Does Ramadan Fasting Affect Spirometric Data of Healthy Adolescents?

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ABSTRACT

PURPOSE: Several studies raised the effects of Ramadan fasting on healthy adults spirometric data, but none was performed in children. The aim of this study was to compare the spirometric data of a group of faster adolescents (n = 26) with an age-matched non-faster one (n = 10).

METHODS: This comparative quasi-experimental study, including 36 healthy males aged 12 to 15 years, was conducted during the summer 2015 (Ramadan: June 18 to July 16). Three sessions (Before-Ramadan [Before-R], Mid-Ramadan [Mid-R], After-Ramadan [After-R]) were selected for spirometry measurements. Spirometry was performed around 5.5 to 3.5 h before sunset and the spirometric data were expressed as percentages of local spirometric norms.

RESULTS: The two groups of fasters and non-fasters had similar ages and weights (13.35 ± 0.79 vs 12.96 ± 0.45 years, 46.8 ± 9.2 vs 41.7 ± 12.6 kg, respectively). There was no effect of Ramadan fasting on forced vital capacity (FVC), forced expiratory volume in 1 s (FEV_1), FEV_1/FVC, peak expiratory flow, and maximal mid-expiratory flow. For example, during the Before-R, Mid-R, and After-R sessions, there was no significant difference between the fasters and non-fasters mean FVC (101 ± 11 vs 99 ± 14, 101 ± 12 vs 102 ± 14, 103 ± 11 vs 104 ± 13, respectively) or FEV_1 (101 ± 13 vs 96 ± 16, 98 ± 11 vs 97 ± 16, 101 ± 10 vs 98 ± 16, respectively).

CONCLUSIONS: Ramadan fasting had no interaction effect with the spirometric data of Tunisian healthy male adolescents.

KEYWORDS: human, lung, pulmonary function test, religion, teens

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Introduction

Ramadan fasting (RF) requires Muslims to abstain from eating and drinking from dawn until the sunset.[1] According to Islamic principles, while pubescent children are obliged to fast during Ramadan, prepubescent ones are exempt from it.[1] However, each year many prepubescent Muslims express their willingness to fast during Ramadan for several reasons (eg, encouraged by their parents, other adults, and/or friends around them, to get accustomed to this discipline, to feel equal with their peers who are fasting, or as psychologically and spiritually led).[1–3] Indeed, even though it might be quite debatable that prepubescent children fast whereas Islam requires such a practice only after puberty, it is a relatively current practice that children attempt their first try to fast the whole holy month while they are still prepubescent.[1,4] Generally, the first attempt is achieved through a progressive approach with half-days of fasting when they are around 6 to 12 years old, to isolated one or a few complete days at later ages, until they perform their first try of fasting the entire month of Ramadan usually from 12 to 15 years of age.[1,2] For examples, it was reported that 100% of the 734 Malaysian junior-level Muslim athletes (mean age: 16 ± 3 years)[5] and that 97% of the 67 adolescents (age range: 10-19 years) with a confirmed diagnosis of type 1 diabetes mellitus[2] practiced RF.

The daytime fasting effects' are strongly influenced by climatic circumstances as Ramadan coming in summer presents diverse features compared with Ramadan in winter.[1,6] In summer, compared with winter, fasting time is longer (16-18 vs 10-12 h a day, respectively), and ambient temperature is higher, probably causing additional behavioral and physiological changes observed during RF (eg, eating and sleep patterns,

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slight dehydration, metabolic responses, circadian variation of body temperature, fatigue).[7] These phenomena are known to alter the respiratory mechanics and then decrease some spirometric data.[7–11] Spirometry test is a useful investigation for diagnosing and monitoring a variety of pediatric respiratory diseases.[12] During Ramadan, spirometry tests remain to be normally performed, on healthy/unhealthy adolescents who fast this holy month. The main query remains; how to read any possible volumes/flows changes throughout RF? Are they related to the effects of RF on lungs? Are they generated by the medication-use (in case of amelioration)? Or are they induced by clinical worsening (in case of deterioration)? Studies raising the effects of RF on healthy subjects' spirometric data included only adults and presented controversial conclusions.[11,13–20] RF in adolescents is already an unexplored area and its implication on their short- and long-term health needs to be studied. To the best of the authors' knowledge, no previous study raised the effects of RF on their spirometric data. Moreover, studies were focused only on the effects of RF on their physical capacities.[6,21-24] Most of the aforementioned adults/adolescents studies present one serious limitation related to the lack of a control-group of non-fasters.[6,11,15–24] So, the internal validity of their findings cannot be attributed solely to RF.[1]

The effects of RF on adolescents' respiratory physiology is not of restricted importance for only the Muslim-majority countries.[1,6,24] Studies raising such effects will instead have clinically relevant implications. In a globalized culture, doctors have to deal with issues like Muslim adolescents that want/insist to fast during Ramadan despite suffering from a chronic disease.[2,3] The lack of information on the effects of RF on healthy adolescents could escort to a universal misunderstanding.[1,6,24] Departing from the above considerations, the main aim of this quasi-experimental study performed on male adolescents aged 12 to 15 years was to compare the spirometric data of a faster group with an age-matched non-faster one.

Population and Methods

Study design

This quasi-experimental study was performed in the school of Kalâa Sghira, Sousse, Tunisia. The study was conducted in compliance with the World Medical Association Declaration of Helsinki (available from https://www.wma.net/wp-content/uploads/2016/11/ethics_manual_arabic.pdf; last visit: May 21, 2019). Approval for the study was obtained from the local Hospital Ethical Committee (approval number 1206/2015), and written consent was obtained from all the study adolescents' parents. All adolescents agreed verbally to participate in this study.

The study was conducted during Ramadan 2015 (June 18-July 16). The elapsed time from dawn to sunset was ~16.5 h at the beginning and ~15.8 h at the end of Ramadan. The ambient temperature and humidity means ± standard deviation (SD) during the study period (59 days) were 32.8°C ± 3.2°C and 68% ± 1%, respectively. The ambient temperature and humidity means ± SD during the Before-Ramadan (Before-R), Mid-Ramadan (Mid-R), and After-Ramadan (After-R) sessions were 32.0°C ± 0.0°C, 31.6°C ± 0.5°C, and 34.7°C ± 0.5°C; and 71.7% ± 2.4%, 63.8% ± 2.6%, and 73.7% ± 1.9%, respectively.

Sample size

The sample size was estimated using a predictive formula, largely detailed in Appendix 1.[25] The sample size for this comparative study was 38 adolescents (28 fasters and 10 non-fasters).

Study population

The adolescents were recruited from the school of Kalâa Sghira, Sousse, Tunisia. At the beginning of the study, letters and calendars containing information about the project and visit dates were given to the parents.

Figure 1 shows the study consort flowchart. Only healthy males aged 12 to 15 years and who volunteered for the study were included. The non-inclusion criteria were active smoking; chronic diseases especially cardio-respiratory ones; obesity; abnormalities of the vertebral column or thoracic cage; thoracic or abdominal surgery; chronic medication-use, lack of cooperation during the spirometry test, and the discovery of an obstructive ventilatory defect (forced expiratory volume in 1 s/forced vital capacity (FEV_1/FVC) < lower limit of normal).[26] The following exclusion criteria were applied: incomplete RF period (for the group of fasters), fasting some days during Ramadan (for the non-fasting group), and absence during the second/third testing session.

Experimental design

The experimental design consisted of three testing sessions: 5 to 7 days Before-R (June 11-13), 3 days at Mid-R (July 2-4), and 10 to 12 days After-R (July 26-28).

During the Before-R session, all adolescents underwent a medical questionnaire. Then, anthropometric data (age, height, and weight) were determined. After that, adolescents underwent spirometry tests followed by a 6-min walk test (6MWT). During the Mid-R and After-R sessions, only anthropometric, spirometric and 6MWT data were determined. Spirometric tests of the three sessions were conducted at the same time of day between 15h00 and 17h00, around 5.5 to 3.5 h before sunset, when fasters are allowed to break their fast.

Collected data and applied definitions

Clinical data were gathered from a simplified medical questionnaire.[27] Questions were asked in Arabic, and the following data were collected: practice of regular sports activities, parents'

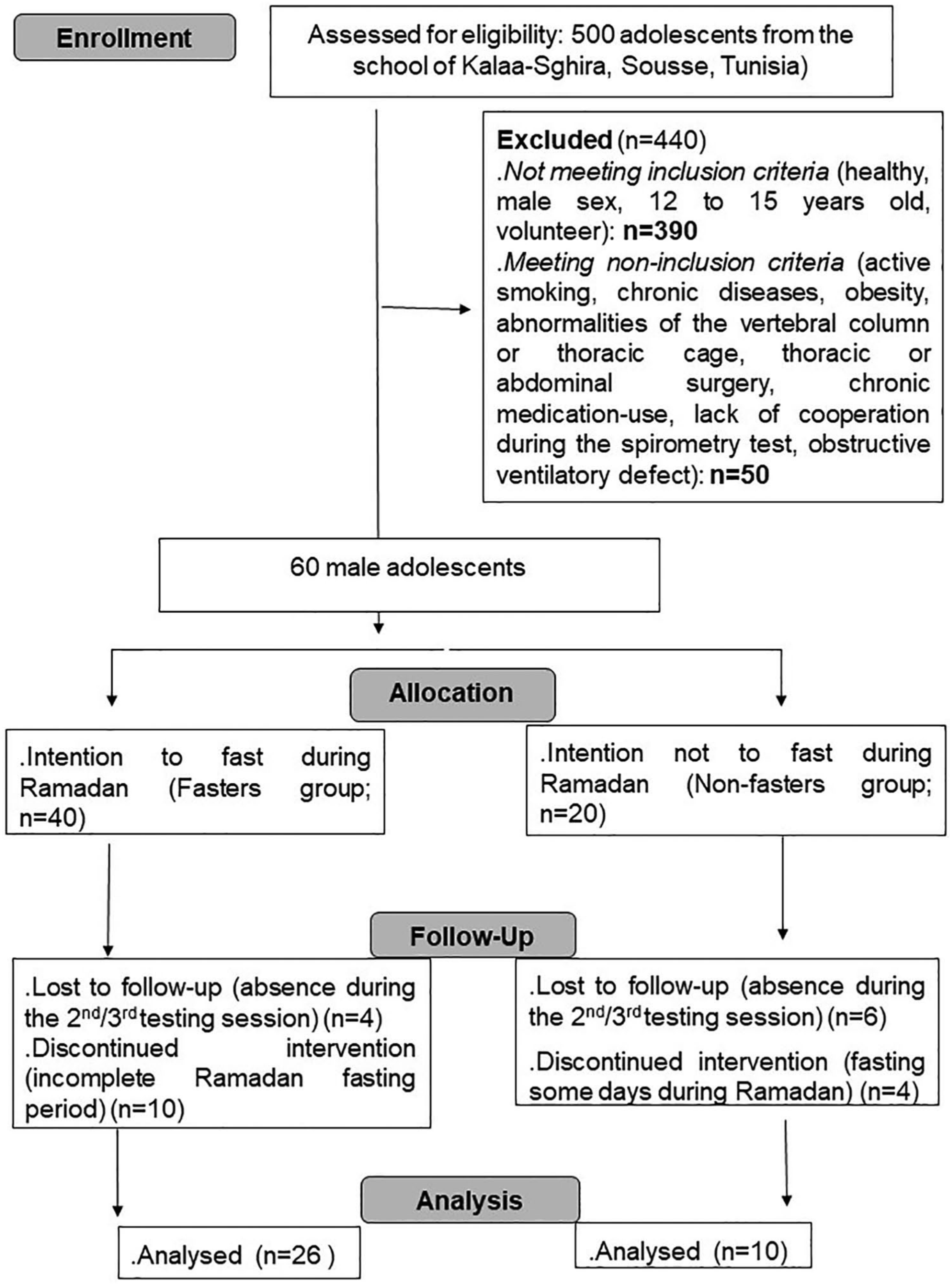

Figure 1. The quasi-experimental study flowchart.

jobs, personal medical or surgical histories, chronic medication use, and smoking habits. Two socioeconomic levels (low/high) were defined based on the parents' jobs. Based on the response to the following question: do you practice any sports activities outside college? two sports activities levels were identified (non-active/active). A complete RF period was defined as a one including 29 days.

Decimal age was taken as the number of complete years from birth to the date of the study. Height (±1 cm) was measured with a height gauge (standing stadiometer type Siber Heghner®) with shoes removed, heels joined, and back straight. Weight (±1 kg) was measured with a digital scale (Tanita TBF-300 body composition analyzer), adolescents with light clothes. Body mass index (BMI, kg/m^2) was calculated. Normal weight, overweight, and obesity were defined.[28]

Spirometry was carried out in the sitting position and a nose-clip was applied. All tests were performed by one qualified person (IL in the authors' list). The turbine of the portable spirometer (SpirobankG MIR via del Maggiolino 12500155 Roma, Italy) was daily calibrated with a 3-L syringe. Spirometry was performed according to international guidelines, and the spirometric data (FVC [L]; FEV_1 [L]; maximal mid-expiratory flow [MMEF, L/s], peak expiratory flow [PEF, L/s], FEV_1/FVC ratio [absolute value], forced expiratory time [FET, s]) were determined.[12] Adolescent was seated comfortably and he was instructed to take a full breath in, then to close the lips around the mouth-piece and blow out as hard and fast as possible. Inspiration was full and unhurried, and expiration tested was continued without any pause. To obtain maximal FVC, adolescent was verbally encouraged to exhale as longer as

Table 1. Characteristics of the two groups of adolescents.

	FASTERS (N = 26)	NON-FASTERS (N = 10)
Age (years)	13.35 ± 0.79	12.96 ± 0.45
Height (cm)	159 ± 9	150 ± 9*
Weight (kg)	46.8 ± 9.2	41.7 ± 12.6
Body mass index (kg/m²)	18.4 ± 2.7	18.3 ± 4.1
Obesity status (normal weight)	23 (88)	8 (80)
Low socioeconomic level[a]	6 (25)	5 (50)
Sports activity status (active)	15 (57)	6 (60)

Anthropometric data were mean ± SD. Obesity status, socioeconomic level, and sports activity status were number (%).
[a]Data were missing for two adolescents from the fasters group.
*$P < .05$ (Mann-Whitney U test) between the two groups.

possible. During the spirometric test, three to four adolescents were watching the performance of their classmates, to reduce the need for instructions before the start of the test. The FVC maneuver was considered well done if there was transient, maximal respiratory effort with no artifacts during the first second of the forced expiration, and if there was no premature termination (sharp decrease of expiratory flow).[12,29] Impossibility to continue further exhalation, a volume-time curve showing no change in volume (<25 mL) for more than 1 s and a FET ⩾ 3 s were used as objectives end-of-test criteria to identify a reasonable FVC effort. A minimum of three reproducible FVC measurements was obtained. FVC and FEV_1 of the best two of the three selected curves varied less than 150 mL. The best FVC and the best FEV_1 were computed, even if the two values did not come from the same curve.[12,29]

Statistical analysis

Quantitative data were expressed as mean ± SD and qualitative ones by relative frequency. The two groups, quantitative and qualitative data for each session, were compared using the Mann-Whitney U test and the chi-square test, respectively. Comparisons of the weight and the spirometric data were made between the three sessions by two ways: (1) one-way analysis of variance (ANOVA) for each group and (2) factorial ANOVA to analyze the higher-order interactive effects of multiple categorical independent factors (groups vs testing sessions).

Percentage changes (%) in FEV_1, FVC, MMEF, and PEF at Mid-R compared with Before-R were determined as follows:

$$Percentage\ change\,(\%) = 100 \times \frac{\left(\begin{array}{l} Mid\text{-}R\ value - \\ Before - R\ value \end{array}\right)}{Before - R\ value}$$

Percentage changes more than "+12%"[12] or less than "–20%"[30] were considered clinically significant, showing lung data amelioration or deterioration, respectively. The percentages of adolescents with FEV_1 and/or FVC changes of more than "+12%" or less than "–20%" were compared. 6MWT data will be explored in an upcoming study.

Analyses were carried out using Statistica software (Statistica Kernel version 6; StatSoft, Paris, France). Significance was set at the 0.05 level.

Results

An initial sample of 60 voluntaries was divided into two groups according to their intentions to fast or not Ramadan (Figure 1). Twenty-four adolescents were withdrawn from the second/third sessions, and the remaining 36 ones were divided into fasters (n = 26) and non-fasters (n = 10) groups (Figure 1). The two groups had similar ages, weights, BMIs, obesity status, socioeconomic levels, and sports activity status. Fasters were significantly taller than non-fasters (Table 1).

There was no significant difference between the two groups mean weight or spirometric data (Table 2). Moreover, factorial ANOVA showed no significant difference between the three testing sessions' weight and spirometric data.

The mean changes of FVC, FEV_1, MMEF, and PEF did not exceed the clinical thresholds of "+12%" or "–20%" (Table 3). No adolescent showed a clinically significant change in FVC (⩽–20% or ⩾+12%) or FEV_1 (⩾+12%). The percentages of adolescents with a clinically significant FEV_1 decrease were similar between the two groups (P = .26).

Discussion

Some spirometric data of 26 fasters and 10 non-fasters healthy male adolescents aged 12 to 15 years with similar ages, weights; BMIs, obesity status, socioeconomic levels, and sports activity status were compared. The two groups had similar spirometric data and similar changes during the three testing sessions. RF did not have any significant impact on the adolescents spirometric data.

Table 2. Weight and spirometric data changes of the fasters (n = 26) and the non-fasters (n = 10) groups during the three sessions.

		BEFORE-R	MID-R	AFTER-R	ONE-WAY ANOVA	FACTORIAL ANOVA
Weight (kg)	Fasters	46.8 ± 9.2	46.6 ± 9.3	47.8 ± 9.3	$F_{(2,75)}$ = 0.1301; *P* = .878	$F_{(2,102)}$ = 0.0254; *P* = .947
	Non-fasters	41.7 ± 12.6	42.2 ± 12.2	43.9 ± 12.5	$F_{(2,75)}$ = 0.0862; *P* = .918	
	P	.124	.174	.197		
FEV_1 (%)	Fasters	101 ± 13	98 ± 11	101 ± 10	$F_{(2,75)}$ = 0.6317; *P* = .534	$F_{(2,102)}$ = 0.1014; *P* = .904
	Non-fasters	96 ± 16	97 ± 16	98 ± 16	$F_{(2,27)}$ = 0.0588; *P* = .943	
	P	.458	.805	.724		
FVC (%)	Fasters	101 ± 11	101 ± 12	103 ± 11	$F_{(2,75)}$ = 0.2902; *P* = .749	$F_{(2,102)}$ = 0.051; *P* = .951
	Non-fasters	99 ± 14	102 ± 14	104 ± 13	$F_{(2,27)}$ = 0.2243; *P* = .800	
	P	.609	.958	.888		
FEV_1/FVC (%)	Fasters	101 ± 10	98 ± 7	99 ± 6	$F_{(2,75)}$ = 1.3476; *P* = .266	$F_{(2,102)}$ = 0.0455; *P* = .955
	Non-fasters	97 ± 5	95 ± 4	95 ± 5	$F_{(2,27)}$ = 0.7297; *P* = .491	
	P	.216	.120	.048		
MMEF (%)	Fasters	104 ± 23	96 ± 21	103 ± 21	$F_{(2,75)}$ = 0.9875; *P* = .377	$F_{(2,102)}$ = 0.1748; *P* = .839
	Non-fasters	92 ± 28	90 ± 26	91 ± 25	$F_{(2,27)}$ = 0.0066; *P* = .993	
	P	.138	.437	.112		
PEF (%)	Fasters	102 ± 17	99 ± 16	103 ± 16	$F_{(2,75)}$ = 0.5502; *P* = .579	$F_{(2,102)}$ = 0.0416; *P* = .959
	Non-fasters	101 ± 17	96 ± 21	99 ± 20	$F_{(2,27)}$ = 0.1352; *P* = .874	
	P	.860	.698	.340		
FET (s)	Fasters	3.4 ± 1.0	3.9 ± 1.2	3.9 ± 1.5	$F_{(2,75)}$ = 1.641; *P* = .201	$F_{(2, 102)}$ = 0.4316; *P* = .650
	Non-fasters	3.4 ± 1.2	3.9 ± 1.0	4.4 ± 1.3	$F_{(2,27)}$ = 1.771; *P* = .189	
	P	.916	.944	.244		

Abbreviations: ANOVA, analysis of variance (ANOVA); FET, forced expiratory time; FEV_1, forced expiratory volume in 1 s; FVC, forced vital capacity; MMEF, maximal mid-expiratory flow; PEF, peak expiratory flow; R, Ramadan.
Spirometric data were expressed as percentages of local norms. Data were mean ± SD. *P*: Mann-Whitney *U* test between the two groups for the same session.

Discussion of methodology

Discussion related to the Ramadan season, the fasting duration, the climatic circumstances, the applied inclusion and non-inclusion criteria, and the number of testing sessions is highlighted in Appendix 1. Contrary to some previous studies aiming to evaluate the effects of RF on healthy adults' lung function data or on healthy male adolescents' physical performances[6,11,15–24] this one opted for a comparative design. The latter is somewhat economical and can be carried out by small convenience groups. The inclusion of a comparative group of non-fasters is a strong point that reduces the possibility of learning effects skewing the results and reinforces the internal validity of the study findings. This study calculated sample size (n = 36)[25] "seemed" to be satisfactory. It is higher than those of some studies aiming to evaluate the effects of RF on healthy adults' lung function data (n = 13,[11] n = 29,[16] n = 32[15]) or on healthy adolescents' physical capacities (sample size varied between 12 and 19).[6,21–24] Since, only flows and mobilized volumes were evaluated, in the future, it would be interesting to evaluate some static volumes and capacities. Information about adolescents' position (sitting or standing), spirometry calibration, applied spirometric guidelines and norms, factors known to modify the spirometric data measurements and interpretation, were provided.

Study limitations

This study presents four limitations. First, applying for a quasi-experimental approach induces some disadvantages[31,32]: (1) the lack of random assignment into test groups can limit the findings generalizability; (2) conclusions about causality are less decisive, (3) due to the threats to internal validity,

Table 3. Spirometric changes in the two groups of adolescents.

	FASTERS (N = 26)	NON-FASTERS (N = 10)
	MEAN ± SD CHANGES (%)[a] OF	
Forced vital capacity (FVC)	1 ± 4	3 ± 4
Forced expiratory volume in 1 s (FEV_1)	−2 ± 7	−0 ± 3
Maximal mid-expiratory flow (MMEF)	−7 ± 11	−1 ± 7
Peak expiratory flow (PEF)	−3 ± 7	−5 ± 8
	NUMBER (%) OF ADOLESCENTS WITH	
FVC increase ⩾ +12%	0 (0)	0 (0)
FVC decrease ⩽ −20%	0 (0)	0 (0)
FEV_1 increase ⩾ +12%	0 (0)	0 (0)
FEV_1 decrease ⩽ −20%	1 (4)	0 (0)

[a]Change (%) = 100 × ([Mid-Ramadan value − Before-Ramadan value]/[Before-Ramadan value]).

statistical analyses may not be meaningful, and (4) some other influencing factors (eg, the pubertal status which significantly influences spirometric data)[33] were not taken into account because data were less controlled. For that reason, future studies evaluating the effects of RF on lung function data of pubescent and prepubescent adolescents are encouraged. The quasi-experimental research presents some benefits (eg, more feasible, useful in identifying general trends from the results, reduces the difficulty surrounding the random assignment of test volunteers, reduce the time and resources required).[31,32] Second, the convenience sampling was a confounding factor. All adolescents were conscious of the study goals, which might raise concern about religious prejudice and then might motivate fasters to cooperate during the spirometry tests. The nocebo effects of observing the religious fasting could be a source of confusion.[34] However, the FET, reflecting the performed expiratory efforts, was unchanged (Table 2). Third, among the studies aiming to evaluate the effects of RF on healthy adults' lung function data, no one included information about the elapsed time between the spirometry test and the last taken meal.[11,14-17,19,20] The latter can influence the spirometric data and in practice, "eating a large meal within two hours pre-testing" is among the activities to avoid prior to spirometry.[12] Fourth, it would have been better to add an additional session (eg, End-Ramadan [End-R]) as done in some relative studies,[6,17,22] to really evaluate the effects of fasting the whole month of Ramadan.

Spirometric data changes

Healthy male adolescents could tolerate fasting the month of Ramadan without significant statistical alteration of their respiratory system functions. Consequently, during Ramadan, the interpretation method of spirometry performed by fasters should not be changed. Moreover, the diagnosis and prognosis of a respiratory condition made on spirometry results are consistent and need no error rectification if a male adolescent is fasting.[18] Given the pioneer character of this study, and despite the fact that adolescents are not miniature adults,[35] spirometric data comparison will be made with similar studies performed on healthy adults. Among the latters, only a few studies examined the impacts of RF on spirometric data with controversial findings.[11,13–20] While some studies reported no interaction effects between RF and spirometric data,[13–16,18] others reported that RF modifies the spirometric data.[11,17,19,20] The present study findings are similar to that of a previous local one where authors concluded that "RF did not bring about any significant changes in the spirometric data of adult males aged 20 to 40 years."[16] The results of the few studies aiming at evaluating the effects of RF on healthy adults' lung function data were largely described elsewhere.[16,36]

The effects of RF on the physical capacities of adolescents seem controversial, but there is a tendency to a reduction in endurance performance, while a minor decrement or no significant effect on short-term explosive performance has been shown.[1,6,21-24] For example, a Tunisian study including 18 non-athletic boys (mean ± SD of age: 12 ± 1 years) concluded that "RF impairs sub-maximal aerobic capacity,"[6] and a speculated negative effect of RF on lung function data was advanced to explain this impairment. For that reason, the merit of this study is to partially "eliminate" the implication of the respiratory mechanical system as a mechanism explaining the above decrement of physical capacity.

Weight changes

RF did not bring about any change in the weight of healthy male adolescents. It seems unlikely that the retained adolescents were dehydrated. Conclusions about the effects of RF on healthy adolescent weight were controversial. While some studies reported no significant change in weight during Ramadan,[6,21,24] another one detected weight gains during the second week of Ramadan (47.0 ± 3.4 kg) compared with Before-R (45.4 ± 3.2 kg).[22] A study performed during Ramadan 2010 has described the effects of RF on weight in 18 Muslim boys aged 9 to 15 years.[37] The weight of the nine pubescent boys increased significantly in the fourth week of Ramadan (55.4 ± 11.0 kg) compared with Before-R (53.9 ± 10.5 kg), and the first week of Ramadan (54.6 ± 10.8 kg). A 2018-cohort study with four testing sessions (Before-R, Mid-R, End-R, After-R) and including 366 Ghanaian adolescents (47% boys, mean age: 15.9 ± 1.8 years) concluded that RF induced a significant weight loss (−1.5 kg) which was regained 1 month After-R.[4] A 2014-systematic review concluded that RF could result in relatively small but significant weight loss, and most of the weight loss was regained within a few weeks After-R.[38]

In conclusion, RF had no interaction effect with the spirometric data of healthy non-athletic male adolescents aged 12 to 15 years fasting during Ramadan. However, this conclusion cannot be extrapolated to adolescents with respiratory conditions who insist/want to fast Ramadan. Future studies, aiming to evaluate the effects of RF on spirometric data, should include adolescents with chronic respiratory diseases (eg, asthma).

Authors' Note

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Author Contributions

SBF, AM, IL, and HBS: literature search, data collection, study design, analysis of data, manuscript preparation, and review of manuscript. FG, MBR, JB, IG, and SR: study design, analysis of data, manuscript preparation, and review of manuscript. All authors read and approved the final manuscript. No honorarium, no grant, no other form of payment was given to anyone of the authors to produce the manuscript.

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Appendix 1

Population and methods

Sample sizeThe null hypothesis was H_0: $m_1 = m_2$ and the alternative hypothesis was H_a: $m_1 = m_2 + d$, where d is the difference between two means, and n_1 and n_2 are the sample size for two groups (fasters and non-fasters) such $N = n_1 + n_2$.

The total sample size was estimated using the following formula[1]:

$$N = \frac{\left((r+1)\left(Z_{\alpha/2} + Z_{1-\beta}\right)^2 \delta^2 \right)}{rd^2}$$

$Z\alpha_{/2}$ is the normal deviate at a level of significance (=1.44 for 15% level of significance); $Z_{1-}\beta$ is the normal deviate at $1-\beta\%$ power with β% of type II error (=0.67 at 75% statistical power); r (equal to n_1/n_2) is the ratio of sample size required for two groups ($r = 2.5$ gives the sample size distribution as 2.5:1 for the fasters and non-fasters groups); δ and d are the pooled SD and difference of FEV_1 means of the two groups determined at Mid-Ramadan. The reason for un-equal sample size was the difficulty to find non-fasters in this age group. Given the pioneer character of this study and since in adults no previous study has included a control group, these two values were obtained from a previous local study of similar hypothesis including young adults.[2] The fasters group has a FEV_1 of 98% compared with the 100% FEV_1 mean of the predicted values derived from the local spirometric norms with a common SD of 5%.[2]

The total sample size was 38 adolescents (28 fasters and 10 non-fasters). The assumption of 25% for nonattendance during the second/third testing session gives a revised sample of 54.

Discussion

Discussion of methodology. This study was performed in Tunisia, during the 2015 summer when the mean elapsed time from sunrise to sundown was ~17 h at the beginning and ~16 h at the end of Ramadan, with average ambient temperature and humidity around, 31.7°C and 67%, respectively. These conditions could be judged somewhat difficult as temperature was quite hot and children were expected to fast long hours prior to the spirometry test (9h40 to 10h30) depending on the time they had their last allowed meal, either before dawn or just before going to bed.[3,4]

As in the majority of relative studies aiming to evaluate the effects of RF on lung function data or on physical performances,[2,4-14] females/girls were excluded. Muslim laws forbid them to fast during their menses and lung function is somewhat lowered during menses.[15] It was previously reported that overweight reduces respiratory well-being, that a low socioeconomic level is associated with a worse lung function, and that the sports activity status may interfere with the independent effects of RF on ventilatory mechanics.[16,17] Since the two groups were matched for the aforementioned parameters, this study's main finding is not impacted. Moreover, since 21%, 35%, and 53% of Tunisian adolescents had overweight, low socioeconomic level and were qualified as active,[18,19] this study group composition (12%-20% were overweight, 25%-50% had low socioeconomic level, and 57%-60% were active) reflected this "healthy" adolescents population as they exist in the real society, increasing the external validity of this study. Since height is the most important influencing factor of children lung growth,[20] and since the fasters were taller than the non-fasters (Table 1), the spirometric data were standardized with respect to height by applying the local spirometric norms.[20]

In previous studies aiming to evaluate the effects of RF on healthy adults' lung function data or on healthy adolescents physical performances,[2,4-14,21,22] the number of sessions varied from two to eight.[5,10]

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