



Effects of Ramadan fasting on blood pressure in hypertensive patients

Effets du mois de ramadan sur la pression artérielle de patients hypertendus

Ihsen Zairi, Mohamed Amine Bejar, Imtinen Ben Mrad, Khadija Mzoughi, Sondos Kraiem

Service de cardiologie Hôpital Habib Thameur, Faculté de médecine de Tunis

RÉSUMÉ

Introduction: Pendant Ramadan, le jeûne par intermittence ainsi que le changement d'horaire de prise des médicaments pourraient contribuer à modifier la pression artérielle et le rythme cardiaque des patients hypertendus.

Objectif : Examiner l'effet du jeûne sur la pression artérielle et la fréquence cardiaque chez des sujets hypertendus traités.

Méthodes: L'étude a recruté prospectivement 60 patients hypertendus, entre avril et juin 2019, et suivis au service de cardiologie de l'hôpital Habib Thameur de Tunis. Une mesure de la pression artérielle sur 24 heures a été effectuée pendant deux périodes: avant Ramadan et les dix derniers jours de Ramadan. La pression artérielle et la fréquence cardiaque sur vingt-quatre heures, en journée et au cours du sommeil ont été comparées.

Résultats: Nous avons étudié 40 femmes et 20 hommes, l'âge moyen était de 58,4 ans. 33,7% des patients étaient diabétiques, 41,7% dyslipidémiques, 15% coronariens. Les patients étaient sous monothérapie dans 45%, association dans 36,7% et sous triple thérapie dans 18,3% des cas. Durant Ramadan, les patients prenaient leurs médicaments une (73,4 %), deux (3,3 %) ou trois (23,3 %) fois par jour entre le coucher et le lever du soleil. La pression artérielle moyenne en ambulatoire sur 24 heures dans l'ensemble du groupe était de $129 \pm 17/74 \pm 10$ mmHg avant Ramadan contre $128 \pm 17/73 \pm 9$ mmHg pendant Ramadan ($p > 0.05$). Nous n'avons pas trouvé de différence significative entre les PAS et PAD diurnes et nocturnes avant et pendant Ramadan, et ce y compris après ajustement sur l'âge, le sexe, les antécédents et le mode de vie.

Conclusion: Dans cette étude, il n'y a pas eu de changements significatifs des pressions artérielles systolique et diastolique et de la fréquence cardiaque entre les 2 périodes de surveillance.

Mots-clés : Hypertension artérielle, Jeûne alimentaire, Ramadan, Mesure ambulatoire de la pression artérielle

SUMMARY

Introduction: During Ramadan, repeated cycles of fasting might contribute to changes in blood pressure among hypertensive patients. Studies on the effects of fasting on the blood pressure of hypertensive patients are scarce and have provided inconclusive results.

Aim: To examine the effect of fasting on ambulatory blood pressure and heart rate in treated hypertensive subjects.

Methods: The study prospectively recruited 60 hypertensive patients between April and June 2019, followed up at the cardiology department of Habib Thameur Hospital of Tunis. A 24-hour pressure monitoring was carried out during two periods: prior to Ramadan and during the last ten days of Ramadan. We compared the average values of 24 hour, awake and asleep systolic and diastolic blood pressure and 24 hour, awake and asleep heart rate.

Results: We studied 40 women and 20 men; mean age was 58.4 years. 33% of the patients were diabetics, 42% dyslipidemics, 15% had coronaropathy. 45% of the patients were on monotherapy, 37% on dual therapy and 18% on a triple antihypertensive therapy. During Ramadan, 74% of the patients were taking the treatment once daily, 3% twice daily, and 23% three times per day. Average 24hour ambulatory blood pressure in the whole group was $129 \pm 17/74 \pm 10$ mmHg before Ramadan and $128 \pm 17/73 \pm 9$ mmHg during Ramadan ($p > 0.05$). Daytime and nighttime mean values of systolic and diastolic blood pressure as well as mean values of heart rate were not different between both periods regardless of age, gender, medical history and lifestyle.

Conclusions: In this study, there were no significant changes in systolic and diastolic blood pressures as well as heart rate during the 2 periods.

Key-words : Hypertension, Fasting, Ambulatory blood pressure monitoring

Correspondance

Ihsen Zairi

service de cardiologie Hôpital Habib Thameur / faculté de médecine de Tunis

E-mail : zairihsen@yahoo.fr

INTRODUCTION

Fasting during Ramadan means abstention from food, liquids, tobacco, medication (oral, inhaler or injection) and sexual activity from sunrise to sunset. The Shour is the last meal of the night taken before dawn. Food and fluids are consumed only at night.

During this month, repeated cycles of fasting, associated with alterations in the daily patterns of sleep, activities and medication timing might contribute to changes in blood pressure and heart rate among hypertensive patients.

Each year, doctors and patients at high cardiovascular risk have to decide together the ability of fasting, the therapeutic adaptations to be made, and the methods of the monitoring [1].

Studies on the effects of fasting on blood pressure and heart rate of hypertensive patients are rare, and have provided inconclusive results.

It is therefore essential for any cardiologist to objectively assess the safety of this holy month, in order to improve patient care and guarantee their physical and psychological well-being.

The aim of our study was to examine the effect of Ramadan fasting on ambulatory blood pressure and heart rate in treated hypertensive subjects.

METHODS

This was a descriptive prospective, mono-centric study including reliable and compliant hypertensive patients. After giving their informed consent, they were enrolled between April and June 2019 (one month before and the month of Ramadan) and followed up at the cardiology department of Habib Thameur Hospital of Tunis.

We included hypertensive patients over 18 years old, with a daily antihypertensive treatment. The non inclusion criteria were patients who do not fast during Ramadan and those with diabetes treated with insulin. We excluded patients who did an incomplete fast during Ramadan, and those who had less than two usable ambulatory blood pressure monitoring.

We performed an individual interview with each patient, during which a clinical examination was carried out

(age, gender, body mass index, age at diagnosis of the hypertension, comorbidities, treatment, and lifestyle).

The following blood tests were requested for each patient: blood sugar levels, glycosylated hemoglobin (HbA1c), serum electrolytes and creatinine, hemoglobin, total cholesterol level (CT), low-density lipoproteins (LDL), high-density lipoproteins (HDL), and triglycerides (TG).

A 24-hour pressure monitoring was carried out during two periods: prior to Ramadan and during the last ten days of Ramadan, using an ambulatory blood pressure monitoring. (GIMA 2018, ABPM 50, Contec Medical Systems Co.Ltd)

All the monitoring sessions started at approximately the same time in the morning at 10 am (within a 2-hour interval). The cuff was placed on the non-dominant arm and removed after 24 hours for the monitoring of the blood pressure and heart rate. Calibration was checked by comparing the auscultatory results with a mercury sphygmomanometer, which were verified to be in close agreement (5 mm Hg). Blood pressure was measured three times per hour between 7.00 am and 11.00 pm, and twice per hour between 11.00 pm and 7.00 am. Subjects were instructed to immobilize their arms during cuff inflation.

The data were then analysed using the following software: ABPM V4.5.0, Copyright © 2015. A minimum of 70% usable BP recordings are required for a valid ABPM measurement session.

We compared in both periods (period A: ABPM one month before Ramadan, and period B: ABPM during the last ten days of Ramadan) the average values of 24-hour systolic and diastolic blood pressure; awake systolic and diastolic blood pressure; asleep systolic and diastolic blood pressure; 24-hour, awake and asleep heart rate.

The software R version 3.6.3 was used to perform the statistical analysis. The statistical tests used to compare data within the periods are the Anova test and Student's t-test. P-value <0.05 was considered statistically significant for all tests.

RESULTS

Our population was made up of 67 % of women and 33 % of men, with an average age of 58 years old. The average BMI of our patients was $29.95 \pm 4.67 \text{ kg/m}^2$ with extremes ranging from 21.07 to 42.57 kg/m^2 . Eighty nine percent of the patients were at least overweight, 47% were obese.

Among our patients, 33% were dayabetic, 42% had dyslipidemia, 15% had a coronaropathy, 47% were obese, and 37% were active smokers.

The duration of hypertension in our study ranged from 1 to 30 years, with an average of 7.48 years. If we consider the treatment, 74% were taking the treatment once daily, 3% twice daily, and 23% three times per day. 45% were on monotherapy, 37% on dual therapy and 18% on triple antihypertensive therapy. (Figure 1)

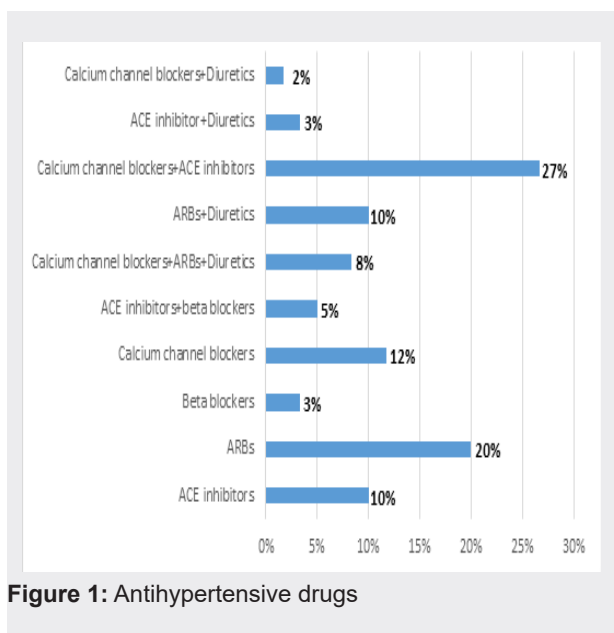


Figure 1: Antihypertensive drugs

During the month of Ramadan, the antihypertensive treatment schedule differs from one patient to another. Among the 74% of the patients taking their treatment once daily, 42% took it after dinner, and 32% during the shour. 3% of the patients took their treatment twice per day, during dinner and shour, and 23% took their treatment three times per day during dinner, at midnight, and during the shour.

All patient biological parameters are summarized in Table 1.

Table 1. Biological parameters of the patients

Parameters	Average and standard deviation	Extremes
HbA1c [%]	6.07 ± 0.81	[4.1-7.95]
Glycemia [mmol/L]	6.27 ± 1.44	[4.41-13.32]
Creatinine [$\mu\text{mol/L}$]	68.95 ± 17.43	[36-119]
Natremia [mmol/L]	138.6 ± 2.4	[134-144]
Kaliemia [mmol/L]	3.9 ± 0.3	[3.4-5]
CT [mmol/L]	5.00 ± 0.93	[2.76-6.93]
TG [mmol/L]	$1,25 \pm 0,51$	[0.30-3.71]
HDL [mmol/L]	1.18 ± 0.23	[0.80-1.90]
LDL [g/L]	1.19 ± 0.32	[0.46-1.90]
Haemoglobin [g/dL]	13.2 ± 1.4	[9.80-16.50]

HbA1c: glycosylated hemoglobin, CT: total cholesterol levels, TG: triglycerides, HDL: high-density lipoproteins, LDL: low-density lipoproteins

Comparison of blood pressure and heart rate in both periods

In our study, average 24h ambulatory blood pressure in the whole group was $129 \pm 17 / 74 \pm 10$ mmHg before Ramadan and $128 \pm 17 / 73 \pm 9$ mmHg during Ramadan ($p > 0.05$). Daytime and nighttime mean values of systolic and diastolic blood pressure as well as mean values of heart rate were not different between both periods.

The average values are summarised in Table 2.

The figure 2 is a representation of the 24-hour course of blood pressure values before Ramadan and during the last ten days of Ramadan.

We compared the average values of blood pressure and heart rate according to gender, age (older than 60 years old or younger), Body Mass Index (over than 25 kg/m^2 or

less), duration of hypertension with a cutoff of 5 years, medical history like the presence of diabetes, dyslipidemia, coronaropathy, smoking and diet. We found out that there are no significant differences between each groups in both periods.

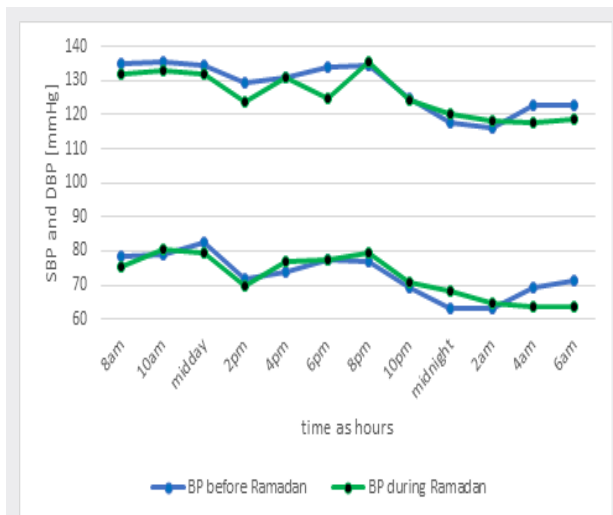


Figure 2. 24-hour course of blood pressure values before Ramadan and during the last ten days of Ramadan

Table 2: Comparison of the groups A and B in all the study population

	Mean value (period A)	Mean value (period B)	P
24 hour systolic average blood pressure [mmHg]	129±17	128±17	0.897
24 hour diastolic average blood pressure [mmHg]	74±10	73±9	0.918
Awake systolic average blood pressure [mmHg]	133±18	133±20	0.999
Awake diastolic average blood pressure [mmHg]	77±11	76±9	0.996
Asleep systolic average blood pressure [mmHg]	120±19	118±24	0.928
Asleep diastolic average blood pressure [mmHg]	67±10	67±10	0.934
24 hour average heart rate [bpm]	71±9	71±7	0.999
Awake average heart rate [bpm]	75±10	75±8	0.917
Asleep average heart rate [bpm]	63±7	66±7	0.157

DISCUSSION

In our study, we compared average values of 24 hour systolic and diastolic blood pressure ; awake systolic and diastolic blood pressure ; asleep systolic and diastolic blood pressure ; in both periods A (before Ramadan) and B (during the last 10 days of Ramadan). There were no significant changes in systolic and diastolic blood pressures as well as heart rate during the 2 periods, the average 24hour ambulatory blood pressure in the whole group was 129±17/74±10 mmHg before Ramadan and 128±17/73±9 mmHg during Ramadan (p>0.05).

Characteristics of the study population

Our population was made up of 2/3 of women and 1/3 of men. Regardless of age, we found a significantly higher value of average asleep systolic blood pressure in women in comparison with men in period A. In addition, significant higher value of average awake systolic blood pressure was found in women in comparison with men during the last ten days of Ramadan.

In contrast to our results, several studies have shown that there is a significant difference between men and women where men have a higher prevalence of hypertension and higher values of blood pressure from 20 to 65 years then the difference between the genders is narrowed [2].

However, as far as we know, there are no large-scale studies that have yielded powerful results enough to change recommendations about hypertension according to gender [3].

The average BMI of our patients was 29.95 ± 4.67kg/m² with extremes ranging from 21.07 to 42.57 kg/m². Eighty nine percent of the patients were at least overweight, 47% were obese.

Several studies showed that a normal BMI was related with a lower prevalence of cardiovascular diseases [4]. The association between obesity and hypertension is complex. A high BMI is one the principal risk factors for hypertension [5,6] and as a result the prevalence of hypertension increases with rising BMI [7,8].

In our study, 33% of the patients were diabetics, 12 under treatment and 8 on diet. In a study carried out in Algeria, in Ain Taya, involving 1511 patients, Biad et al found that the prevalence of diabetes in the population of hypertensive patients was 22.7% [9].

As we all know, type 2 diabetes and hypertension are often present as part of the metabolic syndrome [10].

Moreover, 42% of the patients were dyslipidemic, 18 on lipid-lowering therapy and 7 on diet.

Egan et al. [11], by analyzing three reports from the National Health and Nutrition Examination Surveys from 1988 to 2010, showed that 60.7 to 64.3 % of hypertensive patients also had hypercholesterolemia.

Fifteen percent of the patients had a history of a coronary artery disease, with or without revascularization.

Hypertension is a major risk factor for cardiovascular diseases by accelerating atherogenesis. It approximately doubles coronary heart disease risk [12].

In our study population, about half of the patients (53%) never smoked, 10% stopped smoking for over two years.

Several studies showed that smoking induces a persistent rise in blood pressure and heart rate [13,14].

Just like hypertension, smoking is a major cardiovascular risk factor. Nicotine can temporarily raise blood pressure by an immediate effect on the sympathetic nervous system. Smoking also accelerates the arterial rigidity processes involved in vascular hypertension [15].

If we consider the hypotensive treatment, among our patients, 45% (n=27) were on monotherapy, 37% (n=22) on dual therapy and 18% on a triple antihypertensive therapy. Seventy four percent of the patients were taking the treatment once daily, 3% twice daily, and 23% three times per day. The most commonly drug prescribed in our study population was the inhibitors of the renin-angiotensin system (angiotensin-converting enzyme inhibitors or angiotensin II receptor blockers) found in 30% of the patients, followed by a combination therapy (calcium channel blockers with angiotensin-converting enzyme inhibitors) in 27%.

Our results are in line with those of the french Mona Lisa study that have involved 4825 hypertensive patients: 47% received monotherapy, 34% were on dual therapy and 19% on a triple therapy [16]10 year-age group (35-74 years).

Comparison of the periods A and B

In our study, average 24h ambulatory blood pressure in the whole group was $129 \pm 17/74 \pm 10$ mmHg before Ramadan and $128 \pm 17/73 \pm 9$ mmHg during Ramadan ($p > 0.05$). Daytime and nighttime mean values of systolic and diastolic blood pressure as well as mean values of heart rate were not significantly different between both periods.

Samad et al. [17] showed a significant decrease of blood pressure during the month of Ramadan in 40 normotensive subjects. The measurements of the BP were made one week before the beginning of Ramadan, on the 7th, 14th and 21st days of Ramadan.

Several studies evaluated the effects of fasting on the blood pressure in hypertensive patients and have provided different results.

Some have shown that Ramadan fasting has a beneficial effect on hypertension [18,19]. Nemati and al., in a prospective observational study that was carried out in a group of patients with at least one cardiovascular risk factor in Ramadan 2008, in Mashhad, Iran, found that there was a significant decrease in systolic blood pressure (132.9 ± 16 mmHg before Ramadan versus 129.9 ± 17 mmHg during Ramadan, $p = 0.03$). Although, no significant change in diastolic blood pressure was found (80.2 ± 9 before Ramadan versus 78.6 ± 11 mmHg during Ramadan, $p = 0.14$) [20].

This significant reduction in blood pressure levels at the end of Ramadan may be due to catecholamine inhibition during hunger [21].

In the Kuwait University, the department of Physiology included sixteen sedentary healthy Kuwaiti adult males who were tested during the week before Ramadan, the last 3 days of Ramadan, the week after Ramadan, and the last 3 days of the following month. No significant changes were observed in body composition, cellular and biochemical constituents of blood while systolic blood pressure increased ($p < 0.05$) by the end of Ramadan [22].

However, other studies performed ambulatory BP monitoring before and during Ramadan fasting, and did not find a significant difference among the mean BP of 24 hour, diurnal and nocturnal periods [21,23-25].

Ural et al. [26] have focused on patients with hypertension grade 2 or 3 under dual therapy. The authors have concluded that BP did not change during Ramadan. However, this study was carried out during winter. The duration of fasting was shorter (around 12 hours). Akturk et al. [19] has also included patients taking at least one anti-hypertensive dual therapy. This study was carried out during summer. The authors found a decrease in the 24 hour systolic and diastolic BP during Ramadan.

These contradictory results observed between those studies can be explained by differences in climate and fasting duration between countries as Ramadan is determined by the lunar calendar, which is about 11 days shorter than the solar year; therefore, it is not fixed to any season. Also dissimilar life style and eating habits from one region to another, as well as races and genders of the subjects, health status and medical history of each participant. In addition, many of the studies did not analyse the impact of other factors such as the effects of smoking and physical activity on blood pressure and heart rate during Ramadan.

During this month, people tend to decrease their physical activity in the fasting hours and increase daytime sleepiness [27] life habits (meal frequency, sleep habits. This energy restriction associated with hunger have substantial impact on the autonomic nervous system, leading to an increase in vagal and a decrease in sympathetic tone [28]. Other haemodynamic adaptations appear to include augmented cardiac baroreflex sensitivity, loss of plasma volume and reduced venous return [29,30] i.e. the ejection fraction, the peak ejection rate and changes in end-systolic volume. Also the diastolic function evaluated by the peak filling rate remained normal. Furthermore, no sign of backward failure could be demonstrated since the central blood volume was not significantly increased. Both systolic and diastolic blood pressure (BP). All these modifications can lead to a fall in blood pressure, heart rate and cardiac output [31].

Limitations of the study

The weak points of our study were:

- the mono-centric nature of the study with a low population size,
- no control group (patients who do not fast)
- lack of accurate data on patient dietary surveys

: the nutritional value of food could not be objectively assessed as it was based on patients' self-reporting,

- for technical reasons, we were unable to carry out systematic medical laboratory tests during the month of Ramadan to compare the results in both periods,
- we studied the impact of the month of Ramadan when it occurred during summer, the hot season, which did not allow us to generalize the results.

CONCLUSION

According to our findings, treated hypertensive patients may be assured that, with continuation of previous medications, fasting during the month of Ramadan can be safely undertaken.

However, in order to elaborate recommendations on the management of patients with cardiovascular risk during Ramadan, it would be necessary to realize an international randomized multi-centric study.

Disclosure of funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

Disclosure of any Conflict of interest: none declared.

REFERENCES

1. Ababou M, Ababou R, El Maliki A. Le jeûne du Ramadan au Maroc : un dilemme pour les patients diabétiques et les soignants. *Sci Soc Santé*. 2008; 26: 79-104.
2. Ramirez LA, Sullivan JC. Sex differences in hypertension: where we have been and where we are going. *Am J Hypertens*. 2018; 31: 1247-54.
3. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Eur Heart J*. 2018; 39: 3021-104.
4. Younus A, Aneni EC, Spatz ES, Osondu CU, Roberson L, Ogunmoroti O, et al. A systematic review of the prevalence and outcomes of ideal cardiovascular health in US and non-US populations. *Mayo Clin Proc*. 2016; 91: 649-70.

5. Kapetanakis VV, Rudnicka AR, Wathern AK, Lennon L, Papacosta O, Cook DG, et al. Adiposity in early, middle and later adult life and cardiometabolic risk markers in later life; findings from the British regional heart study. *PLoS One*. 2014; 9:12.
6. Kuwabara M, Kuwabara R, Niwa K, Hisatome I, Smits G, Roncal-Jimenez CA, et al. Different risk for Hypertension, Diabetes, Dyslipidemia, and Hyperuricemia according to level of Body Mass Index in Japanese and American subjects. *Nutrients*. 2018; 10: 1011.
7. Lee C-Y, Lin W-T, Tsai S, Hung Y-C, Wu P-W, Yang Y-C, et al. Association of parental overweight and cardiometabolic diseases and pediatric adiposity and lifestyle factors with cardiovascular risk factor clustering in adolescents. *Nutrients*. 2016; 8: 567.
8. Crawford AG, Cote C, Couto J, Daskiran M, Gunnarsson C, Haas K, et al. Prevalence of obesity, type II diabetes mellitus, hyperlipidemia, and hypertension in the United States: findings from the GE Centricity Electronic Medical Record database. *Popul Health Manag*. 2010; 13: 151-61.
9. Biad A, Chibane A, Makhoul L, Attif L, Lanasri L, Kessous S. Prévalence of diabetes and hypertension in the east of Algiers. *J Hypertens* 2010;28:318-9.
10. de Boer IH, Bangalore S, Benetos A, Davis AM, Michos ED, Muntner P, et al. Diabetes and Hypertension: A position statement by the American Diabetes Association. *Diabetes Care*. 2017; 40: 1273-84.
11. Egan BM, Li J, Qanungo S, Wolfman TE. Blood pressure and cholesterol control in hypertensive hypercholesterolemic patients: national health and nutrition examination surveys 1988-2010. *Circulation*. 2013; 128: 29-41.
12. Kannel WB. Hypertension: reflections on risks and prognostication. *Med Clin North Am*. 2009; 93: 541-58.
13. Tuomilehto J, Elo J, Nissinen A. Smoking among patients with malignant hypertension. *Br Med J Clin Res Ed*. 1982;284: 1086.
14. Gropelli A, Giorgi DMA, Omboni S, Parati G, Mancia G. Persistent blood pressure increase induced by heavy smoking: *J Hypertens*. 1992; 10: 495-9.
15. Madika A-L, Mounier-Vehier C. Tabac et pression artérielle : une relation complexe à mieux connaître. *Presse Médicale*. 2017; 46: 697-702.
16. Wagner A, Arveiler D, Ruidavets JB, Cottel D, Bongard V, Dallongeville J, et al. Etat des lieux sur l'hypertension artérielle en France en 2007 : l'étude Mona Lisa. *Bulletin Epidémiologique Hebdomadaire*, 2008; 49 : 483-6
17. Samad F, Qazi F, Pervaiz MB, Kella DK, Mansoor M, Osmani BZ, et al. Effects of ramadan fasting on blood pressure in normotensive males. *J Ayub Med Coll Abbottabad JAMC*. 2015; 27: 338-42.
18. Khosropanah S, Ashraf F, Handjani AM. The effect of one-day Ramadan fast on blood pressure of hypertensive patients. *Iran Heart J*. 2003; 4: 39-43.
19. Akturk IF, Biyik I, Kocas C, Yalcin AA, Uzun F, Erturk M. The effect of ramadan fasting on blood pressure levels of hypertensive patients with combination therapy. *Int J Cardiol*. 2012; 8: 155.
20. Nematy M, Alinezhad-Namaghi M, Rashed MM, Mozhdehifard M, Sajjadi SS, Akhlaghi S, et al. Effects of Ramadan fasting on cardiovascular risk factors: a prospective observational study. *Nutr J*. 2012; 11: 69.
21. Perk G, Ghanem J, Aamar S, Ben-Ishay D, Bursztyn M. The effect of the fast of Ramadan on ambulatory blood pressure in treated hypertensives. *J Hum Hypertens*. 2001; 15(10): 723-5.
22. Ramadan J. Does fasting during Ramadan alter body composition, blood constituents and physical performance? *Med Princ Pract Int J Kuwait Univ Health Sci Cent*. 2002;11: 41-6.
23. Bouguerra R, Jabrane J, Maâtki C, Ben Salem L, Hamzaoui J, El Kadhi A, et al. La pratique du jeûne du mois de Ramadan chez le diabétique de type 2. *Ann Endocrinol*. 2006; 67: 54-9.
24. Fakhrzadeh H, Larijani B, Sanjari M, Baradar-Jalili R, Amini MR. Effect of Ramadan fasting on clinical and biochemical parameters in healthy adults. *Ann Saudi Med*. 2003; 23: 223-6.
25. Yarahmadi S, Larijani B, Bastanhagh MH, Pajouhi M, Baradar Jalili R, Zahedi F, et al. Metabolic and clinical effects of Ramadan fasting in patients with type II diabetes. *J Coll Physicians Surg--Pak JCPS*. 2003; 13: 329-32.
26. Ural E, Kozdag G, Kilic T, Ural D, Şahin T, Çelebi O, et al. The effect of Ramadan fasting on ambulatory blood pressure in hypertensive patients using combination drug therapy. *J Hum Hypertens*. 2008; 22: 208-10.
27. Taoudi Benchekroun M, Roky R, Toufiq J, Benaji B, Hakkou F. Epidemiological study: chronotype and daytime sleepiness before and during Ramadan. *Thérapie*. 1999; 54: 567-72.
28. Bursztyn M, Mekler J, Wachtel N, Ben-Ishay D. Siesta and ambulatory blood pressure monitoring. Comparability of the afternoon nap and night sleep. *Am J Hypertens*. 1994; 7: 217-21.
29. Landsberg L, Young JB. Fasting, feeding and regulation of the sympathetic nervous system. *N Engl J Med*. 1978; 298: 1295-301.
30. Stokholm KH, Breum L, Astrup A. Cardiac contractility, central haemodynamics and blood pressure regulation during semistarvation. *Clin Physiol Oxf Engl*. 1991; 11: 513-23.
31. Azizi F. Research in Islamic Fasting and Health. *Ann Saudi Med*. 2002; 22: 186-91.