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Anthropometric, Psychosocial, Physiological, and Postural Observances During Ramadan in Men With Chronic Obstructive Pulmonary Disease

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Abstract

This study aimed to carry out a Ramadan observance (RO) on anthropometric, psychosocial, physiological, and postural characteristics of patients with chronic obstructive pulmonary disease (COPD). Twenty COPD patients were evaluated. Tests performed 1 week before Ramadan (C), and during the second (R-2) and the fourth weeks of Ramadan (R-4) included standard anthropometry, spirometry, a quality of life questionnaire (VQ11), a 6-minute walking test (6MWT), measurement of maximal voluntary contraction force of the quadriceps (MVC), Timed Get Up and Go (TUG), Berg Balance Scale (BBS), and Unipedal Stance (UST). During R-2, there were significant decreases in forced vital capacity and forced expiratory volumes, 6MWT distance, MVC, BBS, and UST, with significant increases in TUG and significant changes in VQ11. During R-4, there was some recovery, but all variables remained significantly different from initial control data. To conclude, RO adversely affects pulmonary function, exercise performance, postural balance, and quality of life in COPD, with some recovery by the R-4. Although a number of functional consequences remain to be elucidated, functional losses were insufficient to limit daily living in our sample, but further studies are recommended in those with more severe COPD, paying particular attention to postural disturbances and a possible increase in the risk of falls.

Keywords

chronic obstructive pulmonary disease, Ramadan observance, pulmonary variables, postural balance, exercise performance

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Introduction

Chronic obstructive pulmonary disease (COPD) is a leading cause of morbidity and mortality worldwide (Vestbo et al., 2013); prevalence is high in Tunisia, with 7.8% and 4.2% of the population in disease Stages 1 and 2, respectively (Daldoul et al., 2013). Patients with COPD show an impaired exercise tolerance, often with severe dyspnea, a decreased ability to participate in the activities of daily living, and a poor health-related quality of life (HRQoL; Vestbo et al., 2013). Exercise is limited by a combination of impaired ventilatory function (Agusti et al., 2003) and skeletal muscle dysfunction (Man et al., 2009), with weakness of the lower limbs (Maltais et al., 2000) and impaired balance (Roig et al., 2011).

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The common practice of those observing Ramadan is to have two meals per day: a large meal shortly after sunset and a much lighter one immediately before dawn. Ramadan observance (RO) is characterized by many changes in diet and sleep patterns (Souissi et al., 2007), often with a decrease in the time available for nocturnal sleep (Anis et al., 2009). Studies in athletes have observed altered muscle metabolism (Bouhlel et al., 2006), hormonal changes (Bouhlel, Denguezli, et al., 2008; Bouhlel, Zaouali, et al., 2008), and an impaired physical performance depending on the time of day at which test sessions were performed (Anis et al., 2009; Bouhlel et al., 2013; Meckel et al., 2008).

Sometimes there are disturbances of cognitive function (Tian et al., 2011). The study of Patel et al. (2008) reported postural control impairment in young adults due to momentary lapses of attention after sleep deprivation. Such changes are of particular concern in elderly patients with COPD, as their ability to carry out the activities of daily living may initially be marginal, and any disturbances of balance and cognitive function associated with RO could increase the risk of falls (Laatar et al., 2016).

To 2015, only one study has examined the effects of RO in patients with COPD (Aydin et al., 2014); this report focused almost exclusively on changes in medication use during RO. Most Muslim patients with COPD observe Ramadan (e.g., 93% in Turkey; Aydin et al., 2014), but little is known about the clinical, psychosocial, and physiological effects of such fasting in COPD. The aim of the present study was to analyze the effects of RO on anthropometric, psychosocial, physiological, and postural characteristics in patients with COPD.

Method

Design

The present study was designed as a pilot cross-sectional and experimental study. Observations were made during the Ramadan of 2015 (dates from June 18 to July 16); in Tunisia, the fast had a duration of 16 hr 30 min. The selected variables were measured 3 times: before Ramadan (control or C), during the second week of Ramadan (R-2), and during the last week of Ramadan (R-4). A preliminary familiarization session ensured that participants were habituated to the test protocol. All measurements were completed in the same clinical physiology laboratory, under consistent environmental conditions (temperature: 24 ± 2°C, humidity: 68 ± 3%), and at the same time of day (16:00 p.m.) to avoid circadian effects.

Sample

Participants in this study were 20 male volunteers with COPD from the Farhat Hached Hospital of Sousse, Tunisia, who gave their written and informed consent to take part in a study approved by the local committee for the ethics of human experimentation (The Research Ethics Committee of Farhat Hached Hospital, Sousse; Approval No. 01-2015), in accordance with current legal requirements and the Declaration of Helsinki. Clinically stable individuals with a functional diagnosis of COPD according to the global strategy for the diagnosis, management, and prevention of COPD guideline were selected (Singh et al., 2019; Stage II and III; medication remained unchanged during Ramadan). Smokers, those with cardiovascular or neurological disease, lower extremity musculoskeletal problems, and visual deficits that could affect postural control were excluded.

Patients' Characteristics

All included patients with COPD had a Ramadan fasting history of minimum 5 years, were in stable condition, and were nonsmokers. A questionnaire was performed among patients' medical history, type of prescript medication treatment, activities of daily living of each patient, fasting recommendation, sleep pattern, and eating schedules. None of them have a history of fall within the last 6 months. Moreover, they are autonomous, could perform their daily activity by themselves, and have the same sociocultural level. All patients have the same eating schedules and number of sleep hours per night.

Measures

Anthropometric Measurements. Body mass (BM) and height were assessed when patients were lightly clothed. BM was measured with a digital scale (Harpenden balance scale; Holtain Ltd., Crosswell, UK) and standing height was measured by stadiometer (Harpenden portable stadiometer; Holtain Ltd.). Body mass index (BMI) was calculated as BM divided by the square of the height (Pi-Sunyer et al., 1998).

Biceps, triceps, subscapular, and suprailiac were measured in triplicate with Harpenden skinfold caliper (Holtain Ltd.) and mean values were used for further analysis. The body density was estimated from four measurements of skinfold thickness using the Durnin and Womersley (1974) equation (density = $1.1715 - 0.0779 \times \text{Log}[\Sigma 4$ skinfold thickness]; Durnin & Womersley, 1974). The percentage of body fat mass was estimated using Siri's equation (% fat BM = [4.95 / density − 4.50] × 100; Durnin & Rahaman, 1967). Fat-free mass (FFM) was determined by subtracting fat mass from BM (Buskirk & Mendez, 1984).

Quality of Life Questionnaire (VQ 11). The VQ11 is a reliable and valid measure of COPD-specific HRQoL (Ninot et al., 2013). The 11 items cover three main components:

functional (dyspnea, fatigue, and mobility), psychological (physical confidence, anxiety, depression, and sleep), and social (life project, social life, closeness, and emotional life). A high total score indicates a poor HRQoL (Ninot et al., 2013).

Dietary Intake. Patients recorded meal times and amount of food eaten for 3 days before each session (C, R-2, and R-4), including the last meal before the tests. This was completed by interview using a 24-hr recall method. Dietary records were analyzed for energy intake using Bilnut program (Nutrisoft, Cerelles, France) and food composition tables published by the Tunisian National Institute of statistics (el Ati et al., 1995).

Sleep Evaluation. A questionnaire was used to collect sleep habit data (sleep duration and sleep–wake pattern) from COPD (BaHammam, 2003) and a bridged version of the Horne and Ostberg questionnaire (morningness/eveningness test) was assessed to identify the circadian rhythms. This questionnaire established three behavioral categories (morning type, neither type, and evening type; Horne & Östberg, 1976).

Spirometry. Pulmonary function was tested using a Zan 100 spirometer (Inspire Health GmbH, Germany) according to Respiratory Society recommendations, with data related to Tunisian norms (Ben Saad et al., 2013). The parameters measured were (a) forced vital capacity (FVC), (b) forced expiratory volume in 1 s ($FEV_{1.0}$), and (c) the ratio $FEV_{1.0}$/FVC%.

6-Minute Walking Test (6MWT). Exercise performance was assessed by 6MWT (Holland et al., 2014). It performed indoors, along a flat, straight, 30 m walking course with a tiled surface. Chairs were placed out to allow participants to rest if needed (Holland et al., 2014). Dyspnea and tiredness were measured using the modified Borg Scale, a descriptive marker of perceived exertion of breathlessness and lower-limb fatigue graded on a 0 to 10 scale, before and at the end of the test (Mahler & Horowitz, 1994). The heart rate (HR) and the peripheral oxygen saturation (SpO_2) were recorded by oximeter throughout using a portable Spiropalm (COSMED, Rome, Italy). Two trials were performed and the longest 6MWT distance (6MWTD) was recorded (Holland et al., 2014).

Isometric Leg Force Assessment. After a warm-up phase of the leg extensor muscle consisting of 5 min cycling at 60% of maximum HR reached at the end of 6MWT, three maximal voluntary isometric contractions (MVC) were made (the best value was recorded), separated by 5 min rest intervals. The Globus Ergo system (TESYS 1000, Codogne, Italy) was used. Participants sat with 90° hip flexion and 90° knee flexion, with stabilization straps positioned across the chest and the arms crossed over the chest as contractions were made.

Balance Assessment. Three simple tests assessed balance: the Timed get Up and Go (TUG), the Berg Balance Scale (BBS), and the Unipedal stance (UST) test. The TUG score reflects both balance and functional mobility (Podsiadlo & Richardson, 1991). The time taken to stand from a chair, walk a distance of 3 m, turn around, return to the chair, and sit down was recorded (Podsiadlo & Richardson, 1991); each participant completed the test 3 times and the faster time was recorded.

The BBS is a psychometrically robust clinical measurement of balance for older adults. It assesses performance on five levels, from 0 (*cannot perform*) to 4 (*normal performance*), with 14 items involving functional balance control, including transfer, turning, and stepping; a perfect score is 56 (Tyson & Connell, 2009).

The UST measures the participant's ability to stand on his preferred leg. A unipedal stance is maintained for a long as possible. A failure is defined as shifting the stance foot or placing the lifted foot on the floor. The UST was considered normal if the unipedal stance was maintained for 45 s or longer (Hurvitz et al., 2000). Participants were given three trials and the longest time was recorded.

Analysis. Statistical analyses were performed using Statistica for Windows software (version 6.0; Statsoft, Inc., Tulsa, OK, USA). As data normality was confirmed using the Kolmogorov–Smirnov test, results were reported as the mean $\pm$ *SD*. Pulmonary and 6MWT parameters, balance assessment (TUG, BBS, and UST), dietary intake, sleep duration, and the MVC data were analyzed using a one-way repeated measures analysis of variance (ANOVA; three testing periods). The VQ11 questionnaire was analyzed using a two-way ANOVA (three testing periods $\times$ four components [functional, psychological, relational, and total]). A post hoc (Tukey) test was performed to further analyze the results. Effects sizes for one-way ANOVA were calculated as eta squared (η^2, where partial eta squared equals eta squared) and for two-way ANOVA to assess the practical significance of our finding (Lakens, 2013). The level of significance was set at $p < .05$ throughout.

Results

Table 1 presents the baseline characteristics of patients with COPD.

RO had no significant effect on BM and BMI (Table 2). RO had no significant effect on energy intake (carbohydrate, fat, and protein intake). However, there was a significant decrease ($p < .001$) in fluid intake during R-2 and R-4 compared with C (Table 1).

Table 1. Baseline Characteristics of Patients With COPD.

Low socioeconomic level	8
Low schooling level	10
Ramadan fasting experience (years)	69 ±1.5
Tobacco history (pack-years)	70 ± 39
Respiratory treatments	Bronchodilators Inhaled corticoid Mucoregulators
Medical histories	Stable hypertension Anemia Arterial fibrillation

Note. COPD = chronic obstructive pulmonary disease.

Post hoc showed a significant decrease ($p < .001$) in total and nighttime sleep during R-2 compared with C and a significant increase in nap time ($p < .001$) during Ramadan (R-2 and R-4) compared with C (Table 2).

Concerning the pulmonary variables, all measures decrease during R-2 relative to C (FEV_1, FEV_1%, and FVC, FVC% [all at $p < .001$], and FEV_1/FVC% [at $p < .05$]; Table 2). Values that were already low relative to control period showed a further 15% to 17% decrease during Ramadan. Volumes remained decreased during R-4 (FEV_1 and FEV_1%, $p < .05$, and FVC, $p < .01$), although there was a substantial and statistically significant recovery relative to R-2 (FEV_1% and FVC values, $p < .01$, FVC% and FEV_1/FVC%, $p < .05$).

All VQ11 components (functional, psychological, relational, total) significantly ($p < .001$) deteriorated during R-2 and R-4 compared with C, with no significant changes between R-2 and R-4 despite the total change from 39.35 ± 4.42 in R-2 to 38.5 ± 3.22 in R-4 (Table 3).

A significant decrease of 6MWTD and SpO_2 rest and peak during both R-2 (all at $p < .001$) and R-4 (all at $p < .01$) relative to C was demonstrated in Table 4.

The MVC was significantly lower ($p < .001$) during R-2 (382.89 ± 56.91 N) and R-4 (412.67 ± 59.83 N) compared with C (441.61 ± 64.30 N), although values increased from R-2 to R-4 ($p < .001$; Figure 1).

A higher TUG values (11.41 ± 0.65 s) were demonstrated during R-2 compared with C (10.30 ± 0.64 s, $p < .001$), with some recovery (10.49 ± 0.75 s) at R-4 (R-4 vs. R-2, $p < .001$) (Figure 2). BBS and UST showed significant decreases ($p < .001$) from C to R-2 (53.25 ± 1.22 score to 48.08 ± 3.06 score in BBS; 44.67 ± 1.54 s to 31.88 ± 6.60 s in UST), with partial recovery at R-4 (50.75 ± 2.18 score, $p < .01$ and 39.96 ± 5.73 s, $p < .001$, respectively, in BBS and UST) relative to R-2 (Figure 2).

Discussion

This study demonstrates that the quality of life and postural and physiological characteristics were all deteriorated in patients with COPD during RO. The afternoon performance of the selected tests was depressed by a further 7% to 15% during the second week of Ramadan. However, there was substantial recovery from this deficit by the fourth week of Ramadan.

From an anthropometric point of view, although life changes related to sleep, diet, and various daily activities would be likely to generate changes in body and/or composition, RO did not show any significant change at the different measuring times (R-2 and R-4) in comparison with baselines values. This finding is in line with some previous studies (Finch et al., 1998; Lamine et al., 2006) and indicates that the food momentary deprivation due to Ramadan can be largely compensated for by staggered energy consumption. However, quality of life was impaired during Ramadan. The VQ11 questionnaire scores (functional, psychological, relational, and total) indicated impairments in R-2 and R-4 compared with C, with no significant difference of scores between R-2 and R-4. Borge et al. (2010) previously reported that breathlessness was associated with depression, anxiety, fatigue and sleeping difficulties, and the deterioration of VQ11 score could be related, at least in part, to the substantial decrease of pulmonary function during the fasting period. Effectively, pulmonary variables showed significant decreases during R-2 and R-4 relative to C. The present study was carried out during summer, and in this context, dehydration and fatigue would have contributed more to changes of pulmonary function than would have been the case during a winter celebration of Ramadan (Fenneni et al., 2014). The induced pulmonary changes would presumably be even greater if a summer celebration of Ramadan was observed at high latitude, as in Canada and Europe. Moreover, the impaired quality of life resulted in a significant shortening of nighttime sleep duration during Ramadan, which is partially offset by the increase in daytime naps. Several studies pointed out the role of subjective fatigue sensation during fasting related in part to sleep loss or disruption of normal sleep patterns and/or dehydration (Leiper et al., 2008; Maughan et al., 2010). Sleep deprivation and altered diet are likely to disturb physiological performance (Phillips et al., 1987; Riley & Thakker-Varia, 1995). Those studies demonstrated that the loss of sleep results in a decline in spirometric performance.

From an aerobic performance point of view, RO showed alterations during the first 2 weeks of fasting. The average maximal oxygen consumption of participants (evaluated with the equation of Ross et al., 2010) decreased by almost 2 mL kg^{-1} min^{-1} on the basis of an initial value just under 26 mL kg^{-1} min^{-1}. Although participants remained substantially above the level of 15 mL kg^{-1} min^{-1} where difficulty would have been encountered in undertaking the activities of daily living (Shephard, 2012), a reduction of maximum oxygen consumption

Table 2. Patients parameters (Anthropometric, Pulmonary Parameters, Dietary Intake, and Sleep Evaluation) during Ramadan Observance.

	C	R-2	R-4
Age (years)		72.7 ± 4.1	
Height (m)		1.69 ± 0.04	
BM (kg)	74.3 ± 3.7	74.1 ± 2.9	74.2 ± 3.4
BMI (kg/m²)	25.5 ± 5.5	25.4 ± 5.6	25.2 ± 5
FM (kg)	14.6 ± 1.8	14.5 ± 1.8	14.4 ± 1.8
FFM (kg)	59.8 ± 3.3	59.7 ± 3.0	59.7 ± 2.9
FEV_1 (l)	1.8 ± 0.6	1.5 ± 0.6***	1.6 ± 0.7$^{£}$
FEV_1 % (predicted)	56 ± 21	48 ± 22***	54 ± 22$^{\#\#\#}$
FVC (l)	3.1 ± 0.4	2.6 ± 0.5***	2.9 ± 0.4$^{\#\#\#}$
FVC % (predicted)	79 ± 12	66 ± 13***	73 ± 11$^{££,\#\#}$
FEV_1/ FVC % (predicted)	56 ± 14	51 ± 14*	55 ± 15$^{\#}$
Energy intake (MJ/d)	7.66 ± 0,5	7.60 ± 0.5	7.54 ± 0.5
Carbohydrate intake (g/d)	240 ± 35	235 ± 35	233 ± 34
Carbohydrate intake (% of energy)	52.4 ± 5.9	51.7 ± 7.2	51.8 ± 6.6
Fat intake (g/d)	66.7± 10	67.3 ± 11	67.1 ± 10.7
Fat intake (% of energy)	33.0 ± 5.9	34.0 ± 5.8	33.8 ± 6.4
Protein intake (g/d)	66.2 ± 8.7	64.5 ± 10.1	64.6 ± 9.9
Protein intake (% of energy)	14.6 ± 2.4	14.3 ± 2.5	14.4 ± 2.6
Fluid intake (L/d)	2.0 ± 0.2	1.8 ± 0.1***	1.9 ± 0.9$^{£££}$
Total sleep (hr)	7.9 ± 0.8	7.0 ± 0.8***	6.9 ± 0.7$^{£££}$
Nighttime sleep (hr)	7.4 ± 0.7	4.9 ± 0.6***	4.8 ± 0.7$^{£££}$
Nap (hr)	0.6 ± 0.4	2.1 ± 0.5***	2.1 ± 0.5$^{£££}$

Note. C = before Ramadan; R-2 = the second week of Ramadan; R-4 = the fourth week of Ramadan; BM = body mass; BMI = body mass index; FM = fat mass; FFM = fat-free mass; FEV_1 = forced expiratory volume in one second; FVC = forced vital capacity.
*$p < .05$. ***$p < .001$: Significant differences between C and R-2.
$^{£}p < .05$. $^{££}p < .01$. $^{£££}p < .001$: Significant differences between C and R-4.
$^{\#}p < .05$. $^{\#\#}p < .01$. $^{\#\#\#}p < .001$: Significant differences between R-2 and R-4.

Table 3. Quality of life questionnaire data during Ramadan Observance.

		C	R-2	R-4
VQ11 components	Functional score	6.6 ± 1.3	12.5 ± 1.1***	12.5 ± 1.3$^{£££}$
	Psychological score	8.0 ± 1.6	14.3 ± 3.0***	14 ± 2.6$^{£££}$
	Relational score	7.8 ± 2.4	12.6 ± 2.1***	12.1 ± 1.6$^{£££}$
	Total score	22.5 ± 4.0	39.4 ± 4.4***	38.5 ± 3.2$^{£££}$

Note. C = before Ramadan; R-2 = the second week of Ramadan; R-4 = the fourth week of Ramadan.
***$p < .001$: Significant difference between C and R-2.
$^{£££}p < .001$: Significant difference between C and R-4.

over a short period of time is always detrimental to health because it continues throughout life. Moreover, RO showed a reduction of 6MWTD performance during R-2 and R-4 that could potentially be explained by a cumulative dehydration related to decreases in fluid intakes (Fenneni et al., 2014). Alternatively, there may have been a change of metabolism (especially a switch from glycogen to more lipolytic energy use during submaximal effort; Bouhlel et al., 2006, 2013; Meckel et al., 2008) although no nutritional change was observed during Ramadan. In fact, the study of Meckel et al. (2008) indicated that the decrease in performance does not necessary related to changes in caloric intake and sleep hours during the fast.

The decrease in quality of life indices could decrease psychological resources and have a negative impact on performance on the 6MWT test and other scores (Souissi et al., 2007) that require the maximum effort of the participants.

The MVC was significantly lower during R-2 and R-4 than C. The decrease of fluid intakes, associated to sleep loss was observed during RO may influence MVC. The alteration of neuromuscular performance induced by fluid deprivation, with associated dehydration and

Table 4. 6-Minute Walking Test parameters during Ramadan Observance.

	C	R-2	R-4
6MWTD (m)	521.6 ± 44.7	485.0 ± 55.1***	502.1 ± 50.3££,##
SpO_2			
Rest	95.4 ± 1.1	94.0 ± 0.9***	94.3 ± 1££
Peak	90.8 ± 3.3	88.9 ± 3.6***	88.8 ± 3.2£££
Dyspnea			
Rest	1.2 ± 0.7	1.2 ± 0.7	1.3 ± 0.47
Peak	3.3 ± 1.1	3.8 ± 1.1	3.8 ± 1.3
HR			
Rest	73 ± 8	73 ± 11	73 ± 12
Peak	111 ± 9	123 ± 9	121 ± 8

Note. C = before Ramadan; R-2 = the second week of Ramadan; R-4 = the fourth week of Ramadan; 6MWTD = 6-minute walking test distance; SpO2 = peripheral oxygen saturation; HR = heart rate.
***$p < .001$: Significant difference between C and R-2.
£$p < .05$. ££$p < .01$. £££$p < .001$: Significant differences between C and R-4.
##$p < .01$: Significant difference between R-2 and R-4.

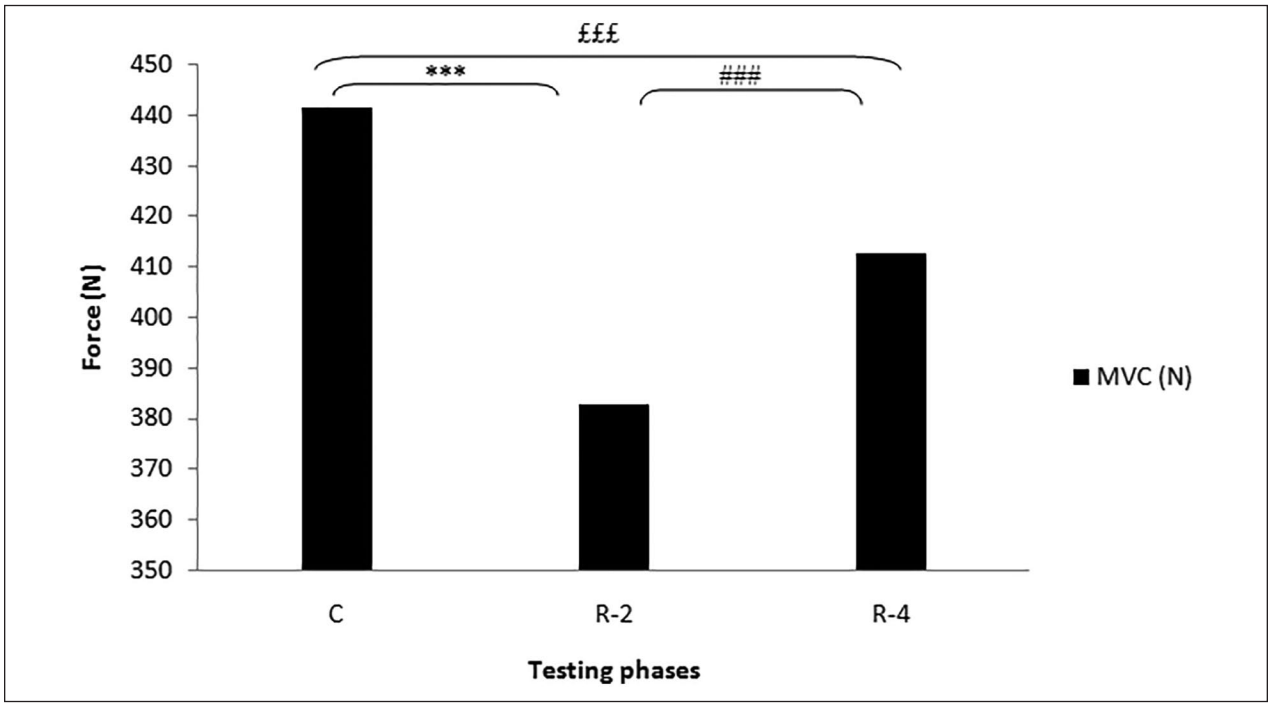

Figure 1. Effect of Ramadan Observance on Maximal Voluntary Contractions Force of the Quadriceps Muscles in Three Testing Phases
Note. C = before Ramadan; R-2 = the second week of Ramadan; R-4 = the fourth week of Ramadan; MVC = Maximal Voluntary contractions.
***$p < .001$: Significant between C and R-2.
£££$p < .001$: Significant between C and R-4.
###$p < .001$: Significant between R-2and R-4.

other metabolic or hormonal changes, could be exacerbated during Ramadan (Ramadan, 2002). Likewise, the shift of circadian rhythms during Ramadan could influence the change in MVC (Anis et al., 2009).

The postural balance measures (TUG, BBS, and UST) showed significant deterioration during Ramadan. This result was already for other population, notably healthy elderly (Laatar et al., 2016). The postural impairment due to Ramadan could be explained, at least in part, by changes in circadian rhythms, including times of meals (Roky et al., 2003) and cumulative sleep deprivation (Laatar et al., 2016; Liu et al., 2001; Nakano et al., 2001)

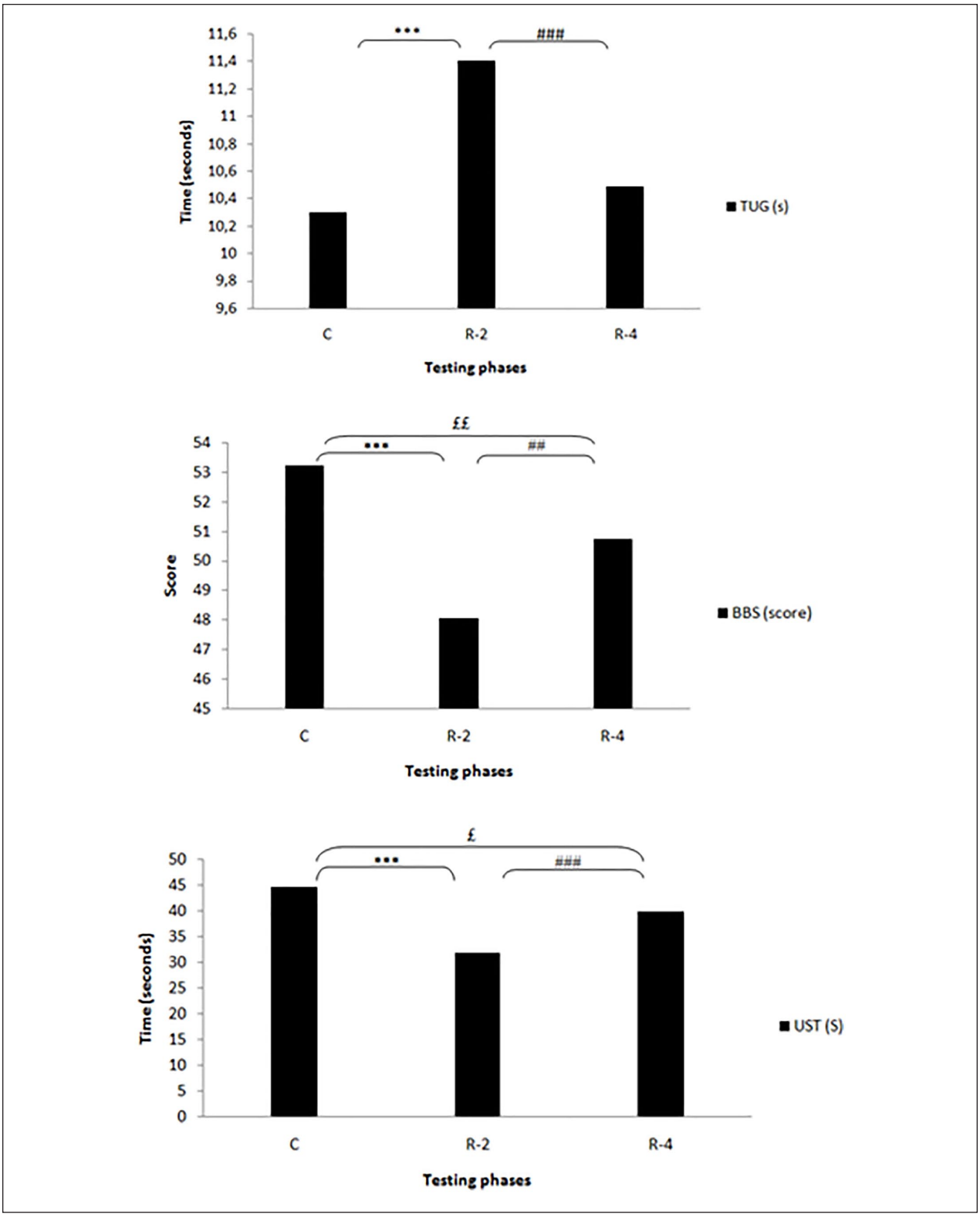

Figure 2. Effect of Ramadan Observance on Balance Assessment (Timed Up and Go, Berg Balance Scale, and Unipedal Stance Tests) in Three Testing Phases

Note. C = before Ramadan; R-2 = the second week of Ramadan; R-4 = the fourth week of Ramadan; TUG = Timed Up and Go test.

$^{***}p < .001$: Significant between C and R-2.

$^{£}p < .05$. $^{££}p < .01$: Significant between C and R-4.

$^{\#\#}p < .01$. $^{\#\#\#}p < .001$: Significant between R-2 and R-4.

that it induces. Sleep deprivation (quality and duration) and reduction in fluid intakes observed in participants during Ramadan can degrade visual (Gomez et al., 2008), vestibular (Avni et al., 2006) muscular, and nervous functions (Kato et al., 2000) and thus negatively affect the physiological component of the postural function (Laatar et al., 2016). Other psychological impairments such as alertness and concentration, reaction times, and mood state (Roky et al., 2000; Shephard, 2012) could induce disturbance of postural balance during Ramadan (Laatar et al., 2016). Possibly, the central nervous system can modify its functional organization to cope with the constraints of Ramadan (Mulder et al., 2002).

Study Limitations

This study has some limitation that need to be considered. In the present study, we did not include a control group who did not fast because the nonfasting Muslim patients do not avow themselves as nonfasting. As well, there is a need to extend observations to women and to those with more severe COPD, patients who are challenged to undertake the activities of daily living even without fasting. Furthermore, it would be interesting to add a formal measure of motivation to distinguish physiological responses to repeated fasting and dehydration from an unwillingness of fasting patients to make the maximal efforts inherent in most of the test measures that we used.

Conclusion

Overall, RO appears to impair psychosocial, physiological pulmonary function, exercise performance, and postural balance in patients with COPD. The deterioration of function is greatest in the second week of Ramadan, with some correction by the fourth week, a phenomenon noted in other studies of healthy participants. The magnitude of the changes that we have observed is not of clinical concern except to patients who are initially in marginal physical condition. Nevertheless, to the extent that balance is impaired, patients with COPD may face an increased risk of falls if they choose to observe Ramadan.

Declaration of Conflicting Interests

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