

The Effectiveness of Ultrasound in Early Detection of Benign Prostatic Hypertrophy; A Case Study of Chitungwiza, Zimbabwe

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Abstract: The aim of the study is to determine the effectiveness of ultrasound for early detection of Benign Prostatic Hypertrophy (BPH) at Chitungwiza Central Hospital. A total of 60 participants were enrolled in this study and there are three sets of data that were conducted; the prostate volume, blood Prostate Specific Antigen (PSA) levels as well as a completed questionnaire for assessing symptoms of BPH. The study concluded that there is a high prevalence of undiagnosed benign prostatic hypertrophy amongst the population of Chitungwiza at 60% of the study population. Age was the greatest risk factor in the development of BPH. A weak positive correlation existed between the measured prostate volume and the prostate specific antigen (PSA) measured in blood ($R=0.441$) making PSA a weak predictor of prostate volume. Strong positive correlations exist however between the prostate volume and the symptom severity ($R=0.617$, $p=0.000$) and quality of life index ($R=0.658$, $p=0.000$) thereby making prostate volume measured by ultrasound a good predictor of symptom severity and quality of life. Age was positively correlated with BPH prevalence, symptom score ($R=0.670$, $p=0.000$) and quality of life ($R=0.701$, $p=0.000$). The study revealed that the use of ultrasound scan combined with the international prostate scoring sheet (IPSS) is necessary for routine screening for the early detection of BPH.

Key words: Benign Prostatic Hypertrophy • Screening • Ultrasound • PSA

INTRODUCTION

Benign prostatic hypertrophy is a serious condition affecting males from the age of 60 onwards [1]. The age of an individual has been shown to contribute significantly to the development of BPH. Studies had shown that the proportion of men in the population with moderate to severe symptoms of BPH doubles with each decade increase in age [2, 3]. The need for earlier diagnosis of this condition and the effects on the management of the condition is well emphasised. It has been acknowledged that BPH is an under-diagnosed condition that significantly affects the quality of life of many men. It was suggested that BPH should be part of the opportunistic health promotion program in men aged over 50 years [3].

Efforts done for BPH diagnosis have evolved over the years and they continue to be improved and evaluated with time. Digital rectal examination is the

primary, clinical examination procedure done to detect BPH [4]. Prostate Specific Antigen tests, while showing remarkable sensitivity in the diagnosis of prostate cancer, can produce un-predictive results in the evaluation of BPH [5].

Screening tools for earlier detection of these conditions have failed to be fully introduced despite this increase in incidence of this condition both in Zimbabwe and internationally. Research done on Japanese man showed that ultrasound is capable of detecting prostate enlargement in patients with no symptoms of the condition [6]. In this study, 33.2 % of the participants had BPH detected using ultrasound. Trans-rectal ultrasound techniques were used during this study. When used in combination with digital rectal examination, ultrasound is shown to detect 73% more prostate pathologies compared to PSA [7]. However no follow up research studies were conducted to cement the finding of these researches.

Whilst other imaging modalities available within radiology departments can be used as screening tools for BPH, their availability and cost remain a limiting factor for their use. Examinations such as IVU which were used for prostate evaluation earlier have been proved to be inferior to ultrasound in the quality of information obtained. Only a small percentage of pathologies, 6.3%, could be detected using IVU only with the rest being able to be detected using Ultrasound imaging [8]. Another review carried out in 1997 further supported the earlier recommendations on the non-importance of IVU in the direct evaluation of the prostate gland [9]. Modalities such as Computed Tomography have the ability to produce high resolution images of the prostate gland but due to the high cost of operating and maintaining the equipment as well as the high radiation dose produced during the examination, its application for screening purposes is not possible. Ultrasound on the other hand is easily available at each and every hospital from district to central hospitals making it an ideal tool for screening purposes. The cost of an ultrasound examination is very low and human expertise for its operation is locally available.

MATERIALS AND METHODS

This research study aimed at determining the prevalence of undiagnosed BPH and evaluating effectiveness of ultrasound in screening for its early detection in Chitungwiza. The research design was descriptive analytical study. It was a one centre study that aimed at looking at the current situation at Chitungwiza Hospital, employing a combination of both quantitative and qualitative strategies. All males aged 40 years and above presenting at the hospital as patients or accompanying relatives were eligible to participate in the study. Non-probability sampling techniques were used and a total of sixty participants were enrolled into the study. Ethical approval for the study was given by the national research council and each participant gave consent before taking part in the study.

The study population was grouped into strata, with each strata having a 10 year with and 15 participants. Each participant was assigned a code so as to conceal their actual identity and from each participant, three sets of data were collected, that is, the prostate volume measurement, the PSA measurement as well as a filled questionnaire. The prostate volume measurement for each participant was determined using a digital ultrasound machine. The scanner was also used to assess the echo-texture of the prostate gland as well as whether the

capsule was intact or not. In order to minimise subjective bias, the researcher sought the assistance of two resident sonographers at the hospital who provided the second and third opinion. For this study, a prostate volume of 32ml and below was considered to be normal whilst that volume above 32ml was recorded as abnormal. A sample of blood was collected from each participant and the blood PSA level determined using the blood analyser in the local laboratory. For this study, a PSA value of 4 nanograms and below was considered normal whilst a PSA value above 4 nanograms was recorded as abnormal.

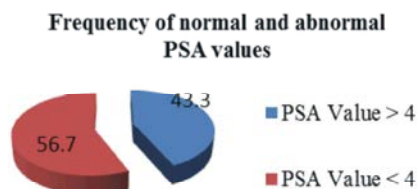
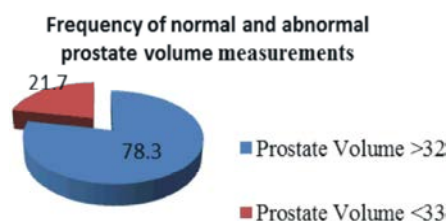
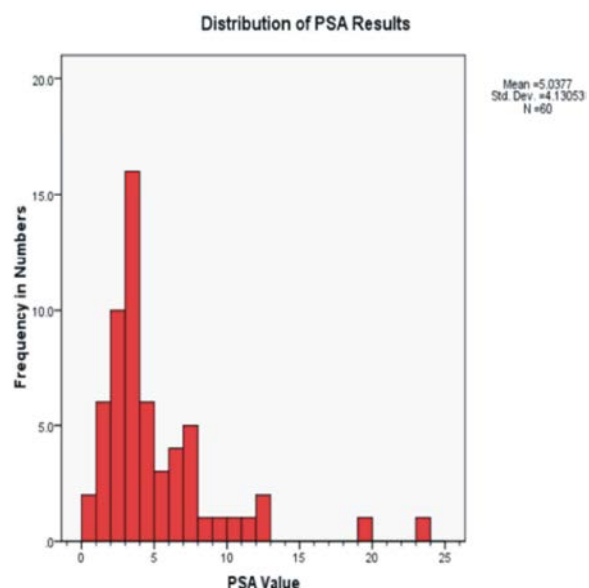
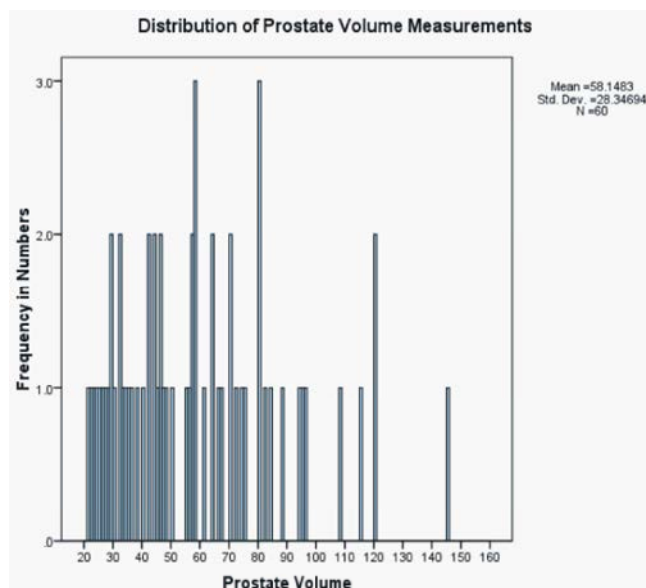
The research questionnaire was the third aspect of the study. It was a simple, short questionnaire comprising of eight questions, seven of which assessed the presence and severity of symptoms related to prostate enlargement. The eighth questions in the questionnaire assessed the level of quality of life as perceived by the participant in light of the reported symptoms. The questionnaire was adopted from the International Prostate Symptom Score (IPSS) formulated by the American Urological Association (AUA). Each symptom was awarded a minimum score of zero and a maximum score of five and all the seven scores were summed up to give an index score of between zero and thirty five. The individual aggregate score were grouped into three categories as recommended by the AUA as follows;

- Mild (symptom scores less than or equal to 7)
- Moderate (symptom Score range 8-19)
- Severe (symptom score range 20-35)

Question number eight was enough to assess the quality of life of the participant and only one question was used in line with the International Scientific Committee (SCI), under the patronage of the World Health Organization (WHO) and the Union for International Cancer Control (UICC) recommendations. The participant would select a single option from a range of seven options ranging from zero to six representing the different levels of quality of life from being delighted to feeling terrible. A coded data collection sheet was used to capture all the data collected from the participants of the study.

RESULTS AND DISCUSSION

A total of sixty data sets were collected during this study and all the data was analysed reflecting 100% response rate. The age of the participants ranged from 40 years to 80 years with each strata having a maximum of 15 participants.



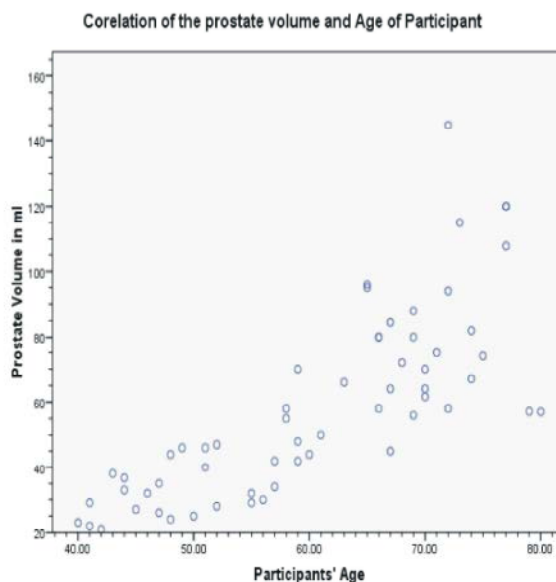
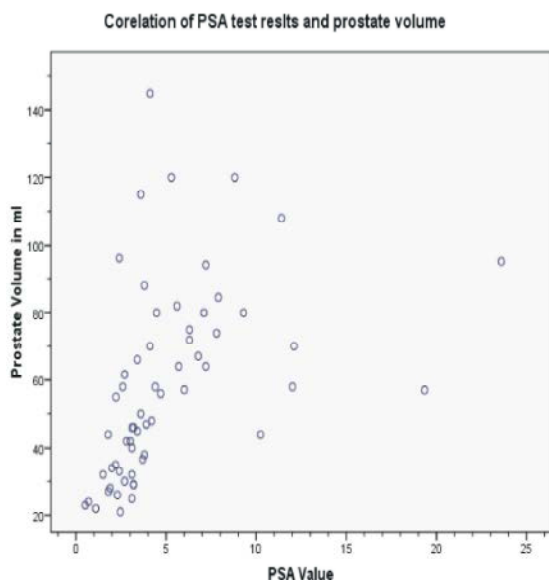
Prevalence of Undiagnosed Prostatic Hyperplasia:

A combination of an ultrasound volume greater than 32ml and symptom score greater than seven was used to indicate benign prostatic hypertrophy. Using these criteria, the prevalence of BPH from this study was 60%. The results of prostate volume measurements and PSA values obtained are shown in the graphs below.

A range of prostate volume results was obtained, the minimum volume being 21ml and the maximum volume being 145ml. These results were further broken down into 2 groups, the normal findings and the abnormal prostate volume measurements. The greatest percentage of the study sample had a prostate volume above 32ml (78.3%) which was considered abnormal. PSA results produced were in nanograms of PSA per ml of blood. A range of results was produced with the minimum being 0.51ng/ml and the maximum being 23.6ng/ml. The results were grouped into normal and abnormal findings producing the data in the following graphs.

This prevalence is very high when compared to other studies that were done utilising the same calculation criteria. A similar study on Korean man reported an overall BPH prevalence of 21% in man aged 50 years and above [10]. In his study, a sample of 553 individuals was used compared to a sample of 60

individuals that was utilised in this study. The sample selection criteria used was different also, with Huh having selected participant in his study using random sampling methods all across Jeju Islands of Korea. In this study participants were selected non-randomly using purposive sampling techniques. In another similar study done on Iranian man, an overall BPH prevalence of 23.8% was reported in a study sample of 8 466 man aged 40 years and above [11]. The study used the systematic random sampling technique using the polling station register as the sample frame. The sample size and sample selection techniques are important factors in the generalisation of the results. It becomes clear that the prevalence from this study is very high, almost 200% higher compared to the two studies outlined above. It is important however to note that the two studies where all national studies aiming at establishing national prevalence of Benign Prostatic Hypertrophy. This study however is a case study of Chitungwiza Central Hospital that intended on establishing the prevalence of BPH at the hospital only. From the current study, the prevalence of BPH at Chitungwiza Central Hospital is 60%. This could be explained from the sampling point where the sample size was small compared to the two national studies cited above.

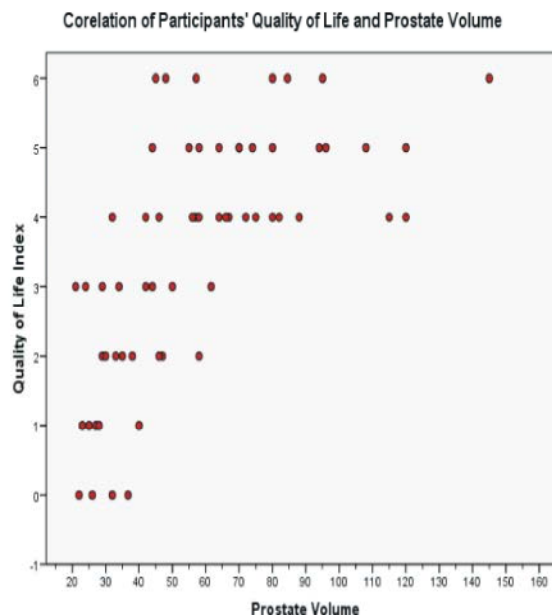
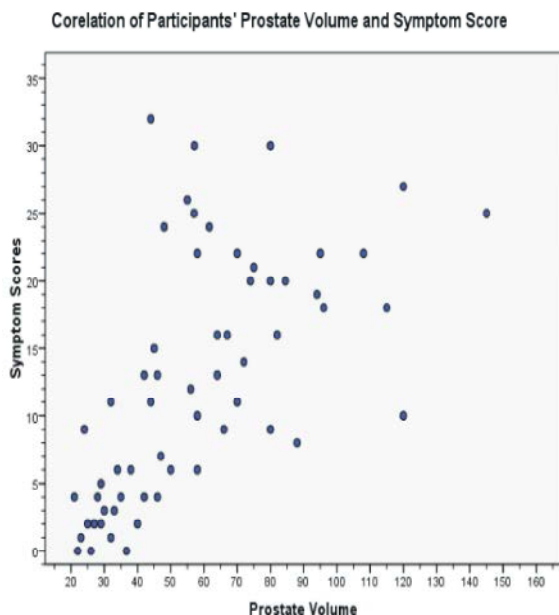


In the current study, the prevalence of BPH showed an increase with the increasing age of participants. BPH prevalence was lower in the 40-49 years group at 14% (2/14), increasing to 33% (5/15) in the 50-59 years group, then 86% (13/15) in the 60-69 years group and 100% in 70 years and above group. The increase in BPH prevalence with age was also reported in previous studies but however, the prevalence reported in this study are very high compared to the other studies [10, 11]. This was so because this study was a case study centring only on one hospital for data collection.

The Relationship Between Prostate Volume and Psa Values: Prostate specific antigen has been in use for many years as an indicator of the occurrence of prostate cancer. Its quantity in blood is used to rule out the possibility of a cancerous prostate in an individual [12]. In this study, there was a positive correlation between the measured prostate volume and the PSA values obtained for each individual ($R=0.441$ $p=0.000$ 95% CI). This implies that every increase of the prostate gland is associated with an increase in the amount of PSA measured in blood but however to a lesser extent. This positive correlation reported in the current study is consistent with findings reported in literature in other similar studies [13, 14]. PSA values measured in this study also displayed positive age dependency where the older the patient, the higher the PSA value measured ($R=5.66$ $p=0.000$ 95% CI). This implies that the increase in volume of the prostate gland results in an increase in prostate tissue that secrete the prostate specific antigen resulting in the elevation of blood PSA. The graph below captures this relationship.

The correlation of PSA and prostate volume is not always true, as shown by a low R value ($R=0.441$), due to the existence of other confounding factors that can produce elevation of the blood PSA. The existence of these factors makes it difficult for blood PSA to be used alone in the estimation of prostate volume. Prostate pathology such as prostate cancer and prostatism can result in the over-production of PSA and the subsequent elevation of blood PSA without an increase in the physical prostate volume [15]. In such cases, the measured PSA values will give a false indication of the prostate volume. PSA values measured in this study also displayed positive correlation with the prostate volume measured by ultrasound. The greater the prostate volume, the higher the PSA value measured ($R=0.66$ $p=0.000$ 95% CI) as shown in the graph above. This implies that the increase in volume of the prostate gland results in an increase in prostate tissue that secrete the prostate specific antigen resulting in the elevation of blood PSA.

Correlation of Prostate Volume, Symptom Severity and Quality of Life: The growth of the prostate gland is associated with the disruption of normal functions of the body systems as well as a change in the lifestyle of the affected individuals [16]. The effects of prostate enlargement warrant the need for early detection and possible intervention in order to minimise or reduce the effects. Symptom severity is an indicator of the occurrence and frequency of the symptoms that are associated with benign prostatic hypertrophy. It gives an indication of the progression of the disease from one point to the other.



In this study, 63% of the participants were moderately to severely symptomatic whilst only 37% were mildly symptomatic. This indicated that the majority of the population presented with significant symptoms that are related to prostate enlargement. The percentages reported here are also closely related to the high prevalence values of BPH reported earlier. The quality of life (QoL) index is an indicator of how each individual feels about the quality of his life in light of the occurrence of benign prostatic hypertrophy symptoms. In this study, 58.4% of the participants felt dissatisfied to terrible with their life in light of the symptoms they are experiencing as a result of prostate enlargement. A strong positive correlation existed between the reported QoL index for each individual and the age ($R=0.701$, $p=0.000$, 95% CI). These findings are in line with other reported findings where the QoL correlated positively with age ($p=0.002$) [10]. This indicates that as the male individual ages, the quality of life they live tend to deteriorate due to the associated symptoms of BPH that they experience.

In this study, the quality of life index was also correlated to the age of the participants where it showed a strong positive correlation ($R=0.658$, $p=0.000$, 95% CI). In agreement with the other results, this finding means that as the prostate volume increases, the individuals will suffer more symptoms with increasing severity thereby resulting in a reduction in the perceived quality of life of the individual. This becomes important as the prostate volume can be used to evaluate the QoL of the individual and ascertain the need for interventions to be done. So the symptom severity score and the quality of life all

show positive correlation with both the age of the participants and the prostate volume measured on the participant.

Effectiveness of Ultrasound in Early Detection of BPH:

Ultrasound has been in use in the imaging of the prostate gland for many years now. Its effectiveness in the determination of prostate volume is undisputed. In this study, the abnormal ultrasound findings ranged from 43% in the 40-49 years group to 67% in the 50-59 years group and 100% in participants aged 60 years and above. The findings in this study are in agreement with findings from a similar study which also reported enlarged prostate measurements at 98% in all the study participants above the age of 60 years [11]. 78.3% of the participants in the current study had an enlarged prostate gland, according to the ultrasound measurements. This is slightly lower than previous findings where 81.8% of his study participants had an enlarged prostate gland on ultrasound [11]. The difference might be due to the slight difference in the sample selection criteria where the current study specified a minimum of age of 40 years whilst previous study specified a minimum age of 50. Accordingly those that are below the age of 50 contributed mainly normal findings with abnormal prostate measurements being 43% of the group.

The ability of ultrasound scanners to accurately estimate the prostate volume presents it as an ideal tool for screening of prostate gland for early detection of enlargement. The prostate volume measurements by ultrasound have been shown in this study to correlate

very positively with the reported symptom severity as well as the quality of life of the individuals. This relationship makes it possible for prostate volume measurement to be used to estimate the symptom severity in an average individual and the quality of life of the same individual. The correlation between the three parameters also makes it easier to monitor the progression of the condition in individuals.

Disease progression is an important factor in screening practice as it enables informed decisions about when to introduce screening measures to be made so that the majority of the population can benefit. In the current study, the 40-49 years age group presented the lowest abnormal prostate measurement with 43% whilst the all the participants had abnormal findings from the age of 60 years. This is important as it can be noted that introduction of screening practices would have to be done within the 40-49 year group. Most effectively, ultrasound would capture the majority of prostate enlargements in individuals from the age of 40 years as stated in the literature. This is further cemented by the research finding that only 14% of the participants in the 49 – 49 years group reported a quality of life index greater than three, meaning the rest, 86%, were satisfied with their life.

CONCLUSION

The study has revealed that BPH is a common condition amongst men aged 40 years and above in Chitungwiza. Its prevalence is very high in the population under study at 60%. BPH has proved to be a common cause of misery and deterioration of quality of life amongst men above the age of 40 years. Ultrasound imaging demonstrated the ability to pick prostate enlargement as early as the age of 40 years. Its use in combination with the international prostate symptom score improves its accuracy in detecting BPH. The study showed that ultrasound is an effective screening tool for early detection of BPH.

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REFERENCES

1. Roger, S.K., 2000. The prostate, small gland big problem, Prostate Research Campaign UK.
2. Sagnier, P.P., G. MacFarlane, P. Teillac, H. Botto, F. Richard and P. Boyle, 1995. Impact of symptoms of prostatism on level of bother and quality of life of men in the French community. *Journal of Urology*, March, 153(3): 669-78.
3. Simpson, R.J., 1997. Benign prostatic hyperplasia. *British Journal of General Practice*, 47: 401.
4. Roger, S.K., 1999. Prostatic diseases and their treatments, second edition, Astra Zeneca Oncology, Health Press.
5. Kyoichi, I., I. Yoshio, K. Yutaka, Y. Hidetoshi and S. Jin, 1995. Diagnostic Significance of Prostate Specific Antigen and the Development of Mass Screening System for Prostate Cancer. *The Journal of Urology*, 154(3): 1085-1089.
6. Watnabe, H., H. Ohe, T. Inaba, Y. Itakura and M. Saitoh and M. Nakao, 1984. A mobile mass screening unit for prostate disease. *Prostate*, 5: 559-65
7. Lee, F., S. Torp-Pedersen, W. Cooner, J. Drago, L. Holtgrewe, P. Littrup and M. Resnick, 1992. Detection and screening for prostate cancer. *Cancer*, 70(suppl): 355-6.
8. Boss, H.P. and H. Knonagel, 1992. Value of intravenous urography versus ultrasound in preoperative assessment of prostatic hyperplasia. *Urologische Abteilung, Spital Limmattal, Zurich*.
9. Koyanagi, T., W. Artibani and R. Correa, 1997. Proceedings of the Fourth International Consultation on BPH, Paris, July. Plymouth: Health Publications, pp: 179-265. <http://www.plymbridge.com/>.
10. Huh, J.S., Y.J. Kim and S.D. Kim, 2012. Prevalence of Benign prostatic hyperplasia on Jeju Island: Analysis from a cross-sectional Community-based survey. *World Journal of Men's Health*, August, 30(20): 131-7.
11. Safarinejad, M.R., 2008. Prevalence of benign prostatic hyperplasia in a population-based study in Iranian men 40 years old or older. *International Urology and Nephrology*, Springer Science+Business Media B.V.
12. Aaron Caplan, M.D. and Alexander Kratz Prostate 2002. Specific Antigen and the Early Diagnosis of Prostate Cancer. *American Journal of Clinical Pathology*, 117: 104-108.

13. Roehrborn, C.G., P. Boyle, A.L. Gould and J. Waldstreicher, 1999. Serum prostate specific antigen as a predictor of prostate volume in men with benign prostatic hyperplasia. *Urology*, 53: 581-589.
14. Vesely, S., T. Knutson, J.E. Damber, M. Dicuio and C. Dahlstrand, 2003. Relationship between age, prostate volume, prostate-specific antigen, symptom score and uroflowmetry in men with lower urinary tract symptoms. *Scandinavian Journal of Urology and Nephrology.*, 37: 322-328.
15. Laguna, P. and G. Alivizatos, 2000. Prostate specific antigen and benign prostatic hyperplasia. *Current Opinion in Urology*, 10: 3-8.
16. Michel, M.C., L. Mehlburger, H. Schumacher, H.U. Bressel and M. Goepel, 2000. Effect of diabetes on lower urinary tract symptoms in patients with benign prostatic hyperplasia. *Journal of Urology*, 163: 1725-1729.