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RESEARCH ARTICLE **OPEN ACCESS**

The Relationship Between Patient Characteristics and Access Site Complications Post PCI: A Cross-Sectional Study

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Abstract:

Introduction: Vascular access complications are among the most common adverse events following percutaneous coronary intervention (*P*CI), often requiring additional recovery and management. Evidence on associated risk factors remains inconsistent, and data from the Middle East are limited.

Methods: A prospective cross-sectional study was conducted in two tertiary hospitals in the United Arab Emirates, adhering to STROBE guidelines. Convenience sampling included 211 adult patients undergoing elective PCI. Access-site complications (ecchymosis, oozing, bleeding, hematoma) were assessed immediately, at 6 hours, and at 24 hours post-sheath removal. Patient characteristics (age, sex, BMI, comorbidities) and procedural factors (*p*uncture site) were recorded. Descriptive statistics summarized incidence; associations were tested using Chi-square (α=0.05).

Results: Of 211 patients (74% male; 68% radial access), complications were significantly associated with age (p=0.021) and female sex (57.4% *vs* 25.5%, p<0.001). Femoral access had a higher risk for bleeding and hematoma (p<0.05). Ecchymosis was most frequent in older females, peaking at 6 hours. BMI and comorbidities showed no significant association.

Discussion: Female sex, older age, and femoral access were key predictors of early post-PCI complications. These findings align with global evidence and underscore the need for tailored monitoring and nursing interventions, particularly in older female patients.

Conclusion: Radial access and targeted care strategies may reduce complication risk and improve outcomes in high-risk groups.

Keywords: Percutaneous coronary intervention, Radial artery, Femoral artery, Vascular access complications, Hemorrhage, Hematoma.

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1. INTRODUCTION

Cardiovascular diseases (CVDs) remain the leading cause of death worldwide, accounting for approximately 18.6 million deaths in 2019 (Lababidi *et al*., 2023) [1], (Roth *et al*., 2020 [2]). In the Middle East, including the United Arab Emirates (UAE), cardiovascular disease remains the leading cause of death. In 2021, about 34% of all deaths in the UAE were due to CVDs, with an age-standardized death rate of 314.1 per 100,000 people (Shorbagi and Ramadan, 2024 [3]).

Coronary artery disease (CAD) remains the most common type of cardiovascular disease and continues to lead to global illness and death. However, its impact extends far beyond physical health - CAD often carries significant psychological burdens, disrupts social life, and places economic strain on patients and their families (Kazukauskiene *et al*., 2021 [4]). Percutaneous coronary intervention (*P*CI) has become a central strategy for revascularizing patients with coronary artery disease. For individuals presenting with acute coronary syndromes, especially ST-elevation myocardial infarction, PCI is the preferred method of reperfusion and is linked to lower rates of death and recurrent infarction when compared with fibrinolytic therapy (Byrne *et al*., 2023 [5], Fazel *et al*., 2020 [6]). In contrast, evidence from large clinical trials in patients with stable coronary disease indicates that an invasive approach does not reduce overall mortality or myocardial infarction compared with optimal medical therapy; however, PCI provides clear relief from angina and leads to significant improvements in quality of life for those with frequent symptoms (Maron *et al*., 2020 [7], Spertus *et al*., 2020 [8]). Because it is less invasive than surgery, PCI is often the procedure of choice when anatomical considerations and patient preferences support catheter-based intervention (Lawton *et al*., 2022 [9]). Percutaneous coronary intervention (*P*CI) is a mainstay of modern care for coronary artery disease. In the United States, PCI is performed at very high volumes each year, with the CathPCI Registry capturing more than 90% of procedures across over 1,700 hospitals (Lima *et al*., 2022 [10]). Despite these benefits, PCI carries the risk of complications, particularly at the vascular access site, which can negatively affect patients' recovery and outcomes.

Access site complications remain one of the most prevalent adverse events following PCI. In a study of 300 patients in Jordan, 38% had a groin complication: ecchymosis in 34%, small hematoma in 20%, large hematoma in about 9.3%, and arteriovenous fistula in 0.3% (AL-Momani and AbuRuz, 2019 [11]). These complications at access sites not only worsen patient outcomes but also lead to more extended hospital stays, increase the economic burden on healthcare organizations, and raise care costs. The evidence indicates patient factors-older age, female sex, and comorbidities such as diabetes, hypertension, chronic kidney disease, anaemia, and peripheral vascular disease-are associated with increased risks of access-site bleeding and other vascular sequelae after PCI. Those risks become evident for women with access-site bleeding and older adults, particularly (Lawton *et al*., 2022 [9], AL-Momani and AbuRuz, 2019 [11], Spirito *et al*., 2021 [12], Hetrodt *et al*., 2021 [13]). Nevertheless, results are inconsistent among populations, and few results have been reported from Middle Eastern countries. Bleeding and its associated complications continue to be a significant issue. Ecchymosis and oozing are common, even under-recognized conditions, and can result in discomfort as well as delayed recovery, and unexpected medical use (Cosman *et al*., 2011 [14]). Hematoma and major bleeding are less common but not insignificant, as blood transfusion requirements, along with prolonged hospitalization, and poor cardiovascular effects (Murali *et al*., 2020 [15], Rana *et al*., 2021 [16]). The reported incidence of vascular complications in patients ranges from 5% to 15%, depending on the access site and procedure method (AL-Momani and AbuRuz, 2019 [11]).

Several studies highlight the influence of gender. Women, post-PCI, have significantly higher bleeding and vascular complications rates compared with men. Younger females (<55 years) have relatively higher risks (Lichtman *et al*., 2014 [17], Peerwani *et al*., 2023 [18]). Likewise, older age is also a predictor of access site complications, especially bleeding or ecchymosis, likely to arise from vascular fragility (Sabo *et al*., 2008 [19], Wu *et al*., 2015 [20]). Though PCI has improved the management of CAD, vascular access complications still represent a common and clinically relevant issue. Diagnostic predictors (age, sex, comorbidities, and procedural concerns) should be recognized to optimize outcomes and clinical treatment. Current data suggest variability, and regional data from the Middle East are limited. Recent studies usually look at individual differences on their own-such as studies specifically assessing sex-related differences in bleeding outcomes or the effects of female sex on these outcomes - rather than their association with other risk factors (Spirito *et al*., 2021 [12], Farhan *et al*., 2021 [21]). Some studies are not stratified by specific demographics -such as age, body mass index, and comorbid conditions - in detail, and so the interplay among these factors is not well studied (Kwok *et al*., 2021 [22]). In addition, regional studies in the Middle East, including the UAE, are limited, hindering the translation of findings into daily local clinical practice. This gap highlights the need for more local research to better understand the association between access-site complications and patient characteristics and to guide targeted interventions.

1.1. Objectives

This study aims to:

(1) Determine the incidence of access site complications post-PCI in two tertiary hospitals in the United Arab Emirates.

(2) Identify patient and procedural associations between patient characteristics and access site complications post-PCI.

2. METHODS

2.1. Study Design

A prospective cross-sectional correlational design was employed to examine the relationship between patient characteristics and access-site complications following PCI. The study was conducted between January and December 2023 in two tertiary-care hospitals in the United Arab Emirates.

2.2. Study Variables

2.2.1. Dependent Variables

Access-site complications post-PCI (bleeding, hematoma, oozing, ecchymosis).

2.2.2. Independent Variables

Patient characteristics (age, gender, BMI, comorbidities) and procedural factors (number of punctures, puncture site).

2.3. Setting

The study was conducted at two tertiary care centers in the UAE where PCI is routinely performed. One center included a 10-bed Cardiac Intensive Care Unit (CICU), and the other had a 22-bed Intensive Care Unit (ICU) that also accommodated cardiac patients. The two sites include advanced interventional cardiology service providers and catheterization labs that perform a high volume of diagnostic and therapeutic interventions (*e.g.*, percutaneous coronary intervention [PCI]).

2.4. Sampling and Sample Size

Convenience sampling was used to recruit eligible patients undergoing PCI who provided informed consent.

Inclusion criteria were:

(1) Patients aged 18 years and older.

(2) Patients can provide informed consent.

(3) Can read and write English

Exclusion criteria were:

(1) Patients undergoing non-PCI procedures.

(2) Patients with vascular complications prior to PCI.

Sample size was estimated using G * Power 3.1.9.4 for a Chi-square test of association, assuming a small-to-medium effect size (Cohen's w = 0.20), an alpha of 0.05 (two-tailed), and a power of 0.80. The required sample size was calculated as n = 199. To ensure an adequate sample size and account for potential data loss, the study enrolled 211 participants.

2.5. Data Collection

The Access Site Complication Observation Sheet was adapted from previously published observational studies and registry frameworks that have examined vascular complications following PCI (AL-Momani and AbuRuz, 2019 [11], Hetrodt *et al.*, 2021 [13], Kwok *et al.*, 2021 [22]). The tool included:

- **Demographic data**: age, gender, BMI, comorbidities
- **Procedural data**: number of punctures and puncture site.
- **Complications**: puncture site-bleeding, hematoma, oozing, ecchymosis.

Assessments were conducted at three time points:

Time-1: immediately after sheath removal.

Time-2: six hours after sheath removal.

Time-3: 24 hours after sheath removal post-procedure.

The access site was inspected, palpated for tenderness or rigidity, and peripheral pulses were assessed. Any complications were recorded by the first author using standardized criteria. Measurements were taken using an electronic weight scale, a flexible ruler; height was obtained from patient records.

During data collection, puncture sites were carefully observed for potential complications. *Oozing* was assessed by placing sterile gauze on the site; if the blood stain on the gauze measured less than 3×3 cm^2, using a disposable ruler for accuracy, it was recorded as oozing but not classified as bleeding (Sabo *et al.*, 2008 [19]). *Ecchymosis* was identified by visual inspection for skin discoloration and confirmed by gentle palpation for pain or swelling; the affected area was measured in centimeters (Cosman *et al.*, 2011 [14]). Bleeding was documented when the pressure dressing became saturated with blood or when a drop in hemoglobin of more than 2 g/dL from baseline was observed (Sabo *et al.*, 2008 [19]). *Hematoma* was evaluated by palpating the swelling around the puncture site and measuring its diameter with a ruler or measuring tape, then categorized as small (<5 cm) or large (>5 cm) (Merriweather and Sulzbach-Hoke, 2012 [23]).

2.6. Data Analysis

All analyses were conducted using SPSS version 21. Descriptive statistics (frequencies and percentages) were used to summarize participant characteristics and to report the incidence of complications (research objective 1). Chi-square tests were applied to assess associations between patient/procedural characteristics and complications (research objective 2). A p-value of <0.05 was considered statistically significant.

2.7. Ethical Considerations

Ethical approval was obtained from the University of Sharjah (REC-22-01-22-01-S), the University Hospital of Sharjah (UHS-HERC-121-24012023), and the Ministry of Health and Prevention, Research Ethics Committees (MOHAP/DXB-REC/ S.O-J /No. 92/ 2022), before initiating the study. Written informed consent was obtained from each participant. Participation was voluntary, with the right to withdraw at any point without consequences. Confidentiality and anonymity were strictly maintained. The study procedures conformed to the ethical principles outlined in the Declaration of Helsinki for research involving human subjects, and the Sex and Gender Equity in Research (SAGER) Guidelines were followed.

3. RESULTS

3.1. Participants' Descriptive Data

A total of 211 patients underwent PCI and were included in the analysis. Most were male (74.0%), and 26.0% were female. By age, 18–39 years comprised 36.0% (n=76), 40–59 years 39.7% (n=84), 60–79 years 22.7% (n=48), and ≥80 years 1.4% (n=3). The radial approach was used in 144 cases and the femoral approach in 67. With respect to comorbidities, 77.3% had at least one (*e.g.*, diabetes, hypertension, peripheral vascular disease) Table **1**.

3.2. Post-PCI Complications

3.2.1. Age

Complications increased with age: 32.0% (18–39 years), 27.1% (40–59 years), 43.8% (60–79 years), and 100% (≥80 years). The association was significant (χ^2 = 9.733, p = 0.021) Table **2**.

3.2.2. Gender

Despite representing only 26.0% of the cohort, females had a higher complication rate (57.4%) than males (25.5%), a highly significant difference (χ^2 = 18.348, p < 0.001) Table **2**.

Table 1. Sociodemographic and clinical characteristics of participants (n = 211).

Variables		Post-PCI Complications			
		Yes		No	
		Count (n)	Percentage (%)	Count (n)	Percentage (%)
Age	18yrs - 39yrs	24	32	52	68
	40yrs - 59yrs	23	27	61	73
	60yrs - 79yrs	21	44	27	56
	> 80yrs	3	100	0	0
Gender	Male	40	25	117	75
	Female	31	57	23	43
Comorbidities	Yes	55	34	109	66
	No	16	34	31	66
BMI	Normal	61	33	124	67
	Overweight and obese	10	38	16	62
Site	Radial	31	22	113	78
	Femoral	40	53	27	40

Note: * This table summarizes the baseline demographic and clinical features of patients who underwent PCI. Age is grouped as 18–39, 40–59, 60–79, and ≥80 years. Gender, comorbidities (diabetes, hypertension, peripheral vascular disease), BMI classification (standard *vs*. overweight/obese), and vascular access site (radial or femoral) are presented as frequencies and percentages.

Table 2. Association between participant characteristics and post-PCI complications (n = 211).

Variable		Post-PCI Complications
Age	Chi-square	9.733
	df	3
	Sig.	0.021
Gender	Chi-square	18.348
	df	1
	Sig.	0.000
Comorbidities	Chi-square	0.004
	df	1
	Sig.	0.948
BMI	Chi-square	0.308
	df	1
	Sig.	0.579
Site	Chi-square	29.844
	df	1
	Sig.	0.000

Note: * This table reports Chi-square test results evaluating associations between demographic/clinical characteristics and the presence of any access-site complication (ecchymosis, bleeding, oozing, or hematoma). Each variable lists Chi-square value, degrees of freedom (df), and *p*-value; statistical significance was set at $p < 0.05$.

3.2.3. Comorbidities

Complication rates were similar with or without comorbidity (~34% each), not significant (χ^2 = 0.004, p = 0.948) Table **2**.

3.2.4. BMI

Normal *vs*. overweight/obese showed no meaningful difference (33.0% *vs* 38.5%), not significant (χ^2 = 0.308, p = 0.579).

3.2.5. Access Site

Femoral access carried a markedly higher complication rate (53.3%) than radial (21.5%), significant (χ^2 = 29.844, p < 0.001) Table **2**.

3.3. Ecchymosis

Ecchymosis increased from immediately post-procedure to 6 hours, then plateaued at 24 hours. Age remained significantly associated at all time points (p < 0.001), peaking in the 60–79-year group (38.9% immediate → 47.4% at six h → 46.5% at 24 h). Females consistently had higher rates than males (immediate: p = 0.013; 6 h: p < 0.001; 24 h: p < 0.001). This gender difference may be explained by smaller arterial caliber and higher sheath-to-artery ratios, thinner vascular walls, lower baseline haemoglobin, and variations in platelet reactivity and vascular responses to antithrombotic therapy, which predispose females to greater access-site bleeding (O'Donoghue and Sarma, 2020 [24], Anderson *et al*., 2024 [25]). Notably, the effect was evident immediately and persisted for more than 6 hours, indicating that it is not a transient phenomenon but a sustained risk factor during the first 24 hours post-procedure. Comorbidities and BMI were not associated (all p > 0.35). The access site was not initially related, but it reached borderline significance at 24 hours (p = 0.050), with higher ecchymosis noted after femoral access Table **3**.

3.4. Bleeding

Immediately after sheath removal, age (p = 0.004) and gender (p < 0.001) were significant; bleeding was most frequent in the 40–59-year age group and in females. The higher bleeding risk observed in women at this stage may be attributed to smaller vessel caliber, higher sheath-to-artery ratios, thinner vascular walls, and differences in vascular reactivity and platelet response, which increase susceptibility to early access-site complications (Merriweather and Sulzbach-Hoke, 2012 [24]). Once hemostasis was achieved and the pressure dressing was maintained, these differences diminished, explaining why age and gender were no longer significant at 6 and 24 hours (all p > 0.30). At 6 hours and 24 hours, age and gender were no longer significant (all p > 0.30). Comorbidities and BMI were not associated at any time point (all p > 0.21). Access site remained a consistent predictor at all time points-higher with femoral access (immediate p < 0.001; 6 h p = 0.007; 24 h p = 0.011) Table **4**.

3.5. Oozing

Gender was significantly associated with oozing at 0 hours (p = 0.001), 6 hours (p < 0.001), and 24 hours (p = 0.001), with females consistently higher. Access site was also significant immediately (p = 0.004) and at 6 hours (p = 0.001), favoring radial over femoral; at 24 hours, the association approached significance (p = 0.057). Age, comorbidities, and BMI showed no significant associations (all p > 0.14) Table **5**.

Table 3. Relationship between participant characteristics and ecchymosis at different time points after sheath removal (n = 211).

Variables		Ecchymosis Immediately After Sheath Removal	Ecchymosis 6 Hours After Sheath Removal	Ecchymosis 24 Hours After Sheath Removal
Age	Chi-square	36.989	32.646	33.140
	Df	3	3	3
	Sig.	0.000	0.000	0.000
Gender	Chi-square	6.156	29.702	30.043
	Df	1	1	1
	Sig.	0.013	0.000	0.000
Comorbidities	Chi-square	0.344	0.398	0.056
	Df	1	1	1
	Sig.	0.557	0.528	0.812
BMI	Chi-square	0.027	0.841	0.456
	Df	1	1	1
	Sig.	0.870	0.359	0.500
Site	Chi-square	0.023	3.605	3.852
	Df	1	1	1
	Sig.	0.880	0.058	0.050

Note: * This table presents the association between patient characteristics (age, gender, comorbidities, BMI, and vascular access site) and the presence of ecchymosis observed at three time points: immediately, 6 hours, and 24 hours after sheath removal. Each row shows the Chi-square statistic, degrees of freedom (df), and corresponding p-value for each variable at each time interval. Significant results (p < 0.05) indicate that the variables are meaningfully associated with ecchymosis at the specified time point.

Table 4. Relationship between participant characteristics and bleeding at different time points after sheath removal (n = 211).

Variables		Bleeding Immediately After Sheath Removal	Bleeding 6 Hours After Sheath Removal	Bleeding 24 Hours After Sheath Removal
Age	Chi-square	13.304	1.788	0.231
	Df	3	3	3
	Sig.	0.004	0.618	0.972
Gender	Chi-square	26.784	0.400	1.047
	Df	1	1	1
	Sig.	0.000	0.527	0.306
Comorbidities	Chi-square	1.549	0.055	3.464
	Df	1	1	1
	Sig.	0.213	0.815	0.063
BMI	Chi-square	0.355	0.222	0.428
	Df	1	1	1
	Sig.	0.551	0.637	0.513
Site	Chi-square	21.198	7.157	6.541
	Df	1	1	1
	Sig.	0.000	0.007	0.011

Note: * This table summarizes associations between participant characteristics (age, gender, comorbidities, BMI, and access site) and the presence of bleeding recorded immediately, 6 hours, and 24 hours after sheath removal. Each section displays the Chi-square statistic, degrees of freedom (df), and corresponding *p*-value for each variable at each interval. Statistically significant results ($p < 0.05$) indicate that variables are independently associated with bleeding over time.

Table 5. Relationship between participant characteristics and oozing at different time points after sheath removal (n = 211).

Variables		Oozing Immediately After Sheath Removal	Oozing 6 Hours After Sheath Removal	Oozing 24 Hours After Sheath Removal
Age	Chi-square	5.474	3.838	2.678
	Df	3	3	3
	Sig.	0.140	0.280	0.444
Gender	Chi-square	11.212	26.784	10.659
	Df	1	1	1
	Sig.	0.001	0.000	0.001
Comorbidities	Chi-square	0.238	0.537	0.036
	Df	1	1	1
	Sig.	0.625	0.464	0.850
BMI	Chi-square	0.178	0.355	1.237
	Df	1	1	1
	Sig.	0.673	0.551	0.266
Site	Chi-square	8.094	10.442	3.627
	Df	1	1	1
	Sig.	0.004	0.001	0.057

Note: *This table presents Chi-square analyses exploring the relationship between oozing and participant factors, including age, gender, comorbidities, BMI, and access site, at three post-procedure observation intervals (immediate, 6 hours, and 24 hours). Each row reports the Chi-square value, degrees of freedom (df), and *p*-value. Significant findings ($p < 0.05$) identify variables showing meaningful associations with oozing at specific time points.

3.6. Hematoma

Across immediate, 6 hours, and 24 hours, access site was the principal determinant of hematoma, with femoral access consistently higher than radial (immediate $p = 0.036$; 6 h $p = 0.002$; 24 h $p = 0.001$). Age, gender, comorbidities, and BMI were not significantly associated at any time point (all $p > 0.10$) Table **6**.

Table 6. Relationship between participant characteristics and hematoma at different time points after sheath removal (n = 211).

Variables		Hematoma Immediately After Sheath Removal	Hematoma 6 Hours After Sheath Removal	Hematoma 24 Hours After Sheath Removal
Age	Chi-square	10.588	5.682	6.262
	Df	6	6	6
	Sig.	0.102	0.460	0.394
Gender	Chi-square	2.668	2.322	1.922
	df	2	2	2
	Sig.	0.263	0.313	0.382
Comorbidities	Chi-square	0.816	1.009	0.805
	df	2	2	2
	Sig.	0.665	0.604	0.668
BMI	Chi-square	2.269	1.933	1.666
	df	2	2	2
	Sig.	0.322	0.380	0.435
Site	Chi-square	6.653	12.172	13.957
	df	2	2	2
	Sig.	0.036	0.002	0.001

Note: * This table presents the association between demographic and clinical characteristics (age, gender, comorbidities, BMI, and access site) and the occurrence of hematoma immediately, 6 hours, and 24 hours after sheath removal. Each variable includes the Chi-square value, degrees of freedom (df), and corresponding *p*-value. Femoral access was consistently associated with hematoma at all intervals, whereas other variables showed no statistically significant relationships ($p > 0.10$).

Taken together, the analyses identified female sex and femoral access as the most consistent risk markers for early post-PCI site-related events. Older age was strongly associated with overall complications and progression of ecchymosis, whereas comorbidities and BMI showed no measurable associations in this cohort. The robustness of the access-site signal across bleeding and hematoma at all time points underscores the procedural contribution to risk. It supports preferential radial access where feasible, alongside enhanced surveillance and nursing care for female and older patients.

Because the overweight and obese subgroups were small, they were combined for stability in BMI analyses. All reported *p*-values were two-sided with $\alpha = 0.05$. No imputation was required; there was no missing outcome data.

4. DISCUSSION

This study examined the association between patient characteristics and access-site complications after PCI, focusing on ecchymosis, bleeding, oozing, and hematoma. The findings highlight associations among age, gender, and access-site complications, whereas BMI and comorbidities did not demonstrate significant associations. These results align with and extend existing evidence, with direct implications for nursing practice. In comparison with the existing evidence, our patterns are broadly consistent. However, some differences are noted, particularly the time-limited age effect on bleeding, suggesting local practice factors (antithrombotic intensity, ambulation timing, and site-specific nursing management) may have contributed to the complication.

4.1. Age as a Contributing Factor

Advancing age was associated with higher rates of ecchymosis, particularly in the 60–79-year group. This is consistent with Sabo *et al*. (2008) [19], who attributed increased bruising in older adults to vascular fragility, and with Wu *et al*. (2015) [20], who reported a marked increase in access-site complications in patients aged 70 years or older. Interestingly, bleeding was more pronounced in the 40–59 age group immediately after sheath removal (Sabo *et al*., 2008 [19], Wu *et al*., 2015 [20]). This differs from the ecchymosis pattern but is supported by Al-Momani and AbuRuz (2019), who emphasized the role of age and elevated systolic blood pressure in groin complications (AL-Momani and AbuRuz, 2019 [11]). Unlike studies showing a steady increase in bleeding with age, our results implicated that this increase is noted in middle-aged patients, which may reflect stronger antithrombotic use (following local protocols), and earlier mobilization in this group; by 6–24 hours, the age effect had faded, similar to reports from settings with rigorous post-haemostasis monitoring. For nursing care, these findings suggest the value of age-adapted interventions such as extended compression, delayed ambulation, and more frequent vascular assessments.

4.2. Gender Differences

Women are over one-quarter of the cohort, but more than half of all reported complications. Moreover, it is in line with global evidence that reported a higher risk of bleeding and vascular complications in women who undergo PCI compared to men (Spirito *et al*., 2021 [12], Peerwani *et al*., 2023 [18]). However, our study had a relatively small number of female participants, which limits its strength and indicates caution in interpretations.

Small sample sizes can sometimes exaggerate associations, and the male-female imbalance in this sample may have had a greater effect.

Nevertheless, the result is in agreement with established explanations. Women generally have smaller vessel caliber, higher sheath-to-artery ratios, and differences in vascular structure and hormonal influences that may increase their vulnerability to bleeding complications after PCI (Spirito *et al.*, 2021 [12]). Importantly, this does not mean that monitoring is needed only for female patients. A more balanced approach is to ensure all patients receive vigilant surveillance after PCI, with particular attention to those at higher risk-such as women, older adults, and patients with multiple comorbidities. This strategy ensures that complications in men are not overlooked, while recognizing that female patients may benefit from closer early observation, thoughtful access-site selection, and tailored education on promptly recognizing warning signs. For nursing practice, this highlights the importance of consistent access-site assessment and complication-prevention strategies for every patient, while applying additional vigilance to high-risk groups. Compared with the literature, our study found that gender differences are similar but concentrated in the earliest post-procedural window, consistent with hypotheses related to sheath-to-artery ratio, haemostasis technique, and mobility practices; standardizing compression protocols and reassessment intervals may narrow this gap without reducing overall vigilance.

An unexpected finding in this study was that immediate bleeding was more frequent among patients aged 40–59 years. Several factors explain this result. Middle-aged patients in this cohort were more likely to present with acute coronary syndromes, undergo PCI, and receive aggressive antithrombotic or anticoagulant therapy, which can increase bleeding risk in patients. In contrast, elderly patients may have been managed with more conservative dosing or procedural approaches, reflecting clinicians' awareness of their heightened bleeding vulnerability. This pattern suggests that bleeding risk is not determined by age alone but may also be influenced by case mix, procedural complexity, and medication practices. Future studies with larger, stratified samples are needed to confirm these associations and clarify whether middle-aged patients carry unique risk profiles in specific clinical contexts.

4.3. Access Site as a Determinant

The choice of access site is strongly associated with the incidence of complications (AL-Momani and AbuRuz, 2019 [11]). Bleeding, hematoma, and oozing were significantly associated with femoral access at all time points, consistent with the findings of Rana *et al*. (2021) [16]. Radial access, on the other hand, is less risky and is frequently recommended as the preferred option when clinically possible. From a nursing perspective, patients with femoral access require prolonged immobilization, increased assessment frequency, and rapid identification of bleeding or hematoma formation. This is consistent with previous studies associating female sex, age, and hypertension with higher complication risks (AL-Momani and AbuRuz, 2019 [11], Sabo *et al.*, 2008 [19]).

4.4. Comorbidities and BMI

Contrary to some prior studies, comorbidities such as diabetes and hypertension were not significantly linked to the presence of complications. Similarly, BMI showed no association with post-PCI complications. Al-Momani and AbuRuz (2019) suggested these factors could contribute to risk; however, standardized procedural protocols and consistent nursing care in the current setting might have reduced their impact (AL-Momani and AbuRuz, 2019 [11]). This indicates that good evidence-based nursing practices may have significant potential to reduce underlying baseline risks. The absence of this effect may also reflect on improved chronic-disease control, a relatively small high-risk subgroup, and protocolized peri-procedural pathways that control variability; collectively, these factors can reduce associations detected in less standardized environments.

4.5. Nursing Implications

The findings of this study emphasize the need for nursing care to address the risk factors for patient- and procedure-related vascular access complications. The study showed that older age, female gender, and femoral access were associated with higher rates of bleeding, ecchymosis, and oozing. Data from these studies, for instance, is also consistent with evidence from earlier studies suggesting that targeted preventive strategies are needed for patients identified as high-risk. Incorporating risk stratification into the standard nursing assessment can enhance surveillance and the rapid identification of complications. In reality, this implies improving post-treatment care regimens by reinforcing haemostasis, ensuring adequate immobilization, and maintaining regular access-site monitoring. Other options for high-risk patients may include reinforced pressure dressings, prolonged observation, and a structured patient education program on the signs of clinical deterioration. Embedding these strategies into nursing procedural protocols and continuing professional development may improve safety, reduce morbidity from complications, and enhance recovery and patient satisfaction.

5. STUDY LIMITATIONS AND STRENGTHS

This study has several limitations. First, the sample size (n = 211) was adequate; however, the findings cannot be generalized because the data were collected from only two centers. Additionally, a convenience sampling method was used, which may have introduced selection bias, as it included only patients who were available during the study period. The study focused on elective PCI cases and excluded patients who underwent emergency interventions, who may have had different risk factors. Finally, complications were monitored only for 24 hours after sheath removal, meaning that complications occurring after this period were not detected, highlighting the need for further studies with extended follow-up.

The strengths of this study include the provision of regional data, as there is insufficient research in this area.

The study used standardized data collection tools that followed established criteria to ensure consistency and improve the reliability of the results. The research evaluated multiple complications, including ecchymosis, bleeding, oozing, and hematoma, rather than focusing on a single complication, thereby providing a comprehensive assessment of post-PCI access-site events.

6. RECOMMENDATIONS

Future research should expand to include emergency PCI cases alongside elective procedures, as this would help determine whether complication risks differ in critically ill patients. Extending the observation period to 48–72 hours or until hospital discharge would allow detection of later-onset complications that may be missed.

Closer nursing surveillance is important for older patients, women, and those undergoing femoral access, as these groups consistently demonstrate a higher risk of complications. More frequent site assessments, longer monitoring periods, and clearer discharge instructions tailored to these patients could meaningfully improve outcomes. Importantly, these adjustments are modest and grounded in real patient data, and therefore could strengthen safety and quality of care without requiring major policy changes.

CONCLUSION

Older age, female gender, and femoral access are linked to the presence of vascular access complications after PCI. In contrast, BMI and comorbidities were not significantly related. For nurses, this emphasizes that not all patients carry the same level of risk. Extra attention to older women and those undergoing femoral access, along with greater use of radial access, when possible, may help reduce post-PCI complications.

AUTHORS' CONTRIBUTIONS

The authors confirm contribution to the paper as follows: S.H.I.U.H.: Served as the Principal Investigator and was responsible for study conception and design, data collection, data analysis, and preparation of the initial manuscript draft; J.M.D.: Supervised and guided the overall conduct of the research; N.A.Y. and F.R.A.: Contributed to the interpretation of results and provided critical intellectual input during manuscript review and revision. All authors critically reviewed the manuscript, contributed to revisions, and approved the final version for publication.

LIST OF ABBREVIATIONS

PCI	=	Percutaneous Coronary Intervention
BMI	=	Body Mass Index
CICU	=	Cardiac Intensive Care Unit
UAE	=	United Arab Emirates
CVD	=	Cardiovascular Disease

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the University of Sharjah (REC-22-01-22-01-S), the University Hospital of Sharjah (UHS-HERC-121-24012023), and the Ministry of Health and Prevention, Research Ethics Committees, UAE (MOHAP/DXB-REC/ S.O-J /No. 92/ 2022).

HUMAN AND ANIMAL RIGHTS

All procedures performed in studies involving human participants were in accordance with the ethical standards of institutional and/or research committee and with the 1975 Declaration of Helsinki, as revised in 2013.

CONSENT FOR PUBLICATION

Written informed consent was obtained from each participant.

STANDARDS OF REPORTING

STROBE guidelines were followed.

AVAILABILITY OF DATA AND MATERIALS

All data generated or analyzed during this study are included in this published article.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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DECLARATION

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