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ORIGINAL RESEARCH

Body mass index and waist circumference in patients with benign prostatic hyperplasia at the Tamale Teaching Hospital, Ghana

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Background: Benign prostatic hyperplasia (BPH) refers to the proliferation of the stromal and epithelial cells at the transition zone of the prostate gland. This may result in bladder outlet obstruction which is associated with distressing lower urinary tract symptoms. There are conflicting reports on the association of obesity with BPH and the severity of the symptoms of lower urinary tract obstruction.

Methods: A cross-sectional study was undertaken to determine the relationship between symptomatic BPH and obesity, among patients presenting to the Urology Unit of the Tamale Teaching Hospital (TTH). The waist circumference (WC) of each participant was measured and their body mass index (BMI) calculated using their weight and height. The severity of lower urinary tract symptoms of each participant was measured using the international prostate symptom score (IPSS), and their prostate volume (PV) measured with a transrectal ultrasound scan. Data were entered into a Microsoft® Excel spreadsheet and exported to Statistical Package for Social Sciences for analysis.

Results: There were positive associations between BMI and PV (r = 0.160), as well as between WC and PV (r = 0.244). Analysis of the association between the IPSS and BMI (r = 0.243), as well as the IPSS and WC (r = 0.294) yielded statistically significant correlations.

Conclusion: Obesity, especially central obesity, is a risk factor for the development of BPH and also worsens lower urinary tract symptoms due to an enlarged prostate.

Keywords: benign prostatic hyperplasia, body mass index, waist circumference

Introduction

Benign prostatic hyperplasia (BPH) refers to the proliferation of the stromal and epithelial cells of the prostate gland. This proliferation of cells is mainly at the transition zone of the prostate gland in the early stages, and may involve the entire gland at a later stage, leaving only a rim of normal glandular tissue beneath the capsule.[1]

It has been associated with risk factors such as ageing and positive family history.[2] In recent times, body habitus has been questioned as a risk factor for the development and progression of symptomatic BPH.[3-6]

This relationship may be attributed to an increase in aromatisation of testosterone to oestrogen, resulting in an increase in the oestrogen:testosterone ratio, promoting hyperplasia of the prostate gland.[7] This is because oestrogen is involved in the induction of androgen receptors on the prostate gland, thus resulting in enhanced proliferation of the prostatic tissue.[8]

It is known that obesity promotes inflammation of the prostate gland resulting in the production of cytokines and growth factors that promote epithelial and stromal hyperplasia.[9] In addition, obesity increases intra-abdominal pressure which in turn increases intra-vesical pressure and, as such, exacerbates lower urinary tract symptoms (LUTS) secondary to BPH.[10]

Globally, BPH is a common disease among men above the age of 40, with the prevalence rising with increasing age.[11] In Ghana there has been an increase in life expectancy from 59.2 to 66.3 years in both males and females, from the year 2000 to 2019.[12] Thus, men are expected to grow older and to develop symptomatic BPH during their lifetime.

The estimated global prevalence of obesity is 13%,[13] while a systematic meta-analysis in 2016 found that approximately 43% of Ghanaian adults were either overweight or obese and that the prevalence was rising.[14] Symptomatic BPH may therefore further be worsened by the increasing prevalence of obesity, if there is an association between these two aspects.

This study aimed to evaluate the impact of obesity, measured by body mass index (BMI) and waist circumference (WC), on BPH as well as on the severity of LUTS due to the enlarged prostate.

Methods

This prospective hospital-based cross-sectional study was conducted at the Urology Unit of the Department of Surgery of the Tamale Teaching Hospital (TTH), which serves the five regions of the northern part of Ghana (Upper East, Upper West, Northern, North East and Savannah). This region has a population of approximately 8 million people. The Urology Unit has a bed capacity of 24 with a total average admission of 520 per annum.

The non-probability convenience sampling technique was used to recruit participants for the study. The study population was all male patients older than 40 years with LUTS secondary to BPH, who attended the urology clinic or the emergency room of TTH. BPH was diagnosed using digital rectal examination (DRE) findings such

as: enlarged, firm prostate with a smooth surface; palpable median sulcus and mobile rectal mucosa over the prostate; and a normal total serum PSA value 0–4 ng/ml.

The BMI of each participant was calculated from their weight and height using the formula weight (kg)/height² (in meters²), and their WC measured with a standard tailor measuring tape. A BMI below 18.5 is defined as underweight, while 18.5–24.5 is defined as normal weight, 25–29.9 is overweight and ≥ 30 is obese. A WC of > 94 cm was considered large WC.

The international prostate symptom score (IPSS) of each participant was graded with a standard score sheet. An IPSS of 8 and above indicated significant LUTS. Also, the quality of life (QoL) score was graded 0–6, where 0 means the participant would be delighted with their symptoms, while 6 means the participant would feel terrible if they had to live with their symptoms and no treatment were given. The scores in between these reflect how the participants would feel if they had to live with their symptoms for the rest of their lives.

All data were entered into a Microsoft® Excel 2016 spreadsheet, and were cleaned, organised and stored. The spreadsheet was exported to the SPSS Statistics software, version 23 (SPSS®, IBM, USA) for statistical analysis. Frequencies and percentages were used to summarise categorical variables and graphs were used to represent categorical variables. Means and standard deviations (SDs) were used to summarise continuous variables.

The non-parametric test (Spearman's Rho correlation) was used to assess the relationship between each predictor variable (BMI, age, IPSS symptom category and duration of symptoms) and the outcome variables of prostatic volume, IPSS and QoL score. Statistical significance was considered to be a *p*-value of less than 0.05.

Results

The mean BMI of the participants was 23.50 (± 2.67) kg/m². The mean prostate volume (PV) (± SD) of participants with normal weight was 67.00 ± 13.75 cm³, while that of participants who were overweight was 71.80 ± 17.97 cm³ (Table I).

Although there was a positive association between BMI and PV (r = 0.160), this association was not statistically significant (p = 0.061), as seen in Table II.

Table I: Descriptive parameters for PV (cm³) for each category of BMI

BMI range	Number	Mean PV ± SD	Minimum	Maximum
Normal weight	100	67.00 ± 13.75	38.80	106.70
Overweight	37	71.80 ± 17.97	37.90	104.90
Obese	1	66.00	66.00	66.00
Total	138	68.28 ± 15.03	37.90	106.70

BMI – body mass index, PV – prostate volume, SD – standard deviation

Table II: Relationship between PV and BMI

			PV
Spearman's Rho	**BMI category**	Correlation coefficient	0.160
		p	0.061
		n	138

BMI – body mass index, PV – prostate volume

There was a statistically significant correlation between the PV and WC (r = 0.244, p = 0.004). The correlation between PV and age yielded a positive relationship; however, this was not statistically significant (r = 0.028, p = 0.747). There was also a significant positive relationship between PV and the IPSS (r = 0.334, p < 0.001) (Table III).

Table III: Relationship between PV and WC, age, IPSS and PSA

		WC	Age	IPSS	PSA
Spearman's Rho	**PV** Correlation coefficient	0.244	0.028	0.334	0.383
	p	0.004	0.747	0.000	0.000
	n	138	138	138	138

WC – waist circumference, IPSS – international prostate symptom score, PSA – prostate-specific antigen, PV – prostate volume

The analysis of the association between IPSS and BMI, as well as the IPSS and WC yielded statistically significant correlations (r = 0.243, p = 0.004 and r = 0.294, p < 0.001, respectively). This is shown in Table IV.

Table IV: Relationship between IPSS and BMI, and IPSS and WC

		BMI	WC
Spearman's Rho	**IPSS** Correlation coefficient	0.243	0.294
	p	0.004	0.000
	n	138	138

BMI – body mass index, WC – waist circumference, IPSS – international prostate symptom score

Of the participants, 26 (18.84%) had a high BMI with a large WC. Of these, 65.38% reported severe symptoms using the IPSS (Table V).

Table V: Symptoms of BPH in participants with high BMI and large WC

	Frequency	Percent
Mild	1	3.85
Moderate	8	30.77
Severe	17	65.38
Total	26	100

BPH – benign prostatic hyperplasia, BMI – body mass index

We found a statistically significant relationship between the QoL and the IPSS (r = 0.595, p < 0.001), PV (r = 0.326, p < 0.001), BMI (r = 0.167, p = 0.051) and WC (r = 0.197, p = 0.021) (Table VI).

Table VI: Relationship between QoL and IPSS, PV, BMI and WC

		IPSS	PV	BMI	WC
Spearman's Rho	**QoL** Correlation coefficient	0.595	0.326	0.167	0.197
	p	0.000	0.000	0.051	0.021
	n	138	138	138	138

IPSS – international prostate symptom score, PV – prostate volume, BMI – body mass index, WC – waist circumference, QoL – quality of life

Among participants who had a high BMI and a large WC (> 94 cm), a majority (73.08%) was between the ages of 60 and 79 years. This is shown in Table VII.

Table VII: Age groups of the participants with a high BMI and a large WC

Age groups	Frequency	Percentage
40–59	6	23.08
60–79	19	73.08
80 or more	1	3.85
Total	26	100

Discussion

Approximately 27.50% of the study participants were either overweight or obese. This is lower than the prevalence of overweight and obese people in Ghana (43%) reported in a meta-analysis by Ofori-Asenso et al.[14] in 2016. This is probably because our study only included men older than 40 years. Also, about 98% of our study participants reside in northern Ghana where the largest part of the population has a low socio-economic status.[15] Thus, low intake of a balanced diet among these people could have accounted for the lower percentage of participants who were overweight/obese, compared to the 2016 study. Also, the main occupation of the people of northern Ghana is farming,[15] which involves a high level of physical activity, resulting in the reduction of body fat.[16]

In Johannesburg, a higher mean BMI was reported among participants (27.31 ± 3.93 kg/m²).[17] In this South African study, 35% of the participants were overweight and 30% were obese,[17] reflecting a difference in mean BMI between their study and ours.

The mean WC of our participants was 91.25 ± 5.42 cm. Approximately 23.90% of the participants had a WC of more than 94 cm. In a Chinese study, patients with BPH were reported to have a mean WC of 81.8 ± 9.4 cm.[18] Jung et al.[19] also reported a lower mean WC of 87.16 ± 7.66 cm in Korean men with BPH.

The mean PV of our participants was 68.28 ± 15.03 cm^3, similar to that found by Aboah et al.[20] In 225 men with LUTS secondary to BPH, they recorded a median PV of 68.90 cm^3 in the Komfo Anokye Teaching Hospital, Kumasi.[20]

However, a study done among men in Nigeria with symptomatic BPH reported a larger mean PV of 83.8 ± 37.7 cm^3.[21]

Obesity is a modifiable risk factor for both cardiovascular diseases and diabetes mellitus.[22,23] Studies have shown that obesity may also be a risk factor for prostate enlargement.[3,4,7] In this study, there was a positive relationship between obesity (measured by BMI and WC) and PV. The mean PV of participants with normal weight was 67.00 ± 13.75 cm^3, while that of participants who were overweight was 71.80 ± 17.97 cm^3.

Spearman's Rho correlation coefficient between PV and BMI, however, was not statistically significant (r = 0.160, p = 0.061). Similarly, Ojewola et al.[24] reported no significant association between BMI and PV in Nigerian men; Mondul et al.[5] reported similar results in the USA; and Raza et al.[25] indicated similar results among Pakistani men as well. In contrast, however, Matsuda et al.[26] demonstrated a positive correlation between BMI and prostate size among Japanese men.

There was a statistically significant correlation between the WC of our study participants and their PVs (r = 0.244, p = 0.004). In a prospective, cross-sectional study at four urology centers in Korea, participants with a WC > 90 cm had larger PVs than those with a WC < 90 cm.[27] A similar finding was made by Mondul et al.[5] among patients with BPH in the USA, and by Wang et al.[28] in Taiwan. Thus, our finding agrees with these studies suggesting that central obesity measured by WC is a more significant risk factor for prostatic enlargement than global obesity measured by BMI.

The impact of obesity on prostatic hyperplasia, and hence BPH, is therefore leaning more towards central obesity than global obesity in ageing men. However, others have presented findings suggesting that both central and global obesity are risk factors for the development of BPH.[29,30]

A study in Korea found that both BMI and WC had a positive correlation with PV,[29] similar to results from a study in France by Pashootan et al.[30]

Mampa et al.[17] reported that both BMI and WC had no positive relationship with PV among South Africans.[17] According to them, obesity and prostate enlargement have no correlation, which is at variance with our finding.

Of the study participants, 26 (18.84%) had a high BMI with a large WC. Of these participants, a large proportion (65.38%) reported severe symptoms using the IPSS. The analysis of the association between IPSS and BMI, as well as the IPSS and WC yielded statistically significant correlations (r = 0.243, p = 0.004 and r = 0.294, p < 0.001, respectively). Our findings thus suggest that both global obesity (measured by BMI) and central obesity (measured by WC) worsen LUTS.

A similar finding was reported in Mozambique, where waist-to-hip ratio (a measure of central obesity) and BMI of participants with BPH had a positive correlation to their IPSS.[31] Mondul et al.[5] and Yelsel et al.[32] had similar findings in USA and Turkey, respectively. Even among children and adolescents, obesity has been found to influence lower urinary tract symptoms; in the Xin-Dian District, New Taipei City, 1 599 children and adolescents without genitourinary abnormality, between the ages of 5 and 15 years, were evaluated.[33] The results revealed that obesity was significantly associated with lower urinary tract symptoms. Thus, the authors concluded that irrespective of age-associated detrusor dysfunction, obesity is a risk factor for LUTS.[33] Furthermore, Orsini et al.[34] demonstrated that physical activity was associated with a lower prevalence of LUTS. This could be as a result of the impact of physical activity in reducing obesity.[16]

The relationship between obesity and LUTS may be explained by the theory which suggests that obesity increases intra-abdominal pressure. The increase in intra-abdominal pressure in turn results in an increase in intra-vesical pressure, and as such exacerbates LUTS secondary to BPH.[9] However, Mampa et al.[17] in South Africa and Mubenga et al.[35] in the Democratic Republic of Congo found

no correlation between lower urinary tract symptoms and obesity, which disagrees with our finding.

In our study, worse symptom scores were associated with worse QoL scores (r = 0.595, p < 0.001). Thus, those who had worse symptoms also reported a poorer QoL . This is similar to what was reported by a multicenter study in five countries where the effect of LUTS on QoL was studied across a variety of cultures (Netherlands, France, UK, Korea and USA).[36] The authors reported that severe lower urinary tract symptoms were associated with a poor QoL .[36]

Participants with larger PVs also reported poorer QoL. A large prostate gland was positively related to a higher IPSS score in our study, thus accounting for the worse QoL associated with a large PV. In one study at the Ghana Police Hospital in Accra, a group of patients with BPH were treated with a plant extract (*Croton membranaceus* root extract).[37] After three months of treatment, a reduction in their PV (from 108 ± 41.3 to 54.5 ± 24.8 cm^3) corresponded with an increase in the percentage of patients who were happy with their state of health from 33% to 83%.[37]

Again, both high BMI and large WC were associated with poorer QoL (r = 0.167, p = 0.051 and r = 0.197, p = 0.021 for BMI and QOL and WC and QOL, respectively). This is probably due to the effect of obesity on a larger PV which results in worse LUTS as was found in this study.

Severe lower urinary tract symptoms were common in the age group of 60–79 years (48%). This group had the largest representation in our study, which may account for this finding. The older age group (80 years and older) in this study was represented by a little over 20%. This is similar a Swedish study,[38] where 1.8% of the participants aged 45–49 years had severe LUTS, while 9.7% of the participants aged 75–79 years had severe LUTS. Ageing results in detrusor dysfunction and, thus, elderly men are more prone to developing LUTS which may be worsened by bladder outlet obstruction due to BPH.[39]

Conclusion

We conclude that a higher BMI and a larger WC are associated with a large PV. Also, a higher BMI and a larger WC worsen lower urinary tract symptoms secondary to BPH.

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Conflict of interest

The authors declare no conflict of interest.

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Ethical approval

The study protocols were submitted to the Komfo Anokye Teaching Hospital Institutional Review Board for review. Ethical approval for the study was obtained from this institution after the review with number KATH-IRB/AP/071/20.

All participants signed an informed consent before they were included in the study.

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