World J Urol
DOI 10.1007/s00345-012-0937-7

ORIGINAL ARTICLE

Lower urinary tract symptoms in relation to region of birth in 95,393 men living in Australia: the 45 and Up Study

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Received: 24 May 2012 / Accepted: 20 August 2012

Abstract
Purpose Lower urinary tract symptoms (LUTS) are very common among older men globally, but evidence regarding the relationship between LUTS and country of origin is limited. This study aimed to investigate the relationship between the prevalence of LUTS and region of birth in a large, ethnically diverse population of older men resident in New South Wales, Australia.
Methods Data on LUTS, demographic and behavioural factors were collected by postal questionnaire from 2006 to 2009 and analysed for 95,393 men aged 45 and over from the 45 and Up Study, who had not had previous prostate surgery. Logistic regression was used to investigate the association between region of birth and moderate/severe LUTS, ascertained using a modified International Prostate Symptom Score, adjusting for age, income, education, alcohol consumption and smoking.
Results Overall, 18,530 (19.4 %) men had moderate or severe LUTS. Compared to Australian-born men, prevalence of moderate/severe LUTS was significantly higher in men born in the Middle East & North Africa, Southeast Asia and North America regions (adjusted odds ratios (OR) = 1.43; 95 % CI = 1.23–1.66, OR = 1.25; 1.10–1.42, OR = 1.26; 1.05–1.52, respectively), whereas men from the UK & Ireland had significantly lower prevalence (OR = 0.85; 0.80–0.90). Patterns of association were generally similar for storage- and voiding-related types of LUTS. However, participants born in Sub-Saharan Africa showed a significantly elevated prevalence of moderate/severe voiding symptoms (1.22; 1.03–1.45) but not storage symptoms, compared to Australian-born respondents.
Conclusion The prevalence of LUTS and of specific subtypes of LUTS varies according to region of birth.

Keywords Lower urinary tract symptoms · Ethnicity · Country of birth · Benign prostatic · Hyperplasia

Electronic supplementary material The online version of this article (doi:10.1007/s00345-012-0937-7) contains supplementary material, which is available to authorized users.

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Introduction

Lower urinary tract symptoms (LUTS) are common among men worldwide, and prevalence increases substantially with age. International studies indicate the prevalence of moderate-to-severe LUTS is 20–40 % for men aged 60 and over [1, 2]. In addition to the morbidity and diminished

Published online: 02 September 2012

quality of life among men suffering from LUTS [3], the condition often requires surgical treatment and is of considerable economic cost to the community [4].

While LUTS is comparatively under-researched, evidence is accumulating on the role of a range of risk factors beyond age, including tobacco smoking [1, 2, 5, 6], alcohol consumption [1, 5], obesity [1, 7], physical activity [2, 8, 9], diet [10–12], metabolic [13] and hormonal factors [1, 14, 15]. Differences in the prevalence and severity of LUTS in men of differing ethnic backgrounds and places of birth could provide additional important clues regarding aetiology and risk factors, as well as disease burden in the community. However, current evidence is patchy and findings are mixed; interpretation is also constrained by the limited number of ethnic groups examined and the relatively small numbers of study participants [1, 5, 16–22]. For example, several studies have reported that African–American men have a higher risk of LUTS compared to white Americans [5, 18], while others observe no significant differences between these groups [21, 23, 24]. Similarly, one study has reported a significantly lower prevalence of straining in men from an Asian background compared to predominantly Caucasian men [19], but others reveal no significant differences between these populations [5, 21].

The aim of the present study is to investigate the association between LUTS and region of birth in a large cohort study from an ethnically diverse male population in New South Wales, Australia. We examine overall LUTS, as well as storage- and voiding-related symptoms separately, since these symptoms have pathophysiological differences [4, 25].

Methods

Study population

The present study uses cross-sectional baseline data from the 45 and Up Study, a large-scale Australian cohort study involving 266,848 men and women aged 45 and over from New South Wales, Australia. The study is described in detail elsewhere [26]. Recruitment started in February 2006 and was completed in 2009. Briefly, individuals aged 45 and older were sampled from the Medicare Australia database, which provides virtually complete coverage of the general Australian population, and joined the study by completing a written self-administered questionnaire on health-related characteristics and demographics which was mailed to them, in addition providing consent for long-term follow-up. The 45 and Up Study questionnaire can be viewed at: http://www.45andup.org.au/downloads/smp/45Up%20Study%20Male%20v3b_f764.pdf. The 45 and Up Study is a study of healthy ageing and over-sampled participants aged 80 and above as well as people resident in rural areas, in order to provide sufficient numbers of participants in these key groups of interest.

Participants

The study population consisted of 123,779 males taking part in the 45 and Up Study. Men who had been diagnosed with prostate cancer in the past ($n = 7{,}836$) and participants who had their whole prostate ($n = 1{,}347$) or part of their prostate removed ($n = 5{,}366$) were excluded from these analyses, as these conditions and operations are known to influence the risk of LUTS, and it was unclear what level of symptoms should be attributed to these men. Men with missing observations for the modified International Prostate Symptom Score ($n = 13{,}825$) and with missing data on age ($n = 12$) were also excluded. A total of 95,393 men (77 %) remained in the sample for the analysis.

Assessment of LUTS

The self-administered 45 and Up questionnaire uses a modified version of the International Prostate Symptom Score (IPSS). The IPSS is a 7-item screening tool used to assess symptoms and symptom severity of the urinary tract, by enquiring about bladder function and related complaints over the past month. It is described in detail elsewhere [27]. The modified IPSS (m-IPSS) uses the same questions regarding symptoms as the original IPSS, but has a 4-point response scale (not at all, sometimes, often, almost always, coded as 0–3 respectively) as opposed to a 6-point response scale used on the original IPSS. The only exception is for the item about nocturia, where respondents are asked 'Over the past month, how many times did you usually get up from bed to urinate during the night?' (with the response options 'never', 'some nights') and to indicate "number of times per night ___" with the scores for this question being: 0 for "never"; 1 for "one or less than one time per night"; 2 for "two times per night"; and 3 for "three or more times per night". The scores were then summed across the different symptom types to give a total up to a maximum of 21.

In order to allow comparability between the m-IPSS and the IPSS and to ascertain scores for mild, moderate, and severe symptom levels corresponding to those from the original IPSS, we calibrated the m-IPSS against the original IPSS using data from the MATeS study, a representative study of Australian men with a broadly comparable age distribution [20]. A more detailed description of this calibration process is included as an appendix to this paper (see Online Resource 1). As a result, the cut-off values for clinical ranges of the m-IPSS were determined as follows:

0–5 (mild/no symptoms), 6–11 (moderate symptoms) and 12–21 (severe symptoms), with 80.6, 15.4 and 4.1 % falling into each of these categories, respectively.

We also calculated symptom scores separately for 'storage' and 'voiding' symptoms (also known as 'irritative' and 'obstructive' symptoms, respectively) as previous studies have indicated there are clinically meaningful differences between these clusters of symptoms [16, 17]. Storage symptoms are related to filling of the bladder and include the following: difficulty postponing urination ('urgency'), having to urinate less than 2 h after finishing previous urination ('frequency') and having to get up frequently during the night to urinate ('nocturia'). Voiding symptoms are those that are related to the process of emptying the bladder and include having to push or strain to start urination ('straining'), a weak urinary stream ('weak stream'), stopping and starting again several times during urination ('intermittency') and the feeling of incomplete emptying of the bladder after urination ('incomplete emptying'). Total symptom scores ranged from 0 to 9 for storage symptoms and from 0 to 12 for voiding symptoms. As outcome measures for our logistic regression analysis, participants with a score of $\geq$4 on the storage symptom scale and scores of $\geq$3 on the voiding symptom scale were classified as 'moderately/severely symptomatic'. These cut-off values were chosen so the proportions of men categorised as moderately or severely symptomatic for these symptom subtypes were similar to the proportions categorised as moderately/severely symptomatic for LUTS overall.

Explanatory variables

Country of birth was determined with the question 'In which country were you born?' followed by a list of 14 countries, as well as the option to write in any country that was not listed. This variable was classified into regions of birth, with a separate category for 'Australian-born' based on a modified version of that used in the Global Burden of Disease Study (see Table 1) [28]. Other variables included age, categorised in 5-year age groups ($\geq$85 aggregated); education, measured as highest level of qualification completed ('no school certificate', 'intermediate school certificate', 'higher school certificate', 'trade/certificate/diploma', 'university degree'); household income defined as yearly household income before tax from all sources (categorised as <AUD \$20,000, \$20,000–\$39,999, \$40,000–\$69,999, $\geq$\$70,000); number of alcoholic drinks per week, ('none', '1–14' '$\geq$15'); smoking ('never', 'past', 'current)'; body mass index (BMI), based on self-reported weight in kilograms divided by the square of self-reported height in metres (kg/m^2) and categorised according to the WHO criteria of underweight (<18.5 kg/m^2), healthy weight (18.5–24.9 kg/m^2), overweight (25.0–29.9 kg/m^2) and obese ($\geq$30 kg/m^2) [29]; and physical activity based on amount and duration of continuous walking, vigorous- and moderate-physical activity, subsequently categorised into session times per week (<4, 4–9, 10–17, $\geq$18).

Statistical methods

We calculated mean [SD] overall LUTS score (m-IPSS) and proportions with moderate/severe LUTS (m-IPSS $\geq$6), storage symptoms (sum score $\geq$4) and voiding symptoms (sum score $\geq$3), according to region of birth. Logistic regression analysis was used to compare the odds of moderate/severe LUTS across regions of birth, with Australian-born men as the reference group, adjusting for age, education, income, alcohol consumption and smoking. These regression models were produced separately for each of the outcome variables: overall LUTS, each individual symptom, and sub-categories of storage symptoms and voiding symptoms. Sensitivity analyses were conducted examining the effect of additional adjustment for physical activity and BMI. Where necessary, variables in the regression models included separate categories for missing values to prevent a loss of observations.

All statistical analysis was done using Stata (Version 11.1; StataCorp LP College Station, TX, USA). Results were considered significant if $p < 0.05$.

Ethical approval for the study was provided by the University of New South Wales Human Research Ethics Committee.

Results

Socio-demographic characteristics of the 95,393 men included in the analysis, according to region of birth, are shown in Table 1. Only 0.9 % of respondents were missing data for place of birth—on average they were older, in lower income households and were less likely to consume 15 or more alcoholic drinks per week, compared to Australian men included in the analyses. Almost three-quarters (74 %) of the men were born in Australia, 10.5 % in the UK & Ireland, 4.6 % in West Europe and $\leq$2 % in each of the other regions. The mean age of the sample was 61.6 years, ranging from 58.6 years in Oceania to 65.9 years in East & Central Europe.

The proportion of men with low household income (<\$20,000 per year) was 15 % in Australian-born men and ranged from 7.9 % (Sub-Saharan Africa) to 30.1 % (Middle East & North Africa); 9.6 % of Australian-born men had no school certificate or other qualification, with proportions ranging from 1.3 % (Central & South Asia) to

Table 1 Demographic characteristics of the study sample by region of birth

Region of birth	Percentage of total (*n*)	Age, mean [SD]	Income <$20,000 % (*n*)	Less than secondary school graduation % (*n*)	Current smoker % (*n*)	≥15 alcoholic drinks/week % (*n*)
Australia	73.7 % (70,310)	61.1 [10.2]	15.0 % (10,544)	9.6 % (6,747)	8.2 % (5,737)	26.9 %(18,909)
New Zealand	2.0 % (1,874)	59.8 [9.5]	14.0 % (262)	9.6 % (180)	8.2 % (153)	25.4 % (476)
Oceania	0.4 % (332)	58.6 [9.6]	17.2 % (57)	10.5 % (35)	10.2 % (34)	19.9 % (66)
East Asia	1.4 % (1,293)	60.1 [10.6]	22.0 % (284)	6.2 % (80)	8.0 % (103)	4.6 % (60)
Southeast Asia	1.6 % (1,513)	59.0 [9.8]	20.6 % (311)	7.9 % (119)	9.2 %(139)	6.3 % (95)
Central & South Asia	0.7 % (634)	59.8 [10.8]	15.6 % (99)	1.3 % (8)	6.6 % (42)	8.5 % (54)
UK & Ireland	10.5 % (9,998)	63.6 [10.5]	15.4 % (1,538)	9.5 % (952)	7.6 % (756)	27.0 % (2,702)
West Europe	4.6 % (4,392)	65.2 [10.3]	22.7 % (995)	13.1 % (576)	9.4 % (412)	17.0 % (747)
East & Central Europe	1.5 % (1,384)	65.9 [11.1]	29.2 % (404)	12.7 % (176)	11.1 % (154)	11.6 % (161)
Middle East & North Africa	1.0 % (937)	61.3 [10.0]	30.1 % (282)	12.0 % (112)	16.3 % (153)	5.0 % (47)
Sub-Saharan Africa	0.8 % (793)	59.4 [9.7]	7.9 % (63)	1.0 % (8)	5.2 % (41)	14.3 % (113)
North America	0.7 % (665)	60.5 [9.6]	8.9 % (59)	0.9 % (6)	5.9 % (39)	25.3 % (168)
Central & South America	0.5 % (432)	60.0 [9.1]	21.1 % (91)	5.3 % (23)	8.6 % (37)	8.3 % (36)
Unspecified Region of birth	0.9 % (836)	64.7 [11.3]	25.4 % (212)	10.7 % (89)	10.9 % (91)	18.7 % (156)
Total	100.0 % (95,393)	61.6 [10.3]	15.9 % (15,201)	9.6 % (9,111)	8.3 % (7,891)	25.0 % (23,821)

13.1 % (West Europe). Men born in the Middle East & North Africa had the highest prevalence of current smoking (16.3 %, Australian born men 8.2 %), and men born in Australia, as well as the UK & Ireland, reported the highest alcohol consumption, 27 % having a minimum of 15 drinks per week.

Overall, the mean IPSS score was 3.25 [SD: 3.28] out of a possible maximum score of 21, and 19.4 % of men were classified as having moderate-to-severe LUTS. As shown in Table 2, mean m-IPSS scores were highest for men from Middle East & North Africa (4.0; [SD: 4.17]), with 27 % of men from this region reporting symptoms consistent with moderate/severe LUTS, compared to a mean score of 3.24 [SD: 3.24] and a prevalence of moderate/severe LUTS of 19 % for Australian-born men. Other regions with a relatively high prevalence of moderate/severe LUTS (i.e. 22–23 %) were East & Central Europe, North America, West Europe and Southeast Asia. After adjusting for age, education, income, alcohol consumption and smoking, compared to Australian men, the odds of moderate/severe LUTS were higher among those born in the Middle East & North Africa (OR = 1.43; 1.23–1.66), North America (OR = 1.26; 1.05–1.52) and Southeast Asia (OR = 1.25; 1.10–1.42) (Table 2; Fig. 1). Mean m-IPSS score was lowest for participants from New Zealand (2.97; [SD = 3.0]), where only 17.7 % had moderate/severe LUTS, but after adjusting for confounders only one region, the UK & Ireland, had significantly lower odds of moderate/severe LUTS, compared to Australian-born men (OR = 0.85; 0.80–0.90; prevalence of 18.5 %).

A similar pattern was observed when storage symptoms and voiding symptoms were examined separately (see Table 3 and Fig. 1), with men born in the Middle East & North Africa, Southeast Asia and North America being the most likely to have increased odds of moderate/severe individual, storage and voiding symptoms. After adjusting for confounders, men born in the Middle East & North Africa were more likely to experience moderate/severe storage (OR = 1.38; 1.18–1.61) and voiding symptoms (OR = 1.47; 1.27–1.70) relative to Australian-born males, as were men from Southeast Asia (OR = 1.29; 1.13–1.48 and OR = 1.18; 1.04–1.34, respectively), while men in North America, as well as Sub-Saharan Africa, were more likely to report moderate/severe voiding symptoms (respectively OR = 1.26; 1.05–1.52 and OR = 1.22; 1.03–1.45). While most regions had significant odds ratios for at least one symptom, the Middle East & North Africa, Southeast Asia and North America were the only regions where odds were elevated for most symptoms (i.e. at least two irritative and two voiding symptoms). Men from the UK & Ireland were the only group that had lower odds of both moderate/severe storage (OR = 0.78; 0.74–0.83) and voiding symptoms (OR = 0.87; 0.82–0.91), compared to Australian-born participants, reflected in lower odds of

Table 2 Mean modified International Prostate Symptom Score (m-IPSS) prevalence of moderate/severe LUTS (m-IPSS >6) and associated adjusted odds ratios, by region of birth

Region of birth	*n*	Mean m-IPSS score [SD]	Moderate/severe LUTS (modified IPSS ≥6)	
			Percentage	Adjusted OR (95 % CI)
Australia	70,310	3.24 [3.24]	19.1	1.00
New Zealand	1,874	2.97 [3.00]	17.7	0.97 (0.86–1.10)
Oceania	332	3.21 [3.31]	20.8	1.22 (0.93–1.61)
East Asia	1,293	3.11 [3.37]	19.6	1.02 (0.89–1.18)
Southeast Asia	1,513	3.42 [3.54]	21.9	**1.25 (1.10–1.42)**
Central & South Asia	634	3.07 [3.28]	18.6	1.01 (0.82–1.24)
UK & Ireland	9,998	3.13 [3.22]	18.5	**0.85 (0.80–0.90)**
West Europe	4,392	3.49 [3.54]	22.2	0.97 (0.90–1.05)
East & Central Europe	1,384	3.57 [3.64]	23.1	0.97 (0.85–1.11)
Middle East & North Africa	937	4.00 [4.17]	27.0	**1.43 (1.23–1.66)**
Sub-Saharan Africa	793	3.26 [3.31]	19.6	1.15 (0.96–1.38)
North America	665	3.63 [3.39]	22.3	**1.26 (1.05–1.52)**
Central & South America	432	3.24 [3.54]	20.6	1.11 (0.87–1.41)
Total	95,393	3.25 [3.28]	19.4	

OR adjusted for age, income, education, alcohol consumption and tobacco smoking status. Total includes men with unspecified region of birth

Bold type face indicates $p < 0.05$

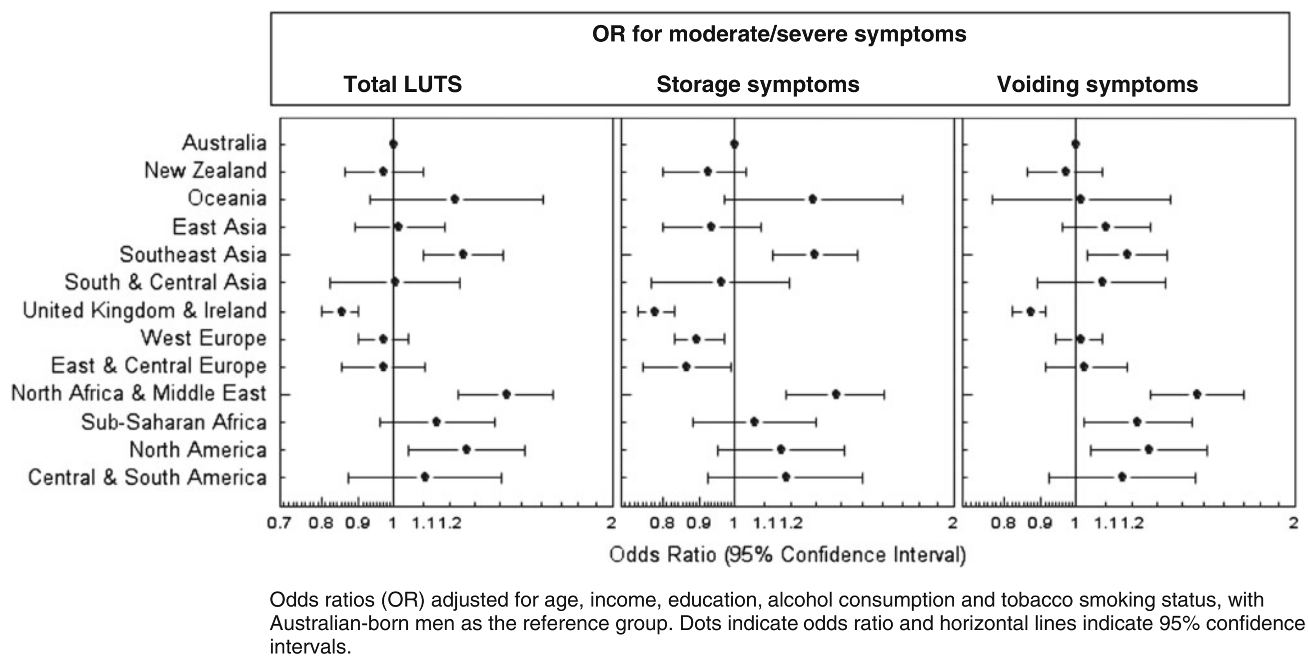

Fig. 1 Adjusted OR for reporting moderate or severe lower urinary tract symptoms, according to region of birth, presented as total lower urinary tract symptoms, storage symptoms and voiding symptoms. OR adjusted for age, income, education, alcohol consumption and tobacco smoking status, with Australian-born men as the reference group. *Dots* indicate OR and *horizontal lines* indicate 95 % CI

several individual symptoms (urgency, nocturia, straining and weak stream). Men born in Western Europe had a significantly reduced risk of moderate/severe storage but not voiding symptoms.

Sensitivity analysis indicated that additional adjustment for physical activity and BMI in the logistic regression models with overall moderate/severe LUTS, storage and voiding symptoms did not materially affect the main

Table 3 Prevalence (%) of moderate-to-severe storage and voiding lower urinary tract symptoms and associated adjusted odds ratios, and odds of experiencing individual symptoms often/always, by region of birth

Region of birth	Storage symptoms					Voiding symptoms					
	Moderate-severe (score ≥4)		Experiencing symptoms often/almost always Adjusted OR (95 % CI)			Moderate-severe (score ≥3)		Experiencing symptoms often/almost always Adjusted OR (95 % CI)			
	Percentage	Adj. OR (95 % CI)	Urgency	Frequency	Nocturia*	Percentage	Adj. OR (95 % CI)	Straining	Weak stream	Intermittency	Incomplete emptying
Australia	17.7	1.00	1.00	1.00	1.00	19.4	1.00	1.00	1.00	1.00	1.00
New Zealand	15.3	0.92 (0.80–1.04)	0.84 (0.68–1.03)	0.90 (0.77–1.05)	0.96 (0.80–1.15)	18.4	0.97 (0.86–1.09)	**0.60 (0.40–0.90)**	0.91 (0.76–1.10)	0.84 (0.67–1.05)	1.01 (0.81–1.26)
Oceania	19.6	1.28 (0.97–1.70)	1.14 (0.74–1.75)	0.92 (0.65–1.31)	**1.73 (1.23–2.43)**	18.7	1.02 (0.77–1.35)	1.09 (0.54–2.21)	0.86 (0.55–1.34)	1.41 (0.92–2.17)	0.96 (0.57–1.62)
East Asia	16.9	0.93 (0.80–1.09)	0.81 (0.63–1.03)	0.86 (0.72–1.03)	1.20 (0.99–1.45)	21.1	1.10 (0.96–1.27)	**1.39 (1.01–1.92)**	1.01 (0.82–1.24)	0.87 (0.68–1.13)	1.16 (0.92–1.48)
Southeast Asia	20.4	**1.29 (1.13–1.48)**	**1.34 (1.11–1.61)**	1.14 (0.98–1.33)	**1.71 (1.45–2.01)**	21.7	**1.18 (1.04–1.34)**	**1.59 (1.20–2.10)**	0.96 (0.79–1.17)	1.00 (0.80–1.27)	**1.54 (1.26– 1.88)**
South & Central Asia	16.3	0.96 (0.77–1.19)	0.99 (0.71–1.37)	0.91 (0.70–1.18)	0.99 (0.73–1.35)	20.4	1.09 (0.89–1.33)	1.20 (0.71–2.02)	0.96 (0.72–1.30)	0.96 (0.67–1.38)	1.08 (0.75–1.56)
UK & Ireland	16.2	**0.78 (0.74–0.83)**	**0.84 (0.77–0.92)**	0.94 (0.88–1.01)	**0.76 (0.70–0.82)**	18.6	**0.87 (0.82–0.91)**	**0.83 (0.71–0.96)**	**0.87 (0.80–0.94)**	0.93 (0.85–1.02)	0.99 (0.90–1.10)
West Europe	19.8	**0.89 (0.83–0.97)**	0.96 (0.85–1.08)	0.93 (0.84–1.02)	0.95 (0.85–1.05)	22.4	1.02 (0.94–1.09)	1.14 (0.95–1.36)	1.03 (0.93–1.14)	1.05 (0.93–1.19)	1.00 (0.87–1.15)
East & Central Europe	20.2	**0.86 (0.75–0.99)**	1.03 (0.84–1.24)	**0.81 (0.68–0.97)**	1.07 (0.90–1.26)	23.3	1.03 (0.91–1.18)	**1.41 (1.07–1.86)**	1.03 (0.86–1.24)	1.07 (0.86–1.32)	1.11 (0.89–1.38)
Middle East & North Africa	24.3	**1.38 (1.18–1.61)**	**1.29 (1.03–1.61)**	**1.36 (1.14–1.63)**	**1.58 (1.30–1.92)**	27.8	**1.47 (1.27–1.70)**	**1.95 (1.45–2.61)**	1.22 (0.99–1.52)	**1.68 (1.35–2.10)**	**1.93 (1.56–2.40)**
Sub-Saharan Africa	16.4	1.07 (0.88–1.30)	1.03 (0.77–1.39)	1.03 (0.82–1.30)	1.15 (0.87–1.51)	21.7	**1.22 (1.03–1.45)**	1.38 (0.88–2.17)	1.14 (0.88–1.46)	1.33 (1.00–1.78)	1.19 (0.86–1.64)
North America	19.0	1.16 (0.95–1.42)	0.96 (0.70–1.32)	**1.27 (1.01–1.60)**	**1.43 (1.09–1.87)**	23.2	**1.26 (1.05–1.52)**	1.45 (0.90–2.34)	**1.50 (1.17–1.91)**	**1.36 (1.00–1.84)**	1.05 (0.72–1.52)
Central & South America	19.4	1.18 (0.92–1.50)	0.83 (0.55–1.26)	1.10 (0.83–1.47)	**1.71 (1.27–2.30)**	22.0	1.16 (0.92–1.46)	1.20 (0.67–2.13)	1.07 (0.76–1.50)	0.94 (0.61–1.44)	1.35 (0.91–1.98)

OR adjusted for age, income, education, alcohol consumption and tobacco smoking status

Bold type face indicates $p < 0.05$

*Categorised as needing to get up to urinate 3 or more times per night findings, that is odds ratios changed by <10 % with additional adjustment.

Discussion

In this large population of older men who had not had previous prostate surgery, we found that those born in the Middle East & North Africa, Southeast Asia and North America were around 20–40 % more likely to report moderate-severe LUTS, compared to men born in Australia. In general, an elevated prevalence of overall LUTS was reflected in increased reporting of both storage and voiding symptoms. Only men born in the UK & Ireland were less likely to report moderate-to-severe LUTS than men born in Australia.

The evidence to date in this area is limited. The higher occurrence of LUTS among men born in the Middle East & North Africa has not, to our knowledge, been reported before, and the reasons for this elevated prevalence are unclear. One possible explanation for this finding is the generally higher prevalence of diseases that affect kidney functioning, thereby potentially causing LUTS more frequently in men born this region, such as genitourinary tuberculosis, schistosomiasis or glomerular diseases [30, 31]. We found no significant difference between men born in Sub-Saharan Africa and Australian-born men in terms of overall LUTS; however, men born in Sub-Saharan Africa were more likely to report voiding symptoms and several individual LUTS. Several studies of African–American men have found a significantly higher risk for LUTS and/or benign prostatic hyperplasia, a condition that is closely associated with the experience of LUTS, in comparison with Caucasian American men [5, 18], while others have not [1, 20, 21, 23, 24].

Similarly, we are unaware of any previous studies reporting an elevated risk of LUTS in men from Southeast Asia or in men from North America. We identified three previous studies that have compared LUTS among men of Asian descent in general with predominantly Caucasian men. Jin et al. [19] found no difference in either the prevalence of LUTS or total prostate volume for 47 Chinese men who migrated to Australia compared to 116 non-Chinese males born in Australia, consistent with our findings of no significant differences in the prevalence of LUTS between men born in East Asia (55 % of whom were born in China) and Australia, except for the symptom 'straining'. One study based in the United States found a significantly lower risk of nocturia and benign prostate hypertrophy in men identifying as "Asian" compared to white men [5], while another found a reduced risk of having surgery for benign prostatic hyperplasia but a similar prevalence of symptoms in Asian versus white US health professionals [21]. The latter study also found that men of southern European ancestry had an elevated risk of LUTS and of surgery for benign prostatic hypertrophy and men of "Scandinavian" ancestry had a slightly decreased risk of LUTS [21] compared to men born in the United States. It is difficult to compare these findings directly with those observed here, since we did not analyse data relating to "ancestry" and men born in these places would have been considered together under the "West Europe" region. The overall risk of LUTS in men from this region did not differ significantly from Australian-born men; however, the prevalence of storage-related symptoms was significantly lower.

Overall, the findings indicate elevated prevalence of LUTS among men from a number of different migrants groups, indicating unmet health need in specific migrant groups with respect to LUTS, relative to Australian-born men. These variations are likely to be driven by a number of different factors, including the underlying risk of LUTS, willingness to report symptoms and the propensity to seek and receive treatment. Many of these are likely to vary according to region of birth and according to health system factors in the country of adoption. It can be inferred from our results that differences in the experience of LUTS by region of birth are not due to differences in the distribution of age, alcohol consumption, tobacco smoking, educational background and household income among participants from different regions of birth. We have conducted sensitivity analysis with additional adjustment for physical activity and BMI in the logistic regression models with overall moderate/severe LUTS, storage and voiding symptoms, which resulted in the same significant associations between symptoms and regions of birth as demonstrated in our results. We cannot exclude other potential unmeasured explanations for the observed difference; for example, differences in central obesity or fat distribution according to region of birth. Linguistic difficulties in interpreting the questionnaire among men for whom English was not a first language may also have contributed to the results. Finally, it should be noted that the absolute differences in the prevalence of LUTS between the men with different regions of birth, although statistically significant, are relatively modest.

The data presented in this analysis relate to the prevalence of symptoms according to region of birth at a specific time point; we excluded men with previous prostate surgery because we were not able to ascertain whether such surgery was as treatment for LUTS and what symptom levels were like prior to surgery. Also, we did not have access to data on medications for LUTS for this paper. Hence, variations in access to treatment by people from different cultural backgrounds may be a factor influencing the prevalence of LUTS. The prevalence of LUTS may also be influenced by cultural differences (or differences in culturally accepted behaviour) in the reporting of symptoms and/or the perception of symptom severity. A study by Ward and Sladden [3] demonstrated a high willingness of Australian men overall to report LUTS once a certain level of discomfort had been reached, suggesting there is a critical point at which men are willing to receive treatment. Respondents who were born in the UK & Ireland were less likely to report storage, voiding and overall LUTS compared to Australian-born men. A study by Fritschi et al. [17] showed no significant difference in the risk of having surgery for benign prostatic hyperplasia for UK- versus Australian-born men. Finally, given the wide range of factors that may influence the risk of LUTS, it remains likely that there is genuine variation in prevalence among men from different regions of the world, above and beyond reporting- and health-services-related factors.

Although storage and voiding symptoms tended to be generally elevated in those with increased overall LUTS, the exceptions to this (e.g. men born in Sub-Saharan Africa) emphasise the importance of distinguishing between symptoms caused by bladder outflow obstruction (voiding symptoms) and symptoms that are related to overactive bladder (storage symptoms). Hence, it is plausible that different mechanisms and causal pathways underlie the manifestation of these symptom domains [4, 25]. However, the results outlined here require replication before firm conclusions can be reached. The terminology used here relates to symptoms only and reflects the current understanding that there are multiple possible causes for LUTS in older men. It avoids direct attribution of symptoms to prostate enlargement or "benign prostatic obstruction" since no symptoms are pathognomonic of these conditions.

Migrant studies can provide valuable clues about disease aetiology and potentially modifiable causes of disease. In particular, marked variation in disease incidence between countries and migrant groups can implicate environmental and lifestyle factors in causing disease. Classic examples of this include variation in breast cancer rates between women in Japan versus the United States, and gradual attenuation in these differences among women of Japanese descent over a period of generations [32]. Although the overall findings of this study provide evidence of variation in LUTS according to region of birth, they do not examine LUTS in first-generation migrants, nor do they allow the distinction between genetic, environmental, lifestyle and health service use factors in explaining this variation. Further research is needed to explore this.

To our knowledge, the association between LUTS and region of birth has not been investigated in such detail previously. The 45 and Up study is the largest cohort study in the Southern Hemisphere, and the population base is one of the most heterogeneous in the world. Specifically, 31 % of the population aged 45 years or older in New South Wales (2006) were born outside of Australia [33], and 26 % of our sample was born outside of Australia. The large size of the study and its diversity allowed well-powered comparisons of the prevalence of LUTS across varied migrant groups in a systematic way. Cohort studies often involve selected groups and produce results based on internal comparisons within the cohort. Theoretical and empirical work have shown these internal comparisons to be valid and reliable [34], and the long-term importance of findings from cohorts such as the British Doctors' Study is further testament to the robustness of this approach. The 45 and Up Study is not designed to be representative of the general population, and the response rate to the baseline questionnaire was 18 %, meaning that although odds ratios calculated from internal comparisons, such as according to region of birth, are valid and robust, caution should be exercised when generalising from the individual prevalence of symptoms and other cohort attributes [34].

There are a number of additional limitations that need to be considered when interpreting the findings from our study. Although our modified IPSS was calibrated carefully against the standard IPSS, issues with comparability and generalisability cannot be excluded. Men with a prior history of surgical treatment for LUTS were excluded from this study. Therefore, our results represent the prevalence at a specific time point among men who have not had previous surgery and may underestimate the overall burden of disease from moderate-to-severe LUTS in the population. The 45 and Up Study was administered in English, and it is likely that the men who were born in non-English speaking countries who took part in the study would be more acculturated than and may differ in other ways from other community members. This means that the risks observed here may be underestimated. Language barriers are also a potential explanation for missing values or inconsistency in answers, which may have led to response bias. Due to the cross-sectional nature of our study and factors that were included, explanations about causality for our findings can only be hypothetical at this stage. However, being born, and country of birth, must precede LUTS, and LUTS cannot plausibly cause someone to be born in a specific location; hence, issues regarding reverse causality are less pertinent to this study than they are to others. It would have been interesting to examine the effect of time since migration on the relationship between LUTS and region of birth and whether the experience of symptoms becomes more similar to Australian-born men over time; however this was beyond the scope of the current analysis.

Conclusion

The prevalences of LUTS and of specific subtypes of LUTS vary by region of birth. In general, men from the Middle East & North Africa, Southeast Asia and North American had an elevated prevalence of both overall LUTS and a range of storage and voiding symptoms.

Acknowledgments The authors would like to thank the men participating in the 45 and Up Study. The 45 and Up Study is managed by The Sax Institute in collaboration with major partner Cancer Council New South Wales; and partners the National Heart Foundation of Australia (NSW Division); NSW Ministry of Health; *beyondblue: the national depression initiative;* Ageing, Disability and Home Care, Department of Human Services NSW; and the Red Cross Blood Service. Emily Banks is supported by the National Health and Medical Research Council.

Conflict of interest None.

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