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Incidence trends of prostate cancer in Sarawak, Malaysia: a 20-year population-based analysis

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Abstract

This study explored the incidence trends of prostate cancer within the Borneo State of Sarawak, with its unique population demography, over a 20-year period. Data was collected from cancer registries spanning from 1996 to 2015, focusing on annual incidence rates and demographics. Joinpoint regression analysis revealed an increasing trend over the years with significant Annual Percent Change (APC) of 3.86 (95% CI 1.3, 7.2). The mean age at diagnosis was significantly trending downwards with an Average APC of −0.31 (95% CI −0.5, −0.1) over the times. Despite having a lower incidence rate compared to Oceania and North America, the rise in prostate cancer incidence within the Asia-Pacific region has been recognised as an area of public health concern and requires further research. Continued efforts in early detection and treatment advancements are substantial.

Keywords Prevalence, Prostate cancer, Trend, Sarawak, Epidemiology

1 Introduction

Prostate cancer is ranked fourth most common cancer in the world [1]. Based on GLOBOCAN 2022, it was estimated that from a total of 19.96 million new cancer cases and about 9.74 million cancer deaths which occurred in 2022, prostate cancer accounted for 7.3% (about 1.47 million cases) and 396,792 deaths worldwide [1]. It is one of the most common cancer among men and have wide variations in incidence rates across regions [1, 2].

With the changing population demographic, rapid urbanisation and change in lifestyle especially within Asian countries, prostate cancer has rapidly become a reflection of health inequities with higher mortality-to-incidence ratio among developing Asian nations compared to developed nations [3, 4]. In Malaysia, recent studies involving patients from multi-sites and multi-ethnicities revealed the median age at diagnosis in Malaysia was 70 years, with majority being Chinese ethnicity (45.2%), followed by Malays (38.3%), Indians (6.7%), Iban-Bidayuh (3.6%); nearly three quarters presented with late stage cancer which were significantly higher amongst Malays (62.5%), Sabah and Sarawak natives (77%), compared to Chinese (50.2%) [3].

Prostate cancer survivors experience various impact and unmet needs post-treatment. These include impact of prostate cancer on their lifestyles such as post treatment side effects and anxiety of cancer relapse, unmet supportive care needs in order to cope with the cancer survivorship, and information needs especially post-treatment care, dietary needs, relapse prevention and prognosis [5]. This finding was also demonstrated in Sarawak whereby a study among prostate cancer patients at the regional referral centre in Sarawak revealed that the most commonly reported unmet supportive care needs were "informed about cancer which is under control or diminishing" and "informed about things you can do to help yourself to get well" under the Health System and Information domain of the Supportive Care Needs Survey-Short Form (SCNS-SF) [6].

In anticipation of these rising challenges, this study aimed specifically to examine the incidence rates and temporal trends of prostate cancer in Sarawak over a 20-year period, stratified by ethnicity, age group, and geographic division, to provide baseline data for health planning. Notably, this study focused specifically on the incidence and time trends of prostate cancer, without assessing risk factors, survival outcomes, or mortality.

2 Methods

2.1 Study design, setting, population

This was a retrospective, population-based descriptive study utilizing data from the Sarawak Cancer Registry. The inclusion criteria of this study was all new prostate cancer cases (ICD-10: C61) diagnosed between 1996 and 2015 in Sarawak. Cases with missing date of diagnosis and duplicates identified during registry verification, were excluded.

Sarawak is the largest State in Malaysia, almost the size of Peninsular Malaysia (132,490 km^2), located north of the Equator on the Island of Borneo occupying an area of 124,450 km^2 [7]. It shares land borders with the State of Sabah (northeast), and international borders with Brunei (north) and Indonesia (south). Sarawak had a population of 1.90 million in 1996 which grew to 2.70 million in 2015 [8]. Recent data shows Sarawak have an average growth of 0.2% between 2010 and 2020 compared to overall Malaysia at 1.7% during the same period [9].

Owing to its land mass and population size, the population density of Sarawak was at 20 per square kilometres, lowest compared to other states, with Malaysia average of 98 per square kilometres [9]. By the year 2020, population migration from rural to urban over the years have led to a distribution of 57% population in urban compared to 43% in rural areas [9]. Sarawak has its own cultural and ethnic diversity unique from other parts of Malaysia. In Sarawak, the major ethnic groups are Iban (28.8%), Chinese (23.5%), Malay (22.9%), Bidayuh (8.0%), Melanau (5.0%) and other local indigenous populations with its major religions being Christianity, Islam and Buddhism [8, 9]. Therefore, a review of prostate cancer epidemiology in Sarawak would serve as vital baseline data to reflect this unique composition in Sarawak.

2.2 Data collection

The data collection of this review is based on the Sarawak Cancer Registry (SCR) which was established in 1996 under the Sarawak State Health Department as the State's population-based cancer registry. Case notifications were obtained from public and private healthcare facilities throughout the state upon diagnosis. Verification and active data

collection was performed by comparing case notes from reporting centres with existing cases in the registry to prevent case duplication.

The 10th revision of the International Classification of Diseases (ICD-10) was used to classify prostate carcinoma in which the code used was C61 – malignant neoplasm of prostate (ICD-10: C61). Data collected was entered into the open-source CanReg software available from the International Association of Cancer Registries (IACR) with the current version being CanReg 5 [10].

In this review, all new cases of prostate cancer diagnosed between 1996 and 2015 in Sarawak was obtained from the Sarawak Cancer Registry (SCR) for analysis. Patient identifiers such as name and National Registration Identification Card (NRIC) number was removed and replaced with the registry's unique registration number to maintain anonymity of the patients. Location of cancer notification was based on the administrative divisions used by the Sarawak Government and population census data were extracted from the Department of Statistics Malaysia (DOSM).

2.3 Statistical methods

Data were anonymized before analysis. Variables extracted included year of diagnosis, age at diagnosis, ethnicity, geographic division of residence, and histological confirmation. Data cleaning and validation were performed using STATA software, with consistency checks to eliminate duplicates. Age-standardised rates (ASR) were calculated using the direct standardization method, applying the World Health Organisation (WHO) world standard population and expressed as per 100,000 population [11]. Trend analysis in this review was conducted using the Joinpoint Regression Program version 5.0.2 available from Statistical Research and Applications Branch, National Cancer Institute [12]. The annual percent change (APC) and average annual percent change (AAPC) with its corresponding 95% confidence interval (CI) were used to quantify the magnitude of each trend. Incidence rate ratios (IRRs) and their 95% confidence intervals were calculated using negative binomial regression, comparing incidence between ethnic groups, age groups, and divisions.

Group differences were analysed with negative binomial regression analysis against reference group using STATA software. Negative binomial regression was performed to quantify the relative incidence rates between demographic groups, helping to identify populations at higher risk. Negative binomial regression was used to account for overdispersion in count data and to estimate incidence rate ratios (IRRs) between groups. The model assumed that the variance exceeded the mean incidence count. The limitations include potential confounding due to unmeasured variables such as comorbidities or socioeconomic status.

2.4 Ethical consideration

This study was approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia (MREC Ref. no.: 22-01151-6KI (2)). As this study used secondary anonymized data, individual consent was not required.

3 Results

3.1 General characteristics of prostate cancer cases

A total of $n = 945$ cases of prostate cancer was reported in Sarawak between 1996 and 2015. Data from the Sarawak Cancer Registry revealed that it was ranked the 7th most common cancer among males in Sarawak over the two-decade period. The majority of cases were diagnosed at the age of 60 and above (87.5%), mainly ethnic Chinese (53.7%), and were reported in Kuching division (48.1%) (Table 1).

3.2 Age-standardized incidence rates

The age-standardised rate (ASR) for all males in Sarawak was 6.1 (95% CI 5.7–6.5) with the highest incidence among ethnic Chinese (ASR 10.5, 95% CI 9.6–11.5), followed by Malays (ASR 5.6, 95% CI 4.7–6.5), Bidayuh (ASR 5.4, 95% CI 4.1–6.8), Iban (ASR 3.3, 95% CI 2.8–3.9) and Melanau (ASR 1.4, 95% CI 0.6–2.2). Compared to Melanau population, negative binomial analysis revealed that the Chinese population in Sarawak had significantly more than 4-times the Incidence Rate Ratio (IRR) of having prostate cancer diagnosed with the IRR = 4.063 (95% CI 1.861–8.867) ($p < 0.001$) (Table 2). Meanwhile, compared to men aged 40–59, those who are 60 and above had more than 16 times the IRR of having prostate cancer diagnosis with IRR = 16.16 (95% CI 11.258–23.188) ($p < 0.001$) (Table 2). In terms of distribution when compared to Kapit division, men in Kuching division had 2.43 times significantly higher IRR ($p < 0.05$) (Table 2).

3.3 Trend analysis using joinpoint regression

Over the 20-year study period, the mean age at time of prostate cancer diagnosis was 69.6 (SD 9.24) years old for men residing in Sarawak. There was a reduction in mean age

Table 1 Demographic characteristics of prostate cancer patients in Sarawak from 1996 to 2015 ($N = 945$)

Demographic characteristics		*n* (%)
Age distribution	Less than 60	118 (12.5)
	60 and above	827 (87.5)
Ethnic distribution	Chinese	507 (53.7)
	Iban	164 (17.4)
	Malay	157 (16.6)
	Bidayuh	67 (7.1)
	Melanau	13 (1.4)
	Others Sarawak Indigenous	30 (3.9)
Division distribution ($N = 842$)	Kuching	405 (48.1)
	Sibu	110 (13.1)
	Miri	98 (11.6)
	Samarahan	68 (8.1)
	Bintulu	39 (4.6)
	Sarikei	29 (3.4)
	Sri Aman	25 (3.0)
	Betong	25 (3.0)
	Kapit	16 (1.9)
	Limbang	16 (1.9)
	Mukah	11 (1.3)
Case distribution by year period ($N = 945$)	1996–2000	164 (17.4)
	2001–2005	203 (21.5)
	2006–2010	201 (21.3)
	2011–2015	377 (39.9)

Table 2 Negative binomial regression analysis to compare crude incidence rates across groups for prostate cancer in Sarawak (1996–2015)

Year		Crude incidence rate	Univariate analysis				Multivariate analysis			
			Incidence rate ratio	95% CI for IRR	Std. Err.	*p*-value	Incidence rate ratio	95% CI for IRR	Std. Err.	*p*-value
	1996–2000	3.2	(base year)							
	2001–2005	3.7	1.32	0.659–2.629	0.465	0.435	1.22	0.751–1.995	0.305	0.417
	2006–2010	3.4	1.00	0.504–1.999	0.353	0.990	0.87	0.527–1.432	0.221	0.582
	2011–2015	6.0	1.33	0.680–2.619	0.459	0.402	1.24	0.768–1.987	0.300	0.383
Division										
	Kuching	3.24	3.10	0.950–10.134	1.874	0.061	2.43	1.031–5.735	1.064	0.042
	Samarahan	1.61	1.92	0.568–6.491	1.193	0.294	1.57	0.641–3.850	0.719	0.323
	Sri Aman	1.32	1.76	0.482–6.459	1.168	0.391	1.129	0.425–2.998	0.563	0.808
	Betong	1.16	1.32	0.347–5.004	0.897	0.685	1.149	0.428–3.090	0.580	0.783
	Sarikei	1.51	1.36	0.374–4.960	0.898	0.640	0.891	0.333–2.383	0.447	0.819
	Mukah	0.51	1.59	0.383–6.601	1.155	0.524	0.990	0.336–2.916	0.546	0.986
	Sibu	1.87	2.29	0.668–7.830	1.436	0.188	1.703	0.688–4.218	0.788	0.250
	Bintulu	1.16	1.40	0.407–4.817	0.883	0.593	1.275	0.503–3.229	0.604	0.609
	Miri	1.56	2.12	0.644–6.989	1.290	0.217	1.752	0.737–4.167	0.774	0.205
	Limbang	1.00	1.13	0.300-4.247	0.763	0.859	1.148	0.427–3.090	0.580	0.784
	Kapit	0.71	(base group)							
Ethnicity										
	Malay	2.9	2.94	1.069–8.103	1.521	0.037	2.140	0.945–4.847	0.893	0.068
	Chinese	8.6	6.85	2.524–18.604	3.492	0.000	4.063	1.861–8.867	1.618	0.000
	Iban	2.4	2.25	0.832–6.094	1.144	0.110	1.671	0.761–3.671	0.671	0.201
	Bidayuh	3.6	2.53	0.836–7.677	1.433	0.100	1.423	0.557–3.640	0.682	0.461
	Other Sarawak indigenous	2.3	1.64	0.542–4.955	0.925	0.382	1.560	0.624-3.900	0.729	0.341
	Melanau	1.0	(base group)				(base group)			
Age										
	0–39	0.01	< 0.001	< 0.001–<0.001	< 0.001	0.993	< 0.001	< 0.001–<0.001	< 0.001	0.979
	60+	47.8	15.977	11.174–22.845	2.915	0.000	16.16	11.258–23.188	2.978	0.000
	40–59	2.5	(base group)							

at time of prostate cancer diagnosis from 71.5 (SD 10.53) years old between 1996 and 2000 to 69.3 (SD 8.28) years old in 2011–2015. Joinpoint regression analysis revealed a significant downward trend of mean age during diagnosis for the interval years between 1996 and 2001 with an Annual Percent Change (APC) of –1.29 (95% CI –3.7, –0.3) (Supplementary Fig. 1). In the subsequent years of 2001 to 2015 however, there was no significant change in trend of age at diagnosis, and it plateaued at an APC of 0.05 (95% CI –0.1, 0.8). Overall, throughout the study period between 1996 and 2015, the mean age at diagnosis was significantly trending downwards with an Average APC of –0.31 (95% CI –0.5, –0.1). When stratified according to ethnicity, the mean age at prostate cancer diagnosis ranges from 66.0 (SD 10.18) years among Melanau to 70.6 (SD 8.06) years among Bidayuh.

Joinpoint regression analysis for prostate cancer incidence in Sarawak between 1996 and 2015 revealed an increasing trend over the years with significant Annual Percent Change (APC) of 3.86 (95% CI 1.3, 7.2) (Supplementary Fig. 2.1 and Supplementary Fig. 2.2).

Between 1996 and 2015, there was a gradual increase in incidence with the APC of prostate cancer for men aged less than 60 with APC of 1.11 (95% CI –2.3, 5.0) though it was not statistically significant (Supplementary Fig. 3).

Meanwhile for men aged 60 and above, there was an initial decline with APC of –2.07 (95% CI –24.9, 46.9) between 1996 and 2009 followed by an increasing trend with APC of 8.47 (95% CI –17.9, 41.1) between 2009 and 2015 (Supplementary Fig. 4).

During the study period, the Chinese in Sarawak was reported to have a significant increase in the trend of prostate cancer with an APC of 4.21 (95% CI 1.1, 8.4) between 1996 and 2015 (Supplementary Fig. 5.1). Meanwhile, there was a significant upward trend of prostate cancer incidence among the Ibans in Sarawak with an APC of 18.9 (95% CI 3.6, 75.1) between 2009 and 2015 (Supplementary Fig. 5.2). It was preceded by an initial downward trend with an APC of –3.8 (95% CI –26.0, 3.4) between 1996 and 2009, thus making the Average APC 2.9 (95% CI –1.2, 7.5) throughout the study period. Similarly, the Bidayuh population had an initial downward trend of prostate cancer incidence at an APC of –5.53 (95% CI –31.1, 3.1) between 1996 and 2006, followed by a significant increase in trend with an APC of 13.17 (95% CI 5.2, 47.1) between 2006 and 2015 (Supplementary Fig. 5.3). Therefore, the Average APC for the Bidayuh population throughout the study period was 2.9 (95% CI –0.6, 7.1). Additionally, the Melanau population had a significant upward trend in prostate cancer incidence between 2010 and 2015 with an APC of 11.76 (95% CI 2.5, 36.5) while being preceded initially by a mild downward slope in prostate cancer incidence between 1996 and 2010 with an APC of –1.28 (95% CI –19.3, 2.5) (Supplementary Fig. 5.4). The Average APC for prostate cancer incidence among Melanau population in Sarawak over the study period was 2.0 (95% CI –0.5, 4.4). Meanwhile, among the Malays, there was a gradual upward trend of prostate cancer incidence at an APC of 3.32 (95% CI –0.4, 8.4) between 1996 and 2015 (Supplementary Fig. 5.5).

4 Discussion

This study demonstrated that prostate cancer in Sarawak has steadily increased over the past 20 years, from 1996 to 2015. The use of negative binomial regression allowed precise estimation of incidence rate ratios across ethnic and geographic groups, highlighting

disparities that would not be evident from crude incidence rates alone. The mean age at diagnosis of prostate cancer has improved over this period. However, there are varying prostate cancer incidence rates among the ethnic groups in Sarawak. In this review, the majority of prostate cancer cases in Sarawak occurred in men aged 60 and above (87.5%), with a mean age at diagnosis of 69.6 years (SD 9.24). The highest incidence rate ratio (IRR) was observed among the Sarawakian Chinese compared to the Melanau.

4.1 Increasing trend in Sarawak and variability of incidence rates between ethnic groups

The observed increase in prostate cancer incidence in Sarawak over the 20 years period was consistent with the trend in Malaysia at that time as well as the whole Asia-Pacific region [13–15]. Despite having a lower incidence rate compared to Oceania and North America [2]the rise in prostate cancer incidence within the Asia-Pacific region has been recognised as an area of public health concern and requires further research [13, 16, 17]. Several potential explanations have been put forth to account for this rising trend within the region such as the 'Westernisation' of dietary intake across the region, ageing population, lower levels of physical activity coupled with the corresponding overweight and obesity epidemic, and the availability of prostate-specific antigen (PSA) testing [2, 13, 17, 18].

Of note, the findings in terms of age at diagnosis, age group, and ethnic distribution during this review were consistent with a recent multi-centre, multi-ethnic prospective study in Malaysia whereby the findings from 1839 new prostate cancer cases had median age at diagnosis of 70 years, majority were 60 and above (92%), Chinese ethnicity (45.2%) followed by Malays (38.3%), Indians (6.7%), and Iban-Bidayuh (3.6%) [3]. The authors raised the concern of having almost three-quarters of patients (72.3%) presenting with late-stage cancer of stage III (14.2%) and stage IV (58.1) while noting a discrepancy between ethnic groups with late-stage cancers detected more frequently among Malays (62.5%), Indians (57%), and Sabah and Sarawak natives (77%) despite their lower incidence rate [3]. This is a clarion call to generate greater public awareness and improve equitable access to prostate health services so that cancer downstaging by early detection and cancer disparities of low incidence with a high percentage of late-stage cancers can be addressed.

4.2 Significant upward trend for certain ethnic groups

Generally, an upward trend across the ethnic groups was expected, in line with the general rise in incidence across the region. However, of note, it was interesting to discover a significant upward trend of incidence among Iban, Bidayuh, and Melanau populations in Sarawak during the study period. The point at which the incidence trended upward among these ethnic groups occurred around the years 2006 (Bidayuh), 2009 (Iban), and 2010 (Melanau). Meanwhile, among the Chinese and Malays, there was a steady rise throughout the study period of 1996 to 2015. The higher incidence among Chinese and Malays could reflect differences in health-seeking behaviour, genetic predisposition, dietary factors, or disparities in PSA screening uptake. Further research is needed to explore these potential explanations.

In Sarawak, the Iban, Bidayuh, and Melanau are a distinct group of indigenous population with Ibans being the majority among them and usually distributed along river basins in the interior of Sarawak's central and southern zones [20]. The rise in incidence among

these indigenous groups of populations could be attributed to increased prostate cancer screening through Prostate Awareness Campaigns in rural areas of Malaysia including Sarawak around 2005 onwards [15, 19]. Furthermore, the rural-to-urban migration of indigenous populations such as the Iban population who established residences in urban and semi-urban areas driven by stabilisation and diversification of employment [21] may have contributed to this rise due to improved access to health services particularly with regards to prostate health. It is likely that having an established screening programme, improved access to prostate-specific antigen testing, enhanced awareness among healthcare providers outside of the main urology referral centre of Sarawak General Hospital in Kuching, and ongoing rural-urban migration has led to the rise amongst population that traditionally reside in more interior areas outside of Kuching division.

4.3 Health promotion and diagnostics capabilities

While the exact magnitude of how much prostate cancer incidence and the reduction in mean age of diagnosis can be attributed to health awareness campaigns remains unclear, it is likely that the availability medical robotics system made an equally significant impact.

It was noted that the availability of minimally invasive robotic surgery system equipment was instrumental in the rapid expansion of screening and diagnosing of prostate cancer in Sarawak. These state-of-the-art medical robotic systems with both diagnostics and curative capabilities, without the complications of open surgeries, meant that clinicians can now offer a safer option with better outcomes to their patients [22, 23].

4.4 Limitations

This is a registry-based study and with it some inherent limitations. Staging data were incomplete in the Sarawak Cancer Registry for many cases during earlier years, preventing meaningful analysis of stage-specific trends. Additionally, outcome measures such as treatment outcomes could not be ascertained in this review. Furthermore, during the period of analysis, Sarawak General Hospital (SGH) in Kuching was the main urology clinic referral centre for the whole of Sarawak. Along with Kuching division being the division with the highest number of populations, coupled with having the main urology services and diagnostics tool, both in the government and private sector, it is likely that such a combination has led to a greater number of cases detected in Kuching. Some ethnic and divisional groups were chosen as reference groups despite small case numbers (e.g., Melanau or Kapit) due to model constraints. This may affect the stability and interpretation of regression estimates. Besides, this study did not include prostate cancer mortality data or survival analysis due to unavailability of mortality linkage in the registry during the study period. Future research should incorporate survival outcomes to better understand disease burden. Lastly, this study did not involve clinical experts such as urologists directly in study design or data interpretation, which may limit clinical contextualization of findings.

5 Conclusion/recommendations

This study highlighted the increasing trend in prostate cancer in Sarawak over a span of two decades, between 1996 and 2015, with notable variations in incidence rates between various ethnicities and geographic regions. This trend is likely driven by an increasing

rural-to-urban migration, lifestyle changes, and the ageing population in Sarawak. Therefore, given these dynamics, it is imperative to acknowledge that the trend will continue and there is a need to ensure the healthcare delivery system in Sarawak adapts to these evolving challenges. Moreover, this study underlines the importance of capacity building and investment in appropriate diagnostic tools beyond the main tertiary hospital in Kuching towards achieving health equity in Sarawak, so that regardless of their geographic location, communities have access to timely and effective prostate cancer diagnosis, treatment, and care. Such development, coupled with systematic health promotion and screening, would ultimately contribute to early detection, and improve health outcomes in prostate health for the region. Future research could explore barriers in prostate cancer screening and unmet needs among prostate cancer survivors from both urban and rural communities in Sarawak to inform policymakers, practitioners, and stakeholders in addressing this pressing public health challenge.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12982-025-00891-1.

Supplementary Material 1.

Supplementary Material 2.

Supplementary Material 3.

Supplementary Material 4.

Supplementary Material 5.

Supplementary Material 6.

Supplementary Material 7.

Supplementary Material 8.

Supplementary Material 9.

Supplementary Material 10.

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What we already know

The most recent study in Malaysia revealed the median age at diagnosis of prostate cancer was 70 years.

Majority were of Chinese ethnicity (45.2%), followed by Malays (38.3%), Indians (6.7%), Iban-Bidayuh (3.6%).

Nearly three quarters presented with late-stage cancer which were significantly higher amongst Malays (62.5%), Sabah and Sarawak natives (77%), compared to Chinese (50.2%).

What this article adds

Prostate cancer in Sarawak has steadily increased from 1996 to 2015, with mean age at diagnosis has improved over this period.

The majority of prostate cancer cases in Sarawak occurred in men aged 60 and above (87.5%), with a mean age at diagnosis of 69.6 years (SD 9.24).

The highest incidence rate ratio (IRR) was observed among the Sarawakian Chinese compared to the Melanau.

Author contributions
EJF, OCH, WKY, TCY – concept, design, control of the research and approval of final version of the manuscript; MW, WKY – collection and preparation of data, primary processing of data and its verification; EJF, OCH, WKY, DJ, EMJ, AH – statistical analysis of material, article write up (material, methods, and results); EJF, TCY, JP, DJ, AA – article write up (introduction, and discussion); TCY, JP, EMJ – proof reading and formatting. All authors approved the final version of the manuscript.

Data availability
The data of this study is available upon request to the corresponding authors.

Declarations

Competing interests
The authors declare no competing interests.

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