Diabetes & Metabolic Syndrome: Clinical Research & Reviews 13 (2019) 350–355

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

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

Review

Anthropometric and cardiometabolic correlates of prostate volume among diabetic and non-diabetic subjects in South-Kivu

L.E. Mubenga [a, *, 1], M.P. Hermans [b], D. Chimanuka [a], L. Muhindo [a], J. Cikomola [c], E. Bahizire [d, e, f], B. Tombal [g]

[a] Department of Urology, Université Catholique de Bukavu (UCB), Bukavu, Democratic Republic of Congo
[b] Division of Endocrinology and Nutrition, Cliniques Universitaires St-Luc and Institut de Recherche Expérimentale et Clinique (IREC), Université Catholique de Louvain, Brussels, Belgium
[c] Division of Endocrinology, Université Catholique de Bukavu (UCB), Bukavu, Democratic Republic of Congo
[d] Center of Research in Epidemiology and Biostatistics and Clinical Research. Université Libre de Bruxelles (ULB), Brussels, Belgium
[e] Department of Medical Microbiology, University of Nairobi, Nairobi, Kenya
[f] Centre de Recherche en Sciences Naturelles de Lwiro, Bukavu, Democratic Republic of Congo
[g] Department of Urology, Université Catholique de Louvain (UCL), Brussels, Belgium

ARTICLE INFO

Article history:
Received 1 September 2018
Accepted 9 October 2018

1. Introduction

Type 2 diabetes mellitus (T2DM) and benign prostate hypertrophy (BPH) are frequent acquired conditions occurring in adulthood [1,2]. The links between these two diseases have been extensively studied, and the prevalence of both increases with age. During each phase of the natural history of T2DM, there are potential underlying mechanisms that may explain the epidemiological association with BPH [1]. In prediabetes and during the early stage of T2DM, chronic hyperinsulinemia compensating for whole-body insulin resistance (IR) may promote prostatic hypertrophy, since elevated plasma insulin was consistently identified as a risk factor (RF) or risk marker for BPH [3,4]. Further, hyperinsulinemia stimulates liver production of tissue growth stimulants, such as Insulin-like growth factors (IGFs), which have a sustained trophic action on prostatic tissues [5,6]. In established T2DM, progressive loss of β-cell function leads to chronic hyperglycemia, which also exerts trophic effects on prostatic tissue [1,7]. Over time, chronic hyperglycemia causes widespread microvascular damages, which may impair local blood flow to prostatic tissue, and also promote oxidative stress, another driver of prostatic cells hyperplasia [8–10]. In the common form of T2DM (i.e. associated with IR and the metabolic syndrome, MetS), patients are usually overweight/obese and sarcopenic as regards anthropometry, as a result of excess caloric intake, inadequate lifestyles, and metabolic inflexibility in the setting of IR/hyperinsulinemia [11]. The objective of this study was to compare prostate volume, anthropometric parameters, cardiometabolic phenotype and fat mass of diabetic patients and non-diabetic controls living in South-Kivu, in order to identify standard or candidate RFs for prostate enlargement. (see Table 4, Fig. 1)

2. Subjects, materials and methods

South-Kivu province is located in the Eastern part of the Democratic Republic of Congo. It has 34 health zones, in which diabetics are often affiliated with a local patient's association.

This study took place from September 2016 to March 2017, and was performed in 10 of the 34 South-Kivu's health zones, selected according to ease of access as well as geographical representativeness. We registered all men with T2DM > 40 years affiliated to local diabetic associations (n: 413). The control group consisted of men recruited among the non-diabetic husbands of the diabetes associations' female diabetic members.

All subjects underwent medical history collection, including occupational status, urological scores (International Prostate Symptom Score (IPSS), Quality of Life Score (QOL), and duration of urological symptoms. According to IPSS and QOL, patients were categorized as mildly symptomatic (IPSS: 0–7) or as moderately to severely symptomatic (IPSS: 8–35), and for QOL as satisfied (QOL: 1–2), moderately bored (QOL: 3–5), and severely bored (QOL: 6–7).

* Corresponding author.
E-mail addresses: leonmubenga@yahoo.fr, emmanuelmubengalm@gmail.com (L.E. Mubenga), michel.hermans@uclouvain.be (M.P. Hermans), chimsdomis@gmail.com, chimsdomis@yahoo.fr (D. Chimanuka), lievinmuhindo@yahoo.fr (L. Muhindo), cikomola.cirhuza@gmail.com, jcikomola@yahoo.fr (J. Cikomola), esto.bahizire@gmail.com (E. Bahizire), bertrand.tombal@uclouvain.be (B. Tombal).
[1] Postal address: 02, Michombero Street, Bukavu, DR Congo.

https://doi.org/10.1016/j.dsx.2018.10.003

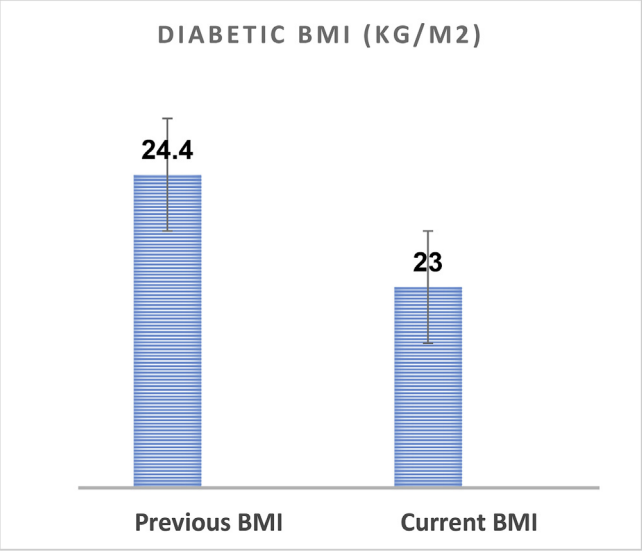

Fig. 1. BMI variation among the diabetic group.

For diabetics, known duration of diabetes, body weight at the time of diabetes diagnosis, and ongoing glucose-lowering drug(s) or other treatment were also recorded.

For each participant, blood pressure, anthropometric parameters (body mass index (BMI), waist circumference), blood glucose, and body composition were determined in the fasting state. BMI was stratified into four categories according to the WHO classification (<18.5 kg/m^2: underweight, 18.5–24.9 kg/m^2: normal range, 25–29.9 kg/m^2: overweight, and ≥30 kg/m^2: obese). Waist circumference (WC) was dichotomized with the International Diabetes Federation (IDF) threshold value suggested for adult men, with subjects whose WC ≥ 94 cm considered as having central obesity.

Body composition was estimated using a bioelectrical tetrapodal body fat analyzer (OMRON BF 508 Impedance-meter) with fat mass categorization and visceral fat scale provided in the manufacturer's manual. All subjects had uroflowmetry measurement using a Flow master 2014 MMS (Medical Measurement System) flowmeter, with wireless communication via Bluetooth.

Post-voiding residual (PVR) volume was measured using suprapubic ultrasonography. Maximum urinary flow rate >15 ml/s was considered normal, and a PVR <50 ml was considered insignificant.

Voiding duration was categorized as follows: < 20 s, 20–60 s, and >60 s.

Digital rectal and transrectal ultrasound (TRUS) examinations of the prostate were performed by a blinded single examiner.

The prostate volume (PV) was measured by TRUS with a Bruel and Kjacer medical portative scanner 7, 5 MHZ. PV was calculated according to the ellipsoid formula [12]: ***Height (H) x Width (W) x Length (L) x π/6.*** The height (H) was obtained from transaxial scanning, and a prostate volume ≥ 30 cc was considered enlarged.

2.1. Exclusion criteria

Among the diabetic group, we excluded patients with T1DM and those with acute diabetes-related metabolic or vascular complications requiring hospitalization.

As each patient had his body composition measured using a tetrapodal bioelectrical impedance device, patients with lower-limb amputation(s), often as a result of gangrene or osteomyelitis, and those with foot ulcer(s) requiring dressings were not eligible for this study.

In the control group, participants with fasting blood glucose ≥126 mg/dl were considered as having newly-diagnosed DM, and were excluded from this study. They were referred to the local diabetes association for further evaluation and management.

In both groups, patients with a medical history of prostate surgery, ongoing medication(s) for BPH, prostate abnormality on DRE and/or on TRUS were excluded (n: 35).

Ultimately, 377 diabetic subjects who met the study criteria were matched to 752 non–diabetic subjects.

2.2. Statistical analysis

Data were analyzed on Stata for Mac version 12.1 (StataCorp, College Station, Texas, USA).

Quantitative variables were summarized as means or medians, with standard deviation (SD) and interquartile range (IQR), respectively. Categorical data were presented as proportions. Comparisons between means were performed using Student's *t*-test for normally-distributed variables, and using Wilcoxson's rank-sum test for asymmetrically-distributed variables.

Odds ratio and 95% confidence interval (95% CI) were used to evaluate the association between prostate volume and other variables. In all analyses, a p-value < 0.05 was considered as statistically significant.

2.3. Ethical considerations

The Catholic University of Bukavu Ethical Committee approved the study protocol and informed consents were received from all participants. For patients with unbalanced hyperglycemia and/or prostate abnormalities, suitable medical advice was provided.

3. Results

Data were obtained from 1129 subjects aged 40–97 years and are summarized in Table 1. Of these 1129 subjects 377 (33.4%) were diabetic, and 752 (66.6%) were non-diabetic.

There was no significant difference regarding age between groups. Urological features, anthropometric parameters and fat mass were on the other hand statistically different between the diabetic and non-diabetic groups.

Moderate to severe lower urinary tract symptoms (LUTS) occurred in 80.9% of diabetics vs 66.9% of non-diabetics (p: < 0.001).

A prostate volume ≥30 cc was observed in 76.7% of diabetics vs 51.3% of non-diabetics (p: < 0.001), while a prostate volume ≥ 100 cc was only observed in 16 subjects, all of whom belonging to the diabetic group. Overall, obesity was observed in <10% of the studied population (6.9% in diabetics, and 2.5% in non-diabetics).

Mean BMI in the diabetic group at diabetes diagnosis, obtained from archived data from the diabetes associations, was significantly higher than current BMI based on contemporary weight (24.4 vs 23 kg/m^2, and P < 0.001).

Since prostate volume was significantly different between groups, the index study was geared towards finding correlates of prostate enlargement among the studied variables.

In unadjusted analysis, prostate volume was associated with age, presence of diabetes, IPSS, QOL score, fasting glucose, urodynamic parameters (flow max, voiding duration, and PVR), body fat, and visceral fat.

After adjustment, age, diabetes, flow max, voiding duration, and BMI were significantly associated with prostate volume.

Table 1
General characteristics of diabetic patients and controls.

Variable	All Patients	Diabetic Group	Non-diabetic Group	p
Age (years)	n = 1129 61.08 ± 10.79	n = 377 61.57 ± 10.7	n = 752 60.83 ± 10.82	0.28*
IPSS	n = 1129 15 (7–22)	n = 377 17 (10–22)	n = 752 13 (5–21)	<0.001**W**
QOL	n = 1129 5 (2–6)	377 5 (2–6)	752 5 (2–6)	0.025 **W**
FLOW MAX (ml/sec)	n = 1126 16.6 ± 8.1	n = 374 15.4 ± 7.9	n = 752 17.2 ± 8.1	<0.001*
Voiding duration (sec)	n = 1126 17.3 (13.0–24.2)	n = 374 19.3 (18.8–31.3)	n = 752 16.4 (12.6–22.2)	<0.001**W**
PVR (cc)	n = 1126 5 (5–20)	n = 374 17 (5–40)	n = 752 5 (5–5)	<0.001**W**
PV (cc)	n = 1129 32 (24–44)	377 40 (30–52)	752 30 (22–39)	<0.001**W**
FBG (mg/dl)	n = 1129 102 (88–124)	n = 377 176 (119.5–274)	n = 752 95 (85–106)	<0.001**W**
BMI (kg/m2)	n = 1129 22.4 ± 3.8	377 23 ± 4.1	752 22.1 ± 3.6	0.001*
WC (cm)	n = 1129 83.8 ± 11.3	n = 377 87.4 ± 11.6	n = 752 82.0 ± 10.6	<0.001*
Fat mass (%)	1129 15.3 (10.2–21.2)	377 17 (10.7–23.4)	752 14.4 (10.2–20.2)	<0.001**W**
VFS (0–30)	n = 1129 6 (4–9)	n = 377 7 (4–10)	n = 752 6 (4–8)	<0.001**W**

IPSS: International prostate symptoms score (0–35). **QOL:** Quality of life score (0–7). **PVR**: Post voiding residual (cc). **PV**: Prostate volume (cc). **FBG**: Fasting blood glucose (mg/dl). **BM**I: Body mass index (kg/m^2). **WC**: Waist circumference (cm). **VFS**: Visceral fat score (0–30 scale).
*: *t*-test.
W: Wilcoxon rank-sum test.

Table 2
Categorization of the main study variables.

Variable	Diabetic Group N = 377	Non-diabetic Group N = 752	p
IPSS	%	%	
Normal	19.1	33.1	<0.001
Moderate to severe	80.9	66.9	<0.001
PV (cc)	%	%	
<30	23.4	48.7	<0.001
≥30	76.6	51.7	<0.001
BMI (kg/m2)	%	%	
Underweight	12.2	14.5	0.29
Normal	61.8	66.8	0.096
Overweight	19.1	16.2	0.22
Obese	06.9	02.5	<0.001
WC (cm)	%	%	
<94	73.7	86.6	<0.001
≥94	26.3	13.4	<0.001
Fat mass (%)	%	%	
<11 (Low)	33.1	41.5	0.006
11–21.9 (Normal)	43.3	44.3	0.75
22–27.9 (High)	14.6	09.7	0.014
≥28 (very high)	09.0	04.5	0.003
VFS (0–30)	%	%	
1-9 (Normal)	69.3	81.9	<0.001
10-14 (High)	22.0	14.8	0.003
15-30 (very High)	08.7	03.3	<0.001

IPSS: International prostate symptoms score (0–35). **PV**: Prostate volume (cc). **BM**I: Body mass index (kg/m^2). **WC**: Waist circumference (cm). **VFS**: Visceral fat score (0–30 scale).

4. Discussion

Previous studies have shown that BPH is associated with several modifiable RFs such as T2DM and obesity. These two common conditions are known to be detrimental to various target organs such as the prostate, through e.g. impaired glucose homeostasis

and abnormal lipid metabolism [13]. To date, no studies have been conducted to elucidate these associative interactions in South Kivu (Eastern DR Congo), a region with a remarkably low prevalence of obesity and related comorbidities, even in case of T2DM [14]. Hence we investigated the association of BPH components, anthropometric measures and body fat in a large-scale study population composed of diabetics and carefully selected non-diabetic controls.

Our data provide further evidence that BPH components are increased in case of diabetes. Thus, dysuria was more intense in diabetic subjects than in controls, as shown by IPSS results and QOL scores. These observations were objectively confirmed by uroflowmetry and PVR measures. Among candidate contributory factors are increased sympathetic tone associated with T2DM, which is also linked to prostatic hypertrophy, and their simultaneous presence may have prejudiced dysuria in these patients [1,3].

Ding et al. [15] performed urodynamic explorations in diabetics and identified other contributors to LUTS, such as detrusor instability and lower bladder compliance. In addition, diabetic autonomous neuropathy due to chronically-poor glycemic control may also affect bladder function, and produce symptoms evocative of prostatic hypertrophy. Thus, diabetic patients with concomitant BPH are more likely to present more frequent symptoms of vesicourinary discomfort and LUTS [1].

Prostate volume was statistically larger in diabetics (Table 1). There are numerous candidate contributors to cause such enlargement in T2DM. Chronic hyperinsulinemia secondary to whole-body IR exerts a potent trophic effects on prostatic cells, and also boosts hepatic production of IGFs, which are also involved in prostate hypertrophy [3–6]. Chronic hyperglycemia in long-standing T2DM, as a consequence of progressive loss of pancreatic β-cell function, also exerts trophic effects on prostate tissue. Several studies have demonstrated the role of interstitial hyperglycemia on prostate hypertrophy, e.g. by stimulation of cellular proliferation [1,7]. In our study, even though diabetic patients were affiliated to local diabetic associations, most of them likely had poor glycemic control, as reflected by frank hyperglycemia (Table 1), as a consequence of inadequate diet, insufficient access to glucose-lowering therapies, limited or lack of self-measurement of blood glucose, all within a context of poorly-developed healthcare and limited financial resources.

All these intertwined abnormalities can also cause micro- and macrovascular damage with ensuing prostatic hypoperfusion. Berger et al. [8] suggested that impairment of blood supply to the prostate has a key role in development of BPH. *In vitro* experiments have shown that hypoxia-stimulated prostate growth may result from upregulated secretion of several growth factors. In diabetics, impaired blood supply to the prostate may arise from atherosclerosis of large vessels (usually as a consequence of hypertension and dyslipidemia) and/or from microangiopathies of smaller vessels, associated with chronic hyperglycemia [8,9], and/or from vascular compression due remodeling of the prostatic stroma, as a consequence of chronic low-grade systemic inflammation [16–18].

Poor glycemic control in diabetics is also a RF for recurrent urinary tract infection and inflammation, both of which can aggravate LUTS. In the Bostanci study [19], inflammation was found to be a RF for BPH, as shown by the frequent presence of inflammatory infiltrates in prostatic tissue, the intensity of which was otherwise correlated with prostate volume. Local production of cytokines by inflammatory cells was shown to stimulate angiogenesis and growth factors synthesis by prostatic tissue [16–21]. Chronic inflammation may lead to a succession of injury and healing episodes affecting the prostate. This may contribute to architectural remodeling of the prostatic stroma, including mechanical vascular compression, which also generates oxidative stress [8–10].

In long-standing T2DM, Al-Tamini et al. [22] reported decreased vitamin D status in the majority of patients. Caretta et al. [23] confirmed this finding and demonstrated that vitamin D exerts a protective role against prostatic hypertrophy. Thus, vitamin D deficiency may promote progressive increase in prostate size. However this condition is unlikely in South- Kivu, which is *a priori* a region with high solar exposition. Further studies on this topic are required to draw plausible conclusions.

Surprisingly, clinical markers of obesity were scant in our study population (Table 2), which does not necessarily attenuate the relationship between overall obesity, T2DM, hyperinsulinemia and growth factors. Several studies show a positive correlation between global obesity (inferred by BMI) and prostate size [3,11], and central obesity (with waist circumference as *proxi*) plays a major role in

Table 3
Association between prostate volume and correlates of prostate enlargement.

Variable	n	% EP	OR (95% CI)	p
Age(years)				<0.001
40–59	471	47.4	1	
≥60	658	68.7	2.44 (1.90–3.14)	
IPSS				<0.001
Mild	321	50.5	1	
Moderate to severe	808	63.5	1.7 (1.30–2.23)	
QOL				0.011
Normal	426	54.2	1	
Moderate	180	64.4	1.53 (1.07–2.19)	
Severe	523	62.7	1.42 (1.09–1.84)	
FLOW MAX (ml/sec)				<0.001
≥15	529	68.8	1	
<15	597	51.6	2.1 (1.6–2.7)	
Voiding duration (sec)				<0.001
<20	710	55.2	1	
20–60	387	68.0	1.72 (1.33–2.23)	
>60	29	58.6	1.15 (0.54–2.44)	
PVR (cc)				0.006
<50	1013	58.3	1	
≥50	113	71.7	1.81 (1.16–2.87)	
Diabetes				<0.001
No	752	51.7	1	
Yes	377	76.6	3.11 (2.34–4.16)	
FBG (mg/dl)				<0.001
<100	857	54.1	1	
≥100	272	77.6	2.93 (2.12–4.08)	
BMI (kg/m2)	n = 1129			0.001*
Underweight	155	49.7	1	
Normal	735	57.7	1.38 (0.97–1.95)	
Overweight	194	70.1	2.37 (1.53–3.69)	
Obese	45	84.4	5.50 (2.31–13.1)	
WC (cm)				<0.001
<94	929	56.3	1	
≥94	200	76	2.46 (1.72–3.56)	
Fat mass (%)				<0.001*
Low	437	56.5	1	
Normal	496	60.3	1.17 (0.90–1.51)	
High	128	64.8	1.42 (0.94–2.14)	
Very high	68	67.6	1.61 (0.93–2.76)	
VFS (0–30)				<0.001
Normal	877	55.9	1	
High	194	70.6	1.90 (1.35–2.66)	
Very high	58	82.8	3.80 (1.89–7.60)	

EP: enlarged prostate. **IPSS:** International prostate symptoms score (0–35). **QOL:** Quality of life score (0–7). **PVR**: Post voiding residual (cc), **PV**: Prostate volume (cc), **FBG**: Fasting blood glucose (mg/dl), **BMI**: Body mass index (kg/m^2), **WC**: Waist circumference (cm). **VFS**: Visceral fat score (0–30 scale).
*: chi-square for trend.

Table 4
Multivariable logistic regression analysis for correlates of prostate hypertrophy.

Variable	Adjusted OR (95% CI)	P
Age(years)		<0.001
40–59	1	
≥60	2.51 (1.93–3.26)	
Diabetes		<0.001
No	1	
Yes	2.92 (2.17–3.92)	
Flow max (ml/sec)		<0.001
≥15	1	
<15	1.70 (1.30–2.22)	
Voiding duration (sec)		<0.046
<20	1	
20–60	1.33 (1.01–1.77)	
>60	–	
BMI (kg/m2)		<0.001
Underweight	0.66 (0.45–0.95)	
Normal	1	
Overweight	1.79 (1.24–2.57)	
Obese	3.57 (1.51–8.46)	

driving prostate enlargement [24–27] (see Table 3).

Cohen et al. [28] suggested that increased intra-abdominal pressure due to central obesity may damage internal spermatic veins valves, resulting in a higher testosterone reflux exposure of the prostate via the communicating venous system.

An intriguing finding of our study was the greater prostate volume of diabetic patients despite low overall obesity prevalence (Table 2). This observation might be due to a more restrictive diet, a poor glycemic control with urinary caloric loss, and insulinopenia-related catabolism in later-stage T2DM, since hypoinsulinemia is frequent in sub-Saharan T2DM males exhibiting the so-called "African diabetes" phenotype [29,30]. Furthermore, the "metabolically obese but normal-weight" (MONW) phenotype is frequent in sub-Saharan African populations [30], with or without T2DM. Interestingly, BMI at the time of diabetes diagnosis was markedly higher than current BMI, which implies a substantial weight loss over time in these diabetics. Despite this weight decrease, their prostate volume was greater than that of their non-diabetics counterparts. Therefore, we hypothesize that a component of BPH may represent some kind of metabolic scar in these diabetic men from South Kivu.

4.1. Limitations

As prostate biopsies were not carried out in this study to formally establishing histological BPH, the possibility of prostate cancer cannot be ruled out in some patients. In addition, more extensive urodynamic explorations in diabetics should be realized in order to identify other causes of LUTS. Further, laboratory analyzes are required to confirm the "metabolically obese but normal-weight" (MONW) phenotype of the diabetics enlisted in this study.

5. Conclusion

T2DM significantly increases the risk of developing BPH, despite a low overall obesity prevalence. As regards body composition, prostate volume was not associated with body fat or visceral fat. Further studies are needed to explain the underlying overlapping mechanisms between T2DM and BPH, two prevalent acquired conditions in South-Kivu. Our data also suggest that screening for diabetes in case of BPH, and vice versa, may be useful in this population.

Source of funding

We received financial support from the following institutions during data collection:

- The "Société Belge d'Urologie" **(SBU)**,
- The 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 during the data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2018.10.003.

References

[1] 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.
[2] 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.
[3] Hammarsten J, Hoëgstedt B, Holthuis N, Mellström D. Components of the metabolic syndrome-risk factors for the development of benign prostatic hyperplasia. Prostate Cancer Prostatic Dis 1998;1(3):157–62.
[4] Nandeesha H, Koner BC, Dorairajan LN, Sen SK. Hyperinsulinemia and dyslipidemia in non-diabetic benign prostatic hyperplasia. Clin Chim Acta 2006;370:89–93.
[5] Protopsaltis I, Ploumidis A, Sergentanis TN, Constantoulakis P, Tzirogiannis K, Kyprianidou C, et al. Linking pre-diabetes with benign prostate hyperplasia. IGFBP-3: a conductor of benign prostate hyperplasia development orchestra? PloS One 2013;8(12):1–9.
[6] Mullan RJ, Bergstralh EJ, Farmer SA, Jacobson DJ, Hebbring SJ, Cunningham JM, et al. Growth factor, cytokine, and vitamin D receptor hyperplasia in a community-based cohort of men. Urology 2006;67:300–5.
[7] Kim WT, Yun SJ, Choi YD, Kim G, Moon S, Choi YH. Prostate size correlates with fasting blood glucose in non- diabetic benign prostatic hyperplasia patients with normal testosterone levels. J Kor Med Sci 2011;26:1214–8.
[8] Berger AP. Vascular damage induced by type 2 diabetes mellitus as a risk factor for benign prostatic hyperplasia. Diabetologia 2005;48:784–9.
[9] Berger AP, Bartsch G, Deibl M, Alber H, Pachinger O, Fritsche G, et al. Atherosclerosis as a risk factor for benign prostatic hyperplasia. BJU Int 2006;98:1038–42.
[10] Chen IH, Tsai YS, Tong YC. Correlations among cardiovascular risk factors, prostate blood flow, and prostate volume in patients with clinical benign prostatic hyperplasia. Urology 2012;79(2):409–14.
[11] 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.
[12] Kim SB, Cho I, Min SK. Prostate volume measurement by transrectal Ultrasonography : comparison of height obtained by use of transaxial and midsagittal scanning. Korean J Urol 2014;55:470–4.
[13] Chen Z, Miao L, Gao X, Wang G, Xu Y. Effect of obesity and hyperglycemia on benign prostatic hyperplasia in elderly patients with newly diagnosed type 2 diabetes. Int J Clin Exp Med 2015;8(7):11289–94.
[14] Kachunga P, Masumbuko B, Belma M, Kashongwe Z, Hermans M, M'buyamba JR. Age and living in an urban environment are major determinants of diabetes among South Kivu Congolese adults. Diabetes Metab 2012;38:324–31.
[15] Ding J, Qi L, Zu X, Shen P. Urodynamic studies on benign prostatic hyperplasia combined with diabetes mellitus. J Cent S Univ 2010;35(7):705–10.
[16] Fibbi B, Penna G, Morelli A, Adorini L, Maggi M. Chronic inflammation in the pathogenesis of benign prostatic hyperplasia. Int J Androl 2010;33(3):475–88.

[17] Hamid A, Umbas R, Mochtar CA. Recent role of inflammation in prostate Diseases : chemoprevention development opportunity. Acta Med Indones-Indones J Intern Med. 2011;43:59–65.
[18] Kramer G, Mitteregger D, Marberger M. Is benign prostatic hyperplasia (BPH) an immune inflammatory Disease ? Eur Urol 2007;51:1202–16.
[19] Bostanci Y, Kazzazi A, Momtahen S, Laze J, Djavan B. Correlation between benign prostatic hyperplasia and inflammation. Curr Opin Urol 2013;23(1):5–10.
[20] Konwar R, Gara R, Singh M, Singh V, Chattopadhyay N, Bid HK. Association of interleukin-4 and interleukin-1 receptor antagonist gene polymorphisms and risk of benign prostatic hyperplasia. Urology 2008;71:868–72.
[21] Mishra VC, Allen DJ, Nicolaou C, Sharif H, Hudd C, Karim OMA, et al. Does intraprostatic inflammation have a role in the pathogenesis and progression of benign prostatic hyperplasia ? BJU Int 2007;100:327–31.
[22] Al-Tamini DJ, Ali AF. Serum 25(OH) D in diabetes mellitus type 2: relation to glycaemic control. J Clin Diagn Res 2013;7:2686–8.
[23] Caretta N, Vigili de Kreutzenberg S, Valente UGG, Pizzol D, Ferlin A, Avogaro A, Foresta C. Hypovitaminosis D is associated with lower urinary tract symptoms and benign prostate hyperplasia in type 2 diabetes. Andrology 2015;3:1062–7.
[24] Lee RK, Chung D, Chughtai B, Te AE, Kaplan SA. Central obesity as measured by waist urinary is predictive of severity of lower urinary tract symptoms. BJU Int 2012;110:540–5.
[25] Lee S, Min HG, Choi SH, Kim YJ, Oh SW, Kim YJ, Park Y, Kim SS. Central obesity as a risk factor for prostatic hyperplasia. Obesity 2006;14(1):1–8.
[26] Parsons JK, Sarma AV, McVary K, Wei JT. Obesity and benign prostatic hyperplasia: clinical connections, emerging etiological paradigms and future directions. J Urol 2009;182(6):S27–31.
[27] Parsons JK, Kashefi C. Physical activity, benign prostatic hyperplasia, and lower urinary tract symptoms. Eur Urol 2008;53:1228–35.
[28] 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;11:317–20.
[29] Dehout F, Haumont S, Gaham N, Amoussou-guenou KD, Hermans MP. Metabolic syndrome in Bantu subjects with type 2 diabetes from sub-Saharan extraction Prevalence, gender differences and HOMA hyperbolic product. Diabetes Met Syndr Clin Res Rev 2008;2:5–11.
[30] Hermans MP, Amoussou-guenou KD, Bouenizabila E, Sadikot SS, Ahn SA, Rousseau MF. The normal-weight type 2 diabetes phenotype revisited. Diabetes Met Syndr Clin Res Rev 2016;10:82–8.