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Novel insights into clinical characteristics and in-hospital outcomes of patients undergoing percutaneous coronary intervention in Vietnam

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ABSTRACT

Background: Little is known about percutaneous coronary intervention (PCI) practices and outcomes in low-and middle-income nations, despite its rapid uptake across Asia. For the first time, we report on clinical characteristics and in-hospital outcomes for patients undergoing PCI at a leading cardiac centre in Vietnam.

Methods: Information on characteristics, treatments, and outcomes of patients undergoing PCI was collected into the first PCI registry through direct interviews using a standardised form, medical record abstraction, and reading PCI imaging data on secured disks. Subgroup analysis was also conducted to explore gender differences.

Results: Between September 2017 and May 2018, 1022 patients undergoing PCI were recruited from a total of 1041 procedures. The mean age was 68.3 years and two thirds were male. While 54.4% of patients presented with acute coronary syndromes, the rate of ST-elevation myocardial infarction was 14.5%. The majority of lesions were classified as type B2 and C and the radial artery was the most common access location for PCI (79.2%). The use of drug-eluting stents was universal and the angiographic success rate was 99.4%. Cardiac complications following PCI were rare with the exception of major bleeding (2.0%). Female patients were older with relatively more comorbidities and a higher incidence of major bleeding than males ($p < 0.05$).

Conclusions: Findings of this study provide an opportunity to benchmark current PCI practices in Vietnam, identify possible care gaps and potentially inform the adoption of treatment guidelines as well as use of prevention strategies.

1. Introduction

Percutaneous coronary intervention (PCI) has been demonstrated to be an effective treatment for coronary heart disease (CHD) worldwide since its inception in the late 1970s [1,2]. The procedure has become more widely used in Asia, where CHD was the leading cause of death (approximately 16.2% of all deaths in 2016) [3,4], with around one million PCIs undertaken in 2016 alone [5]. Notwithstanding the apparent benefits of PCI, post-procedural cardiac complications remain a concern, including death, myocardial infarction (MI) and bleeding [6,7].

Abbreviations: ACC/AHA, American College of Cardiology/American Heart Association; ACS, Acute coronary syndrome; APAC, Asia-Pacific; CABG, Coronary artery bypass grafts; CHD, Coronary heart disease; DAPT, Dual-anti platelet therapy; DES, Drug eluting stent; ECG, Electrocardiogram; GRACE, Global Registry of Acute Coronary Events; MI, Myocardial infarction; NSTEMI, Non-ST-elevation myocardial infraction; PCI, Percutaneous coronary intervention; STEMI, ST-elevation myocardial infraction; UA, Unstable angina; VNHI, Vietnam National Heart Institute.

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Accumulating data in the USA and Europe have shown that the occurrence of these adverse cardiac events differed according to patient characteristics, such as gender, age or comorbidities [6,8,9]. In Asia, cardiac registries in some high-income countries have also reported similar findings [10,11], while relevant data remains limited in lower-and middle-income countries. Additionally, most medical care provided for CHD patients in Asian countries is based on the European or North American guidelines developed from large domestic registries [12–14]. It is not clear whether the non-Asian data reflects the Asian experience, nor whether the guidelines are well suited to the Asian population. Thus, data from real-world practice in less developed countries are very important to establish current benchmarks and determine appropriate management and preventive strategies for these populations.

Vietnam is a middle-income nation in South-East Asia, where PCI has been widely used in modern cardiac based treatments for CHD, the second leading cause of death [15]. Data pertinent to PCI is scare on the epidemiology, management and outcomes of patients undergoing the procedure in Vietnam [16]. The aim of this paper is to provide novel insights concerning the clinical characteristics and in-hospital outcomes of patients undergoing PCI in Vietnam based on the first PCI registry conducted at a leading cardiac hospital in Vietnam.

2. Methods

2.1. Study setting

Data were derived from a registry, which was established at the Vietnam National Heart Institute (VNHI), Hanoi, Vietnam during September 2017-May 2018. Full details of this PCI registry was previously described [17]. As the leading cardiac centre nationwide, VNHI provides the highest quality of healthcare services for around 17,000 cardiovascular inpatients and 80,000 out-patients annually. In 2018, the total number of cardiac interventional procedures undertaken at VNHI was approximately 12,000 [16]. Initial discussions were held with clinical leaders in cardiology to ensure there was support for the implementation of the registry by senior clinical and executive staff.

2.2. Data collection

This single-centre, hospital-based registry adapted the data collection forms currently used in the Victorian Cardiac Outcomes and Melbourne Interventional Group registries, Australia [18,19]. Information on demographic, clinical and procedural information, and outcomes of patients who underwent PCI was recorded on standardised data abstraction forms with standard definitions for all fields. The study protocol was approved by the Curtin University Ethics Committee before the commencement of data collection (HRE 2017-0378). Patients had the right to opt out of the study without impacting on their care. Data collection was conducted by a team of specifically trained local investigators at VNHI.

2.2.1. Patient characteristics

Information on participant demographics, medical history, cardiovascular risk factors (diabetes, hypertension, dyslipidemia, cerebrovascular disease), clinical symptoms and presentation (acute coronary syndrome (ACS), cardiogenic shock, cardiac arrest), left ventricular ejection fraction, and pre-procedural renal status was collected via both patient interviews and medical records. ACS includes unstable angina (UA), non-ST-elevation myocardial infraction (NSTEMI) or ST-elevation myocardial infraction (STEMI). STEMI was defined as the presence of at least 0.1-mV ST-segment elevation or new pathological Q waves in ≥ 2 contiguous ECG leads or new left bundle branch block with elevation of cardiac enzyme levels above the reference range. NSTEMI was defined if either of the following was present: elevated cardiac enzyme levels above the reference range, ST-segment depression, T-wave abnormalities or ischemic symptoms. UA was named in the presence of prolonged chest pain without cardiac enzyme elevation.

2.2.2. Procedures and medications

The strategy for the specific coronary intervention (e.g. choice of stent, medication) was at the discretion of the interventionists. Injured lesion segments were coded following the classification of the Syntax Score [20] and guidelines for the lesion type of American College of Cardiology/ American Heart Association (ACC/AHA) [21]. A procedure was considered successful if there was a residual stenosis of less than 10% following coronary stenting and the rate of coronary blood perfusion of Thrombosis in Myocardial Infarction 2 or 3 flow. Pre and post procedural medical therapies such as oral antiplatelet, aspirin, anti-thrombin, and glycoprotein IIb/IIIa inhibitors were evaluated according to the 2016 ACC/AHA guidelines [22]. Medications and procedural data were obtained by extracting medical records and reading secured procedural disks.

2.2.3. Clinical outcomes

Medical records were extracted to document in-hospital complications including death, new or recurrent MI, cardiogenic shock, bleeding, post-procedural renal impairment, new requirement for dialysis, unplanned target vessel revascularisation (revascularisation for the previously cured coronary artery) by PCI or coronary artery bypass grafts (CABG), stent thrombosis, and stroke. MI was defined as an elevation of cardiac biomarkers more than 5 the upper limit of normal, and evolutionary ST-segment elevations or development of new Q-waves in at least 2 contiguous ECG leads. Cardiogenic shock was defined by hypotension (systolic BP <90 mmHg lasted from 30 min and over, evidence of end-organ hypo perfusion or elevated filling pressures).

Bleeding was classified by the Bleeding Academic Research Consortium [23], and major bleeding was defined by any transfusion or by a drop in haemoglobin ≥ 3.0 g/dl. Acute renal impairment was defined as a rise of creatinine ≥ 44.2 μmol/L or $\geq 25\%$ up to 5 days after the index PCI, compared to baseline creatinine. Stroke was defined as the patient's persistent loss of neurological function due to an ischaemic or haemorrhagic event [24]. Stent thrombosis was defined as the occurrence of a thrombus or angiographic documentation of vessel occlusion within a pre-existing stent or within 5 mm of the proximal or distal stent edges [25]. Medical records were reviewed to identify these cardiac events.

2.3. Statistical analysis

Data on demographic, clinical, procedures and outcomes were presented as numbers (and percentages) for categorical variables, and means (with standard deviations) for continuous variables. Descriptive statistics were used to summarise characteristics of the study participants. Fisher exact or Chi-square tests were undertaken to compare categorical variables, and Student's t tests or analysis of variance (ANOVA) were applied to compare continuous variables. All p-values were two-tailed with significance defined as $p \leq 0.05$. All statistical analyses were performed using the SPSS statistical package (SPSS Version 20.0 for Windows; SPSS Inc., Chicago, IL).

Table 1
Clinical characteristics (n = 1022).

	Overall	Female	Male	P value*
Patients	1022	326 (31.9)	696 (68.1)	_
Age (years), mean ± SD	68.3 ± 10.3	70.9 ± 9.4	67.0 ± 10.5	<0.0001 †
Kinh people	989 (96.7)	321 (98.5)	667 (95.8)	0.045
From provinces outside Hanoi	796 (77.9)	233 (71.5)	563 (80.9)	0.001
Education				
Primary school and lower	83 (8.1)	47 (14.4)	36 (5.2)	<0.0001
Secondary school	367 (35.9)	122 (37.4)	245 (35.2)	
High school	164 (16.0)	40 (12.3)	124 (17.8)	
College and higher	408 (39.9)	117 (35.9)	291 (41.8)	
Current/ past occupation				
Officer worker	389 (38.1)	120 (36.8)	269 (38.6)	<0.0001
Manual worker	163 (15.9)	67 (20.6)	96 (13.8)	
Farmer	255 (25.0)	107 (32.8)	148 (21.3)	
Tradesperson	64 (6.3)	17 (5.2)	47 (6.8)	
Others	151 (14.8)	15 (4.6)	136 (19.5)	
Poverty [a]	44 (4.3)	19 (5.8)	25 (3.6)	0.175
Low income [b]	762 (74.5)	279 (85.6)	483 (69.4)	<0.0001
Body mass index (kg/m^2)				0.071
Low (<18.5)	107 (10.5)	38 (11.7)	69 (9.9)	
Normal (18.5–22.9)	518 (50.7)	178 (54.6)	340 (48.9)	
High (≥23.0)	397 (38.8)	110 (33.7)	287 (41.2)	
ST-elevation myocardial infarction	148 (14.5)	38 (11.7)	110 (15.8)	0.097
Non-ST-elevation myocardial infarction	166 (16.2)	57 (17.5)	109 (15.7)	0.518
Unstable angina	242 (23.7)	83 (25.5)	159 (22.8)	0.402
Non-acute coronary syndrome	466 (45.6)	148 (45.4)	318 (45.7)	0.931
Left ventricular ejection fraction (%), mean ± SD	59.4 (±14.7)	61.7 (±14.6)	58.2 (±14.7)	0.001 †
Moderate to severe renal impairment [c]	25 (2.4)	5 (1.5)	20 (2.9)	0.283
Cardiogenic shock	11 (1.1)	3 (0.9)	8 (1.1)	>0.999
Cardiac arrest	6 (0.6)	2 (0.6)	4 (0.6)	>0.999

Data are presented as n (%), otherwise specified.
*Comparing female and male subjects; [a] Obtained certificates of poor and near poor household; [b] Individual monthly income < 216 USD with the exchange rate of 23.150 VND; [c] Creatinine > 200 μmol/L.

3. Results

3.1. Patient characteristics

A total of 1022 patients were enrolled into the registry. Of these, 19 patients had a second PCI, meaning a total of 1041 procedures, treating 1276 lesions.

Demographics and clinical characteristics of participants are summarized in Table 1. Two-thirds of the study population were male. The participants' mean age (±SD) was 68.3 years (10.3) and females were approximately 4 years older than men ($p < 0.0001$). The majority of patients were Kinh (96.7%), the largest ethnic group in Vietnam, and those living in other provinces outside Hanoi accounted for nearly 80%. The proportions of participants with college or higher education, conducting office work and with a low income were 39.9%, 38.1% and 74.5%, respectively.

In total, 54.4% of the patients presented with ACS, with the respective prevalence of STEMI, NSTEMI and UA being 14.5%, 16.2% and 23.7% (Table 1). Only 1.1% of the participants experienced cardiogenic shock, and 0.6% had cardiac arrest before PCI. The prevalence of overweight or obesity (BMI ≥ 23.0 kg/m^2) was 38.8%. The prevalence of hypertension, previous PCI and hyperlipidaemia were 67.2%, 35.1% and 29.9%, respectively (Fig. 1).

Compared with males, females had a lower education level, monthly income and were more likely to do manual work ($p < 0.0001$). Additionally, females also had a higher prevalence of risk factors such as hypertension, diabetes, and hyperlipidaemia ($p < 0.05$) with the exception of current smoking and previous PCI ($p < 0.05$) compared to males.

3.2. Lesion, procedural characteristics and medications prior to PCI

There were 1276 lesions which required subsequent treatment within 1041 procedures (Table 2). A total of 1275 lesions was used for analysis due to missing information of one lesion. Radial artery and left anterior descending (LAD) were the most common procedural entry and target vessel (79.2% and 46.7%, respectively). 11.9% patients were undergone left main PCI. Although 94.2% of the lesions were type B2 and C according to ACC/AHA classification, there was a high rate of angiographic success (99.4%). Just above one-third of the lesions required at least 2 stents and almost 96% of stents used were over 20 mm in length. Drug eluting stents (DES) were used in all cases and IVUS was utilized in 3.6% of cases. Common agents used prior to PCI were antithrombin, clopidogrel and aspirin, accounting for 36.2%, 80.0% and 97.5%, respectively. Prior to procedures, patients were given low-molecular-weight-heparin, while unfractionated heparin was used during PCI.

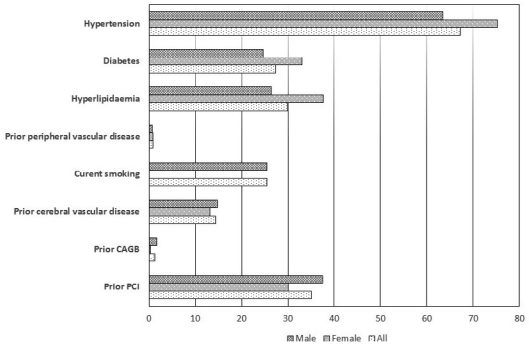

Fig. 1. Risk factors of study participants.

Compared with females, males were more likely to have disease in the left main coronary artery, chronic total occlusions, stent restenosis, and ≥ 2 stents per lesion ($p < 0.05$). They tended to receive ticagrelor, while their female counterparts were relatively

Table 2
Lesion, procedural characteristics and medications prior to PCI (n = 1276*).

	Overall	Female (n = 406)	Male (n = 870)	P value
Lesions	1276	406 (31.8)	870 (68.2)	_
Percutaneous entry location				
Radial	824 (79.2)	263 (79.2)	561 (79.1)	>0.999
Femoral	217 (20.8)	69 (20.8)	148 (20.9)	
Target vessel				
Left main	152 (11.9)	29 (7.1)	123 (14.2)	<0.0001
Left anterior descending	596 (46.7)	208 (51.2)	387 (44.5)	0.030
Right coronary	406 (31.8)	118 (29.1)	288 (33.1)	0.164
Circumflex	271 (21.2)	80 (19.7)	191 (22.0)	0.394
PCI with ≥ 2 lesions	218 (17.1)	69 (17.0)	149 (17.1)	>0.999
Type B2 and C lesions	1202 (94.2)	381 (93.8)	821 (94.5)	0.745
Chronic total occlusion	61 (4.8)	10 (2.5)	51 (5.9)	0.012
Restenotic lesions	64 (5.0)	11 (2.7)	53 (6.1)	0.014
Stents used for each lesion				
≤1	788 (61.8)	271 (66.7)	517 (59.5)	0.015
≥2	487 (38.2)	135 (33.3)	352 (40.5)	
Mean (±SD)	1.5 (±0.71)	1.42 (±0.64)	1.54 (±0.74)	0.002
Stent length > 20 mm	1181 (95.9)	375 (95.2)	806 (96.2)	0.502
Mean stent length (±SD)	34.6 (±8.7)	34.5 (±8.9)	34.7 (±8.7)	0.656
Angiographic success	1267 (99.4)	405 (99.8)	862 (99.2)	0.448
Drug-eluting stent use	1231 (96.5)	394 (97.3)	837 (97.1)	0.998
Balloon only	36 (2.8)	11 (2.7)	25 (2.9)	
Guidance of IVUS	46 (3.6)	13 (3.2)	33 (3.8)	0.654
Medications				
Fibrinolytic therapy	2 (0.2)	1 (50.0)	1 (50.0)	0.536
Glycorprotein IIb/IIIa	0 (0.0)			
Antithrombin therapy	377 (36.2)	111 (34.3)	266 (37.5)	0.227
Ticagrelor	176 (16.9)	35 (10.5)	141 (19.9)	<0.0001
Clopidogrel/Ticlopidine	833 (80.0)	284 (85.5)	549 (77.4)	0.003
Aspirin	1015 (97.5)	320 (96.4)	695 (98.0)	0.172

*missing information of one lesion.
Data are presented as n (%), unless specified. IVUS: Intravascular Ultrasound.

more likely to be prescribed with clopidogrel prior to PCI (both p < 0.05).

3.3. In-hospital outcomes and medications post PCI

Complications following PCI during hospital stay were rarely observed, with a relatively small proportion of new renal impairment and post-procedural bleeding (3.2% and 2.0%, respectively) (Table 3). Median length of hospital stay was 2 days and over 92% of patients were treated with aspirin, antiplatelet, angiotensin receptor blockers and statin post PCI as recommended in the ACC/AHA guideline [22].

Major bleeding rate was higher in females than males (p < 0.05). Ticagrelor was commonly used in males, while clopidogrel was frequently prescribed in the latter (p < 0.0001).

4. Discussion

This study was the first to provide novel insights into demographic and clinical characteristics as well as in-hospital outcomes of patients undergoing PCI at a leading cardiac interventional centre in Vietnam. The results indicated gender differences in several demographic and socioeconomic factors, clinical presentation and treatment which may be potentially important in the design of optimal care.

4.1. Demographic and clinical characteristics

The mean age of patients received PCI in our study was eight year younger than the overall national life expectancy in 2016 of 76.3 [26]. However, this age is higher than average ages of other PCI populations, including neighbouring countries with similar life expectancy such as China, Thailand and Malaysia (62.0, 62.7 and 57.0 years old, respectively) [27–29] and countries with more economical development and higher life expectancy such as Australia, Japan and South Korea (approximately 63.0–65.0 years old) [7,18,30]. As patients at VNHI were largely transferred from lower level hospitals, our study population tended to have more comorbidities and older age. Potential barriers to receive timely care such as medical awareness of patients, economic resource and family constraints should be further investigated.

The prevalence of non ACS (45.6%), STEMI (14.5%), NSTEMI (16.2%) and UA (23.7%) were generally comparable to data derived from a recent study of the national PCI registry in Thailand [31]. However, ACS presentation was more common in other PCI registries, especially with the proportion of STEMI patients (over 30%) [18,28]. For instance, the China PEACE registry reported that the prevalence of STEMI, NSTEMI and UA in patients undergoing PCI was 34.8%, 8.1% and 41.8% respectively [29]. One possible explanation is that acute patients were more likely to receive medical therapy or PCI in district or provincial hospitals, and only more severe patients were referred to VNHI.

Consistent with previous studies, including the Asia-Pacific Evaluation of Cardiovascular Therapies collaborative study [32], our study participants generally presented with common cardiovascular disease risk factors such as hypertension, diabetes, dyslipidaemia, past PCI, prior stroke and smoking. It is interesting that the prevalence of most those risk factors in our study was similar, despite a much lower proportion of dyslipidaemia (30%). For instance, some recent studies in China, Thailand, Malaysia and Australia showed that approximately two thirds of their patients experienced hyperlipidaemia [18,28,29,31]. Reasons for such difference are not clear, but it may be due, in part, to a conceivably healthy and low-fat diet of our study participants [33]. Indeed, the prevalence of prior stroke and prior PCI in our study were among the highest in comparison with other studies [18,28,29,31]. The rapid

Table 3
In-hospital outcomes and medications post PCI (n = 1041).

Outcomes	All (n = 1022)	Female (n = 332)	Male (n = 709)	p
New renal impairment	33 (3.2)	11 (3.3)	22 (3.1)	>0.999
New dialysis	9 (0.9)	1 (0.3)	8 (1.1)	0.286
Cardiogenic shock	4 (0.4)	1 (0.3)	3 (0.4)	>0.999
New/recurrent MI	3 (0.3)	2 (0.6)	1 (0.1)	0.24
Unplanned PCI	2 (0.2)	1 (0.3)	1 (0.1)	>0.999
Stent thrombosis	2 (0.2)	2 (0.6)	0 (0.0)	0.102
Major bleeding	21 (2.0)	12 (3.6)	9 (1.3)	0.023
Stroke	5 (0.5)	1 (0.3)	4 (0.6)	>0.999
Death	8 (0.8)	4 (1.2)	4 (0.6)	0.47
Hospital length (day), median	2.0	2.0	2.0	0.69
Hospital length > 2 days	33.0	34.3	32.4	0.59
Medications				
Aspirin	1033 (99.7)	329 (99.7)	704 (99.7)	>0.999
Clopidogrel/Ticlopidine	835 (80.5)	290 (87.8)	545 (77.2)	<0.0001
Ticagrelor	201 (19.5)	40 (12.2)	161 (22.9)	<0.0001
Beta Blockers	397 (38.5)	138 (41.8)	259 (37.0)	0.125
Angiotensin-receptor blockers	952 (92.2)	308 (93.6)	644 (91.6)	0.317
Statin	1033 (99.7)	330 (100.0)	703 (99.6)	0.556
Other lipid lowering therapy	3 (0.3)	3 (0.9)	0 (0.0)	0.032
Oral anticoagulation therapy	4 (0.4)	2 (0.6)	2 (0.3)	0.956

Data are presented as n (%), unless specified.

expansion of PCI in recent years and strokes remain the leading cause of death in Vietnam might explain for this difference [26].

Patterns of gender differences in demographic, socioeconomic and clinical factors are consistent with prior research [8,34,35]. For example, our study showed females receiving PCI accounted for nearly one-third of total participants, those females were generally older and had more comorbidities than males. In our data, the female to male ratio was 0.47, which contrasts with the general Vietnamese population group age 64 and above which has a female to male ratio of 1.6 [36]. This lower incidence of PCI in females might be explained by the relatively lower priority in families of females compared to males in Vietnamese culture. This may be exacerbated by the high cost requirement of the procedure itself and other hospital treatments in the national centre as VNHI. More males were transferred from other provinces to VNHI for PCI in comparison to females ($p = 0.001$), which may support this theory. Additionally, presenting females were on average 4 years older than males ($p < 0.0001$). The protective impact of oestrogen in females in delaying the onset of cardiovascular disease is likely to be part of the explanation [37]. The 4-year age gap also partly explains more comorbidities seen in females such as hypertension, diabetes and hyperlipidaemia in our study. The Global Registry of Acute Coronary Events (GRACE) indicated that, in the group of patients undergoing cardiac intervention, females had higher rates of diabetes, hypertension, but were less likely to smoke [9]. Data from several systematic review with meta-analysis also confirmed that females with cardiovascular risk factors were more likely to have incident CHD than males [38,39].

4.2. Lesion, procedural characteristics and medications prior to PCI

The radial artery was the most common entry site of PCI procedures, which is similar to the practice in China [29], but different from Australia, Japan and Malaysia where the femoral access is quite popular [28,30,34]. The prevalence of treated lesions classified as ACC/AHA type B2 and C in our study (94%) is higher than data in previous studies (60–70%) [18,31]. VNHI is the largest provider of cardiac intervention nationwide, where patients with PCI may have advanced coronary lesions subsequent to milder lesions being treated at other hospitals with potential less experienced interventionists. Greater number of type B2 and C lesions might also be attributed to the use of longer stents in our study. The use of DES was universal, which contrasts with a more mixed picture elsewhere [8,34,35]. In our study, not all left main PCIs were accompanied with IVUS use, partly due to the high cost and the avaibility of this technique in the centre. Regarding medication used, our patients were less likely to receive glycoprotein IIb/ IIIa, but tended to be prescribed with ticagrelor when compared to their counterparts in other studies [34,40]. Similar to some regional countries [7,18,28], our data showed the left anterior descending and the right coronary artery were the most common lesion locations and the rate of in-stent restenosis was low (5%). The procedural success rate was as high as other countries in the Asia Pacific (APAC) region, despite some differences in clinical practices [32].

It is worth mentioning some gender differences observed in the present study. In general, females receiving PCI had lower procedural risks relative to males. Results from the GRACE registry indicated that females were more likely to have normal/mild diseases and less likely to have injured lesion in left main vessel [9]. Although this is not direct comparison as GRACE contained patients undergoing catheterization only, our finding is in line with that result. Similarly, a nationwide study in patients undergoing PCI in Korea reported that males had more chronic lesions in left main vessel, and required a higher number of stents than females [35]. Data from a national cardiovascular registry in America also revealed that females had a lower risk of angiographic features, and needed shorter stents [8].

4.3. In-hospital outcomes and medications post PCI

Overall, our data showed lower rates of in-hospital outcomes among patients undergoing PCI compared with other countries in the APAC region [32]. For instance, the rate of in-hospital death (0.8%) was the lowest when compared to the corresponding data in other studies in China (2.2%), Korea (2.3%) and Australia (2.2%) [18,29,41]. Our PCI participants were also more likely to have shorter hospital stay (2 days) than their counterparts in China (10 days) and Australia (4.2 days) [18,29]. Shorter duration of hospital stay may indicate a low mortality rate before discharge in this study, and such a potential relationship will be investigated in the future. Regarding post procedural medication use, our results are in line with some other reports in Asia. For instance, aspirin was immediately provided to most patients after PCI procedure and

remained until post discharge [14]. Despite the wide variation of dual-anti platelet therapy (DAPT) in the region, aspirin and clopidogrel were also used as the most common DAPT in our study, so were studies from Korea and China [7,29].

Previous studies have largely reported that, females were at a higher risk of having complications or worse PCI-specific outcomes, e.g. death, bleeding or cardiogenic shock than males [8,34,42]. Likewise, females in our study were more likely to have major bleeding relative to males. It is possible that females were older, had a higher prevalence of coronary risk factors, and a smaller body size as well as smaller arteries than males at the time of PCI procedure [8,35]. It is also worth noting that most current PCI-based devices and medication therapies have been designed relatively equally between males and females, without a specific gender indication [43]. Thus, more focused efforts should be taken to prevent and reduce bleeding complications in female patients with PCI.

4.4. Study limitations

There are some limitations to our study. Despite data was collected at the national and biggest cardiac interventional centre in Vietnam, our findings might not be representative of the whole nation, particularly in terms of lesion type and uptake of cutting-edge interventions as VNHI is a single centre only. Furthermore, some uncertainties and recall errors of patients in self-reporting the socioeconomic status as well as cardiovascular risk factors might occur, which can contribute to the differences observed. Additional dedicated studies should be conducted to provide more overall views of PCI practices in Vietnam.

5. Conclusion

Our study based on the first Vietnamese PCI registry provides an opportunity to understand current insights of clinical characteristics and in-hospital outcomes of patients undergoing PCI in Vietnam. It also indicated gender differences in demographic and clinical characteristics together with procedural performance and in-hospital outcomes. The findings may contribute to evaluating PCI-related practices, identifying the gaps in sex-specific care for cardiovascular health, and potentially developing appropriate treatment guidelines.

Declaration of Competing Interest

The authors report no relationships that could be construed as a conflict of interest.

Acknowledgment

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References

[1] O. Soran, A. Manchanda, S. Schueler, Percutaneous coronary intervention versus coronary artery bypass surgery in multivessel disease: a current perspective, Interactive CardioVascular Thoracic Surgery 8 (6) (2009) 666–671.
[2] M. Movahed, R. Ramaraj, M. Jamal, M. Hashemzadeh, Nationwide trends in the utilisation of percutaneous coronary intervention (PCI) in the United States of America based on gender and ethnicities, EuroIntervention 5 (3) (2009) 343–348.
[3] World Health Organization. Health statistics and information systems. Disease burden, 2000-2016. 2017 [Available at: http://www.who.int/healthinfo/global_burden_disease/estimates/en/index1.html . Accessed September 12, 2019].
[4] H. Thomas, J. Diamond, A. Vieco, S. Chaudhuri, E. Shinnar, S. Cromer, P. Perel, G. A. Mensah, J. Narula, C.O. Johnson, G.A. Roth, A.E. Moran, Global Atlas of Cardiovascular Disease 2000-2016: the path to prevention and control, Glob Heart 13 (3) (2018) 143, https://doi.org/10.1016/j.gheart.2018.09.511.
[5] R. Gao, The evolution of percutaneous coronary intervention in Asia: in celebration of the 40th anniversary of percutaneous transluminal coronary angioplasty, Asia Intervention 3 (2017) 95–96.
[6] B. Ricci, O. Manfrini, E. Cenko, Z. Vasiljevic, M. Dorobantu, S. Kedev, G. Davidovic, M. Zdravkovic, O. Gustiene, B. Knežević, D. Miličić, L. Badimon, R. Bugiardini, Primary percutaneous coronary intervention in octogenarians, Int. J. Cardiol. 222 (2016) 1129–1135.
[7] S. Han, G.-M. Park, Y.-G. Kim, M.-W. Park, S.H. Her, S.-W. Lee, Y.-H. Kim, Trends, characteristics, and clinical outcomes of patients undergoing percutaneous coronary intervention in Korea between 2011 and 2015, Korean Circ J 48 (4) (2018) 310, https://doi.org/10.4070/kcj.2017.0359.
[8] N. Akhter, S. Milford-Beland, M.T. Roe, R.N. Piana, J. Kao, A. Shroff, Gender differences among patients with acute coronary syndromes undergoing percutaneous coronary intervention in the American College of Cardiology-National Cardiovascular Data Registry (ACC-NCDR), Am. Heart J. 157 (1) (2009) 141–148.
[9] S. Dey, M.D. Flather, G. Devlin, D. Brieger, E.P. Gurfinkel, P.G. Steg, G. FitzGerald, E.A. Jackson, K.A. Eagle, Sex-related differences in the presentation, treatment and outcomes among patients with acute coronary syndromes: the Global Registry of Acute Coronary Events, Heart 95 (1) (2009) 20–26, https://doi.org/10.1136/hrt.2007.138537.
[10] H. Kaneko, J. Yajima, Y. Oikawa, S. Tanaka, D. Fukamachi, S. Suzuki, K. Sagara, T. Otsuka, S. Matsuno, R. Funada, H. Kano, T. Uejima, A. Koike, K. Nagashima, H. Kirigaya, H. Sawada, T. Aizawa, T. Yamashita, Impact of aging on the clinical outcomes of Japanese patients with coronary artery disease after percutaneous coronary intervention, Heart Vessels 29 (2) (2014) 156–164.
[11] Y.-J. Li, S.-W. Rha, K.-Y. Chen, Z. Jin, Y. Minami, L. Wang, Q. Dang, K.L. Poddar, S. Ramasamy, J.-Y. Park, D.J. Oh, M.H. Jeong, Clinical characteristics and mid-term outcomes of acute myocardial infarction patients with prior cerebrovascular disease in an Asian population: lessons from the Korea Acute Myocardial Infarction Registry, Clin. Exp. Pharmacol. Physiol. 37 (5-6) (2010) 581–586.
[12] D. Hasdai, S. Behar, L. Wallentin, N. Danchin, A.K. Gitt, E. Boersma, et al., A prospective survey of the characteristics, treatments and outcomes of patients with acute coronary syndromes in Europe and the Mediterranean basin; the Euro Heart Survey of Acute Coronary Syndromes (Euro Heart Survey ACS), Eur. Heart J. 23 (2002) 1190–1201.
[13] A. Budaj, D. Brieger, P.G. Steg, S.G. Goodman, O.H. Dabbous, K.A.A. Fox, A. Avezum, C.P. Cannon, T. Mazurek, M.D. Flather, F. Van De Werf, Global patterns of use of antithrombotic and antiplatelet therapies in patients with acute coronary syndromes: insights from the Global Registry of Acute Coronary Events (GRACE), Am. Heart J. 146 (6) (2003) 999–1006.
[14] Y. Huo, P. Thompson, W. Buddhari, J. Ge, S. Harding, L. Ramanathan, E. Reyes, A. Santoso, L.-W. Tam, G. Vijayaraghavan, H.-I. Yeh, Challenges and solutions in medically managed ACS in the Asia-Pacific region: expert recommendations from the Asia-Pacific ACS Medical Management Working Group, Int. J. Cardiol. 183 (2015) 63–75.
[15] World Health Rankings. Vietnam: Coronary Heart Disease. 2017 [Available at: https://www.worldlifeexpectancy.com/viet-nam-coronary-heart-disease. Accessed September 10, 2019].
[16] Vietnam National Heart Institue. Vietnam National Heart Institute: 28 years development (1989-2017). 2017 [Available at: http://vientimmach.org.vn/. Accessed August 1st 2019.].
[17] H.T.T. Vu, H.T.T. Nguyen, H.M. Pham, L.D. Do, Q.N. Nguyen, R. Norman, R.R. Huxley, N.M. Pham, C.M.Y. Lee, C.M. Reid, Establishment of a percutaneous coronary intervention registry in Vietnam: rationale and methodology, Global Heart 15 (1) (2020) 30, https://doi.org/10.5334/gh.78210.5334/gh.782.s1.
[18] J. Yeoh, M.B. Yudi, N. Andrianopoulos, B.P. Yan, D.J. Clark, S.J. Duffy, et al., Evolution of Australian Percutaneous Coronary Intervention (from the Melbourne Interventional Group [MIG] Registry), Am. J. Cardiol. 120 (2017) 47–54.
[19] D. Stub, J. Lefkovits, A.L. Brennan, D. Dinh, R. Brien, S.J. Duffy, N. Cox, V. Nadurata, D.J. Clark, N. Andrianopoulos, R. Harper, J. McNeil, C.M. Reid, The Establishment of the Victorian Cardiac Outcomes Registry (VCOR): Monitoring and Optimising Outcomes for Cardiac Patients in Victoria, Heart Lung Circulation 27 (4) (2018) 451–463.
[20] Syntax score working group. Syntax score. 2019 [Available at: http://www.syntaxscore.com/ Accessed October 20, 2019.].
[21] G.N. Levine, E.R. Bates, J.C. Blankenship, S.R. Bailey, J.A. Bittl, B. Cercek, C.E. Chambers, S.G. Ellis, R.A. Guyton, S.M. Hollenberg, U.N. Khot, R.A. Lange, L. Mauri, R. Mehran, I.D. Moussa, D. Mukherjee, H.H. Ting, P.T. O'Gara, F.G. Kushner, D.D. Ascheim, R.G. Brindis, D.E. Casey Jr, M.K. Chung, J.A. de Lemos, D. B. Diercks, J.C. Fang, B.A. Franklin, C.B. Granger, H.M. Krumholz, J.A. Linderbaum, D.A. Morrow, L.K. Newby, J.P. Ornato, N. Ou, M.J. Radford, J.E. Tamis-Holland, C.L. Tommaso, C.M. Tracy, Y.J. Woo, D.X. Zhao, 2015 ACC/AHA/SCAI Focused Update on Primary Percutaneous Coronary Intervention for Patients With ST-Elevation Myocardial Infarction: An Update of the 2011

ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention and the 2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Society for Cardiovascular Angiography and Interventions, Circulation 133 (11) (2016) 1135–1147.

[22] G.N. Levine, E.R. Bates, J.A. Bittl, R.G. Brindis, S.D. Fihn, L.A. Fleisher, et al., Correction to: 2016 ACC/AHA Guideline Focused Update on Duration of Dual Antiplatelet Therapy in Patients With Coronary Artery Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines: An Update of the 2011 ACCF/AHA/SCAI Guideline for Percutaneous Coronary Intervention, 2011 ACCF/AHA Guideline for Coronary Artery Bypass Graft Surgery, 2012 ACC/AHA/ACP/AATS/PCNA/SCAI/STS Guideline for the Diagnosis and Management of Patients With Stable Ischemic Heart Disease, 2013 ACCF/AHA Guideline for the Management of ST-Elevation Myocardial Infarction, 2014 AHA/ACC Guideline for the Management of Patients With Non-ST-Elevation Acute Coronary Syndromes, and 2014 ACC/AHA Guidelineon Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery, Circulation 134 (2016) e192–e194.

[23] R. Mehran, S.V. Rao, D.L. Bhatt, C.M. Gibson, A. Caixeta, J. Eikelboom, S. Kaul, S. D. Wiviott, V. Menon, E. Nikolsky, V. Serebruany, M. Valgimigli, P. Vranckx, D. Taggart, J.F. Sabik, D.E. Cutlip, M.W. Krucoff, E.M. Ohman, P.G. Steg, H. White, Standardized bleeding definitions for cardiovascular clinical trials: a consensus report from the bleeding academic research consortium, Circulation 123 (23) (2011) 2736–2747.

[24] R.L. Sacco, S.E. Kasner, J.P. Broderick, L.R. Caplan, J.J.(. Connors, A. Culebras, M.S. V. Elkind, M.G. George, A.D. Hamdan, R.T. Higashida, B.L. Hoh, L.S. Janis, C.S. Kase, D.O. Kleindorfer, J.-M. Lee, M.E. Moseley, E.D. Peterson, T.N. Turan, A.L. Valderrama, H.V. Vinters, An updated definition of stroke for the 21st century: a statement for healthcare professionals from the American Heart Association/American Stroke Association, Stroke 44 (7) (2013) 2064–2089.

[25] G. Lemesle, C. Delhaye, L. Bonello, A. de Labriolle, R. Waksman, A. Pichard, Stent thrombosis in 2008: Definition, predictors, prognosis and treatment, Archives of Cardiovascular Diseases 101 (11-12) (2008) 769–777.

[26] World health rankings. Vietnam Health profile. 2018 [Available at: https://www.worldlifeexpectancy.com/country-health-profile/viet-nam. Accessed August 12, 2019].

[27] R. Krittayaphong, S. Boonbaichaiyapruck, S. Kiatchoosakun, C. Piamsomboon, C. Chotinaiwattarakul, R. Kunjara-Na-Ayudhya, et al., Demographics and Outcomes of Percutaneous Coronary Intervention in Thailand: Data from Thai Percutaneous Coronary Intervention Registry, J. Med. Assoc. Thai 100 (2017) 270–279.

[28] W.A.W. Ahmad, R.M. Ali, M. Khanom, C.K. Han, L.H. Bang, A.F.Y. Yip, A.M. Ghazi, O. Ismail, R. Zambahari, S.K. Hian, The journey of Malaysian NCVD—PCI (National Cardiovascular Disease Database—Percutaneous Coronary Intervention) Registry: a summary of three years report, Int. J. Cardiol. 165 (1) (2013) 161–164.

[29] X. Zheng, J.P. Curtis, S. Hu, Y. Wang, Y. Yang, F.A. Masoudi, J.A. Spertus, X.i. Li, J. Li, K. Dharmarajan, N.S. Downing, H.M. Krumholz, L. Jiang, Coronary Catheterization and Percutaneous Coronary Intervention in China: 10-Year Results From the China PEACE-Retrospective CathPCI Study, JAMA Intern. Med. 176 (4) (2016) 512, https://doi.org/10.1001/jamainternmed.2016.0166.

[30] Y. Numao, S. Suzuki, H. Kano, J. Yajima, Y. Oikawa, S. Matsuno, T. Arita, N. Yagi, H. Semba, Y. Kato, T. Otsuka, T. Uejima, T. Yamashita, Eleven-year temporal trends of clinical characteristics and long-term outcomes in patients undergoing percutaneous coronary intervention for acute coronary syndrome in the Shinken database, Heart Vessels 34 (2) (2019) 199–207.

[31] S.K.P. Kiatchoosakun, P. Kaewsuwana, C. Chotinaiwattarakul, C. Piumsomboon, Percutaneous coronary intervention in the elderly: results from the Thai National Percutaneous Coronary Intervention Regsitry (TPCIR), EuroIntervention 6 (2010) 611–615.

[32] C.M. Reid, B. Yan, W.A. Wan Ahmad, L.H. Bang, S.K. Hian, T. Chua, M. Chan, J. Beltrame, S.J. Duffy, A. Brennan, A. Ajani, The Asia-Pacific Evaluation of Cardiovascular Therapies (ASPECT) Collaboration —Improving the quality of cardiovascular care in the Asia Pacific Region, Int. J. Cardiol. 172 (1) (2014) 72–75.

[33] P.H. Nguyen, G. Strizich, A. Lowe, H. Nguyen, H. Pham, T.V. Truong, S. Nguyen, R. Martorell, U. Ramakrishnan, Food consumption patterns and associated factors among Vietnamese women of reproductive age, Nutr. J. 12 (1) (2013), https://doi.org/10.1186/1475-2891-12-126.

[34] A.H. Al-Fiadh, N. Andrianopoulos, O. Farouque, B.P. Yan, S.J. Duffy, K. Charter, S. Tongyoo, G. New, T. Yip, A. Brennan, G. Proimos, C.M. Reid, A.E. Ajani, D.J. Clark, Contemporary outcomes in women undergoing percutaneous coronary intervention for acute coronary syndromes, Int. J. Cardiol. 151 (2) (2011) 195–199.

[35] D.-W. Park, Y.-H. Kim, S.-C. Yun, J.-M. Ahn, J.-Y. Lee, S.-J. Kang, S.-W. Lee, C.W. Lee, S.-W. Park, S.-J. Park, Sex difference in clinical outcomes after percutaneous coronary intervention in Korean population, Am. Heart J. 167 (5) (2014) 743–752.

[36] Vietnam Population. Vietnam age structure, 2019 [Available at: https://countrymeters.info/en/Vietnam#age_structure. Accessed October 1st, 2019].

[37] E.J. Spary, A. Maqbool, T.F.C. Batten, Oestrogen receptors in the central nervous system and evidence for their role in the control of cardiovascular function, J. Chem. Neuroanat. 38 (3) (2009) 185–196.

[38] S.A.E. Peters, Y. Singhateh, D. Mackay, R.R. Huxley, M. Woodward, Total cholesterol as a risk factor for coronary heart disease and stroke in women compared with men: a systematic review and meta-analysis, Atherosclerosis 248 (2016) 123–131.

[39] S.A.E. Peters, R.R. Huxley, M. Woodward, Diabetes as risk factor for incident coronary heart disease in women compared with men: a systematic review and meta-analysis of 64 cohorts including 858,507 individuals and 28,203 coronary events, Diabetologia 57 (8) (2014) 1542–1551.

[40] C.Y. Lee, N.N. Hairi, W.A. Wan Ahmad, O. Ismail, H.B. Liew, R. Zambahari, R.M. Ali, A.Y.Y. Fong, K.H. Sim, M. Lipinski, Are There Gender Differences in Coronary Artery Disease? The Malaysian National Cardiovascular Disease Database – Percutaneous Coronary Intervention (NCVD-PCI) Registry, PLoS ONE 8 (8) (2013) e72382, https://doi.org/10.1371/journal.pone.007238210.1371/journal.pone.0072382.t001.

[41] J.-S. Jang, K.-R. Han, K.-W. Moon, D.W. Jeon, D.-H. Shin, J.-S. Kim, D.-W. Park, H.-J. Kang, J. Kim, J.-W. Bae, S.-H. Hur, B.O. Kim, D. Choi, H.-C. Gwon, H.-S. Kim, The Current Status of Percutaneous Coronary Intervention in Korea: Based on Year 2014 Cohort of Korean Percutaneous Coronary Intervention (K-PCI) Registry, Korean Circ. J. 47 (3) (2017) 328, https://doi.org/10.4070/kcj.2017.0071.

[42] S.K. Chua, K.G. Shyu, H.F. Hung, J.J. Cheng, H.M. Lo, S.C. Liu, et al., Gender and age differences in short- and long-term outcomes following primary percutaneous coronary intervention for ST-elevation myocardial infarction, Acta Cardiol. Sin. 30 (2014) 274–283.

[43] A.J. Lansky, J.S. Hochman, P.A. Ward, G.S. Mintz, R. Fabunmi, P.B. Berger, G. New, C.L. Grines, C.G. Pietras, M.J. Kern, M. Ferrell, M.B. Leon, R. Mehran, C. White, J.H. Mieres, J.W. Moses, G.W. Stone, A.K. Jacobs, Percutaneous coronary intervention and adjunctive pharmacotherapy in women: a statement for healthcare professionals from the American Heart Association, Circulation 111 (7) (2005) 940–953.