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
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

| 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*                     | 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          |

* Denotes events happened throughout data collection timeline (May 17–May 23, 2020). Table adapted from Alfawaz and their colleagues [15].
| 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)     |
| House wife                                                                | 77 (15.4)     |
| Family members                                                            |               |
| 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)    |
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 \(\pm\) 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 their physical activity level during lockdown and Ramadan, respectively. When analysing the relationship between physical activity level and weight status, it was found that not changing physical activity has associated significantly with weight loss (P<0.001). On the contrary, increasing physical activity has associated significantly with weight gain (P<0.001) (Table 3, Fig. 2).

**Fig. 1** Weight status among participants during Ramadan and Covid-19 lockdown. Data represent frequency (n=481) of (a) people who gained weight, (b) people who lost weight, and (c) people who did not have any weight change. Paired t-test was used A to compare weight change within groups of before Ramadan and Covid-19 lockdown and after this period. Unpaired t-test was used B to compare weight differences between groups. Data at which values differed significantly, *p<0.05, **p<0.01, ***p<0.001
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...
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

Fig. 3 Relationship between lifestyle habits and weight status among participants during Ramadan and Covid-19 lockdown. Data represent frequency (n=481) of (▲) people who gain weight, (●) people who lost weight, and (▲▲) people who did not have any weight change. Chi square test was used A to assess the relationship between amount of water drinking and weight change between groups, B to assess the relationship between increased quantity of meals and weight change between groups, C to assess the relationship between amount of exercising and weight change between groups, D to assess the relationship between sleep time and weight change between groups, E to assess the relationship between screen duration and weight change between groups, F to assess the relationship between smoking and weight change between groups. Data at which values differed significantly, *p < 0.05, **p < 0.01, ***p < 0.001
severe forms of respiratory failure. Thus, global pub-
lic health and community nutrition campaigns targeted
Ramadan and other severe diseases [48, 49]. For instance, 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 can massively affect people’s life satisfaction and anxiety levels, which can sub-
sequently be manifested in weight gain [34]. Obesity can be
considered as a condition of chronic low-grade inflam-
mation, given the immunomodulatory effects of the adi-
pokine secreted from the adipose tissue [35], which can
downregulate both the immune and adaptive immune
responses, increasing the body’s vulnerability to infec-
tions 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 pub-
lic 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 lev-
els extend to the same factors when considering multi-
variable 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 multi-
variable 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 prob-
lematic 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 meta-
abolic 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 restaur-
ants) [43]. However, 53% of participants of the current
study who gained weight have adapted home-cooking
for their food intake than before the lockdown. Never-
theless, 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 find-
ings 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 com-
parable 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 calorific 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 out-
come 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 cru-
cial factor of the individual risk assessment and manage-
ment strategy during pandemics as COVID-19, given
its significant effect against responding to an infectious
agent [47]. This protective effect arises from the immu-
nomodulatory effects of several phyto-, micro-, and
macronutrients that have profound roles in immuno-
competence. 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.

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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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