The relationship between male pattern baldness and prostate cancer risk: a meta-analysis

Jiang Zhao*, Xingyou Dong*, Bishao Sun, Xiaoyan Hu, Xing Luo, Jing Luo, Hongwei Chen, Zhengxing Yang, Jie Xu, Tao Zhou, Xiao Zhong, Longkun Li

Department of Urology, Second Affiliated Hospital, The Army Military Medical University, Chongqing 400037, China. *Equal contributors.

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Abstract: Background: Both male pattern baldness and prostate cancer are age-dependent and androgen-related conditions. Many studies have investigated the relationship between male pattern baldness and prostate cancer risk, but have shown inconsistent results. Hence, we performed a meta-analysis to assess the correlation between male pattern baldness and prostate cancer risk. Material/Methods: A meta-analysis was conducted to evaluate the association of these two conditions. PubMed, Embase, and Medline were used to search the studies that considered the relationship between these two diseases through June 2017. OR and 95% CI were used to calculate the pooled risk with a fixed-effects model. Results: Ten studies that involved 5091 cases and 6423 controls were included in our study to assess the relationship between male pattern baldness and the risk of prostate cancer. No significant relationship between male pattern baldness and prostate cancer risk was found based on a summary OR (95% CI) of 1.06 (0.97, 1.16). However, in subgroup analysis, a significantly positive association between vertex pattern baldness and prostate cancer risk was found, with the pooled OR (95% CI) being 1.26 (1.12, 1.43). Frontal and frontal + vertex pattern baldness, however, were not associated with an increased risk of prostate cancer, with pooled OR (95% CI) of 1.03 (0.85, 1.24) and 1.05 (0.92, 1.20) respectively. Conclusions: This study suggests a significantly positive association between vertex pattern baldness and prostate cancer risk, but no significantly positive association between other types of male pattern baldness and prostate cancer risk. However, further studies are warranted to confirm these findings.

Keywords: Baldness, prostate cancer, risk, meta-analysis

Introduction

Male pattern baldness, which is referred to as androgenic alopecia, is a common phenomenon among older adult males [1, 2]. It is age-dependent and characterized by varying degrees of hair loss at the frontal and vertex areas of the scalp [3]. Studies have shown that male pattern baldness is a heritable and androgen-related phenomenon. Dihydrotestosterone (DHT) [4, 5], a testosterone metabolite, has been demonstrated to be the most important factor associated with male pattern baldness [6, 7]. Similarly, androgens and DHT also play important roles in the development of prostate cancer. Androgens are required for prostate cancer development, and the upregulation of androgen receptor expression can promote the growth of prostate cancer. Moreover, a change in the production level of DHT may also influence the subsequent development of prostate cancer [8]. Considering that androgens seem to contribute to the pathogenesis of both male pattern baldness and prostate cancer, some associations between male pattern baldness and prostate cancer risk have been hypothesized [9].

The relationship between these two conditions has been studied for many years, but findings from these studies have been inconclusive. Many studies have not shown a significant relationship between male pattern baldness and prostate cancer risk [10-17], but a positive association between them was found in other studies [18, 19]. On the one hand, these inconsistent results may be partly due to the differences in male baldness patterns [17], but on the other hand, the sample sizes were relatively small in each single study, and therefore, the evidence was limited. Hence, in this study, a meta-analysis was conducted to evaluate the
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![Diagram of study selection process]

**Figure 1.** Flow chart of study selection.

- Association of male pattern baldness with prostate cancer risk. Additionally, the influence of different patterns of baldness was assessed with respect to prostate cancer risk.

**Methods**

**Literature search and study selection**

A literature search was performed using Medline, Embase, and PubMed databases to identify studies that have reported a relationship between male pattern baldness and prostate cancer risk June 2017 with "baldness" or "alopecia" and "prostate cancer" as the keywords. Additionally, the references of the identified studies were reviewed to find other potential studies.

**Included criteria**

The literature that fit the following criteria were included in the study: 1. the study had a case-control study design; 2. the study reported the relationship between male pattern baldness and prostate cancer risk; 3. the study was published in English and full-text was available; 4. OR and 95% CI of prostate cancer for baldness were reported.

**Exclusion criteria**

The exclusion criteria were as follows: 1. the study was a cohort or other study design; 2. the study was a case report, review, or conference abstract; 3. the study was not published in English or full text was not available; 4. the study reported data that were not associated with our study.

- The titles or abstracts of all the searched studies were scanned to confirm potential studies for inclusion. For those studies where inclusion was difficult to determine based on the titles and abstracts only, the full text was scanned.

**Data extraction and quality assessment**

The following data were extracted from the included studies: the first author's last name, publication year, population, sample size, OR and 95% CI of prostate cancer for any of the baldness patterns. The study quality was assessed according to the Newcastle-Ottawa quality assessment scale (NOS) [20]. The total score was 9 stars, and a study with seven or more stars was considered to be a high-quality study. All the above procedures were conducted by two independent reviewers, all disputes were resolved by discussion.

**Statistical analysis**

In this study, STATA software version 12.0 was used to analyze the data. The combined OR (95% CI) was used to calculate the association of male pattern baldness with prostate cancer risk. For the assessment of heterogeneity among the studies, Cochran Q and I² tests were used [21]. A fixed-effects model was used to combine the overall OR [22]. A sensitivity analysis was then conducted to assess the effect of a single study on the overall OR by the removal of one study at a time. A funnel plot and Bgger's tests were used to assess publication bias. Finally, stratified analyses were performed to assess the relationship between different patterns of baldness and prostate cancer risk. Differences with P-values less than 0.05 were considered statistically significant.

**Results**

**Literature selection process and study characteristics**

**Figure 1** illustrates the literature selection process. Originally, 697 studies were found. After
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Table 1. The main characteristics of the included studies

<table>
<thead>
<tr>
<th>Study (Year)</th>
<th>Population</th>
<th>Sample Size (n)</th>
<th>Age</th>
<th>RR (95% CI)a</th>
<th>RR (95% CI)b</th>
<th>RR (95% CI)c</th>
<th>RR (95% CI)d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demark et al. (1997)</td>
<td>American</td>
<td>140/146</td>
<td>50-70</td>
<td>0.88 (0.54, 1.43)</td>
<td>0.63 (0.26, 1.49)</td>
<td>0.94 (0.57, 1.56)</td>
<td>NA</td>
</tr>
<tr>
<td>Hsieh et al. (1999)</td>
<td>Greek</td>
<td>320/246</td>
<td>&lt; 60, 61-79, &gt; 80</td>
<td>0.91 (0.58, 1.44)</td>
<td>0.94 (0.58, 1.51)</td>
<td>0.88 (0.53, 1.46)</td>
<td>NA</td>
</tr>
<tr>
<td>Demark et al. (2000)</td>
<td>American</td>
<td>134/145</td>
<td>45-70</td>
<td>1.17 (0.72, 1.90)</td>
<td>0.82 (0.41, 1.63)</td>
<td>1.90 (1.01, 3.58)</td>
<td>0.58 (0.19, 1.76)</td>
</tr>
<tr>
<td>Giles et al. (2002)</td>
<td>Australian</td>
<td>1446/1390</td>
<td>&lt; 55, 55-69</td>
<td>1.11 (0.93, 1.32)</td>
<td>0.98 (0.79, 1.23)</td>
<td>1.54 (1.19, 2.00)</td>
<td>1.14 (0.90, 1.45)</td>
</tr>
<tr>
<td>Faydac et al. (2008)</td>
<td>Turk</td>
<td>44/108</td>
<td>50-75</td>
<td>0.94 (0.34, 2.64)</td>
<td>0.78 (0.22, 2.71)</td>
<td>1.00 (0.35, 2.85)</td>
<td>NA</td>
</tr>
<tr>
<td>Cremers et al. (2010)</td>
<td>Dutch</td>
<td>938/2160</td>
<td>&lt;55, 55-70, &gt;70</td>
<td>1.11 (0.90, 1.35)</td>
<td>1.08 (0.86, 1.37)</td>
<td>1.19 (0.94, 1.52)</td>
<td>1.05 (0.82, 1.34)</td>
</tr>
<tr>
<td>Wright et al. (2010)</td>
<td>American</td>
<td>999/942</td>
<td>40-74</td>
<td>0.87 (0.72, 1.04)</td>
<td>0.76 (0.61, 0.95)</td>
<td>NA</td>
<td>1.03 (0.82, 1.29)</td>
</tr>
<tr>
<td>Yassa et al. (2010)</td>
<td>French</td>
<td>388/281</td>
<td>NA</td>
<td>0.96 (0.70, 1.30)</td>
<td>1.01 (0.69, 1.48)</td>
<td>0.92 (0.60, 1.41)</td>
<td>0.90 (0.52, 1.57)</td>
</tr>
<tr>
<td>Thomas et al. (2013)</td>
<td>American</td>
<td>408/786</td>
<td>NA</td>
<td>1.78 (1.20, 2.66)</td>
<td>1.74 (1.19, 2.55)</td>
<td>1.65 (1.13, 2.41)</td>
<td>NA</td>
</tr>
<tr>
<td>Zeigler et al. (2013)</td>
<td>American</td>
<td>318/219</td>
<td>33-93</td>
<td>1.69 (1.05, 2.74)</td>
<td>1.86 (0.99, 3.51)</td>
<td>1.23 (0.88, 1.73)</td>
<td>NA</td>
</tr>
</tbody>
</table>

aRisk of prostate cancer for any type of pattern baldness; bRisk of prostate cancer in men with frontal pattern baldness; cRisk of prostate cancer in men with vertex pattern baldness; dRisk of prostate cancer in men with frontal + vertex pattern baldness.
the titles or abstract were scanned, as well as the full-text, most of the studies were excluded for various reasons. Finally, a total of 10 case-control studies that reported the relationship between male pattern baldness and prostate cancer risk were included [10-19].

Table 1 shows the main characteristics of the 10 included studies. In total, 5133 cases and 6423 controls were included. The publication years of the included studies ranged from 1997-2013. Five studies were conducted in American populations [10, 12, 16, 18, 19], while each of the remaining five studies was conducted in Greek [11], Australian [13], Turkish [14], Dutch [15] and French populations [17]. All of the studies reported the relationship between any type of baldness or frontal pattern baldness and prostate cancer risk, nine studies reported the association between vertex pattern baldness and prostate cancer risk [10-15, 17-19], and five reported the association of frontal + vertex pattern baldness with prostate cancer risk and or bladder cancer risk [12, 13, 15-17]. All of the included studies were determined to be high quality (NOS ≥ 7 stars).

Meta-analysis results

Among the included studies, eight showed no significant relationship between any type of pattern baldness and prostate cancer risk, and only two studies suggested that any type of pattern baldness was associated with the risk of prostate cancer compared with the patients without pattern baldness. The present study indicated that no significant relationship exists between any type of pattern baldness and prostate cancer risk, where the summary OR (95% CI) was 1.06 (0.97, 1.16); in addition, low evidence of significant heterogeneity was found ($I^2 = 45.9\%$, $P = 0.055$). These results are presented in Figure 2.

A sensitivity analysis was then conducted to evaluate the influence of each individual study on the pooled OR. The pooled ORs were similar to each other, and no one study significantly modified the combined OR (Figure 3). Moreover, a funnel plot was generated and Egger's tests were performed to show evidence of publication bias. The results demonstrated low evidence of publication bias ($P = 0.460$). The funnel plot of the studies is presented in Figure 4.
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When the studies were stratified based on baldness patterns, evidence of a significantly positive association of vertex pattern baldness and prostate cancer risk was found as the pooled OR (95% CI) was 1.26 (1.12, 1.43). However, frontal and frontal + vertex pattern baldness were not associated with an increased risk of prostate cancer, as the pooled OR (95% CI) was 1.03 (0.85, 1.24), 1.05 (0.92, 1.20), respectively. These results are presented in Figures 5-7.

Discussion

Ten studies that involved 5091 cases and 6423 controls were included in this study to assess the relationship between male pattern baldness and the risk of prostate cancer. A significant association of vertex pattern baldness was found with prostate cancer risk. However, any type of pattern baldness and frontal and frontal + vertex pattern baldness were not associated with an increased risk of prostate cancer.

Low evidence of heterogeneity was detected, and all of the included studies were performed in Western populations. Although they were based in different countries, the populations shared many characteristics in terms of prostate cancer incidence, lifestyle, and other factors. Furthermore, all of the included studies had a high quality assessment score and were all published in English. Finally, the risk estimates of each included study were adjusted for full potential confounders.

The relationship between male pattern baldness and the risk of prostate cancer has been reported by a large number of observational studies. In 1997, a case-control study conducted by Demark-Wahnefried et al., was to our knowledge, the first observational study to assess the association of male pattern baldness and the risk of prostate cancer [10]. Nevertheless, these investigators did not find a significantly positive relationship between these two conditions, but a higher level of free testosterone was detected in the men with vertex pattern baldness compared with the men with little or no baldness. This result suggested that the testosterone level was remarkably correlated with male pattern baldness. In 2000, another case-control study conducted by Demark-Wahnefried et al. also did not find a positive association of any type of pattern baldness and prostate cancer risk [12]. However, that study determined that vertex pat-
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Termin baldness was positively associated with an increased risk of prostate cancer (OR = 1.90, 95% CI = 1.01-3.58). Five subsequent case-control studies did not show a positive
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relationship between these two conditions [13-17]. However, one study that included 1446 cases and 1390 controls found that vertex pattern baldness was positively correlated with prostate cancer (OR of 1.54) [13]. In 2010, a study showed that any type of pattern baldness was significantly and inversely associated with prostate cancer risk by age 40, but no significant relationship was observed between any type of pattern baldness and prostate cancer risk at any age [15]. Another subsequent case-control study suggested that the risk of prostate cancer by age 20 was twice as high in men with any pattern baldness compared with men without baldness [17], but when baldness at any age was considered, no significant association was found. Recently, two case-control studies were performed [18, 19]. Both of them reported a positive association of any type of pattern baldness with the risk of prostate cancer, but only one showed that vertex and frontal + vertex pattern baldness were linked to an increased risk of prostate cancer [18]. Faced with many inconsistent results, this study aimed to use a new meta-analysis to clarify the relationship between prostate cancer risk and male pattern baldness, and found a positive association only between vertex pattern baldness and prostate cancer risk. According to the analysis, the risk of prostate cancer was increased by 26% in men with vertex pattern baldness compared with the controls, but no significantly positive association was found between prostate cancer risk and any type of pattern baldness, frontal pattern baldness, or frontal + vertex pattern baldness. Although the pathologic mechanisms behind these results were unclear, the changes in androgen and DHT levels might be a primary bridge between vertex pattern baldness and prostate cancer risk [23, 24]. Another potential mechanism was that high levels of insulin-like growth factor (IGF-1) have been linked to an increased prostate cancer risk [25]. Moreover, IGF-1 might play an important role in the hair patterning of men [26]. For each 59 ng/mL increase in IGF-1, the rates of vertex baldness doubled.

As more studies and evidences have accumulated, additional studies were included in the current study, and the findings of our study are coincident with those of the previous meta-analysis [27]. However, the results of our study further clarified the relationship between male pattern baldness and prostate cancer risk. Our study support the idea that vertex pattern baldness is positively associated with the risk of prostate cancer. This result is important in the context of prostate cancer screening and public health. Furthermore, the sample size of each
original study and those of the previous meta-analysis were small. More prostate cancer cases and controls were included in the present study, which greatly enhanced the statistical power and provided more reliable results.

The limitations of the present study should be taken into consideration. First, all of the included studies were case-control studies, and both recall and selection bias were difficult to avoid. Positive association of male pattern baldness with prostate cancer risk was given more attention by individuals with baldness, as they would be more likely to go to hospitals for prostate cancer screening than individuals without baldness. Second, although most of the included studies were adjusted for many confounders and there was low evidence of heterogeneity, some residual confounding factors may not have been controlled for in the original studies. Third, all of the included studies were conducted in populations of Western countries, and thus whether our findings will be supported by other populations is unclear. Fourth, both male pattern baldness and prostate cancer are age-related disorders, but few studies within our analysis showed a relationship between these two conditions among men of different ages. Male pattern baldness and prostate cancer always appear in men of older age and that these people also have a higher risk of cardiovascular diseases, where regular aspirin use could decrease the risk of prostate cancer [28], which may have influenced our results.

Conclusions

The present meta-analysis suggests a significant and positive association of vertex pattern baldness with prostate cancer risk, however, no significantly positive association was found between other types of male pattern baldness and prostate cancer risk. More studies based on other populations as well as mechanistic studies are warranted.

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Disclosure of conflict of interest

None.

Address correspondence to: Xiao Zhong and Longkun Li, Department of Urology, Second Affiliated Hospital, The Army Military Medical University, Chongqing 400037, China. Tel: +86-23-68755623; Fax: +86-23-68755623; E-mail: 491291077@qq.com (XZ); Tel: +86-13983615565; Fax: +86-23-68755623; E-mail: lilongk@hotmail.com (LKL)

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