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# Comparison Of Clinical Outcomes After Successful Angioplasty And Percutaneous Coronary Intervention With Age Related Differences

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## Abstract

**Background:** The clinical manifestations and outcomes of percutaneous coronary intervention (PCI) vary across age, but these differences have not been well delineated, especially in South Asian patients where premature coronary artery disease is becoming common. The majority of the available PCI registry evidence currently is mostly older adult cohorts with a gap in comparative evidence of younger and older patient groups.

**Objective:** Young (<40 years) and Older (≥40 years) patients presenting with acute coronary syndrome (ACS) undergoing PCI To compare clinical, hemodynamic, comorbidity, lipid and biochemical parameters in each time frame between the presentation of the cases.

**Methods:** A cross-sectional, and descriptive quantitative study was carried out across several tertiary cardiac centers (EverCare Hospital, Sheikh Zaid, and MSK). Non-probability consecutive sampling was used to recruit a total of 319 patients with established ACS (STEMI, NSTEMI, or unstable angina) undergoing PCI. The patients have been stratified into two categories; Young (<40 years, n = 65) and Older (≥40 years, n = 254). The normality assessment was done by Shapiro-Wilk test and the independent

samples t-test or the Mann-Whitney U test was used to compare continuous variables. The chi-square test was used to compare categorical variables. The statistical significance was predetermined at $p < 0.05$.
**Results:** Of the 319 patients, 65 (20.4%) were in the Young group and 254 (79.6%) were in the Older group. The ACS type that appeared most frequently in both groups was NSTEMI (Young: 46.2; Older: 42.9), but there was no significant difference in the distribution of ACS types (2 = 0.375, p = 0.829). There was no statistically significant difference between the two groups in gender, BMI, heart rate, blood pressure, total cholesterol, LDL, triglycerides, ALT or any cardiovascular comorbidity such as hypertension (52.3% vs 53.5%), diabetes mellitus (35.4% vs 43.3%) and dyslipidemia (4 NT-proBNP was the most significant parameter with the Older group showing a higher median of 190.9 pg/mL than that of the Young group (146.8 pg/mL) (p = 0.019), showing more myocardial wall stress in the old patients.
**Conclusion:** At the time of admission, Young and Older ACS patients who came to find PCI had a rather similar clinical profile. Due to high prevalence of the conventional cardiovascular risk factors in the Young group, there is a great burden of premature cardiometabolic risk among South Asian young adults. The only distinguishing biomarker was NT-proBNP, which indicated increased ventricular wall stress among the older group. Future studies that involve the use of angiographic outcomes and post-procedural outcomes data are necessary to complete the characterization of the variations of age on the outcomes of PCI.

## Introduction

Age-related differences in clinical outcomes following successful angioplasty and percutaneous coronary intervention (PCI) is the comparison between the response of younger and old patients to PCI in terms of myocardial perfusion, angiography pattern, complication and general recovery following the procedure. Even though PCI is a standard intervention and life-saving procedure in the case of the Acute Coronary Syndrome (ACS), it does not have similar effects and outcomes across all age groups. Peers tend to have varied patterns of disease, risk factors and post-procedure healing abilities than adults, making age a significant determinant in forecasting the outcomes of PCI and post-operative prognosis [1].
ACS is a significant health burden worldwide and it encompasses STEMI, NSTEMI and unstable angina. ACS is traditionally considered to be reported in older patients, however, recently among younger adults this issue is noted to be relevant because the risk factors associated with cardiovascular problems start to be observed at an early age. Smoking, dyslipidemia, obesity, sedentary lifestyle, and metabolic dysfunction induced by stresses is a common presentation in younger patients [2].
Older individuals are more likely to present with multiple chronic comorbidities such as diabetes mellitus, hypertension, chronic kidney disease, and long-standing atherosclerosis that significantly influence both the severity of coronary artery disease (CAD) and the outcomes of revascularization procedures. These conditions are not isolated; rather, they interact synergistically to accelerate vascular damage and complicate treatment responses. Diabetes and hypertension contribute to endothelial dysfunction, increased inflammation, and accelerated plaque formation, leading to more diffuse and complex coronary lesions. In older patients, atherosclerosis is often long-standing and widespread, involving multiple vessels with heavy calcification [3].
Percutaneous Coronary Intervention (PCI) is in place as the most favored revascularization method in the appropriate ACS patients across the world. It consists of balloon angioplasty and stents placement to revive blood flow to the heart. The goals of successful PCI include optimal myocardial perfusion (which can be described by TIMI III flow), prevent myocardial damages, and decrease mortality [4].
The biological response to PCI, however, may have a great difference between the younger and older people because of the variations in the coronary artery structure,

plaque structure, inflammatory reaction, and microvascular integrity. Plaque composition and structure vary significantly between age groups. Younger patients more often have lipid-rich, soft plaques with thinner fibrous caps, which are easier to modify mechanically but more prone to rupture. Older patients typically have plaques that are fibrotic, heavily calcified, and diffuse [5].Research has continually demonstrated that younger patients with ACS tend to have single-vessel disease, less-calcified plaques, localized thrombus, and a limited extent of diffuse atherosclerosis. The focal nature of the lesions in younger patients enables easy deployment of the stent and recovery of better perfusion following a PCI. They have a vascular endothelium of relatively better health which facilitates quick healing, low rates of restenosis and fewer post-procedural complications. The fewer comorbidities among younger people also help them to recover better and make their stay in the hospital take less time. Consequently, younger adults tend to show better myocardial perfusion outcomes, fewer adverse in-hospital events, and better prognosis during the long-term after successful PCI [6].

Comparatively, the elderly appears with more developed disease. Among the cardiovascular system structural and functional changes, which are inherent in aging, are endothelial malfunction, arterial stiffness, ongoing inflammation, as well as dysfunction of the microvascular circulation Aging is also accompanied by chronic low-grade inflammation, which accelerates atherosclerosis and impairs vascular healing. In addition, microvascular dysfunction characterized by reduced capillary density and impaired autoregulation limits myocardial perfusion even when large coronary vessels are treated [7].The multi vessel coronary artery disease, dense calcification lesions, diffuse atherosclerotic disease, and limited coronary flow reserve are also more likely to be observed in older patients. These features render PCI technically difficult and are linked with delayed reperfusion, increased risk of the no-reflow phenomenon, increase an odd of procedural complications, and extended recovery. Dense calcified lesions are another hallmark of aging coronary arteries. Heavy calcification limits vessel flexibility and makes lesion crossing, balloon expansion, and optimal stent deployment more difficult. As a result, higher inflation pressures or adjunctive plaque- modifying techniques may be required, increasing the risk of vessel dissection, perforation, or stent under expansion. [8].

Despite the evidence of the world-wide burden among older adults with ACS, a significant change in epidemiology exists: ACS is on the rise among young adults, particularly in South Asian populations. This is caused by the lifestyle changes, increased tobacco use, poor diets, and hereditary factors. Although this is an increasing trend, most of the published PCI outcome research continues to concentrate on older patients, and thus, there is still a gap in the literature making a direct comparison of young and old patients [3].When determining the actual effectiveness of PCI, it is necessary to compare the results in different age groups due to the differences between the young and old patient since they are not similar in the overall presentation of clinical manifestations, the distribution, and severity of cardiovascular risk factors, as well as the nature and the degree of metallic cardiac lesions. They also differ in terms of their angiographic appearance, their physiological reaction to reperfusion treatment, and their chances of occurrence of post-procedure complications. Furthermore, age is also a determinant in the long-term survival of cardiovascular diseases, and therefore age-based outcome comparison is an important aspect of true assessment of the efficacy of PCI. The differences necessitate the need to customize treatment plans like stent selection, length of medication, monitoring vigor and rehabilitation process based on patient age. An enhanced insight into the outcomes of old age can assist in making decisions in an emergency situation, improving counseling of the patient, and assisting in personal care [9].

Although the excessive load of ACS in the aged populations has been well documented, the increasing number of premature coronary artery diseases that are manifested in young adults has left an urgent demand of direct age-related comparisons. A variety of modern PCI registries seem to focus on older or very older patients, yet younger ACS patients or younger cohorts are generally underrepresented. Moreover, regional inequalities are also to be considered. The coronary artery diseases in South Asian populations exhibit the highest rate of premature onset in the world and this has been attributed to genetic makeup, the metabolic features, and lifestyle changes [10]. There are notable gaps in research in spite of the studies. The current PCI registries and clinical trials are predominantly represented with older patients, whereas younger ACS groups are underrepresented. Despite the increase in ACS incidence in young adults, in particular, South Asia, there is a lack of strong comparative studies comparing PCI outcomes in younger and older age groups. Various researches specifically target very elderly or octogenarian patients without any meaningful comparisons to younger groups. Regional differences are also to be considered: South Asia is one of the regions with the highest number of premature coronary disease, but one of the few studies that investigate age-specific results of PCI in this population.

## LITERATURE REVIEW

Younger and older patients are incredibly different in terms of lesion morphology, vascular restructuring, inflammatory burden, comorbidities, and microvascular outcomes, which lead to different outcomes regardless of the technically successful PCI. Younger patients typically present with softer, lipid-rich plaques and exhibit positive vascular remodeling, allowing better arterial expansion and more favorable blood flow post-intervention. In contrast, older patients often have fibrotic, heavily calcified lesions and negative remodeling, which can limit luminal expansion despite successful stent deployment [3].Younger ACS patients are more likely to have a different risk factor profile as compared to older patients. Younger people tend to display behavioral and lifestyle-related risk factors: smoking, dyslipidemia, obesity, and psychosocial pressure. There is a steep increase in modifiable risk factors in adults younger than 45 in the world in particular smoking and lipid abnormality [9].

Older people have a developed burden of lifetime comorbidities such as type 2 diabetes, hypertension, chronic kidney disease, peripheral vascular disease, and systemic inflammation. These perpetuate risk factors hasten endothelial dysfunction and diffuse atherosclerosis resulting in more complicated and calcified coronary lesions. Elderly patients usually appear with an advanced disease, which significantly influences the planning and implementation of PCI [3].

Age-based variation is also apparent in the morphology of lesions. Softer plaques with high thrombus burden are typical of younger patients as they have suffered rupture or erosion of the plaque and not the result of long calcified lesions. The culprit lesions of younger ACS patients (under the age of 35 years) tend to be caused by an acute plaque rupture with the preservation of the vascular structure [11].On the other hand, aged persons exhibit calcified and chronic occlusions, and non-focal atherosclerotic diseases. Calcium nodules and fibrocalcific plaques make the procedure more challenging, restrict ideal expansion of the stents, and make it more prone to complications, including dissection, distal embolization and poor stent deployment [6].Single-vessel involvement is most commonly seen in young patients which is usually of the LAD artery and this is usually seen in older adults with multivessel coronary artery disease. In a 2022 study comparing angiographic results of young and elderly patients with PCI had angiography, the plaque burden, vessel tortuosity, luminal narrowing, and coronary calcification were significantly higher in older patients. Such anatomical features make PCI more difficult and necessitate highly skilled adjunctive measures, such as atherectomy, intravascular lithotripsy, and cutting balloons, thus making the peri-procedural risk [8].

Age also has an effect on microvascular functionality which becomes a critical factor in predicting the outcome of PCI. Aging is linked to endothelial dysfunction and vasodilation, as well as low microvascular reserve. As a result, the elder patients have a greater risk of the no-reflow phenomenon, even in the case of the successful opening of the epicardial artery during PCI. The microvascular blockage causes a problem of poor myocardial reperfusion, increased ischemic injury, and less functional recovery [3].Younger patients do not lose microvascular responsiveness and endothelial integrity as easily, which allows them to resume normal flow parameters like TIMI III flow faster than older patients following PCI [12].

Younger patients of PCI have better post- procedural TIMI III flow rates in comparison to older patients. This enhancement in perfusion is associated with an enhancement in left ventricular recovery, a decrease in infarct size, and a decrease in morbidity in the short term. It has also been indicated that the myocardium of younger adults is more resistant to ischemia and recovers more effective since they possess healthier myocardial tissue, less fibrosis, suitable collateral circulation, and fewer structural abnormalities. The myocardium of elderly patients is less resilient and even brief periods of the ischemia can result in widespread myocardial dysfunction [13].

The patients who are younger are less prone to complications during the PCI. They have reduced rates of coronary dissection, arrhythmias, acute stent thrombosis and contrast induced nephropathy. The incidence of periprocedural complications is significantly more often in older patients who are more than 70 or 80 years old because of vascular frailty, calcium formation, poor renal performance, and poor hemostatic equilibrium. One of the most alarming adverse events in patients of PCI in the elderly population is bleeding. There was a significant increase in the risk of bleeding among older patients as a result of frailty, polypharmacy, and platelet dysfunction, which make the use of antithrombotic therapy more difficult [5].

Slow-flow or no-reflow is more frequent among the elderly ACS patients. This complication has a strong correlation with the impaired microcirculation and results in the increased size of myocardial infarction, the acute heart failure occurrence, and the in-hospital mortality. These complications are not common in younger patients, as they have a higher vessel caliber, intact microvasculature, and less chronic endothelial dysfunction [14].Analyzed younger patients more favorably respond in terms of clinical outcomes in hospitalization as they are less likely to die and experience fewer major adverse cardiovascular events (MACEs). Observational data were analyzed on outcomes of 23,000 patients of South Asian ACS and the results showed that in-hospital mortality, cardiogenic shock incidence, acute pulmonary edema, malignant arrhythmias, and frequent ischemia were significantly reduced in younger patients. This tendency has been also reported in recent PCI studies conducted in Europe, Australia, and Asia. The young patients have an advantageous characteristic of rapid metabolic reaction, highly effective repair of the myocardium, and reduced comorbidity, which improves the short-term outcomes [15].

Acute kidney injury, infections, arrhythmias, extended ICU hospitalization, and functional recovery are some of the complications that are common in elderly patients. The women aged above 60 years are poorer in a number of researches, which may be attributed to the post-menopausal microvascular dysfunction, smaller vessel size, and late presentation [9].Elder citizens, in their turn, remain at greater risks in the long-term perspective because of progressive atherosclerotic disease, advanced comorbidity, and decreased physiological reserve. LTC is greatly deteriorated by chronic kidney disease, diabetes, hypertension, and heart failure. It has been determined that elderly patients experience higher rates of late stent thrombosis, recidivism, development of new lesions, and cardiac mortality to as many as several years following PCI. Weakness, cognitive impairment, and non-adherence to medicine are also other factors that lead to poor prognosis [16].

Complete revascularization is more likely to be applied to younger patients, and it has proven to have a clear positive prognosis. Nevertheless, full revascularization in the elder patients is not always possible because of the complicated coronary anatomy, diffuse disease, high level of calcification, and increased risks of the procedures. Thus, when a culprit-only intervention is prioritized by clinicians in the elder patients, this tends to happen particularly in cases of hemodynamic instability or comorbidity [17].

Intravascular imaging investigation of OCT and IVUS conducted in the last decade has elucidated the features of plaque in age groups. It is found that younger patients are more likely to have thin cap fibroatheromas and plaque rupture with big lipid cores whereas older patients exhibit calcified nodules, fibrocalcium plaques and diffuse intimal thickening. These structural variations have a direct influence on the stent expansion dynamics and under-expansion risk that is one of the most powerful predictors of late stent thrombosis with older populations [18].

Increase in the incidence of acute coronary syndrome (ACS) among people under 45 years of age, especially South Asian and Middle Eastern. Researchers explain this trend by the growing popularity of smoking, metabolic syndrome, sedentary lifestyle, and genetic predisposition. Younger ACS patients also tend to be less chronic and systemic in nature, which is in part the reason why they tolerate the procedures better and are able to recover after interventions [19].

Hypertension, diabetes mellitus, chronic kidney disease, and systemic inflammation cause decades of endothelial damage to the elderly patients. Multicenter cohort studies have recently shown both CBD of chronic inflammatory load and oxidative stress to play a role in diffuse atherosclerosis and multivessel pathology in patients older than 70 years. These pathophysiological alterations do not only make planning of PCI difficult, but also predisposes to the risk of incomplete revascularization [20].

Angiographic observations in patients with very young ACS (under 35 years of age) suggest that the single-vessel disease with thrombotic LAD artery is in the majority of patients. As they get older, in contrast to the elderly, their coronary architecture is usually maintained, with only a small amount of chronic calcification. This anatomical saving enables to expand the stent better and achieve higher success rates in immediate restoration of TIMI III flow [21].

Elderly cohorts are characterized by severe coronary calcification and chronic total occlusions (CTOs) much more frequently. Recent PCI registries (2019-2024) state that patients 75 years are much more prone to the necessity of adjunctive plaque modification methods including rotational atherectomy, orbital atherectomy or intravascular lithotripsy. Such added interventions add to the duration of the procedures, load contrast, and the risk of the periprocedural period, especially in weak people [22].

The angiographic comparisons always reveal that vessel tortuosity, lesion length, and SYNTAX scores in older populations are greater. The use of multivessel coronary artery disease has been seen to be almost twice as prevalent in patients beyond 70 years compared to not exceeding 50 in Asian and European PCI registries. The anatomy complication also leads to increased staged procedures and partial revascularization among the aged [23].Aging correlates with the diminished bioavailability of nitric oxide, endothelial senescence, and decreased coronary flow reserve. These modifications put the elderly patients at risk of experiencing no-reflow phenomenon in the face of successful recanalization of the epicaldium. No-reflow plays a significant role in the increase of the infarct area, heart failure prevalence, and in-hospital mortality in older patients [24].

Cardiac MRI data show that the size of the infarct and myocardial salvage index of younger patients with STEMI who receive primary PCI is not smaller. Increased myocardial resilience, reduced baseline fibrosis and improved collateral circulation are the factors associated with improved left ventricular functional recovery [25].

Increased TIMI III flow rates in younger patients after the procedure. Other recent multicenter studies support the fact that full ST-segment recovery and myocardial blush grade is much higher in younger cohorts, and that this is a predictor of lower short-term morbidity. On the contrary, myocardium of the elderly is more prone to ischemia-reperfusion injury because of mitochondrial dysfunction and oxidative stress [26].

Recent meta-analyses, 2017-2024, indicate that patients with 75 years old have much greater chances of contrast-induced nephropathy, complications of vascular access, and periprocedural arrhythmias. Radial access has been demonstrated to have a significant effect on bleeding complications within an elderly population, but there is increased overall bleeding risk because of platelet unresponsiveness, weakness, and polypharmacy [27].

The occurrence of slow-flow/no-reflow in the elderly patients with ACS. These findings are supported by large-scale PCI registries, which show that patients who are over 70 years have a 1.5-2-fold higher risk of microvascular obstruction. This complication predicts short-term mortality and adverse remodelling on its own [28].Multinational observational studies show a constant lower in-hospital mortality and major adverse cardiovascular events (MACE) among younger patients who undergo PCI. Minimal cardiogenic shock, acute pulmonary edema, and malignant arrhythmias are factors that lead to their good outcomes in the short term. Particularly, these benefits are attributed to intact cardiac reserve and lack of extreme diastolic dysfunction [29].

Acute kidney injury, infection, and long hospital stay among patients aged 65 and above. There is more recent evidence that frailty is a very powerful independent predictor of mortality and post-PCI complications, rather than chronological age. Comorbidity scores, grip strength and gait speed have been found to be added to the frailty indices to enhance better risk stratification compared to the conventional age groups [30].That geriatric patients receiving PCI treatment tend to be late hospital arrivals after the onset of the symptoms. This would add to an increase in ischemic time and myocardial salvage, even with technically successful revascularization. Classical symptoms were more likely to manifest earlier in younger patients, which leads to more myocardial preservation and early left ventricular recovery[31].

The concept of bleeding risk prediction models in the PCI populations and reached the conclusion that age was one of the strongest independent predictors of major bleeding events. Access-site hematoma, gastrointestinal bleeding, and transfusion needs amongst the elderly were also significantly high. These results encourage specific antithrombotic choices in elderly patients to strike a balance between the ischemic risks and hemorrhagic risks [32].

The complex PCI procedures and indicated that complex lesion, bifurcation disease, and chronic total occlusion, and heavy calcification, were significantly more common in the elderly. Complex PCI was been linked to more procedural time and the use of more contrast and, hence, to an increased risk of renal impairment and periprocedural complications in older adults [33].Older adults experienced lower percentages of full ST-segment after restoration of epicardial flow. This observation indicates chronic microvascular impairment and ischemia-reperfusion damage of elder myocardium. Patients at younger ages had a better grade of myocardial blush, hence a functional recovery [26].

The dual antiplatelet therapy in high-risk patients with high bleeding and strategies that are abbreviated. The researchers found that the reduced DAPT coupled with the single antiplatelet therapy, decreased bleeding, but did not increase ischemic occurrence in elderly patients with PCI. This was especially applicable to vulnerable people with a number of comorbidities [34].Severe target lesion failure and repeat revascularization at follow-up were both independently linked to severe coronary calcification, which is mostly observed in older patients. The authors highlighted the significance of plaque modification strategies in order to maximize the stent expansion in this age group [35].

Sex- and age-based disparities in outcomes after PCI and discovered that elderly women exhibited more bleeding and vascular morbidity as opposed to elderly men. Mechanisms that were suggested to have contributed to these findings include hormonal changes, smaller vessel caliber and more endothelial dysfunction [36].

Complete revascularization strategies were proved more advantageous to younger patients, as they showed a reduced occurrence of ischemia. Conversely, older patients commonly received staged or partial intervention on procedural risk grounds and this practice was well correlated with tolerable but relatively high recurrent event rates [17]. At the six-month follow-up, the younger patients were much improved in left ventricular ejection fraction. Older patients experienced modest functional improvement, which is probably because old myocardial fibrosis and poorer regeneration [37].Comorbidity clustering such as diabetes mellitus with chronic kidney disease were highly associated with unfavorable outcomes in the elderly PCI populations. Multimorbidity was also related to the increased hospitalization and cardiac mortality in the long term, which demonstrates that multidisciplinary management should be implemented [38].

In spite of similar success rates of the procedure, the composite endpoint of death, myocardial infarction, and stroke was on the rise with age advancement. The authors of the research stressed that the inability to peri-procedural stress tolerance is associated with vascular stiffness in old patients and the lack of adaptability in hemodynamics, despite the angiographic outcome being favorable [2].The occurrence of contrast-induced nephropathy in patients who underwent PCI and established that the incidence was higher in patients aged over 60 years. Independent predictors included reduced renal reserve, diabetes and increased contrast volume. Acute kidney damage was closely connected with the long-term hospitalization and the high short-term mortality in the elderly group [39].

The safety of new-generation drug-eluting stents after a long period of time and found a sustained reduction in very late stent thrombosis in relation to first-generation stents. Despite reduced death rates of all ages due to device-related complications, old patients still demonstrated an increased overall mortality level, which suggests that systemic and non-device-related factors still are significant prognosis determinants [40].The pattern of biomarker analysis demonstrated that there were more levels of oxidative stress and inflammatory mediators in older STEMI patients. These biological processes were linked to an enlarged infarct size and failed salvage of myocardial tissue even when the coronary flow is restored [41].

The risk of bleeding is highly affected by the older age. Age-based risk scoring systems with age enhanced prediction of adverse events and informed modification of antiplatelet therapy [32].Functional outcome was slower in elderly patients and had more residual angina than in the younger patients. Nevertheless, the quality-of-life indices in both groups increased significantly, which proves that PCI is useful even during old age [42].

Severe calcification observed mostly in aged patients was closely linked to inappropriate stent implantation and augmented need of complimentary plaques modifying devices. Optimal lesion preparation enhanced much better long-term patency rates [43].

Intracoronary imaging-guided PCI and discovered that IVUS- or OCT-guided intervention resulted in a decrease of major adverse cardiac events, especially in those patients with complex anatomy. Imaging optimization strategies were found beneficial especially to elderly patients with diffuse disease [44].

younger patients were associated with repeat PCI because of their premature atherosclerosis improvement with time. Nevertheless, their survival on the whole was still better than with old patients who died more of heart failure and non-cardiac diseases [45].

The individualized therapy of low-dose regimens reduces bleeding rates without affecting ischemic safety. Individualized therapy was especially applicable in patients who have atrial fibrillation and are receiving PCI [46].

Subclinical ventricular dysfunction remained more frequent in older people despite normal ejection fraction. The follow-ups depicted a greater full recovery of myocardial

mechanics in younger patients [47].Decrease in the overall mortality is observed as a result of advances in interventional cardiology, although age was still a stable determinant of unfavorable outcome. Patients aged more than 80 years were more prone to hospitalization of heart failures as compared to their younger counterparts [48].
Combination therapy has a strong likelihood of increasing the risk of bleeding among patients over the age of 70 years, which requires personalized changes of duration and dosage. Young patients were more tolerant to the increased regimens [49].
There were delayed endothelial coverage and more neoatherosclerosis in the older patients at the one-year follow-up. The younger age group had faster endothelialization, which minimized the risk of adverse events in the late stages [50].
Improvements in door-to-balloon time and recorded that despite the optimization of reperfusion systems, older patients gained lesser myocardial salvage benefit than younger patients. Age microvascular dysfunction was proposed to be a major explanatory variable [51].Elderly patients showed more rapid deterioration of renal function over the follow-up, especially in patients with chronic kidney disease on the baseline. Renal loss was a predictor of cardiovascular death on its own [52].

MATERIAL AND METHODS
**Study Design:** Cross-sectional, Descriptive- Quantitative study.
**Study settings:** Multicenter hospitals (Ever Care Hospital, Sheikh Zaid, MSK)
**Duration of study:** 04 months
**Sample Size:** 334 patients
**Formula:** For a cross-sectional study, the standard formula used is:

$$n = Z^2 p\,(1 - p)/\,d^2$$

n = required sample size
Z = Z-score at 95% confidence level = 1.96
p = expected prevalence
q = 1 − p
d = margin of error (precision)
Values Used (Derived from Parent Article)
From the parent article by Wang et al., 2021, 32% of very elderly female ACS patients underwent PCI.
p = 0.32
q = 1 − 0.32 = 0.68
Z = 1.96
d = 0.05

**Calculation**
Final Sample Size
Minimum required sample size = 334 patients

**Sampling Technique**
A non-probability convenient sampling technique used in this research.

**Sample Selection**
**Inclusion Criteria:**
Patients diagnosed with ACS (STEMI, NSTEMI, or Unstable Angina).
Patients undergoing Percutaneous Coronary Intervention.
Age <40 years or >40 years at the time of procedure.
Complete angiographic and clinical records available.
These criteria align with standard ACS diagnostic and PCI recommendation guidelines.

**Exclusion Criteria:**
Patients with incomplete medical or angiographic data.
Patients managed conservatively (no PCI).
Prior coronary artery bypass grafting (CABG)
Non-atherosclerotic coronary disease (e.g., vasospasm, SCAD)
Excluding confounding conditions is consistent with published PCI studies.

## DATA COLLECTION PROCEDURE

Data for this study were obtained from several sources such as catheterization laboratory records, patient medical charts, electronic health system (EHS) databases, and pertinent laboratory and imaging reports. Demographic and clinical data obtained included age, sex, body mass index (BMI), smoking history, diabetes mellitus, hypertension, dyslipidaemia, family and history of cardiovascular disease, previous myocardial infarction, previous stroke, and peripheral artery disease. The clinical presentation was determined by the acute coronary syndrome (ACS) type (STEMI, NSTEMI, or unstable angina) and admission vital signs and symptom duration. On angiographic analysis, the number of diseased vessels, severity of stenosis, thrombus burden, calcification and pre-procedural TIMI flow grade were determined. Other procedural data including the type of stent (drug-eluting or bare metal), number of stents deployed, balloon angioplasty use, post-PCI TIMI III flow, and door-to-balloon time in STEMI patients were also recorded. Heart rate, SBP and DBP on admission, clinical outcomes (complications, mortality and hospital readmission if applicable) were all dependent variables.

## DATA ANALYSIS PROCEDURE

The data were typed and analyzed with the help of the Statistical Package of the Social Sciences (SPSS) 27.0. The mean and standard deviation (SD) of normally distributed data were used as the continuous variables whereas the median and interquartile range (IQR) were used as the non-normally distributed variables. Frequencies and percentages were used to provide a summary of categorical variables. The ShapiroWilk test was used to check whether the continuous data were normal to come up with the right statistical test. The independent samples t-test was used to compare the two independent groups (Young <40 years vs Older ≥40 years) with normally distributed variables, and MannWhitney U test with non-normally distributed variables. The Chi-square (chi-square) test was employed to analyze categorical variables such as gender distribution, ACS type, comorbidities and smoking status. The p-value was taken to be less than 0.05 as significant. This analysis was performed to compare the differences in demographic variables, clinical and hemodynamic variables at admission, comorbidity variables, lipid profile and biochemical variables between the two age groups of patients that received percutaneous coronary intervention

## RESULTS

### Study Population and Group Distribution

This study enrolled 319 patients who met the inclusion criteria, and who have been receiving percutaneous coronary intervention (PCI) in the participating centers. The study protocol stratified patients into two groups, the Young group, which included patients under the age of 40 years (n = 65; 20.4%), and the Older group, which included patients at age 40 years or older (n = 254; 79.6%). Figure 5.1 shows the distribution. In the Young group, ages ranged from 30 to 39 years with a mean of 34.78 ± 3.19 years. Ages of the older group were 40-84 years with a mean of 54.37 +8.40 years. The Mann-Whitney U test (U = 0.000, p < 0.001) statistically showed that there was a significant difference between the age of the two groups, which proved that the groups were separated.The total sample size was 208 men (65.2), and 111 women (34.8). Gender distribution was similar between the groups: 40 males (61.5%) and 25 females (38.5%)

in the Young group, and 168 males (66.1%) and 86 females (33.9%) in the Older group. Chi-square analysis revealed no statistically significant difference in gender distribution between the two groups ($\chi^2 = 0.302$, $p = 0.583$).

**Figure 1: Study Population — Age Group and ACS Type Distribution (n = 319)**

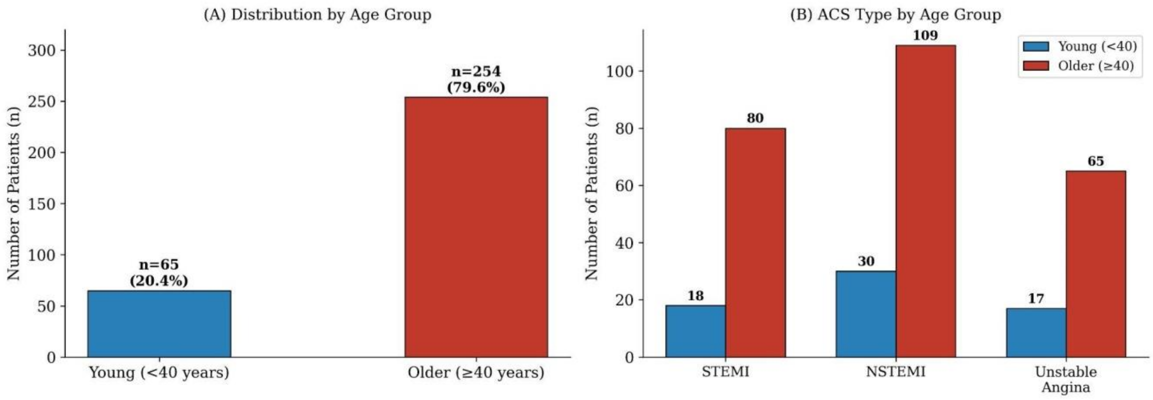


Figure 1: (A) Bar chart showing the proportion of Young (<40 years) and Older (≥40 years) patients. (B) Grouped bar chart showing ACS type distribution by age group.

**ACS Type Distribution by Age Group**

Table 1 shows the distribution of acute coronary syndrome (ACS) subtypes in the two age groups. The most common presentation in both groups was NSTEMI, which comprised 46.2% of the Young group (n = 30) and 42.9% of the Older group (n = 109). In the Young group, 18 patients (27.7%) had STEMI and 80 patients (31.5%) in the older group. The Young and Older groups had 26.2 (n = 17) and 25.6 (n = 65) respectively, which were unstable angina. Chi-square test showed that there was no statistically significant difference in the distribution of ACS type between the two age groups (2 = 0.375, df = 2, p = 0.829).

**Table 1: ACS Type Distribution by Age Group (n = 319)**

| **ACS Type** | **Young (<40)n (%)** | **Older (≥40)n (%)** | **Totaln (%)** |
|---|---|---|---|
| STEMI | 18 (27.7%) | 80 (31.5%) | 98 (30.7%) |
| NSTEMI | 30 (46.2%) | 109 (42.9%) | 139 (43.6%) |
| Unstable Angina | 17 (26.2%) | 65 (25.6%) | 82 (25.7%) |
| **Total** | **65 (100%)** | **254 (100%)** | **319 (100%)** |

Note: $\chi^2 = 0.375$, df = 2, p = 0.829 (not significant). UA = Unstable Angina.

**Comparison of Clinical and Hemodynamic Parameters at Admission**

The two groups were compared in terms of continuous clinical and hemodynamic parameters at admission. Table 2 shows the entire comparison and Figure 5.2 shows the hemodynamic parameters and the distribution of BMI.

**Figure 2: Clinical Parameters at Admission — Young vs Older Age Group**

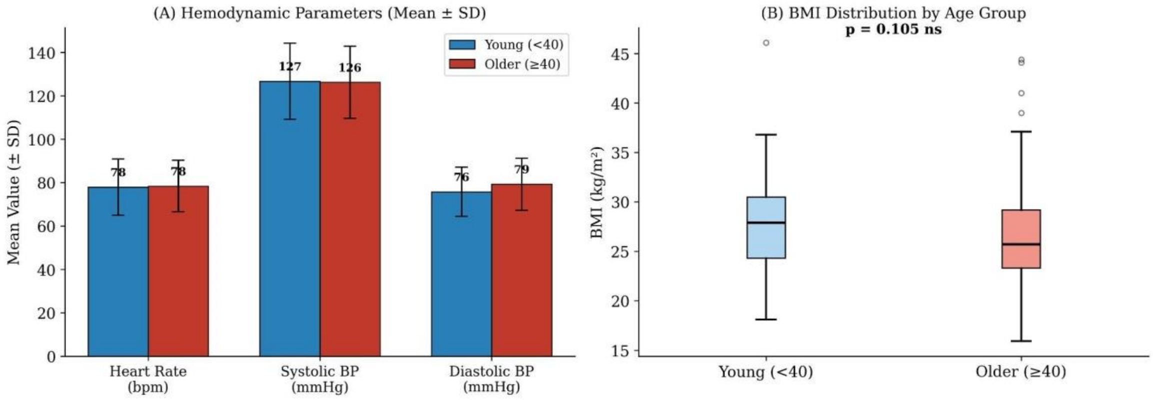


Figure 2: (A) Mean ± SD of hemodynamic parameters at admission by age group. (B) BMI distribution (box plot) by age group. p = 0.105, ns.

The Young group had a mean BMI of 27.69 and the Older group had 26.56 with no statistically significant difference between the two groups (Mann-Whitney U = 9492.5, p = 0.062). There were no differences in mean heart rate at admission, with the mean heart rate being 77.92 ± 12.98 bpm in Young group and 78.35 ± 11.88 bpm in Older group (p = 0.497). Mean systolic blood pressure was 126.68 ± 17.49 mmHg in the Young group and 126.22 ± 16.64 mmHg in the Older group, with no significant difference (t = 0.194, p = 0.847). The mean diastolic blood pressure was 75.71 ± 11.32 mmHg in the Young and 79.25 ± 11.98 mmHg in the Older group; the difference was not statistically significant (Mann-Whitney U = 7024.0, p = 0.064).

**Table 2: Comparison of Continuous Variables between Young and Older Age Groups (n = 319)**

| Variable | Test Used | Young (<40)Mean ± SD | Older (≥40)Mean ± SD | Statistic | p-value | Sig. |
|---|---|---|---|---|---|---|
| Age (Years) | Mann-Whitney U | 34.78 ± 3.19 | 54.37 ± 8.40 | 0.000 | <0.001 | s |
| BMI (kg/m²) | Mann-Whitney U | 27.69 ± 4.98 | 26.56 ± 5.03 | 9492.5 | 0.0623 | ns |
| Heart Rate at Admission (bpm) | Mann-Whitney U | 77.92 ± 12.98 | 78.35 ± 11.88 | 7804.0 | 0.497 | ns |
| Systolic Blood Pressure (mmHg) | Independent t-test | 126.68 ± 17.49 | 126.22 ± 16.64 | 0.194 | 0.8466 | ns |
| Diastolic Blood Pressure (mmHg) | Mann-Whitney U | 75.71 ± 11.32 | 79.25 ± 11.98 | 7024.0 | 0.0636 | ns |
| Total Cholesterol (mmol/L) | Mann-Whitney U | 5.30 ± 1.07 | 5.60 ± 1.21 | 6992.0 | 0.0571 | ns |
| LDL Cholesterol (mmol/L) | Independent t-test | 3.28 ± 0.94 | 3.28 ± 0.86 | 0.001 | 0.9995 | ns |
| Triglycerides (mmol/L) | Mann-Whitney U | 1.87 ± 0.72 | 1.90 ± 0.70 | 7989.5 | 0.6895 | ns |
| ALT (U/L) | Independent t-test | 32.77 ± 12.92 | 33.07 ± 12.48 | -0.174 | 0.8619 | ns |
| NT-proBNP (pg/mL) | Mann-Whitney U | 169.37 ± 119.08 | 220.43 ± 159.66 | 6699.5 | 0.019 | s |

Note: $p < 0.001$, $p < 0.05$, ns = not significant. Mann-Whitney U test used for non-normally distributed variables; independent samples t-test used for normally distributed variables (assessed by Shapiro-Wilk test)

**Comorbidity Profile by Age Group**

The chi-square analysis was used to compare the prevalence of cardiovascular comorbidities and risk factors prevalent in the two groups. Table 3 and Figure 3A show the results.

The Young group had 34 patients with hypertension (52.3%), whereas the Older group had 136 patients with hypertension (53.5%), and there was no significant difference between the groups (2 = 0.002, p = 0.969). There were 23 patients with diabetes mellitus who were in the Young group and 110 patients with diabetes mellitus in the older group; this was not statistically significant (2). The prevalence of dyslipidemia between the two groups was the same, with 46.2% in the Young group and 46.5% in the Older group (2 = 0.000, p = 1.000). Anthropometric data were found to show that 23 Young patients (35.4%), and 104 Older patients (40.9%) had prior myocardial infarction which had no significant difference (2 (456) = 0.456, p = 0.500). Prior stroke was uncommon in both groups: 2 patients (3.1%) in the Young group and 16 patients (6.3%) in the Older group ($\chi^2 = 0.495$, $p = 0.482$). In terms of statistical significance, peripheral artery disease (PAD) was found in 4 Young patients (6.2) and 35 Older patients (13.8) which was not statistically significant (2.139, p = 0.144). In terms of smoking status, 29.2% of Young patients were current smokers versus 20.9% of Older patients but there was no significant difference in the distribution of smoking categories across groups ( 2 = 4.079, p=0.130, df=2). All the comorbidity comparisons were not statistically significant on $p < 0.05$.

**Table 3: Categorical Variables — Chi-Square Analysis by Age Group (n = 319)**

| Variable | Young (<40)n (%) | Older (≥40)n (%) | χ² | p-value | Sig. |
|---|---|---|---|---|---|
| Gender: Male | 40 (61.5%) | 168 (66.1%) | 0.302 | 0.5828 | ns |
| Gender: Female | 25 (38.5%) | 86 (33.9%) | | | |
| Hypertension: Yes | 34 (52.3%) | 136 (53.5%) | 0.002 | 0.969 | ns |
| Hypertension: No | 31 (47.7%) | 118 (46.5%) | | | |
| Diabetes Mellitus: Yes | 23 (35.4%) | 110 (43.3%) | 1.030 | 0.3101 | ns |
| Diabetes Mellitus: No | 42 (64.6%) | 144 (56.7%) | | | |
| Dyslipidemia: Yes | 30 (46.2%) | 118 (46.5%) | 0.000 | 1.000 | ns |
| Dyslipidemia: No | 35 (53.8%) | 136 (53.5%) | | | |
| Prior MI: Yes | 23 (35.4%) | 104 (40.9%) | 0.456 | 0.4996 | ns |
| Prior MI: No | 42 (64.6%) | 150 (59.1%) | | | |
| Prior Stroke: Yes | 2 (3.1%) | 16 (6.3%) | 0.495 | 0.4818 | ns |
| Prior Stroke: No | 63 (96.9%) | 238 (93.7%) | | | |
| PAD: Yes | 4 (6.2%) | 35 (13.8%) | 2.139 | 0.1436 | ns |
| PAD: No | 61 (93.8%) | 219 (86.2%) | | | |
| Smoking: Current smoker | 19 (29.2%) | 53 (20.9%) | 4.079 | 0.1301 | ns |
| Smoking: Former smoker | 7 (10.8%) | 51 (20.1%) | | | |
| Smoking: Never smoked | 39 (60.0%) | 150 (59.1%) | | | |

Note: χ² = Chi-square statistic; PAD = Peripheral Artery Disease; MI = Myocardial Infarction; ns = not significant.

**Lipid Profile and Biochemical Markers**

The two age groups were compared in terms of lipid profile values, and the various biochemical markers were selected. Table 4 gives the results and Figure 3B shows the results.

The mean total cholesterol was 5.30 ± 1.07 mmol/L in the Young group and 5.60 ± 1.21 mmol/L in the Older group; this difference was not significant (Mann-Whitney U = 6992.0, p = 0.057). LDL cholesterol was identical between the two groups, both recording a mean of 3.28 mmol/L (Young: 3.28 ± 0.94 mmol/L; Older: 3.28 ± 0.86 mmol/L; t = 0.001, p = 0.999). The mean triglyceride levels were also similar, 1.87 ± 0.72 mmol/L in the Young group and 1.90 plus 0.70 mmol/L in the Older group (p = 0.690). ALT levels were similar in both groups (Young: 32.77 ± 12.92 U/L; Older: 33.07 ± 12.48 U/L; t = -0.174, p = 0.862).
The sole biochemical marker that proved to be statistically different between the two groups was NT-proBNP (Mann-Whitney U = 6699.5, p = 0.019). The Young group had a lower mean NT-proBNP of 169.37 ± 119.08 pg/mL (median: 146.8 pg/mL; IQR: 91.8–237.4 pg/mL) compared to the Older group, which recorded a mean of 220.43 ± 159.66 pg/mL (median: 190.9 pg/mL; IQR: 111.2–279.8 pg/mL). This result suggests a much greater cardiac wall stress in the older group during the presentation of PCI.

**Figure 3: Comorbidity Prevalence and Lipid Profile — Young vs Older Age Group**

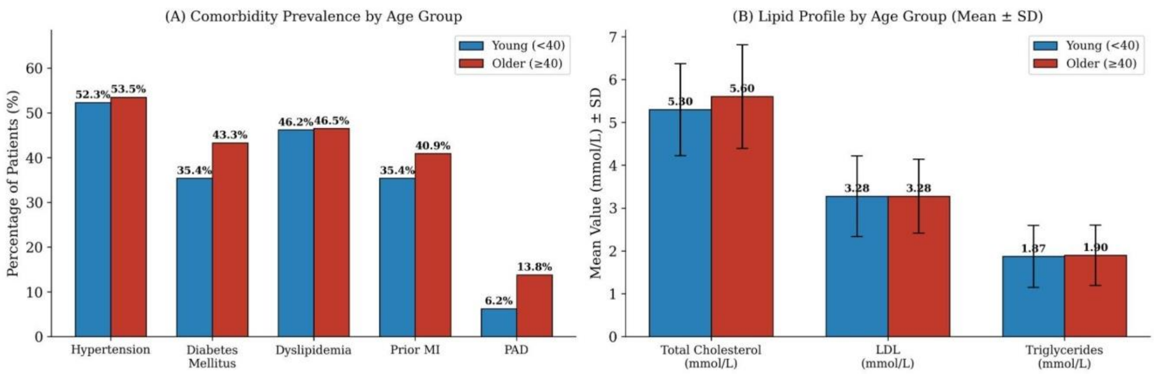


Figure 5.3: (A) Grouped bar chart showing comorbidity prevalence by age group. (B) Mean ± SD of lipid profile parameters by age group.

**Table 4: Lipid Profile and Biochemical Markers — Young vs Older Age Groups (n = 319)**

| **Variable** | **Young (<40)Mean ± SD** | **Older (≥40)Mean ± SD** | **Test Used** | **p-value** | **Sig.** |
|---|---|---|---|---|---|
| Total Cholesterol (mmol/L) | 5.30 ± 1.07 | 5.60 ± 1.21 | Mann-Whitney U | 0.0571 | ns |
| LDL Cholesterol (mmol/L) | 3.28 ± 0.94 | 3.28 ± 0.86 | Independent t-test | 0.9995 | ns |
| Triglycerides (mmol/L) | 1.87 ± 0.72 | 1.90 ± 0.70 | Mann-Whitney U | 0.6895 | ns |
| ALT (U/L) | 32.77 ± 12.92 | 33.07 ± 12.48 | Independent t-test | 0.8619 | ns |
| NT-proBNP (pg/mL) [Mean ± SD] | 169.37 ± 119.08 | 220.43 ± 159.66 | Mann-Whitney U | 0.019 | * |
| NT-proBNP (pg/mL) [Median (IQR)] | 146.8 (91.8–237.4) | 190.9 (111.2–279.8) | | | |

Note: p < 0.05, ns = not significant. NT-proBNP = N-Terminal Pro-Brain Natriuretic Peptide; ALT = Alanine Aminotransferase; IQR = Interquartile Range.

**Summary of Significant Findings**

In all clinical, hemodynamic, comorbidity, lipid, and biochemical comparisons made between the Young (<40 years) and Older (≥40 years) PCI patient groups, only a single variable, NT-proBNP, had a statistically significant between-group difference ($p = 0.019$). All other continuous variables such as BMI, blood pressure variables, and lipid values and all categorical variables such as gender, type of ACS, and comorbidities did not present statistically significant differences between the two age groups. These results indicate that the two groups were largely similar in their clinical presentation during the time of PCI.

## DISCUSSION

This was a comparative study that involved clinical parameters on the day of presentation between the Young (<40 years) and Older (≥40 years) patients undergoing percutaneous coronary intervention in acute coronary syndrome in tertiary cardiac centers. The main conclusion of this investigation is that there was a significant similarity in the two age groups on a wide spectrum of clinical, hemodynamic, comorbidity, lipid, and biochemical parameters with the exception of NT-proBNP which was significantly higher in older group.The study enrolled 319 PCI patients, of whom 65 (20.4%) were classified as Young (<40 years) and 254 (79.6%) as Older (≥40 years). The relatively low ratio of young patients is in line with the epidemiological fact that ACS is mostly more common among the older adult population; but the large number of young PC patients is an indication of the increasing prevalence of premature coronary artery disease among South Asian populations. In a study which examined 23,560 South Asian ACS patients, Sheikh et al. (2023) reported a high percentage of younger manifestations, explaining it by a high level of smoking, dyslipidemia, and metabolic dysfunction since early age [53]. The same outcome was reported by Kumar et al. (2023), who found a rising prevalence of ST-elevation ACS among young adult South Asians, where smoking and dyslipidemia were reported as the most prevalent risk factors among this population [19].

The distribution of ACS subtypes — STEMI, NSTEMI, and unstable angina — was not significantly different between the Young and Older groups ($\chi^2 = 0.375$, $p = 0.829$). The most frequent presentation in the Young and Older groups was NSTEMI, which constituted 46.2% and 42.9% of all presentations, respectively. This observation aligns with the registry data of NSTEMI becoming the most common ACS subtype in contemporary PCI cohorts across age groups and is indicative of better diagnosis at early stage and higher usage of high sensitivity assays of troponin [10]The similar proportion of STEMI presentations across both groups — 27.7% in the Young and 31.5% in the older group — is noteworthy. The proportion of STEMI and the results of primary PCI were generally similar between the age groups, with the success rates of the procedure being high in younger patients[2]. The similar STEMI distribution of the current study indicates that the acuity of index coronary event was not different across groups, which further indicates the homogeneity of the population of the study at the time of presentation.

There was no significant difference between heart rate at admission, systolic and diastolic blood pressure between the Young and Older groups. The clinical implications of this finding are that the two groups had an overall similar haemodynamic stability during the PCI procedure. The same has been observed in multi-center PCI registries wherein young and middle-aged ACS patients had reported with similar admission blood pressure and heart rate profiles[13].BMI was not significantly different between the Young group (27.69 ± 4.98 kg/m²) and the Older group (26.56 ± 5.03 kg/m²; $p = 0.062$). The Young group had a statistically non-significant higher mean BMI than the other group. The high BMI in the younger patients is in line with the observation in South Asian cohorts of ACS where metabolic obesity and insulin resistance have been identified to be the key contributors of premature coronary artery disease in this group despite the lack of any existing diabetes [19].

The most notable results of this study are high cardiovascular comorbidities prevalence in the Young group that was closely similar to the prevalence in the older group in all measured risk factors. Hypertension was identified in 52.3% of Young patients, almost the same as the 53.5% among the Older group (p = 0.969). The prevalence of diabetes mellitus was 35.4% and 43.3% in Young and Older patients, respectively, which is not significant (p = 0.310). Both groups had almost equal frequencies of dyslipidemia (46.2% vs 46.5; p = 1.000).These results question the hypothesis that younger patients with ACS present a less comorbidity burden. An increasing amount of literature has outlined a unique phenotype of young ACS patients with a multiplicity of conventional risk factors, especially in the South Asian populations [10]. young adults with ACS who underwent PCI showed that the rates of hypertension, dyslipidemia, and smoking in patients aged under 40 years were high and justified the idea that premature CAD is caused by aggressive cardiometabolic risk profile, but not by the age-associated accrual of risk [14]. This new paradigm is reinforced by the equal prevalence of comorbid conditions in the current study according to age.

Young patients had a higher probability of having prior myocardial infarction (35.4% vs 40.9% p = 0.500) whereas Older patients had a higher prevalence of peripheral artery disease (13.8% vs 6.2%). The prevalence of previous stroke was not found in both groups and there was no significant difference between them (p = 0.482).In relation to smoking, more Young patients (29.2) were current smokers than Older patients (20.9), which can be explained by the fact that as reported by Kumar et al. (2023) and Sheikh et al. (2023) [10, 19], tobacco use is a leading risk factor in premature coronary artery disease among young adults of South Asian descent. The Older group included more former smoker (20.1% vs 10.8%), which is probably due to a reduction in smoking over time after having the cardiac events. The general smoking distribution was not significantly different (2 = 4.079, p =.130), but the tendency towards active smoking among younger patients is clinically relevant.

The lipid profiles between the two groups were generally similar. There were no statistically significant differences between the Young and Older groups in terms of total cholesterol, LDL cholesterol and triglycerides. The average LDL was the same in both groups at 3.28 mmol/L, exceeding the guideline-recommended value of less than 1.8mmol/L in high-risk cardiovascular patients, in agreement with the Grundy et al., (2019) ACC/AHA cholesterol management guidelines [9]. This result underscores poor lipid management in both age groups at the time of ACS presentation and supports the importance of vigorous lipid-lowering therapy irrespective of the age of the patient post-PCI.There was a numerically greater mean total cholesterol in the Older group (5.60 ± 1.21 mmol/L vs 5.30 ± 1.07 mmol/L) that was not statistically significant (p = 0.057). In part this marginal non-significance can relate to the fact that the sample size of the Young group is smaller than that of the older group, and should be taken with a grain of salt. The almost similar LDL levels in groups are in line with other results found by Chaudhary et al. (2024), who noted similar lipid levels in very young and older STEMI patients, even though the culprit plaque morphology in the two groups was different [18].

The only parameter that showed a statistically significant difference between the Young and Older groups was NT-proBNP (Mann-Whitney U = 6699.5, p = 0.019). The Older group had a significantly higher median NT-proBNP of 190.9 pg/mL (IQR: 111.2–279.8 pg/mL) compared to 146.8 pg/mL (IQR: 91.8–237.4 pg/mL) in the Young group. NT-proBNP is a biomarker of myocardial stress at the wall, ventricular dysfunction, and adverse cardiac remodellation which has been validated. High NT-proBNP during presentation with ACS indicates a higher hemodynamic efficiency and extent of myocardial workload.The high NT-proBNP in the older group is in line with the established association between aging, ventricular contraction, diastolic malfunction and increased neurohumoral stimulation in the environment of ischemic heart events. Nishihira et al. (2022) showed that older patients with heart failure (AMI) and undergoing PCI had much higher levels of natriuretic peptides that are linked to poor post-PCI outcomes [15]. Equally, Fallahzadeh et al. (2022) found that the indices of cardiac dysfunction were more advanced in older ACS patients presenting with PCI and partially manifested through increased biomarkers of wall stress [4]. Current observation of a noteworthy high NT-proBNP in the older group, without other notable clinical variations, is likely to indicate that the key physiological disparity between the Young and Older PCI patients at presentation in this group is ventricular wall stress and subclinical cardiac dysfunction.

There was no significant difference in the levels of ALT in both groups ($p = 0.862$) and this shows that there is no difference in the hepatic functioning at the time of presentation, which is pertinent since high levels of ALT can indicate metabolic liver disease and systemic inflammatory burden in ACS patients.The general trend in the results - general clinical equivalence in almost all the measured parameters, excepting NT-proBNP - has significant clinical implications. It implies that, when the selection of Young and Older ACS patients to undergo PCI is based on the same inclusion criteria, they will be presented with a corresponding risk factor burden, ACS acuity, and haemodynamic profiles. This refutes the fact that younger PCI patients are uniformly lower risk or have a different clinical phenotype at the time of intervention.

These results are consistent with the view that was presented by Kennedy et al. (2023), who found that total ischemic time and age are both independent predictors of PCI outcomes in STEMI, yet younger patients with the same burden of comorbidity might not respond differently to faster reperfusion strategies than older patients [7]. The results of the current study indicate that age on its own, without any other differentiating clinical characteristics, might not be adequate as a single stratification factor to be used to assess procedural risk among this group of patients.

## Conclusion

In this study, the comparison of clinical, hemodynamic, comorbidity, lipid, and biochemical parameters between the Young (<40 years, n = 65) and Older (≥40 years, n = 254) patients receiving percutaneous coronary intervention due to acute coronary syndrome in several tertiary cardiac centers was conducted. Enrollment was done on 319 patients.

The main conclusion of this paper is that the Young and Older patient groups were generally similar in terms of almost all clinical parameters assessed. There were no statistically significant differences between the two groups in terms of ACS type distribution, gender, BMI, admission heart rate, systolic and diastolic blood pressure, lipid profile (total cholesterol, LDL, triglycerides), liver enzymes (ALT), and all cardiovascular comorbidities such as hypertension, diabetes mellitus, dyslipidemia, prior MI, prior

NT-proBNP was the only variable that differed significantly between Older and Young patients as it was significantly higher in Older patients (median: 190.9 pg/mL vs 146.8 pg/mL; $p = 0.019$). Such observation indicates the increased myocardial wall stress and subclinical ventricular dysfunction during PCI presentation in the older group, which is in line with the established impact of aging on cardiac remodelling and neurohumoral activation.

These results show that the clinical profile of Young and Older ACS patients who undergo PCI according to the same inclusion criteria in the tertiary cardiac centers of Pakistan is quite similar. The prevalence of the traditional cardiovascular risk factors such as hypertension (52.3%), diabetes mellitus (35.4%), dyslipidemia (46.2%), and active smoking (29.2%) in the Young group indicates the premature cardiometabolic risk burden among South Asian young adults, which could be a causative factor in the overlap of clinical presentations between age groups in.

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