# Male circumcision and prostate cancer: A geographical analysis, meta-analysis, and cost analysis (Revised) 

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#### Abstract

Introduction: Attempts to find an association between male circumcision and prostate cancer risk have produced inconsistent results. Methods: Age-standardized prostate cancer incidence, life-expectancy, geographical region, and circumcision prevalence from 188 countries were compared using linear regression analysis. Following a systematic literature review, a meta-analysis was performed on studies meeting inclusion criteria with evaluations of between-study heterogeneity and publication bias. A cost analysis (discounted at $3 \%$ and $5 \%$ per annum) was performed using the meta-analysis's summary effect and upper confidence interval. Results: Univariate analysis revealed a trend for a positive association between country-level age-standardized prostate cancer incidence (per 100000 person-years) and circumcision prevalence ( $\beta=0.0887$; 95\% confidence interval $[\mathrm{CI})]-0.0560,+0.233$ ), while multivariate analysis found a significant positive association ( $\beta=0.215 ; 95 \% \mathrm{Cl} 0.114,0.316$ ). Twelve studies were included in meta-analysis. The random-effects summary odds ratio of the risk of being genitally intact was 1.10 ( $95 \% \mathrm{Cl} 0.96,1.26$, between-study heterogeneity $\chi^{2}{ }_{15}=27.43 ; \mathrm{p}=0.03 ; \mathrm{I}^{2}=82.8 \%$ ). There was no evidence of publication bias. Cost analysis found infant circumcision was prohibitively costly, returning only between $1.6 \$$ and $13.8 \$$ for each dollar expended. Conclusions: Circumcision may be a positive risk factor on geographical analysis, but not in case-case-controlled studies. Circumcision is not economically feasible for preventing prostate cancer.


## Introduction

Prostate cancer is a common malignancy in elderly men, the primary cause of which is not clearly known. Dietary habits, behavioral factors, and race have been identified as potential risk factors. ${ }^{1}$ The notion that circumcision may reduce the risk of prostate cancer originated in 1942 with Abraham Ravich, who repeated these same "finding" over the next 25 years. ${ }^{2-4}$ Since then a handful of studies have evaluated the contribution of circumcision status to the risk
of prostate cancer with mixed results. In their 1989, 1999, and 2012 policy statements on neonatal circumcision, the various circumcision Task Forces of the American Academy of Pediatrics (AAP) fail to mention prostate cancer. ${ }^{5-7}$ In its 2018 guidelines on neonatal circumcision, the Canadian Urological Association noted, "a borderline association on univariate analysis between circumcision and prostate cancer risk. ${ }^{\prime \prime \prime}$ Attention to this issue has generated an informal geographic analyses of the incidence of prostate cancer, ${ }^{9,10}$ a formal geographical analysis of prostate cancer mortality, ${ }^{11}$ two concurrent meta-analyses, ${ }^{12,13}$ and an informal cost analyses. ${ }^{14}$ Subsequently, more epidemiological data have become available. This report will update and more thoroughly analyze any association between male circumcision and prostate cancer.

## Methods

## Geographic analysis

Country-level epidemiological data of the age-standardized incidence of prostate cancer was obtained from the International Agency for Research on Cancer (IARC) 2012 GLOBOCAN report. ${ }^{15}$ Circumcision prevalence by country was procured from previously published estimates. ${ }^{16}$ World Health Organization 2016 estimates of life-expectancy by country were used. ${ }^{17}$ The weight assigned for population for each country was calculated by taking the number of cases reported in the IARC report for that country and dividing it by the age-standardized incidence (per 100000 person-years). Univariate and multivariate linear regression models were developed using age-standardized incidence (per 100000 person-years) as the dependent variable and circumcision prevalence, male life expectancy, and the region (Middle East, sub-Saharan Africa, Europe, Asia, North America, South America, Australia/New Zealand, Central America/ Caribbean, and Pacific Islands) as independent variables. Analysis of residuals was performed.

## Meta-analysis

Following the recommendations of Stroup et al for the metaanalysis of observational studies, ${ }^{18}$ studies were identified in a MEDLINE search using the search terms "circumcision" and "prostate cancer" on December 16, 2018. Additional studies were identified using the bibliographies of studies identified in the search and by surveying researchers in the field. Inclusion criteria included randomized clinical trials, cohort studies, cross-sectional studies, and case-controlled studies. Jewish men have a significantly lower prevalence of prostate cancer than circumcised Gentiles (odds ratio [OR] 3.23; 95\% confidence interval [CI] 1.56, 6.69), ${ }^{19}$ indicating the potential for confounding. Consequently, comparisons between Jewish men and other populations were excluded.

When available, the primary analysis was performed using raw data. In one case, the raw data were obtained by contacting the study's lead author. ${ }^{20}$ If within a study a clear distinction was evident between strata, each stratum was included separately.

DerSimonian and Laird random-effects summary results and between-study heterogeneity were calculated using the Mantel-Haenszel method. ${ }^{21}$ To test for potential outliers, the dataset from each publication was individually excluded from the analysis to measure the impact measures of between-study heterogeneity. The exclusion of a study would be justified by a statistically significant reduction of the between-study heterogeneity $\chi^{2}$. Sensitivity analysis was performed with each of these studies excluded. The number of studies and the percentage of participants excluded to reach $I^{2}$ thresholds of $50 \%$ and $25 \%$ were estimated. ${ }^{22}$ Metaregression of study characteristics was performed. ${ }^{23}$ Summary odds ratios report the risk prostate cancer associated with being genitally intact.

Publication bias was assessed using funnel graphs and linear regression analysis, ${ }^{24}$ funnel plot regression, ${ }^{25}$ and an adjusted rank correlation test. ${ }^{26}$ Any adjustments for publication bias were performed using the "trim and fill" method. ${ }^{27}$ Linear regression analyses and assessment of publication bias and meta-regression analyses were performed using SAS version 8.02 (SAS Institute, Cary, NC, U.S.). All reported p -values are two-sided.

## Cost analysis

A hypothetical model of one million men was constructed using the age-standardize incidence of prostate cancer (96.6 per 100000 person-years $)^{15}$ and the life expectancy $(78.3)^{17}$ in Finland going from a circumcision rate of zero to $100 \%$. The cost of an infant circumcision has been estimated to be $\$ 285 .{ }^{28}$ The average cost of treating prostate cancer was assumed to be approximately $\$ 20000 .{ }^{14}$ The average age of detection of prostate cancer and initiation of treatment is 70
years. The attributable proportion was calculated ([summary OR - 1]/summary OR) to determine the number of cases of prostate cancer averted through circumcision. The summary random-effects OR and upper $95 \% \mathrm{Cl}$ from the meta-analysis were both put into models that employed $3 \%$ and $5 \%$ per annum discount rates.

## Results

## Geographical analysis

The results of the univariate and multivariate linear regression are seen in Table 1. These results indicate that circumcision prevalence is positively associated with the incidence of prostate cancer. A significant positive correlation was found between life expectancy and prostate cancer incidence ( $\beta=$ 2.46; 95\% CI 1.71, 3.21; $\mathrm{t}=6.44 ; \mathrm{p}<0.0001$ ), as well as a negative correlation between life expectancy and circumcision prevalence ( $\beta=-0.0512$; 95\% CI -0.0766, -0.0258; $t=-3.98 ; p=0.0001$ ). This indicates that men in countries with a higher circumcision prevalence did not live as long. This association did not persist when adjusted for the various regions of the world ( $\beta=-0.0249 ; 95 \% \mathrm{Cl}-0.0594,+0.00441$; $t=-1.70 ; p=0.09$ ). There was no significant interaction (effect modification) between circumcision prevalence and life expectancy ( $\mathrm{p}=0.84$ ). Region of the world was significantly associated with life expectancy, circumcision prevalence, and the incidence of prostate cancer (data not shown). An examination of the residuals found they were normally distributed, with Mexico, the U.S., China, and India as significant outliers $\left(r_{\text {student }}>4\right)$.

Table 1. Geographical analysis of 188 countries of the country-level, age-standardized incidence (per 100000 person-years) of prostate cancer as a function of countrylevel male circumcision prevalence using linear regression analysis

Factor $\quad$ Beta $(\beta)$| $95 \%$ |
| :---: |
| confidence |
| interval |$\quad$ t $\quad$ p

| Univariate analysis |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: |
| Circumcision prevalence | 0.0887 | $-0.0560-+0.233$ | 1.21 | 0.23 |
| Bivariate analyses |  |  |  |  |
| $\quad$ Circumcision prevalence | 0.236 | $0.101-0.370$ | 3.47 | 0.0007 |
| Life expectancy | 2.85 | $2.09-3.61$ | 7.37 | $<0.0001$ |
| Circumcision prevalence | 0.153 | $0.0350-0.272$ | 2.56 | 0.0114 |
| Region | $\mathrm{F}=55.07$ |  |  | $<0.0001$ |
| Multivariate analysis |  |  |  |  |
| $\quad$ Circumcision prevalence | 0.215 | $0.114-0.316$ | 4.20 | $<0.0001$ |
| Life expectancy | 2.13 | $1.65-2.62$ | 8.65 | $<0.0001$ |
| Region | $\mathrm{F}=60.78$ |  |  | $<0.0001$ |

## Meta-analysis

Fifty-one publications were identified using the MEDLINE search. Of these, only seven met the inclusion criteria. ${ }^{20,29 \cdot 34}$ An additional three studies were identified using bibliographies. ${ }^{35-37}$ A further two studies were identified through contacting researchers in the field. ${ }^{19,38}$ All studies identified were case-controlled studies whose characteristics are listed in Table 2. Two studies reported clear racial distinctions, ${ }^{30,34}$ so each stratum was considered separately. One study ${ }^{37}$ reported on data collected in Washington state from January 1, 1993 through December 31, 1996, while a later study ${ }^{33}$ added data collected from January 1, 2002 through December 31, 2005. The data collected in the two times frames are considered separately.

The results of the meta-analysis are shown in Table 3. The random effects summary effect OR was 1.10 ( $95 \% \mathrm{Cl} 0.96$, 1.26). There was significant between-study heterogeneity ( $\chi^{2}{ }_{12}=27.43 ; \mathrm{p}=0.03 ; \mathrm{I}^{2}=82.8 \%$ ).

Two studies were identified as potential outliers. ${ }^{30,36}$ When either of these studies was removed, the $I^{2}$ dropped below $25 \%$. When both these studies were removed from the metaanalysis, the $I^{2}$ was zero and the summary effect OR was 1.07 ( $95 \% \mathrm{Cl} 0.99,1.15$ ). The results reported among black men in Montreal ${ }^{14}$ was also a potential outlier ( $\chi^{2}{ }_{1}=4.42$; $\mathrm{p}=.036$ ), but the study as a whole was not an outlier.

For each study, the natural logarithm of the OR was plotted in the $x$-axis against the inverse of variance in the $y$-axis (Fig. 1). This funnel plot appears symmetrical. There is no evidence of publication bias in Begg and Mazudar's adjusted rand correlation test (original $\mathrm{p}=0.21$; alternate $\mathrm{p}=0.19$ ), or the linear aggression regression analysis of Egger and associates (unweighted $\mathrm{p}=0.23$; weighted $\mathrm{p}=0.17$ ) or Macaskill,

Walter, and Irving (unweighted $\mathrm{p}=0.27$; weighted $\mathrm{p}=0.25$ ). A "trim and fill" evaluation found no evidence of a missing study.

Meta-regression evaluated the impact of publication after the introduction of screening with prostate-specific antigen (PSA) test and found no statistically significant difference ( $\mathrm{t}=0.72$; $\mathrm{p}=0.48$ ). There was no statistically significant difference between studies that were population-based as opposed to institution-based ( $\mathrm{t}=1.17$; $\mathrm{p}=0.26$ ).

## Cost analysis

Based on the meta-analysis, with the summary randomeffects OR estimated at 1.10 and the upper $95 \%$ confidence limit at 1.26, the attributable proportion would range from $9.09-20.63 \%$. In the population of one million over 78.3 years, we would expect 75638 men to develop prostate cancer. Going from a circumcision rate of zero to $100 \%$ would theoretically prevent 6876-15 608 cases of prostate cancer, with a savings of $\$ 137-312$ million in treatment costs. The cost of circumcising a million boys would be $\$ 285$ million. The opportunity costs of expending $\$ 285$ million on a neonate would be $\$ 2.26$ billion ( $3 \%$ discount) to $\$ 8.67$ billon ( $5 \%$ discount) at 70 years of age. For every dollar spent on circumcision, one would expect to save 6.1-13.84 ( $3 \%$ discount) or 1.6-3.6థ ( $5 \%$ discount). To be less costly, either a circumcision needs to cost less than \$15.78-35.72 (3\% discount) or \$4.11-9.30 ( $5 \%$ discount), or the average cost of treating a case of prostate cancer would need to exceed \$144 800-328 680 (3\% discount) or \$555 484-1 260910 (5\% discount).

| First author | Location | Patient source* | Controls | Data collection method |
| :---: | :---: | :---: | :---: | :---: |
| Kaplan 1966 | Chicago | Hospital | BPH | Chart review |
| Wynder 1971 | New York | Hospital | No prostatic disease | Person-to-person interview |
| Rotkin 1977 | California, Chicago | Hospital | Matched pairs | Physical examination |
| Ross 1987 | California, Chicago | Population | Neighborhood | Person-to-person interview |
| Mandel 1987 | Minneapolis/ Saint Paul | Hospital/ population | Matched for age, sex, and race | Person-to-person interview |
| Newell 1989 | Texas | Hospital | Treatment center and time, 2 controls per case | Questionnaire |
| Ewings 1996 | Somerset and East Devon | Hospital | One control with BPH, one control with nonurological condition | Person-to-person interview |
| Rosenblatt 2001 | Kings County Washington | Population | Random-digit dialing, age-matched | Person-to-person interview |
| Madsen 2008 | Denmark | Population | Prostate cancer and population controls | Telephone interview |
| Wright 2012 | Washington State | Population | Random-digit dialing, matched by 5-year age groups | Person-to-person interview |
| Spence 2014 | Montreal | Population | Electoral list, matched by age | Person-to-person interview |
| Nair-Shalliker 2017 | New South Wales | Population | Cancer-free | Questionnaire |

[^0]Table 3. Meta-analysis of studies assessing the association between male circumcision and prostate cancer considering intact genitalia as a risk factor

| Study | Intact case | Circumcised <br> case | Intact control | Circumcised <br> control | Odds <br> ratio | 95\% confidence <br> interval |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: |
| Kaplan | 34 | 19 | 90 | 61 | 1.21 | $0.63,2.32$ |
| Wynder | 143 | 29 | 121 | 21 | 0.86 | $0.46,1.58$ |
| Rotkin | 52 | 59 | 54 | 57 | 0.93 | $0.55,1.58$ |
| Ross - White | 81 | 61 | 57 | 85 | 1.98 | $1.23,3.18$ |
| Ross - Black | 99 | 43 | 84 | 58 | 1.59 | $0.97,2.59$ |
| Mandel | 124 | 102 | 137 | 103 | 0.91 | $0.63,1.32$ |
| Newell | 50 | 44 | 114 | 53 | 0.53 | $0.31,0.89$ |
| Ewings | 123 | 36 | 221 | 104 | 1.61 | $1.04,2.49$ |
| Rosenblatt | 253 | 500 | 215 | 488 | 1.15 | $0.92,1.43$ |
| Madsen | 85 | 1 | 99 | 4 | 3.43 | $0.38,31.32$ |
| Wright | 294 | 707 | 254 | 688 | 1.03 | $0.92,1.37$ |
| Spence - White | 814 | 526 | 790 | 525 | 1.03 | $0.88,1.20$ |
| Spence - Black | 81 | 22 | 44 | 31 | 2.59 | $1.34,3.63$ |
| Spence - Asian | 19 | 6 | 50 | 20 | 1.05 | $0.44,5.01$ |
| Spence - other | 42 | 33 | 59 | 53 | 1.14 | $0.64,2.06$ |
| Nair-Shalliker | 389 | 931 | 296 | 712 | 1.01 | $0.84,1.20$ |
| Random-effects summary effects OR |  |  |  |  | 1.10 | $0.96,1.26$ |

Between-study heterogeneity $\chi^{2}{ }_{15}=27.43 ; p=0.03 ; 1^{2}=82.8 \%$.

## Discussion

The geographical analysis discovered a positive association between circumcision prevalence and the incidence of prostate cancer. The meta-analysis of 12 studies failed to document a significant association between male circumcision and prostate cancer incidence. The cost-analysis found infant circumcision to be a prohibitively costly option to avert prostate cancer.

This is the fourth published geographical analyses of county-level data of prostate incidence and circumcision prevalence. Morris and colleagues reported an analysis attributed to Waskett of 51 countries that documented a significant negative association between circumcision prevalence and prostate cancer incidence ( $\mathrm{p}=0.02$ ). ${ }^{9}$ This analysis was subsequently expanded to 181 countries with similar results ( $\mathrm{p}<0.0001$ ). ${ }^{10}$ The source of the circumcision prevalence data and the methods of calculation were not provided in either of these reports. An analysis of the current dataset that does not weigh each country's datapoint for population size was able to replicate their results ( $\beta=-0.311 ; 95 \% \mathrm{Cl}$ $-0.205,-0.418 ; \mathrm{t}=-5.75 ; \mathrm{p}<0.0001$ ), but such an unweighted model is not informative, as such an analysis attributes Comoros as much influence on the final estimate as China.

Wachtel et al published a geographical analysis looking at the prevalence of male circumcision (stratified into rates less than $20 \%, 21-80 \%$, and more than $80 \%$ ) on prostate cancer mortality. ${ }^{11}$ Although their specific methodology is not stated, it appears they used a Poisson regression model, adjusting for gross per-capita national income, religion, and

WHO region. It is unclear from their report how the calculations were made or what the results mean. No account is given for life expectancy. More importantly, the results of the analysis do not support the conclusions reached by the authors. ${ }^{39}$ The report focused only on mortality, which may be impacted by several factors, including life expectancy.

Two previous meta-analyses have been published. A 2015 meta-analysis of seven studies found a non-significant increase of prostate cancer risk in intact men (OR 1.14; $\mathrm{p}=0.19$; $\left.\mathrm{I}^{2}=65 \%\right) .{ }^{12}$ A 2016 meta-analysis of six case-control studies found a significantly greater prevalence of intact genitalia in prostate cancer patients compared with controls (OR 1.11; 95\% CI 1.02, 1.22). ${ }^{13}$

While one of these analyses suggested difference before and after the introduction of PSA testing, the meta-regression analysis in the current study failed to find a difference. The 2015 meta-analysis failed to include one study, ${ }^{32}$ and the 2016 failed to include three studies ${ }^{29,30,32}$ that should have been identified in a cursory PubMed search. Because prostate cancer has been associated with sexually transmitted infections (with the speculation that these infections ascend to the prostate, resulting in local irritation and malignancy), and because sexually transmitted infections have been purported to be more common in intact men, circumcision advocates have speculated that circumcision reduces the risk of prostate cancer. ${ }^{9,11,14}$

This theory, which follows in the footsteps of the theory that smegma causes prostate cancer, ${ }^{4,40}$ has several deficiencies. First, prostate cancer usually arises in the posterior lobe, which is the furthest away from the urethra. ${ }^{19}$ If the ascending infection theory were true, one would expect the


Fig. 1. Funnel plot of studies assessing the association between male circumcision and prostate cancer with the natural logarithm of the odds ratio on the $x$-axis and the inverse of variance on the $y$-axis. OR: odds ratio.
portion of the prostate cancer closest to the urethra to host more carcinomas.

Second, the irritation theory is not well-supported by the inconsistent empirical evidence. ${ }^{41-45}$ A 2014 meta-analysis found men with a history of any sexually transmitted infection at a significantly greater risk for prostate cancer. When broken down into specific infections, a history of gonorrhea was associated with a significant increased risk of prostate cancer, but no significant differences were seen for Treponema pallidum, Chlamydia trachomatis, Trichomonas vaginalis, Ureaplasma urealyticum, Mycoplasma hominis, herpes simplex virus type 1 or type 2 , human herpes virus 8, or cytomegalovirus. ${ }^{46}$ Circumcision has no association with a history of gonorrhea. ${ }^{47}$ While one study reported an association between prostate cancer and a positive serology for HPV16 and HPV18 but no other strains of HPV, ${ }^{45}$ the same group of researchers subsequently failed to confirm any association. ${ }^{48}$ Other studies have been unable to detect HPV DNA in human prostatic malignancies. ${ }^{49,50}$

Morris and colleagues ${ }^{9}$ emphasized the role of Moloney murine leukemia virus in prostatic cancer in patients with a genetic variant of HPC1 that encodes RNaseL. ${ }^{51,52}$ Hohn and colleagues were unable to replicate this findings. ${ }^{53}$ Lee and colleagues subsequently found that the virus, which is not a naturally acquired human infection, was a contaminant. ${ }^{54}$ The publications purporting this theory ${ }^{51,52}$ were, in turn, retracted. ${ }^{55,56}$

It is noteworthy that Wright et al "believe there is strong biological plausibility for a relation between circumcision and the risk of [prostate cancer]," yet their own study failed to confirm this (OR $1.05 ; 95 \% \mathrm{Cl} 0.87,1.27$ ). ${ }^{33}$

Third, the speculative infection theory does not explain the increased prostate cancer mortality among Roman Catholic priests. ${ }^{41}$

Fourth, men infected with HIV are at greater risk for other sexually transmitted infections and at greater risk for infec-
tion-related cancers, yet large-scale prospective studies of the risk of prostate cancer in HIV-infected men have found that these men have significantly lower incidence of prostate cancer than the general population. ${ }^{57}$ If prostate cancer risk was related to infection, we would expect the incidence to be greater in HIV-infected men. ${ }^{58}$

Finally, the assertion that intact men are at greater risk of sexually transmitted infections is debatable. Urethritis is more common in circumcised men, HPV infects intact and circumcised men equally, and the studies on Trichamonas vaginalis are inconsistent. ${ }^{46}$ Furthermore, if circumcision was effective in lowering prostate cancer, one would have expected a drop in the incidence of prostate cancer as the circumcision rate of men entering their seventh and eight decade of life increased in the U.S. Instead between 1987 and 1992, the age-standardized incidence rate of prostate cancer increased from 102.9 per 100000 person-years to 189.4 per 100000 person-years. ${ }^{59}$

Weaknesses in these analyses include reliance on estimates rather than actual data collection to determine circumcision prevalence in each country. These estimates were determined by individuals with a strong history of circumcision advocacy. One estimate stands out: the $14 \%$ circumcision prevalence in China. Because of China's large population, the linear regression was recalculated using a circumcision prevalence of $2.7 \%$. This change slightly altered the overall finding of the geographical analyses (univariate: $\beta=0.136 ; 95 \% \mathrm{Cl} 0.000754,0.274 ; \mathrm{t}=1.96$; $\mathrm{p}=0.0513$; multivariate: $\beta=0.236 ; 95 \% \mathrm{Cl} 0.142,0.330 ; \mathrm{t}=4.96 ; \mathrm{p}<0.0001$ ).

Population-sized, weighted, country-specific datapoints avoids allowing small countries having the same influence on the estimate as larger countries. The caveat with weighting each datapoint is that the quality of the data collected in each country may vary. If poor-quality data is collected in a populous country, this weakness may be amplified because of the country's size. Similarly, well-collected data from a smaller country would not receive the weight it may deserve. This concern also applies to studies included in a metaanalysis: the weight given to a study in a meta-analysis is based on variance, which is based on the number of participants in a study, not on the quality of the data collection. Male circumcision is a highly contentious issue, so applying quality criteria to studies included in a review article has the potential to be clouded by subjective factors, including which criterion to apply. For example, an author of a review article ${ }^{60}$ assessing the health impact of the procedure personally assigned a high-quality rating to a study in which he was the lead author. ${ }^{61}$ To avoid any conflict of interest and any charges of subjective bias, it was elected to forgo making quality assessments of the studies included in the meta-analysis.

Average life expectancy was included in the regression model because prostate cancer incidence had a significant
positive association and circumcision prevalence had a significant negative association with life expectancy. If a country has a low life expectancy, fewer men will reach an age at which prostate cancer presents itself. This phenomenon should be captured by using calculated, age-standardized rates. The positive association between age-standardized rates and life expectancy indicates that age may have either a multiplier effect on prostate cancer incidence or it may be a marker for favorable socio-economic conditions. Life expectancy remained a significant factor on both bivariate and multivariate analyses.

The studies included in the meta-analysis had several methodological weaknesses. Nearly all relied on patient reports to determine circumcision status. Some studies used patients with other types of medical conditions as the control group, ${ }^{19,31}$ introducing the potential for selection bias. ${ }^{58}$

For the future, studies that determine circumcision status based on physical examination are needed. We also need national estimates of circumcision prevalence that are not based merely on speculation.

The prostate cancer incidence and life expectancy of Finland was used for the baseline cost-analysis calculations because of its historically low prevalence of male circumcision and disease incidence on par with other developed countries. In other countries, such as the U.S., the circumcision prevalence varies by region, race, and year of birth, which would make meaningful calculations more difficult. While the costs of performing a circumcision and treating prostate cancer also vary by region and country, any differences would be extremely unlikely to alter the conclusion that circumcision is an exorbitantly expensive approach for preventing prostate cancer.

## Conclusions

The link between circumcision status and the risk of prostate cancer is tenuous at best. A 2016 review of prostate cancer in The Lancet fails to mention circumcision. ${ }^{62}$ It was ignored by the American Academy of Pediatrics in 1989, 1999, and 2012, ${ }^{5-7}$ but was resurrected by the Centers for Disease Control and Prevention in 2014. ${ }^{63}$ Raising the possibility that circumcision may reduce the risk of prostate cancer is attractive to circumcision advocates because prostate cancer is a relatively common cancer in men. Demonstrating even a limited association between circumcision and prostate cancer risk can result in substantial numbers across a population. When asked why he robbed banks, Willie Sutton quipped, "Because that's where the money is." Given the vested interests and the potential financial payout, circumcision proponents are unlikely to back away from using prostate cancer as an excuse to perpetuate the practice.

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[^0]:    *Distinction between subjects drawn from a hospital-based setting and those drawn from the general population. BPH: benign prostatic hyperplasia.

