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Increasing incidence of prostate cancer in Taiwan

A study of related factors using a nationwide health and welfare database

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Abstract

Over the past decades, the incidence of prostate cancer in Taiwan kept rising. Many possible factors including the utility of prostate specific antigen tests, lifestyle remodeling, and patient's comorbidities may contribute to the increasing of incidence or prostate cancer. We aim to use the nationwide Health and Welfare Database (HWD) to investigate possible associated factors.

We used HWD, a nationwide database of medical information, to assess the incidence of prostate cancer, utilization of prostate-specific antigen (PSA) test, and underlying diseases of patients and to evaluate whether there was a common trend among these factors.

In total, 32,508 patients with newly diagnosed prostate cancer from 2006 to 2013 were identified. The incidence rate of prostate cancer per 100,000 men increased from 35.47 in 2006 to 52.87 in 2012. The number of patients with prostate cancer and underlying diseases related to metabolic syndrome increased every year. The number of total PSA tests and patients undergoing PSA testing, as well as average times of PSA testing per person in the whole population, increased every year. The average PSA test times of patients with newly diagnosed prostate cancer within 3 years before the diagnosis of prostate cancer also increased every year. There was a high correlation between the average PSA test times and the number of patients with newly diagnosed prostate cancer ($r^2 = 0.9734$).

The trends of incidence of prostate cancer, utilization of PSA testing, and underlying diseases related to metabolic syndrome at the diagnoses of cancer were similar, increasing every year in the study period. The results suggested that increasing use of PSA tests may increase the diagnosis of prostate cancers. Underlying diseases related to metabolic syndrome might also affect the incidence of prostate cancer.

Abbreviations: AJCC = American Joint Committee on Cancer, ANOVA = Analysis of variance, CKD = chronic kidney disease, HWD = Health and Welfare Database, ICD-9-CM = International Classification of Diseases, 9th revision, Clinical Modification, NHI = National Health Insurance, PSA = prostate specific antigen, SEER = National Cancer Institute's Surveillance, Epidemiology, and End Results.

Keywords: incidence of prostate cancer, metabolic syndrome, prostate cancer, PSA screening

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The data that support the findings of this study are available from a third party, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are available from the authors upon reasonable request and with permission of the third party.

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1. Introduction

Prostate cancer is the most frequently diagnosed cancer and the second leading cause of cancer death in men in the United States.[1] The risks factors include age, family history, black race, and some genetic variations, as well as geographical differences.[2,3] The incidences vary among different countries, which are higher in Oceania, Australia, New Zealand, America, Europe, and Micronesia and lower in Asia and Africa except for southern Africa. In addition, the incidence is increasing in many countries over the past 10 years, especially in Asia.[4]

There are many possible causes related to the increase in prostate cancer incidence. The widely used prostate-specific antigen (PSA) screening and subsequent prostate needle biopsy may increase early detection of prostate cancer, thereby increasing the incidence.[5,6] In addition, a Western-type diet[7–9] and metabolic syndrome[10,11] also increase the risk of prostate cancer. However, a large-scale nationwide study to evaluate the long-term trend and relationship between the increasing incidence of prostate cancer and these possible factors is lacking.

In Taiwan, the incidence of prostate cancer significantly increased in the past decades, from 17.22 per 100,000 population in 1999 to 29.14 per 100,000 population in 2014.[12] It is the fifth leading cause of cancer incidence and the seventh leading cause of cancer death for men in 2015 in Taiwan.[13] Therefore, we aimed to use the national health insurance data of Taiwan to analyze possible factors related to the yearly increase in the incidence of prostate cancer in Taiwan, especially focusing on PSA testing and underlying comorbidities.

2. Methods

2.1. Database

We used the Health and Welfare Database (HWD) from Health and Welfare Data Science Center of Taiwan to conduct this study. The database consists of all the registry files and medical claim data of the National Health Insurance (NHI) in Taiwan. All the standard evaluation examinations, procedures, and treatments of common diseases were reimbursed in the NHI. The population of Taiwan is around 23.3 million in 2013. The population coverage rate of NHI is 99.9% of all residents of Taiwan in 2013, and there were around 25.68 million registries in the whole database, including foreigners with resident certificate.[14] Hence, the database could represent the medical and health status of the whole Taiwanese population.

2.2. Ethical statements

This study was approved by the Institutional Review Board of Chang Gung Memorial Hospital (CGMH-IRB-104-7909B). This was a database analysis study. The registries and medical claims in the HWD were all transformed to digits and delinked from personal private and confidential information. Individuals could not be identified from the database. No informed consent was needed.

2.3. Study population

During the study period from 2006 to 2013, we used the International Classification of Diseases, 9th revision, Clinical Modification (*ICD-9-CM*) 185.0 to retrieve data of patients with the newly diagnosed prostate cancer in each year as the study population. The study population was correlated with the catastrophic certification file. The catastrophic certification is a certification of cancer and patients with cancer could use it to have medical fee discount on treatments for cancer. Patients could obtain catastrophic certification only after pathological approval of cancer. By correlating the diagnostic code with catastrophic certification file, the study population could be confirmed as true patients with prostate cancer instead of miscoding. Patients with missing data or prostate cancer diagnosed before 2006 were excluded from the study.

2.4. Parameters

Comorbidities of hypertension (*ICD-9-CM* 401–405), diabetes mellitus (*ICD-9-CM* 250), hyperlipidemia (*ICD-9-CM* 2720–2724, 2728), viral hepatitis (*ICD-9-CM* 070), and chronic renal insufficiency (*ICD-9-CM* 585) were recorded. Underlying comorbidities were defined as chronic diseases diagnosed at least 1 year before the diagnosis of prostate cancer. The stage of prostate cancer at diagnosis was recorded according to the American Joint Committee on Cancer (AJCC) staging system. The patients diagnosed before 2010 were referred to AJCC 6th edition, and patients diagnosed after the publish of AJCC 7th edition were referred to the AJCC 7th edition. The cancer stage was retrieved from the Cancer Registry Database of Taiwan, and prostate cancer was included in the detailed cancer registry since 2008. Therefore, the cancer stage data were available since 2008. Specific insurance claim codes were used to retrieve PSA test (12081C, 7052C) and prostate needle biopsy (79401C, 79402C) in the database. PSA test times of the whole population were used to investigate the trend of PSA testing in Taiwan. Average PSA test times of each newly diagnosed prostate cancer patient within 3 years before the diagnosis of cancer were also recorded to evaluate whether increasing PSA test numbers could increase the diagnosis of prostate cancer. We included patients with prostate cancer from 2006 to 2013, so the PSA times within 3 years before diagnosis of cancer were recorded since 2008. Prostate biopsy times were analyzed in the same manner.

2.5. Statistics

We used χ^2 test to analyze the yearly differences of demographic data, comorbidities and cancer stage. Analysis of variance test was used to analyze the difference between yearly mean PSA test and prostate biopsy times. Pearson correlation was used to test the relationship between PSA test/prostate biopsy numbers and newly diagnosed prostate cancer patient number. All the analyses were conducted by the statistical software SAS (version 9.4; SAS Institute Inc., Cary, NC).

3. Results

A total of 32,508 patients with newly diagnosed prostate cancer from 2006 to 2013 were identified. The yearly incidence rate (A) and age-specific incidence rate (B) of prostate cancer are shown in Figure 1. The incidence rate increased gradually, from 35.47 per 100,000 male population in 2006 to 52.87 per 100,000 male population in 2012, except from 2012 to 2013 with only a small decrease. Demographic data of enrolled patients are presented in Table 1. The number of patients with newly diagnosed prostate cancer increased gradually from 3040 in 2006 to 4732 in 2013. The major age group at diagnosis was 71- to 80 years' old, with a

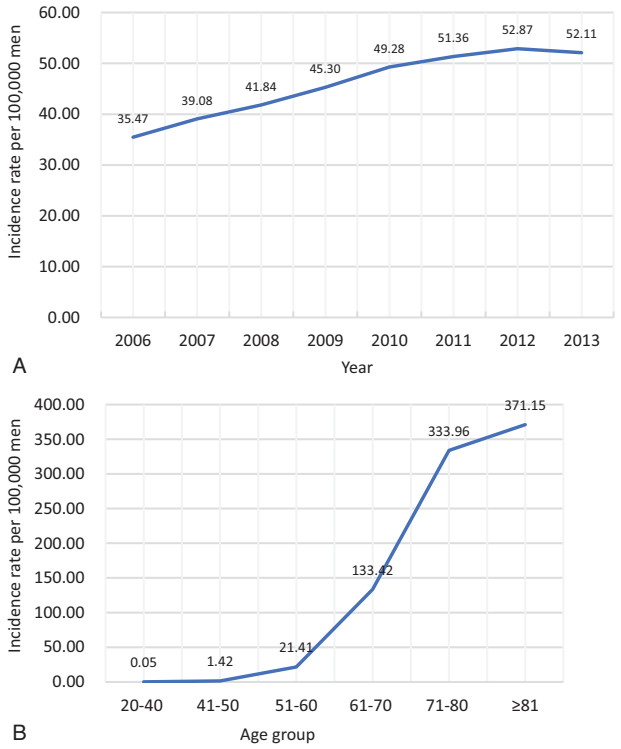

Figure 1. Incidence rate of prostate cancer from 2006 to 2013 (A) and the average age-specific incidence rate of prostate cancer (B).

trend toward a younger group of 51- to 70 years' old ($P < .0001$) from 2006 to 2013. The insurance amount was according to the average monthly income of a family, roughly reflecting the socioeconomic status of patients. Yearly increasing percentage of patients with prostate cancer with higher family income was noted ($P < .0001$).

Table 2 shows the comorbidities and clinical stage at diagnosis. The percentage of patients with prostate cancer with metabolic syndrome-related underlying chronic disease, such as hypertension, diabetes mellitus, or hyperlipidemia in each year increased ($P < 0.0001$) from 2006 to 2013. Although the stage distribution varied by year, there was no significant yearly difference between localized cancer stages (Stage I and II) and advanced/metastatic stages (Stage III and IV) (data not shown). Since the prevalence of viral hepatitis and chronic kidney disease (CKD) was high in Taiwan, we have included them for analysis. The results also showed the percentage of prostate cancer patients with viral hepatitis and CKD increased in each year.

PSA screening is not a standard cancer screening program in Taiwan. Total PSA tests and numbers of patients undergoing PSA testing in the whole Taiwanese population every year is presented in Table 3. The total number of PSA test times and patients undergoing PSA testing and average times of PSA testing per patient all increased from 2006 to 2013. We also investigated the trend of prostate biopsy numbers, and it also slightly increased every year. The percentage of the population who underwent prostate biopsy after PSA testing was 2.47% in 2006, increased gradually until 2011, and was stable at 2.85% in 2013.

To evaluate the relationship between PSA test and newly diagnosed prostate cancer, we analyzed the PSA test times of patients with prostate cancer within 3 years before prostate cancer was diagnosed (Table 4). The PSA test and prostate biopsy at definite diagnosis were not counted into the analyzed data. The percentage of patients with cancer undergoing PSA within 3 years before diagnosis increased yearly, from 95.34% in 2008 to 97.46% in 2013. The average PSA test times also increased every year, from 2.99 times per person in 2008 to 3.87 times in 2013. In addition, 42.58% of patients with prostate cancer in 2008 had undergone prostate biopsy within 3 years before the definite diagnosis, and the proportion increased to 56% in 2013. The correlation of newly diagnosed prostate cancer numbers with average PSA test times and average prostate biopsy times within 3 years before diagnosis is illustrated in Figure 2. There was a high correlation between prostate cancer case numbers and average PSA test times ($r^2 = 0.9734$) and a moderate correlation between prostate cancer case numbers and prostate biopsy times ($r^2 = 0.536$).

Table 1

Yearly demographic data of patients with newly diagnosed prostate cancer.

Year	2006	2007	2008	2009	2010	2011	2012	2013	Total	*P*-value
Newly diagnosed prostate cancer (N)	3040	3376	3650	3982	4372	4592	4764	4732	32,508	
Age, y										<.0001
20–40	1 (0.03%)	2 (0.06%)	6 (0.16%)	2 (0.05%)	0 (0%)	2 (0.04%)	1 (0.02%)	1 (0.02%)	15 (0.05%)	
41–50	29 (0.95%)	15 (0.44%)	15 (0.41%)	29 (0.73%)	34 (0.78%)	25 (0.54%)	33 (0.69%)	33 (0.7%)	213 (0.66%)	
51–60	193 (6.35%)	251 (7.43%)	282 (7.73%)	337 (8.46%)	354 (8.1%)	403 (8.78%)	391 (8.21%)	437 (9.23%)	2648 (8.15%)	
61–70	765 (25.16%)	868 (25.71%)	869 (23.81%)	1045 (26.24%)	1162 (26.58%)	1242 (27.05%)	1279 (26.85%)	1314 (27.77%)	8544 (26.28%)	
71–80	1435 (47.2%)	1563 (46.3%)	1635 (44.79%)	1695 (42.57%)	1806 (41.31%)	1858 (40.46%)	1944 (40.81%)	1835 (38.78%)	13771 (42.36%)	
≥81	617 (20.3%)	677 (20.05%)	843 (23.1%)	874 (21.95%)	1016 (23.24%)	1062 (23.13%)	1116 (23.43%)	1112 (23.5%)	7317 (22.51%)	
Insured region										.0009
Northern Taiwan	1464 (48.16%)	1620 (47.99%)	1799 (49.29%)	1931 (48.49%)	2143 (49.02%)	2133 (46.45%)	2240 (47.02%)	2127 (44.95%)	15457 (47.55%)	
Middle Taiwan	673 (22.14%)	810 (23.99%)	842 (23.07%)	941 (23.63%)	1019 (23.31%)	1187 (25.85%)	1138 (23.89%)	1177 (24.87%)	7787 (23.95%)	
Southern Taiwan	806 (26.51%)	817 (24.2%)	906 (24.82%)	990 (24.86%)	1079 (24.68%)	1097 (23.89%)	1219 (25.59%)	1270 (26.84%)	8184 (25.18%)	
Eastern Taiwan	69 (2.27%)	95 (2.81%)	77 (2.11%)	94 (2.36%)	103 (2.36%)	140 (3.05%)	130 (2.73%)	121 (2.56%)	829 (2.55%)	
Outlying islands	28 (0.92%)	34 (1.01%)	26 (0.71%)	26 (0.65%)	28 (0.64%)	35 (0.76%)	37 (0.78%)	37 (0.78%)	251 (0.77%)	
Insured amount (NT$)										<.0001
Dependent	360 (11.84%)	322 (9.54%)	260 (7.12%)	142 (3.57%)	56 (1.28%)	9 (0.2%)	4 (0.08%)	4 (0.08%)	1157 (3.56%)	
1–19,999	1335 (43.91%)	1359 (40.25%)	1442 (39.51%)	1624 (40.78%)	1663 (38.04%)	1646 (35.84%)	1651 (34.66%)	1564 (33.05%)	12284 (37.79%)	
20,000–39,999	1036 (34.08%)	1323 (39.19%)	1487 (40.74%)	1691 (42.47%)	1940 (44.37%)	2165 (47.15%)	2288 (48.03%)	2279 (48.16%)	14209 (43.71%)	
≥400,000	309 (10.16%)	372 (11.02%)	461 (12.63%)	525 (13.18%)	713 (16.31%)	772 (16.81%)	821 (17.23%)	885 (18.7%)	4858 (14.94%)	

Table 2

Comorbidities and cancer stage at diagnosis.

Year	2006	2007	2008	2009	2010	2011	2012	2013	Total	
Newly diagnosed prostate cancer (N)	3040	3376	3650	3982	4372	4592	4764	4732	32508	*P*-value
Hypertension	1715 (56.41%)	1898 (56.22%)	2076 (56.88%)	2317 (58.19%)	2543 (58.17%)	2780 (60.54%)	2886 (60.58%)	2885 (60.97%)	19100 (58.75%)	<.0001
Diabetes mellitus	600 (19.74%)	737 (21.83%)	801 (21.95%)	938 (23.56%)	1056 (24.15%)	1116 (24.3%)	1213 (25.46%)	1219 (25.76%)	7680 (23.62%)	<.0001
Hyperlipidemia	534 (17.57%)	671 (19.88%)	741 (20.3%)	864 (21.7%)	1012 (23.15%)	1214 (26.44%)	1261 (26.47%)	1286 (27.18%)	7583 (23.33%)	<.0001
Viral hepatitis	107 (3.52%)	112 (3.32%)	126 (3.45%)	151 (3.79%)	155 (3.55%)	182 (3.96%)	213 (4.47%)	232 (4.9%)	1278 (3.93%)	.0009
Chronic renal insufficiency	138 (4.54%)	167 (4.95%)	183 (5.01%)	228 (5.73%)	243 (5.56%)	289 (6.29%)	347 (7.28%)	385 (8.14%)	1980 (6.09%)	<.0001
Clinical stage (AJCC)*										<.0001
Stage I	—	—	19 (0.72%)	25 (0.73%)	388 (9.98%)	448 (10.82%)	464 (10.88%)	425 (9.7%)	1769 (7.79%)	
Stage II	—	—	1262 (48.15%)	1702 (49.75%)	1504 (38.7%)	1588 (38.34%)	1650 (38.69%)	1698 (38.76%)	9404 (41.4%)	
Stage III	—	—	278 (10.61%)	347 (10.14%)	486 (12.51%)	543 (13.11%)	560 (13.13%)	563 (12.85%)	2777 (12.22%)	
Stage IV	—	—	745 (28.42%)	908 (26.54%)	1161 (29.88%)	1232 (29.74%)	1247 (29.24%)	1321 (30.15%)	6614 (29.12%)	
Unknown	—	—	317 (12.09%)	439 (12.83%)	347 (8.93%)	331 (7.99%)	344 (8.07%)	374 (8.54%)	2152 (9.47%)	

AJCC = American Joint Committee on Cancer.

* Before 2010, the staging was according the AJCC 6th and after 2010 it's according to AJCC 7th.

Table 3

PSA testing and prostate biopsy times of the general population.

	2006	2007	2008	2009	2010	2011	2012	2013	Total
PSA									
PSA population	198,996	222,669	244,047	269,495	292,945	304,970	328,510	356,183	2217,815
Total PSA test times	286,457	325,324	356,169	399,328	437,624	464,278	503,292	543,650	3316,122
Average PSA test times	1.44	1.46	1.46	1.48	1.49	1.52	1.53	1.53	1.50
Prostate biopsy									
Biopsy population	4907	5389	6159	6811	8064	9201	9471	10,148	60,150
Total prostate biopsy times	5171	5629	6511	7170	8514	9804	10,087	11,046	63,932
Average prostate biopsy times	1.05	1.04	1.06	1.05	1.06	1.07	1.07	1.09	1.06
Population who underwent biopsy/PSA	2.47%	2.42%	2.52%	2.53%	2.75%	3.02%	2.88%	2.85%	2.71%

PSA = prostate-specific antigen.

4. Discussion

In this study, we used a nationwide health insurance database and reported that the incidence rate of prostate cancer in Taiwan increased yearly from 2006 to 2012. Total PSA test times and average personal PSA test times, as well as the number of patients undergoing PSA testing also increased every year. In addition, the proportion of patients with comorbidities related to metabolic syndrome upon diagnosis of cancer increased yearly. Furthermore, there was a high correlation between newly diagnosed prostate cancer case numbers and average PSA test times within 3 years before the diagnosis of cancer.

PSA screening is not a standard cancer screening program in Taiwan. There are 3 cancer screenings in Taiwan for now, the oral cancer, cervical cancer, and female breast cancer. Every healthy individual fulfills the age or risk factor criteria can go to the hospital for the screening test for free. Prostate cancer is not included in the standard cancer screening. This means patients can get PSA tests only when they go for self-pay health checkup or when they go to the hospital for specific complaints, such as lower

Table 4

PSA testing and prostate biopsy times within three years before the diagnosis of prostate cancer.

	2008	2009	2010	2011	2012	2013	Total	
Newly diagnosed prostate cancer (N)	3650	3982	4372	4592	4764	4732	26,092	*P*
PSA								
PSA population	3480 (95.34%)	3828 (96.13%)	4197 (96%)	4467 (97.28%)	4652 (97.65%)	4612 (97.46%)	25236 (96.72%)	
Total PSA test times	10,394	12,940	14,794	16,777	17,915	17,865	90,685	
Average PSA test times	2.99	3.38	3.52	3.76	3.85	3.87	3.59	.0003
Prostate Biopsy								
Prostate biopsy population	1554 (42.58%)	1681 (42.21%)	2090 (47.8%)	2403 (52.33%)	2544 (53.4%)	2650 (56%)	12922 (49.52%)	
Total prostate biopsy times	1695	1860	2289	2654	2881	3044	14,423	
Average prostate biopsy times	1.09	1.11	1.10	1.10	1.13	1.15	1.12	.0980

PSA = prostate-specific antigen.

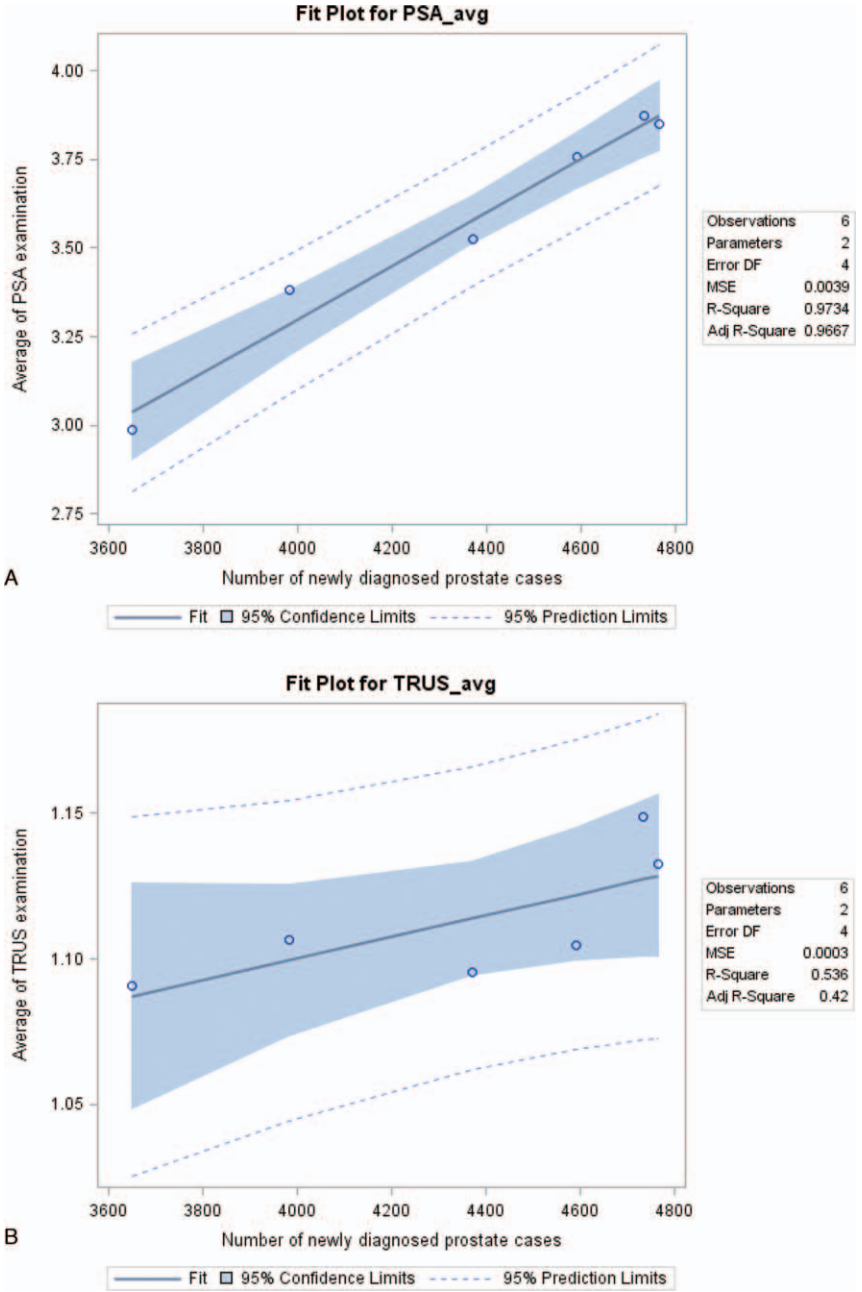

Figure 2. Correlation between average PSA test times (A) and average prostate biopsy times (B) per person within 3 years before the diagnosis of prostate cancer. PSA = prostate-specific antigen, TRUS = transrectal ultrasound-guided prostate biopsy.

urinary symptoms. Clinicians checked PSA according to patients' ages, symptoms, risk factors for cancer, and their own clinical experiences. One study conducted with NHI dataset in Taiwan showed a high diversity of PSA testing patterns among clinicians.[15] However, there was no large-scale investigation into the trend of PSA testing, and the trend of PSA testing is increasing. The results of our study suggested that increasing incidence of prostate cancer in Taiwan may relate to the increasing usage of PSA tests.

PSA testing was largely used as a screening tool for prostate cancer since the approval by the Food and Drug Administration of America to monitor cancer progression in 1986. The incidence of prostate cancer dramatically increased thereafter, with an increasing rate of 12% per year to the peak in 1992 of 237.2 per 100,000 male population in America.[16] Although early detection of prostate cancer may decrease cancer mortality,[17–19] many studies had revealed possible overdiagnosis of prostate cancer due to PSA screening. Etzioni et al conducted a computer simulation model of PSA screening and compared the results to the prostate cancer incidence in the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) registry data from 1988 to 1998 and found that the possible overdiagnosis rates were 15% and 44% for whites and blacks, respectively, in America during this period.[20] Welch et al used SEER data and age-specific

male population to determine the overdiagnosis of prostate cancer after 1986 and reported that >1 million additional men were diagnosed with prostate cancer and treated in America from 1986 to 2005 after the introduction of PSA, and the increased cancer cases were dramatic in younger men.[16] Overdiagnoses of prostate cancer by PSA screening may result in unnecessary prostate biopsy, which has possible complications, and overtreatments of early stage and low-risk prostate cancer, which may be indolent and asymptomatic that would not affect patient's life expectancy or life quality.[21]

The result of our study also showed that the increase in patients with newly diagnosed prostate cancer was correlated with increased PSA testing. The trend of diagnosis at a younger age is similar in our data. During the 8-year study period, the patients tend to be younger when they were diagnosed with prostate cancer, with 47.2% to 38.78% in the 71- to 80-year age group, 25.16% to 27.77% in 61- to 70-year age group, and 6.35% to 9.23% in the 51- to 60-year age group from 2006 to 2013. However, the distribution of cancer stages at diagnosis did not significantly shift to an early stage in our data. The possible reasons for this difference are the different medical-service-utilizing habits between younger and older people in Taiwan. The younger population tends to undergo regular health examination and seek medical treatments when they feel any discomfort, whereas many older people would only go to the hospital when the symptoms are severe.

The US Preventive Services Task Force Recommendation Statement had suggested against PSA screening for patients older than 75 years in 2008 and further against PSA screening for all men in 2012.[22] An analysis conducted by Jemal et al showed that the incidence of prostate cancer per 100,000 population for men older than 50 years in America decreased from 540.8 in 2008 and 505.0 in 2010 to 416.2 in 2012.[23] Another study by Gershman et al revealed that the prostate biopsy rates in America significantly decreased after the 2008, 2012, and 2013 American Urological Association guidelines were published.[24] Indeed, recommendations and guidelines may affect clinical practices of physicians and hence result in changes in the epidemiology of cancer and associated evaluations and treatments. However, in consideration of the different medical-service-utilizing patterns and no significant increase in early-stage cancer diagnoses, further analysis of biopsy rates and complications, treatment patterns, and survival of patients with prostate cancer is needed to address if PSA screening is necessary in Taiwan.

In addition to PSA screening, some other risk factors such as environmental factors and diet were shown to be related to prostate cancer. In the signature study conducted by Shimizu et al, Japanese immigrants in Los Angeles had a higher incidence of prostate cancer than those in the homeland.[25] Western food was popular in Taiwan since 20 to 30 years ago. This could possibly also affect the incidence of prostate cancer. However, there was no related data about diet in the database we used for the present study. Instead, we analyzed some underlying diseases related to metabolic syndrome. Metabolic syndrome is a clustering of several medical conditions, such as central obesity, high blood pressure or blood sugar level, high serum triglyceride level, and low high-density lipoprotein levels. Many studies were conducted to evaluate the relationship between metabolic syndrome and prostate cancer, but the effect is not conclusive.[26,27] The main impact of metabolic syndrome on prostate cancer is on aggressive cancer features and worse outcome.[28] A recent study revealed that cancerous cells' response to cellular adenosine triphosphate (ATP) depletion may be the possible mechanism.[9] We investigated the underlying diseases of hypertension, diabetes mellitus, and hyperlipidemia, which were diagnosed at least 1 year before the diagnosis of prostate cancer. The result showed that the percentage of patients with these chronic comorbidities at diagnosis of prostate cancer increased yearly. This may imply diseases related to metabolic syndrome might also play a role in tumorigenesis of prostate cancer.

There were some limitations of this study. First, no PSA values for each test in the database were available. Hence, we cannot confirm whether increasing PSA testing is related to increasing abnormal PSA results that need close follow-up or simply just for PSA. Second, body weight or body mass index was not included in the database. The *ICD-9-DM* code for metabolic syndrome was not frequently coded by clinicians in Taiwan. Therefore, we used other chronic comorbidities for the study. However, the age and comorbidities were not adjusted, and aging is related to the development of these chronic diseases; thus, there is a possible bias in this point. Third, we used a cross-sectional study design to investigate the association of metabolic syndrome and the incidence of prostate cancer. The main reason is that the study period of our database in not long enough to conduct a cohort study since the development of prostate cancer may take up to 10 years. Therefore, we cannot conclude there is a direct correlation of metabolic syndrome and prostate cancer based on our finding but can only say diseases related to metabolic syndrome might play a role in the tumorigenesis of prostate cancer. Lastly, we did not investigate the complications of prostate biopsy and follow-up the outcome of patients with prostate cancer, so the impact of increasing PSA testing on cancer mortality could not be assessed. Nevertheless, this is a nationwide population-based cohort study, and it shows the trends of prostate cancer incidence, age at diagnosis, PSA testing status, and the possible impact of underlying diseases on prostate cancer in Taiwan, where the epidemiology of prostate cancer may be different from Western countries.[29]

5. Conclusion

In the present study, we showed that the increasing incidence of prostate cancer in Taiwan may be related to the increasing usage of PSA tests. Increasing PSA test numbers are correlated with the increasing diagnosis of prostate cancer. The percentage of patients with underlying diseases related to metabolic syndrome at diagnosis of prostate cancer increased, implying that metabolic syndrome may play a role in the development of prostate cancer. Further analysis of biopsy complications, cancer stages, and prognosis is needed to evaluate whether PSA screening is necessary in Taiwan for better cancer survival or may also result in overdiagnosis and overtreatments.

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