Diabetes & Metabolic Syndrome: Clinical Research & Reviews 13 (2019) 776–780

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Original Article

Metabolic syndrome components and prostatic hyperplasia among diabetic and non-diabetic men in the Eastern DR Congo: A cross-sectional study

L.E. Mubenga [a,*], D. Gruson [b], M.P. Hermans [c], E. Bwenge [d,e], B. Tombal [f]

[a] Department of Urology, Université Catholique de Bukavu (UCB), 02, Michombero Street, Bukavu, Democratic Republic of Congo
[b] Department of Laboratory Medicine, Cliniques universitaires Saint-Luc and Université Catholique de Louvain, Brussels, Belgium
[c] Division of Endocrinology and Nutrition, Cliniques universitaires St-Luc and Institut de Recherche Expérimentale et Clinique (IREC), Université catholique de Louvain, Brussels, Belgium
[d] Institute of Health and Society - Institut de Recherche Santé et Société (IRSS) School of Public Health, Université Catholique de Louvain, Brussels, Belgium
[e] Ecole régionale de santé publique, Université Catholique de Bukavu (UCB), Bukavu, Democratic Republic of Congo
[f] Department of Urology, Université Catholique de Louvain (UCL). Brussels, Belgium

ARTICLE INFO

Article history:
Received 6 November 2018
Accepted 30 November 2018

1. Introduction

Metabolic syndrome (MetS) is a cluster of cardiometabolic disorders including elevated triglycerides (TG), low high-density lipoprotein cholesterol (HDL-C), abnormal glucose homeostasis, hypertension and obesity. This entity is becoming an increasingly prevalent problem worldwide, including in sub-Saharan Africa, due eg. to adoption of Westernized lifestyles [1].

The presence of a MetS is increasingly considered to be involved in the genesis of BPH [2–7]. However, most studies linking BPH to the MetS were performed in single populations, including a mix of diabetics and non-diabetics. The conclusions thus drawn indifferently apply to both diabetics and non-diabetics, despite the many confounders related to differences in glucose homeostasis, as well as medications use and dietary habits. In addition, MetS components distribution and severity differ according to ethnicity [8].

This study aimed at elucidating which among MetS components represent risk factors or risk markers associated with BPH genesis in diabetic and non-diabetic subjects recruited among diabetic associations of the South-Kivu region in the DR Congo.

2. Methods

This study was conducted in the eastern DR Congo province of South-Kivu and used a sub-sample of a larger study conducted in the region [9].

The primary study from which the current sample was drawn was conducted among 377 patients with diabetes recruited from 10 diabetes patient's associations and 752 individuals without diabetes recruited from the neighborhood.

Due to limited resources regarding laboratory assays, we selected for the present study a sub-sample of 300 individuals (100 with diabetes and 200 without diabetes) using a systematic sampling method.

For each participant, blood pressure, anthropometric parameters measurement (body mass index (BMI), waist circumference), and a blood sample collection were realized in the fasting state.

A digital rectal examination and a prostate volume (PV) scanning were performed by a single physician.

All laboratory analyzes were carried out at a central automatized laboratory, at Saint-Luc academic hospital in Brussels. The variables measured included fasting serum glucose total cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C; calculated using Friedewald's formula), high-density lipoprotein cholesterol (HDL-C), insulin, total testosterone, sex hormone-binding protein (SHBG), and prostate specific antigen (PSA).

Free androgen index (FAI) was calculated as follows: [(total testosterone/SHBG) x 100] [10].

* Corresponding author.
E-mail addresses: leonmubenga@yahoo.fr, emmanuelmubengalm@gmail.com (L.E. Mubenga), damien.gruson@uclouvain.be (D. Gruson), michel.hermans@uclouvain.be (M.P. Hermans), esbwenge@gmail.com (E. Bwenge), bertrand.tombal@uclouvain.be (B. Tombal).

https://doi.org/10.1016/j.dsx.2018.11.064

MetS components were defined according to the joint *interim* statement of the International Diabetes Federation task force on epidemiology and prevention; the National Heart, Lung, and Blood Institute; the American Heart Association; the World Heart Federation; the International Atherosclerosis Society; and the International Association for the Study of Obesity [11].

To enable comparison between diabetic and non-diabetic subjects, only the extra-glycemic components of the MetS were considered, namely elevated blood pressure, enlarged waist, high TG and low HDL-C levels.

2.1. Statistical analysis

Statistical analyses were carried out using Stata 15 (StataCorp, College Station, Texas, USA).

Quantitative variables are summarized into means or medians, with standard deviation (SD) and interquartile range (IQR), respectively, depending on whether the shape of the distribution was symmetrical or not. Categorical data are presented as frequencies and proportions.

Comparisons between means were done using Student's *t*-test for normally-distributed variables, and Wilcoxson's rank-sum test for variables with skewed distributions.

To establish the independent factors associated with prostate size, we run bivariable and multivariable generalized linear regression models with the inverse − Gaussian family and the identity link. This model was used given that prostate volume distribution is right-skewed, since in such a scenario, ordinal least-squared regression modelling would lead to biased estimates.

We also used robust standard errors to account for heteroscedasticity of variances.

Data were brought in the multivariable model based on a conservative p-value ≤ 0.2 at bivariable analysis and/or on biological plausibility. In all analyses, a p-value < 0.05 was deemed statistically significant.

3. Results

The two groups were statistically similar for all extraglycemic components of the MetS. In addition, both groups had elevated mean systolic blood pressure and low HDL-C (Table 1).

Regarding the other parameters, diabetics had higher fasting glucose, insulin, and prostatic volume. However, their testosterone and free androgen index (FAI) were lower by 13% and 52% respectively, compared to non-diabetic subjects (Table 2).

Table 1
Extraglycemic components of the metabolic syndrome.

Variable	All	Diabetics	Non-diabetics	p-value
	(n: 300)	(n:100)	(n:200)	
Age **(years)**	62.9 ± 10.2	62.7 ± 10.7	63 ± 9.9	0.8
SBP **(mm Hg)**	140.5 ± 24.2	141.3 ± 25.4	140. ± 23.7	0.7
DBP **(mm Hg)**	85.5 ± 14.3	83.8 ± 13.4	86.4 ± 14.7	0.2
Waist Circ **(cm)**	88 (79–95)	89 (80–95)	87 (78.5–95.2)	0.2
TG **(mg/dL)**	105.5 (82.3–133)	109 (83–144)	105 (82–131)	0.4
HDL-C **(mg/dL)**	29.3 ± 11.3	29.4 ± 11.7	29.2 ± 11.2	0.9

SBP: Systolic blood pressure (mm Hg). DBP: Diastolic blood pressure (mm Hg).
Waist circ: Waist circumference (cm). TG: triglycerides (mg/dL).
HDL-C: High-density lipoprotein cholesterol (mg/dL).

In the diabetic group, prostatic volume was related to LDL-C, SHBG, insulin, and free androgen index (FAI). In addition, there was a negative correlation between prostatic volume and testosterone level in this group (Table 3). On the other hand, prostatic volume was related to LDL-C in the non-diabetic group, whereas a negative and not statistically significant correlation was observed between prostatic volume and testosterone (Table 4).

The two groups thus shared LDL-C as risk factor for prostate enlargement (Tables 3 and 4).

4. Discussion

This study assessed the association between MetS components and prostate size in diabetic and nondiabetic subjects recruited among diabetic associations in South-Kivu. It shows that the four standard nonglycemic MetS components are not associated with prostate size. However, other cardiometabolic parameters, such as LDL-C and insulin, are strongly related to prostatic hyperplasia.

Numerous studies have highlighted the links between prostatic volume and the MetS, either as a dichotomous condition, or via its defining components [2–4,12,13].

In a study by Gacci et al. [2], prostatic volume (PV) and prostatic anterior-posterior diameter were positively associated with the number of MetS components. However, the most often mentioned MetS components are insulin resistance with subsequent diabetes and obesity [14].

Byun et al. [3] suggested that each MetS component could represent a risk factor for BPH development, since they demonstrated an increase in PV severity, consistent with the increase in MetS score components.

The conclusions drawn from these observations should be considered with caution for several reasons, including the lack of

Table 2
Comparison of urological features and other metabolic components by diabetes status.

Variable	All	Diabetics	Non-diabetics	p-value
	(n:300)	(n:100)	(n:200)	
BMI **(kg/m^2)**	23 (20–25.6)	23 (20–25.4)	23 (20.1–26)	0.7
FBG **(mg/dL)**	97 (86–124)	170.5 (122–326.5)	89 (83–99)	<0.001
INSULIN **(ρmol/L)**	31.5 (15–62.3)	39.2 (19.6–87.5)	26.5 (13.5–50)	0.0004
LDL-C **(mg/dL)**	105.8 ± 39.2	107.4 ± 36.9	104.9 ± 40.3	0.6
SHBG **(nmol/L)**	102 (74.4–134.2)	98 (73.4–133)	103.8 (74.4–134.7)	0.8
TESTOSTERONE**(ng/mL)**	25.1 ± 10.2	22.7 ± 11.4	26.2 ± 9.3	0.005
t PSA **(ng/mL)**	1.3 (0.7–2.6)	1.5 (0.7–2.9)	1.2 (0.6–2.6)	0.7
f PSA **(ng/mL)**	0.3 (0.2–0.7)	0.3 (0.2–0.6)	0.3 (0.2–0.7)	0.4
PV **(cc)**	37 (26–53.5)	49 (37.5–7.5)	30.5 (24–43)	<0.001
FAI	23.4 (18.2–32)	22.2 (18.3–27.2)	25 (18.1–34.6)	0.003

BMI: Body mass index (kg/m^2). FBG: Fasting blood glucose (mg/dL).
LDL-C: Low-density lipoprotein cholesterol (mg/dL). SHBG: Sex hormone-binding globulin (nmol/L).
tPSA: Total prostate specific antigen (ng/mL). fPSA: Free prostate specific antigen (ng/mL).
PV: Prostate volume (cc). FAI: free androgen index [(Total testosterone/SHBG) x 100].

Table 3
Bivariable and multivariable regression analyses for predictors of prostate hypertrophy in the diabetic population.

Variable	Unadjusted β coefficient	95% CI	p-value	Adjusted β coefficient	95% CI	p-value
AGE	0.4	[- 0.04; 0.8]	0.08			
SBP	0.02	[- 0.2; 0.3]	0.9			
DBP	0.07	[- 0.4; 0.5]	0.7			
BMI	0.9	[- 0.5; 1.1]	0.5	0.14	[- 0.5; 0.8]	
Waist Circ	0.02	[- 0.4; 0.5]	0.9			
LDL-C	0.1	[- 0.005; 0.2]	0.06	0.2	[0.08; 0.3]	<0.001
HDL-C	- 0.1	[- 0.4; 0.1]	0.3			
TG	0.01	[- 0.06; 0.08]	0.71	- 0.02	[- 0.1; 0.07]	
t PSA	1.9	[- 0.9; 4.9]	0.2			
f PSA	7.5	[0.1; 14.8]	0.05	0.8	[- 2.8; 4.4]	
SHBG	- 0.08	[- 0.2; 0.002]	0.06	0.3	[0.04; 0.5]	0.02
TESTOSTERONE	- 0.2	[- 0.6; 0.2]	0.3	- 1.6	[- 2.5; - 0.6]	0.001
FBG	0.03	[- 0.02; 0.07]	0.3	0.02	[- 0.02; 0.5]	
INSULIN	0.08	[0.02; 0.14]	0.01	0.08	[0.02; 0.13]	0.007
FAI	0.4	[- 0.004; 0.8]	0.05	2.04	[1.1; 3.03]	<0.001

SBP: Systolic blood pressure (mm Hg). **DBP**: Diastolic blood pressure (mm Hg).
BMI: Body mass index (kg/m2). Waist circ: Waist circumference (cm).
LDL-C: Low-density lipoprotein cholesterol (mg/dL). **HDL-C**: High-density lipoprotein cholesterol (mg/dL).
TG: triglycerides (mg/dL). **tPSA**: Total prostate specific antigen (ng/mL).
fPSA: Free prostate specific antigen (ng/mL). **SHBG**: Sex hormone binding globulin (nmol/L).
FBG: Fasting blood glucose (mg/dL). **FAI**: free androgen index [(Total testosterone/SHBG) x 100].

consensus on the definitions of both MetS and BPH, the large variation among the studied populations regarding age, genetics, dietary habits, and environmental risk factors [4]. In addition, diabetics and non-diabetics were not analyzed separately in the study populations, despite obvious differences in carbohydrates and lipids metabolism.

In the present study, diabetic and non-diabetic subjects were considered separately in order to clearly identify risk factors for prostate hyperplasia among the metabolic parameters of interest. These two populations were similar with respect to age and the extraglycemic components of the MetS, but significantly differed regarding major glycemic components such as FBG and fasting insulin levels.

Elevated blood glucose (BG) is frequently mentioned in BPH genesis, both in diabetics and non-diabetics [15,16].

Bourke and Griffin in 1966 were the first to evoke the role of abnormal glucose homeostasis in prostatic enlargement, suggesting an association between diabetes mellitus and BPH [17].

Later, other authors confirmed this observation, putting forward a trophic role of glucose on prostatic tissues, even though the precise underlying mechanism(s) are still unclear [18,19].

Among the extraglycemic MetS components, Gacci et al. [2] noted that only dyslipidemia (increased serum TG and reduced HDL-C, the defining abnormalities of atherogenic dyslipidemia or AD) was associated with an increased risk of BPH (>60 cc).

We observed that although mean LDL-C level was within the normal range in both groups, it was strongly associated with prostate volume. This association was observed in both diabetics and non-diabetics (Tables 3 and 4).

Interestingly, Agrawal et al. suggested that the link between an altered lipid profile and increased PV could be at the level of induction and maintenance of an inflammatory state within the prostatic tissue by dyslipidemia, thought to induce cells growth [20].

Further, Hammarsten et al. reported a significant negative correlation between HDL-C and prostate volume. Men with low HDL-C had a larger prostate volume (49 ml versus 39 ml), and a faster annual BPH growth rate (1.022 versus 0.78 ml/year) than those of men with high HDL-C [21].

Table 4
Bivariable and multivariable regression analyses for predictors of prostate hypertrophy in the non-diabetic population.

VARIABLE	Unadjusted β coefficient	95% CI	p-value	Adjusted β coefficient	95% CI	p-value
AGE	0.2	[-0.2; 0.5]	0.3			
SBP	- 0.05	[-0.14; 0.04]	0.3			
DBP	- 0.08	[-0.2; 0.08]	0.4			
BMI	- 0.6	[-1.02; 0.2]	0.005	- 0.5	[- 0.9; - 0.08]	0.02
Waist Circ	- 0.09	[- 0.3; 0.1]	0.4			
LDL-C	0.1	[0.06; 0.2]	<0.001	0.1	[0.05; 0.2]	0.001
HDL-C	0.1	[- 0.1; 0.4]	0.4			
TG	0.04	[- 0.03; 0.09]	0.2	0.02	[- 0.03; 0.07]	
t PSA	0.6	[- 0.9; 2.2]	0.5			
f PSA	2.4	[- 3.1; 7.9]	0.4	0.8	[- 2.8; 5]	
SHBG	0.05	[- 0.09; 0.002]	0.06	- 0.02	[- 0.08; 0.04]	
TESTOSTERONE	- 0.2	[- 0.5; 0.07]	0.14	- 0.08	[- 0.4; 0.3]	
FBG	- 0.2	[- 0.3; - 0.02]	0.03	- 0.1	[- 0.3; 0.05]	
INSULIN	0.1	[- 0.08; 0.3]	0.3	0.006	[- 0.1; 0.1]	
FAI	- 0.006	[- 0.003; 0.02]	0.6	- 0.004	[- 0.03; 0.02]	

SBP: Systolic blood pressure (mm Hg). **DBP**: Diastolic blood pressure (mm Hg).
BMI: Body mass index (kg/m2). Waist circ: Waist circumference (cm).
LDL-C: Low-density lipoprotein cholesterol (mg/dL). **HDL-C**: High-density lipoprotein cholesterol (mg/dL).
TG: triglycerides (mg/dL). **tPSA**: Total prostate specific antigen (ng/mL).
fPSA: Free prostate specific antigen (ng/mL). **SHBG**: Sex hormone binding globulin (nmol/L).
FBG: Fasting blood glucose (mg/dL). **FAI**: free androgen index [(Total testosterone/SHBG) x 100].

In addition, Khovidhunkit et al. [22] noted that low HDL-C may not only be related to abnormal lipid metabolism, but also to infection and inflammation. This is linked to the fact that certain HDL subclasses are intended to fight infections, especially parasitic, and inflammation. Therefore, one may speculate that low HDL-C in the study population could be related to higher rates of chronic or acute infections and inflammation, as observed in many regions in sub-Saharan Africa [22,23].

It is worth noting that people of African descent usually have normal-to-low fasting and nonfasting TG levels [24,25]. Thus, the mean values > 100 mg/dL observed in this study could be considered as relatively high, even if it does not exceed the threshold of 150 mg set in the current MetS definition.

As for the other extraglycemic components of the MetS (hypertension, central obesity), an influence on prostatic hypertrophy was not observed in this study. This finding could be due to the size of the analyzed sample and which could have made the study underpowered.

Despite numerous reports on the concomitance of BPH and hypertension, there is no consistent pathway for formally establishing a causation link between these two common acquired conditions [26–29], even though increased sympathetic activity was hypothesized as overlapping pathophysiological factor for both ailments [27].

Men with central obesity (ie. with a waist circumference >90 cm) are more likely to have a higher IPSS and larger prostate volume than men without central obesity. This finding implicates the need to manage both conditions simultaneously, and to adoption parallel preventive strategies.

Cohen [30] advanced an attractive "hypogonadal-obesity-increased intra-abdominal pressure (IAP)—BPH-LUTS connection" hypothesis for the development of BPH. Accordingly, increased IAP due to central obesity may damage venous valves in internal spermatic veins, leading to reflux of blood containing high concentrations of testosterone to the prostate, via the communicating prostatic venous system. Simultaneously, increased aromatase activity was observed in the fat tissues, leading to decreased whole-body testosterone levels.

Overall, high systolic blood pressure, reduced serum HDL-C, and relatively increased serum TG added as extra-glycemic components of the MetS in this study. Despite being similarly represented in the two groups, they were not associated with PV.

Contrarily, prostate volume was associated with fasting insulin levels in the diabetic population. Therefore it could be inferred that abnormal glucose metabolism including insulin resistance, compensatory hyperinsulinemia, glucose intolerance and subsequent diabetes, may play a substantial role in prostate hypertrophy. Although there is a proportional relationship between an increasing MetS score and decreased insulin sensitivity, it has been demonstrated to date only in Caucasian populations, and such a relationship may not *de facto* exist in sub-Saharan Africa, at least by applying the current criteria defining hypertriglyceridemia, which seem unsuitable for Bantu populations [24,25,31].

Several reports have also substantiated the hypothesis that abnormal glucose homeostasis may negatively affects circulating sex hormones levels [32,33].

In this study, total testosterone levels were significantly lower in diabetics, confirming previous studies [34]. Interestingly, testosterone level showed an inverse association with PV, and this association was stronger in diabetics. (Tables 2 and 3).

Unlike several studies showing that SHBG concentrations are altered in diabetics [35], results gathered from this study did not find any difference in SHBG between the two populations. We hypothesize that the low testosterone level seen in diabetics could be the result of a decrease in production rather than higher levels of SHBG.

Accordingly, the free androgen index, which represents the ratio [(total testosterone/SHBG) x 100], showed the same trend than testosterone.

Numerous studies reported a link between T2DM and low testosterone levels, even though the underlying mechanisms for this association are unclear.

A first group of authors envisioned age, stating that both the prevalence and incidence of diabetes and hypogonadism increase with ageing [35]. However, in our study population, age was not statistically different between the groups.

The second mechanism is central obesity. Various studies mentioned increased aromatase activity in excess abdominal fat. This enzyme rapidly transforms testosterone into estrogen [30,36]. However, such hypothesis does not hold in the present study, in which central obesity was remarkably infrequent in both groups. (Table 1).

A more likely candidate to account for low testosterone levels in diabetics is abnormal glucose homeostasis, as chronic hyperglycemia negatively affects testosterone production [32]. Therefore, a hypogonadism thus generated may promote prostatic hypertrophy.

On the other hand, some authors noted that a low testosterone level was associated with the onset of diabetes. According to these studies, testosterone replacement therapy (TRT) could be beneficial on overall glucose homeostasis, by increasing skeletal muscle mass, by decreasing adipose tissue, thereby improving whole-body insulin sensitivity [33–37].

In a meta-analysis, Ding et al. [38] found such a strong relationship between hypogonadism and T2DM that they that they proposed a lowered testosterone level as a predictor of T2DM. However, longitudinal prospective studies are required to ascertain whether such an hypothesis is applicable to sub-Saharan Africans.

5. Conclusion

Our data show that standard MetS components are not linked to prostatic hypertrophy. However, abnormal glucose homeostasis determinants are thought to play a substantial role in driving prostatic hypertrophy, possibly by modulating circulating sex hormones levels without altering SHBG concentration.

Given these, it might be useful to include testosterone dosage in diabetic monitoring, while considering LDL-C assessment and control as potential preventive strategies for BPH in both diabetic and non-diabetic subjects.

Source of funding

We received financial support from the following institutions:

- "Société Belge d'Urologie" (SBU),
- Vlaamse Interuniversitaire Raad (VLIR).

Competing interests

The authors declare that they have no competing interests.

Acknowledgements

The authors are grateful to the "Société Belge d'Urologie" (SBU), and the Vlaamse Interuniversitaire Raad (VLIR) for their financial supports for data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2018.11.064.

References

[1] Ejike CECC, Ezeanyika LUS. Metabolic syndrome in sub-Saharan Africa : "smaller twin" of a region's prostatic diseases ? Int Urol Nephrol 2008;40: 909–20.

[2] Gacci M, Sebastianelli A, Salvi M, De Nunzio C, Vignozzi L, Corona G, et al. Benign prostatic enlargement can be influenced by metabolic profile: results of a multicenter prospective study. BMC Urol 2017;17:22.

[3] Byun HK, Sung YH, Kim W, Jung JH, Song JM, Chung HC. Relationships between Prostate-specific antigen, prostate volume, and components of metabolic syndrome in healthy Korean men. Korean J Urol 2012;53:774–8.

[4] Abdollah F, Briganti A, Suardi N, Castiglione F, Gallina A, Capitanio U, et al. Metabolic Syndrome and benign prostatic hyperplasia: evidence of a potential relationship, hypothesized etiology, and prevention. Korean J Urol 2011;52: 507–16.

[5] Fu Y, Zhou Z, Yang B, Zhang K, He L, Zhang X. The relationship between the clinical progression of benign prostatic hyperplasia and metabolic syndrome: a prospective study. Urol Int 2016;97(3):330–5.

[6] Vignozzi L, Rastrelli G, Corona G, Gacci M, Forti G, Maggi M. Benign prostatic hyperplasia: a new metabolic disease? J Endocrinol Invest 2014;37(4): 313–22.

[7] Nandy PR, Saha S. Association between components of metabolic syndrome and prostatic enlargement: an Indian perspective. Med J Armed Forces India 2016;72:350–5.

[8] Mugo M, Sowers JR. Metabolic syndrome: implications of race and ethnicity. Ethn Dis 2004;14(4). S2-26-31.

[9] Mubenga LE, Hermans MP, Chimanuka D, Muhindo L, Cikomola J, Bahizire E, Tombal B. Anthropometric and cardiometabolic correlates of prostate volume among diabetic and non-diabetic subjects in South-Kivu, vol. 13; 2019. p. 350–5 (Accepted for publication in Diabetes & Metabolic Syndrome: Clinical Research & Reviews. Ref: DMSCRR_2018_355).

[10] Vermeulen A, Verdonck L, Kaufman JM. A critical evaluation of simple methods for the estimation of free testosterone in serum. J Clin Endocrinol Metabol 1999;84(10):3666–72.

[11] Alberti KGMM, Eckel RH, Grundy SM, Zimmet PZ, Cleeman JI, Donato KA, Fruchart J-C, James WPT, Loria CM, Smith Jr SC. Harmonizing the metabolic syndrome: a joint interim statement of the international diabetes federation task force on epidemiology and prevention; national heart, Lung, and blood Institute; American heart association; World heart federation; international Atherosclerosis society; and international association for the study of obesity. Circulation 2009;120:1640–5.

[12] De Nunzio C, Aronson W, Freedland SJ, Giovannucci E, Parsons JK. The correlation between metabolic syndrome and prostatic diseases. Eur Urol 2012;61:560–70.

[13] Doğan Y, Uruç F, Aras B, Şahin A, Kıvrak M, Ürkmez A, et al. The relationships between metabolic syndrome, erectile dysfunction and lower urinary tract symptoms associated with benign prostatic hyperplasia. Turkish Journal of Urology 2015;41(1):7–12.

[14] Jiang M, Stranda DW, Francoa OE, Clark PE, Haywarda SW. PPARγ: a molecular link between systemic metabolic disease and benign prostate hyperplasia. Differentiation 2011;82(4–5):220–36.

[15] Pan JG, Liu M, Zhou X. Relationship between lower urinary tract symptoms and metabolic syndrome in a Chinese male population. J Endocrinol Invest 2014;37(4):339–44.

[16] Yin Z, Yang J-R, Rao J-M, Song W, Zhou K-Q. Association between benign prostatic hyperplasia, body mass index, and metabolic syndrome in Chinese men. Asian J Androl 2015;17:826–30.

[17] Bourke JB, Griffin JP. Hypertension, diabetes mellitus, and blood groups in benign prostatic hypertrophy. Br J Urol 1966;38(1):18–23.

[18] Kim WT, Yun SJ, Choi YD, Kim GY, Moon SK, et al. Prostate size correlates with fasting blood glucose in non-diabetic benign prostatic hyperplasia patients with normal testosterone levels.

[19] Stamatiou K, Lardas M, Kostakos E, Koutsonasios V, Michail E. The impact of diabetes type 2 in the pathogenesis of benign prostatic hyperplasia : a review. Adv Urol 2009;818965:1–3.

[20] Agrawal A. Metabolic syndrome and BPH: what do we know? Letter to the Editor. Med J Armed Forces India 2017;73:101–3.

[21] Hammarsten J, Hoëgstedt B, Holthuis N, Mellstroëm D. Components of the metabolic syndrome - risk factors for the development of benign prostatic hyperplasia. Prostate Cancer Prostatic Dis 1998;1(3):157–62.

[22] Khovidhunkit W, Kim M-S, Memon RA, Shigenaga JK, Moser AH, Feingold KR, Grunfeld C. Effects of infection and inflammation on lipid and lipoprotein metabolism: mechanisms and consequences to the host. J Lipid Res 2004;45: 1169–96.

[23] Lyons JG, Sliwa K, Carrington MJ, Raal F, Pretorius S, Thienemann F, Stewart S. Lower levels of high-density lipoprotein cholesterol in urban Africans presenting with communicable versus non-communicable forms of heart disease: the 'Heart of Soweto' hospital registry study. BMJ Open 2014;4, e005069.

[24] Yu SK, Darleen C, Castillo DC, Courville AB, Sumner AE. The triglyceride paradox in people of African descent. Metab Syndrome Relat Disord 2012;10(2):77–82.

[25] Sumner AE. Ethnic differences in triglyceride levels and high-density lipoprotein lead to underdiagnosis of the metabolic syndrome in Black children and adults. J Pediatr 2009;155(3). S7.e7–S7.11.

[26] Boyle P. Epidemiology of benign prostatic hyperplasia: risk factors and concomitance with hypertension. Br J Clin Pract Suppl 1994;74:18–22.

[27] Michel MC, Heemann U, Schumacher H, Mehlburger L, Goepel M. Association of hypertension with symptoms of benign prostatic hyperplasia. J Urol 2004;172(4 Pt 1):1390–3.

[28] Hwang EC, Kim SO, Nam DH, Yu HS, Hwang I, Jung SI, Kang TW, Kwon DD, Kim GS. Men with hypertension are more likely to have severe lower urinary tract symptoms and large prostate volume. Low Urin Tract Symptoms 2015;7(1):32–6.

[29] Torralba NJA, Ruiz TJ, Pérez BV, Pastor SG, Cubillana LP, Albacete PM. Relation between hypertension and clinical cases of benign prostatic hyperplasia. Arch Esp Urol 2003;56(4):355–8.

[30] Cohen PG. Abdominal obesity and intra-abdominal pressure: a new paradigm for the pathogenesis of the hypogonadal-obesity-BPH-LUTS connection. Horm Mol Biol Clin Invest 2012;11(1):317–20.

[31] Hermans MP, Bouenizabila E, Ahn SA, Rousseau MF. How to transform a metabolic syndrome score in an insulin sensitivity value? Diabetes Metab Res Rev 2016;32:87–94.

[32] Ryl A, Rotter I, Slojewski M, Dolegowska B, Grabowska M, Baranowska-Bosiacka I, Laszczynska M. Hormone concentration, metabolic disorders and immunoexpression of androgen and estrogen-alpha receptors in men with benign prostatic hyperplasia and testosterone deficiency syndrome. Folia Histochem Cytobiol 2015;53(3):227–35.

[33] Tsai EC, Matsumoto AM, Fujimoto WY, Boyko EJ. Association of bioavailable, free, and total testosterone with insulin resistance. Influence of sex hormone-binding globulin and body fat. Diabetes Care 2004;27(4):861–8.

[34] Ozcan L, Besiroglu H, Dursun M, Polat EC, Otunctemur A, Ozbek E. Comparison of the clinical parameters of benign prostate hyperplasia in diabetic and non-diabetic patients. Arch Ital Urol Androl 2017;89(1):26–30.

[35] Betancourt-Albrecht M, Cunningham GR. Hypogonadism and diabetes. Int J Impot Res 2003;15(Suppl 4):S14–20.

[36] Guay AT. The emerging link between review hypogonadism and metabolic syndrome. J Androl 2009;30:370–6.

[37] Akinloye O, Popoola BB, Ajadi MB, Uchechukwu JG, Oparinde DP. Hypogonadism and Metabolic Syndrome in Nigerian male patients with both Type 2 diabetes and hypertension. Int J Endocrinol Metabol 2014;12(1), e10749.

[38] Ding EL, Song Y, Malik VS, Liu S. Sex differences of endogenous sex hormones and risk of Type 2 Diabetes. JAMA 2006;295:1288–99.