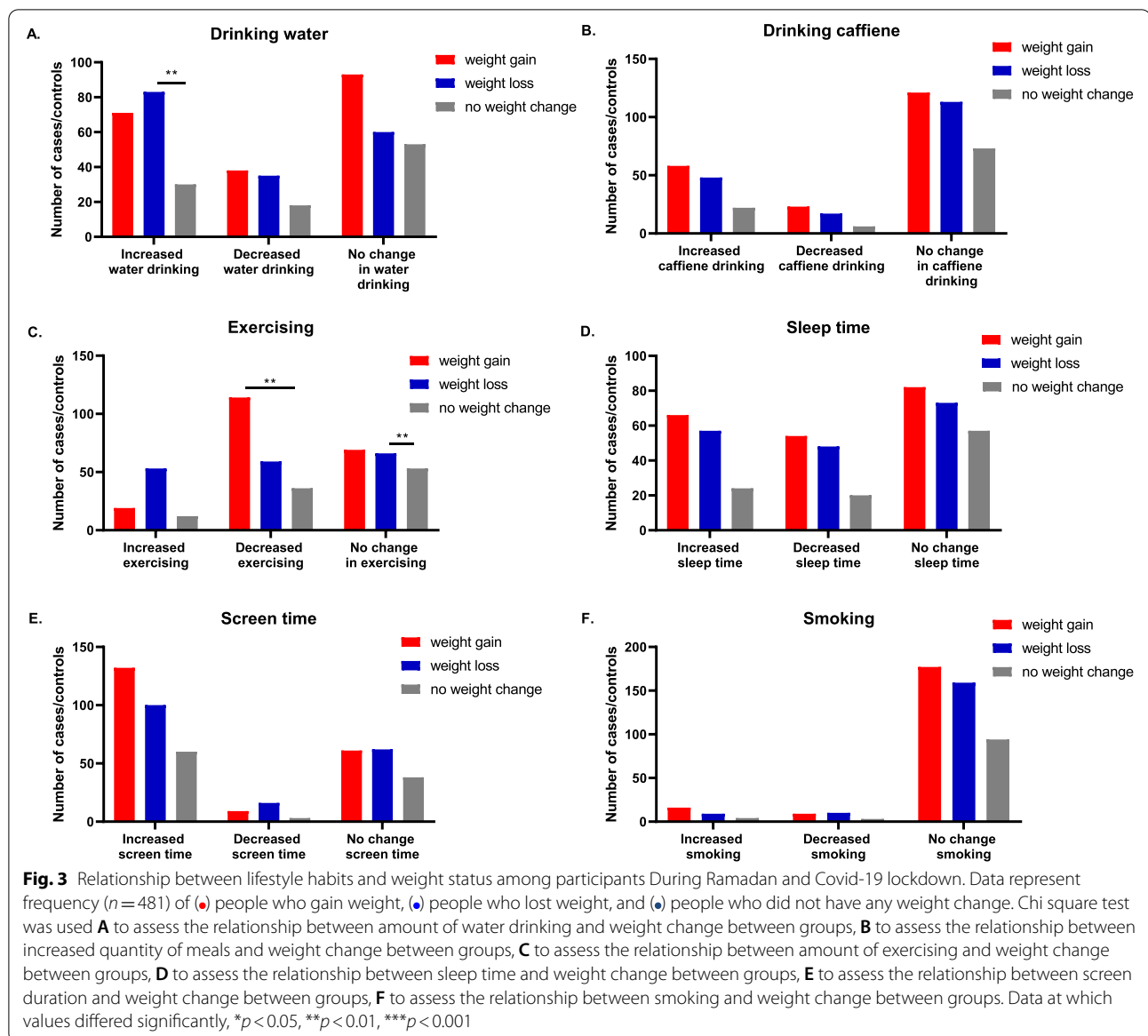
Discussion

To the best of the author's knowledge, this research is the first to highlight the impact of both COVID-19 quarantine and Ramadan fasting on weight status, and the association between weight change and lifestyle factors

including dietary habits, physical activity, water intake, screen and sleep times, and smoking, and the underlying factors that attributed to the change in weight status among the population living in the KSA. In general, this study has found that increasing number of meals and not adapting healthy cooking methods as the most dominant cooking technique of food consumption are the main risk factors for weight gain, while exercising as the main protective factor.

Weight change related to Covid-19 pandemic and Ramadan fasting

Around 42% of the recruited participants have had around 5% lockdown and Ramadan weight gain in the current findings, which is clinically significant amount of weight to be gained with its substantial predisposition of comorbidities over subsequent years [19]. Thus, protection from unfortunate health effects will likely happen by managing weight gain during COVID-19 [20, 21]. This result is in line with other researches during COVID-19 quarantine internationally [3, 6, 11, 22–25], and nationally [18]. Fewer people with weight gain have been



reported in other studies in comparison to the current study [26].

On the other hand, around 38% of the recruited participants have had around 5% lockdown and Ramadan weight loss in the current findings, which is clinically significant amount of weight to be lost, as it is associated with physiological and biochemical benefits [27]. This finding is in line with the result in the Chinese study [25] and other local ones [18, 26]. Other papers have reported fewer people with weight loss [5, 6, 22, 28]. When comparing between the groups, the percentage of participants who gained weight was minimally, but significantly, higher than the percentage of participants who lost weight.

Although the outcomes of the present research are in line with previous research concerning weight change during quarantine, they do not coincide entirely with previous research concerning weight change during Ramadan. It was shown that intermittent fasting (as in Ramadan) can cause significant weight loss in many previous studies, including a 2020 systematic review and meta-analysis [29–31]. However, these studies have been conducted earlier to the times of COVID-19 crisis, where people were less stressed and more living their normal life without being confined to their homes. High level of stress and low level of life satisfaction can both influence weight gain [32, 33]. Traditionally, specific ritual and social behaviours are known to take place during

Ramadan; including social gatherings during main meals in a buffet style and prayers and worship. During the pandemic, many families could not have applied many of the traditions they used to, given the governmental lockdown and home confinement policies and the fear of contracting infection. This have massively affected people's life satisfaction and anxiety levels, which can subsequently be manifested in weight gain [34]. Obesity can be considered as a condition of chronic low-grade inflammation, given the immunomodulatory effects of the adipokine secreted from the adipose tissue [35], which can downregulate both the immune and adaptive immune responses, increasing the body's vulnerability to infections and decrease its responsiveness to antimicrobial and antiviral drugs, and vaccinations [36]. Moreover, the reduction of protective cardiorespiratory reserves due to excess ectopic fat can have detrimental effects on lung function [37, 38]. As a consequence, individuals with obesity are threatened from developing serious illnesses including COVID-19 infection, if infected, or other more severe forms of respiratory failure. Thus, global public health and community nutrition campaigns targeted towards sustaining normal weights, especially during times of quarantine, are required.

Dietary habits change related to Covid-19 pandemic

Analysis has showed that both increasing the quantity of meals and not adapting healthy cooking methods as the dominant technique of food preparation are directly associated factors with weight gain. The significance levels extend to the same factors when considering multivariate regression analysis, which indicates the importance of these factors to be considered as risk factors for weight gain during home confinement and Ramadan.

On the contrary, home cooking, not increasing the quantity of meals consumed, and adapting healthy cooking methods as the dominant technique of food preparation (as boiling and grilling) are all directly associated factors with weight loss. However, these factors did not reach significance levels when considering multivariate regression analysis, indicating the partial influence of these factors on weight loss during lockdown and Ramadan.

It can be concluded from the current results that home confinement is a serious dietary threat, especially to individuals with obesity and overweight, as more problematic eating behaviors are exhibited in these groups, including frequent food consumption and overeating in the absence of hunger [39, 40]. Such behaviors might get further stimulated during lockdown owing to, often, unlimited availability to large amounts of foods during the extended stay at home, as previous research showed [41]. This can lead to a disturbance in the time-restricted

feeding window; a known factor that has a positive effect in dysmetabolism and obesity and promote robust metabolic cycles [42]. Previous research further supports the link between higher amounts of food consumption with the global lockdown [2, 3, 28, 37].

Foods cooked at home are considered healthier and/or lower in calories than foods away from home (as restaurants) [43]. However, 53% of participants of the current study who gained weight have adapted home-cooking for their food intake than before the lockdown. Nevertheless, 51% and 44% of participants of the same weight group have reported an increase in quantity of foods and/or meals consumed and not acquiring healthy cooking methods as boiling and grilling, respectively. These findings could be explained by the fact that some cooking methods may not be considered as healthy, especially if people added large amount of fat and sugar which would add extra amounts of calories, and would increase food palatability and thus making it more appealing in such challenging circumstances. In addition, such foods are traditionally known to be consumed in Ramadan, even before the pandemic, and are known to increase the risk of infections [44–46]. Generally, these results are comparable to those in Bakhsh et al. study, and are further explained by studies in Spain and Italy, where they found that homemade cakes and breads were the most common Google search terms and were higher consumed than before lockdown [3, 4, 18, 28]. Thus, a similar trend in cooking and food choices may have been found in Saudi Arabia. Nevertheless, 64.6% of participants who lost weight have relied on consuming home-cooked meals, which seems to be healthier and less caloric way of cooking, as 54.5% of participants from the same group have considered healthy cooking methods (as boiling and grilling) as the main technique of food preparation. This outcome is in line with the Spanish study, where they found better adherence to healthy cooking methods for food preparation during the lockdown [4].

It is proposed that a healthy diet is considered as a crucial factor of the individual risk assessment and management strategy during pandemics as COVID-19, given its significant effect against responding to an infectious agent [47]. This protective effect arises from the immunomodulatory effects of several phyto-, micro-, and macronutrients that have profound roles in immunocompetence. In contrast, nutritional deficiencies have been known to increase host vulnerability to infections and other severe diseases [48, 49]. For instance, during outbreaks as COVID-19, the Mediterranean diet was proposed to be followed due to its role in boosting the immune system [50], which was feasible and well-adhered to by Italian and Spanish population [4, 28]. Moreover, following healthy well-balanced diet during Ramadan

is recommended, given its immunomodulatory effects against infections and to reduce or maintain weight [51]. On the contrary, it has been suggested that unhealthy diets negatively affect host susceptibility to infections and subsequent recovery [52, 53]. Subsequently, a vicious cycle of weight gain and increased risk of infection will cause both COVID-19 and to obesity be regarded as two colliding public health pandemics [54, 55]. Therefore, it is mandatory for people with overweight or obesity to stick to an individual risk management strategy that includes healthy well-balanced diet [47, 56].

Lifestyle habits change related to Covid-19 pandemic

Analysis has showed that decreasing physical activity level is directly associated with weight gain. However, this factor does not reach significance level when considering multivariate regression analysis, indicating the partial effect of physical activity level on weight gain during lockdown and Ramadan.

On the other hand, increasing water intake, and maintaining physical activity level as before lockdown and Ramadan periods are all directly associated with weight loss. The significance level extends only to the physical activity levels when considering multivariate regression analysis, which indicates the importance of this factor to be considered as a protective element against weight gain during lockdown and Ramadan.

This finding support recent research, as it is well established the dose–response relationship between weight loss and physical activity levels [57]. Moreover, the findings of the present research are in line with earlier research that show the dramatical global influence of COVID-19 quarantine on lifestyle activities, including the physical activity involvement [58, 59]. This is logical to expect, given the diverse governmental confinement policy on movement restrictions during COVID-19 pandemic which will directly affect the participation in physical activity [60]. It was shown previously in China that differences in physical activity level was associated with both different regional policies on confinement and socio-economic levels [61]. The decrease in physical activity level is even more affected due to Ramadan fasting, where it is reported previously to be reduced during the holy month [62]. Thus, addressing these factors when designing physical activity interventions via the involvement of remote dietitian services, social media campaigns, and health care authorities are essential for such pandemic in the future.

It is interesting that the present study found no association between screen time and weight change. However, it is stated in a previous review that any link between sedentary lifestyle, including screen time, and weight gain may not appear as a causal relationship [63]. The current

study findings coincide with the mentioned review, where screen time may not be a predictor for weight change during lockdown and Ramadan.

Noteworthy, the current study took place in Saudi Arabia and was conducted in a relatively short time, as suggested previously [64]. However, sharing a part of the middle east on how the lockdown resulted from the epidemic during Ramadan can influence the dietary and lifestyle behaviors and weight, as in Saudi Arabia, for the first time can provide valuable insights to the neighboring gulf and Arabian countries. Nevertheless, the current outcomes should be considered for future-similar circumstances aimed towards the prevention and preparation if any lockdown-incidents are to be necessitated. Future consideration should include the permissibility to not to fast and the fluctuation in weight as a result of water retention and hormonal changes during the menstrual cycle in child-bearing aged women, where excluding these days and this change in weight are needed before including this group in the analysis. Moreover, self-reported dietary and lifestyle behaviors and weight recall at the same time point based on an online and anonymous questionnaire rather than standardized baseline measures to objectively confirm the data prior to and following the study timeline, in addition to the mixed genders and the broad age groups can all be underlined as study limitations. Thus, the outcomes of the current research should be considered as a rough measure rather than an accurate value. Overcoming the mentioned weaknesses were, however, impossible baring in mind the challenges of running such a study in a restricted period of time as Ramadan in a national lockdown.

Conclusion

To the best of the author's knowledge, this research is the first to highlight the impact of weight change and the related dietary and lifestyle habits during Ramadan of COVID-19 quarantine in Saudi Arabia. Number of people who gained weight were significantly higher than weight loss. The weight gain was shown to be associated with decreased level of physical activity while increased quantity of meals and not adapting healthy cooking method can both be considered as potential risk factors. The results also showed an association between weight loss and adapting home cooking and healthy cooking methods, increasing water drinking, and not increasing quantity of meals consumed while not changing the level of physical activity in everyday life can be considered as protective factors. Assessing these changes during Ramadan of COVID-19 quarantine provided valuable perspective on the health and wellbeing of Saudi Arabia citizens. These findings should be considered in future studies to

question the persistence of Covid-19 related weight and habit changes.

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-022-13953-9>.

Additional file 1. English version of the questionnaire.

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Authors' contributions

The author confirms sole responsibility for the following: study conception and design, data collection, analysis and interpretation of results, and manuscript preparation, editing, and approval.

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Availability of data and materials

All data generated or analysed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee for Scientific Research and Post Graduate Studies at the College of Applied Medical Sciences, King Abdulaziz University, Saudi Arabia, (reference number FAMS-EC2020-004). An informed consent was provided by all study participants at the beginning of the online questionnaire.

Consent for publication

Not applicable.

Competing interests

The author declares that she has no competing interests.

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