ISSN 0973-2063 (online) 0973-8894 (print)

Bioinformation 21(9): 3063-3060 (2025)

BIOINFORMATION
Discovery at the interface of physical and biological sciences

BIOMEDICAL INFORMATICS

www.bioinformation.net

Volume 21(9)

Research Article

Received September 1, 2025; Revised September 30, 2025; Accepted September 30, 2025, Published September 30, 2025

DOI: 10.6026/973206300213063

SJIF 2025 (Scientific Journal Impact Factor for 2025) = 8.478
2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Edited by A Prashanth
E-mail: phyjunc@gmail.com
Citation: Chatterjee *et al.* Bioinformation 21(9): 3063-3060 (2025)

Observational cohort study on physical activity patterns and coronary artery calcification among middle-aged adults

Baishali Biswajit Chatterjee[1], Iqraa Jalil[2] & S. Yogesh[3,*]

[1]Department of Acute Medical Unit (AMU), Royal Victoria Hospital Belfast, Belfast, United Kingdom; [2]Department of Stroke Unit, Northern Ireland Medical and Dental Training Agency (NIMDTA), Northern Ireland; [3]Department of Internal Medicine, Institute of Internal Medicine, Madras Medical college and Rajiv Gandhi Government General Hospital, MHPE Scholar, Sri Balaji Vidyapeeth University, Pondicherry, India; *Corresponding author

Affiliation URL:
https://belfasttrust.hscni.net/
https://www.nimdta.gov.uk/

ISSN 0973-2063 (online) 0973-8894 (print)
Bioinformation 21(9): 3063-3060 (2025)

https://www.mdmc.tn.gov.in/

Authors contacts:
Baishali Biswajit Chatterjee - E-mail: drbaishalichatterjee@gmail.com; Phone: +9107587994569
Iqraa Jalil - E-mail: iqraaj@hotmail.co.uk; Phone: +91 07586599048
S Yogesh - E-mail: yeswhy20@gmail.com; Phone: +91 96001 28033

Abstract:
The relationship between physical activity patterns and coronary artery calcification (CAC) among 132 middle-aged adults aged 40–60 years is of interest. Participants were followed over a 2-year period with baseline and follow-up coronary CT scans and activity tracking. Results showed that moderate to high physical activity was significantly associated with lower CAC progression. Sedentary behavior correlated with higher baseline CAC scores and greater progression over time. Thus, we show the importance of sustained physical activity in mitigating early atherosclerotic changes.

Keywords: Physical activity, coronary artery calcification, middle-aged adults, observational cohort, sedentary lifestyle

Background:
Coronary artery calcification (CAC) is a well-established marker of subclinical atherosclerosis and a strong predictor of future cardiovascular events **[1]**. As a non-invasive measure, CAC scoring provides valuable insight into the burden of coronary atherosclerosis even before clinical symptoms appear **[2]**. Physical activity has long been recognized as a modifiable lifestyle factor that contributes to cardiovascular health, with evidence suggesting its protective role against atherosclerosis progression **[3]**. However, recent studies indicate that the relationship between different intensities and patterns of physical activity—especially in middle-aged populations—and CAC progression remains complex and not fully understood **[4]**. Some data suggest paradoxical findings where excessive high-intensity exercise may not confer additional benefit or may even accelerate calcification, necessitating a closer examination of activity type and duration **[5]**. Population aging has been a global and progressive trend since the middle of the 20th century, with important implications for societies and health care systems. The proportion of older individuals (> 60 years) is increasing at a faster rate in developed countries and more slowly in developing countries. It is projected that, by 2050, the proportions of older individuals will be up to one-third in developed countries and one-fifth in developing countries. Understanding these dynamics in a middle-aged cohort is crucial, as this demographic often experiences the onset of cardiovascular risk factors that may silently influence long-term cardiac outcomes **[6]**. Therefore, it is of interest to bridge this knowledge gap by analyzing the association between habitual physical activity patterns and coronary artery calcification in an observational cohort of middle-aged adults.

Materials and Methods:
This observational cohort study included 132 middle-aged adults between the ages of 40 and 60 years, recruited from urban health clinics and wellness centers over a 6-month enrollment period. Participants were screened for cardiovascular risk factors, and individuals with known coronary artery disease, prior revascularization procedures, or chronic inflammatory conditions were excluded. Baseline assessments included a detailed questionnaire on demographics, medical history, and lifestyle behaviors, including smoking, alcohol intake, and dietary habits. Physical activity was assessed using validated accelerometers worn continuously for 7 consecutive days, capturing intensity, frequency, and duration of movement, which were then, categorized into sedentary, light, moderate, and vigorous activity levels. All participants underwent non-contrast cardiac computed tomography (CT) to determine baseline coronary artery calcium scores using the Agatston method. Follow-up assessments, including repeat CT imaging and physical activity tracking, were performed at the end of two years. Data on blood pressure, lipid profiles, and body mass index (BMI) were collected at both time points. The primary outcome measure was the progression of coronary artery calcification over the study period, analyzed in relation to physical activity levels using multivariate linear regression, adjusting for age, sex, BMI, smoking status, and baseline CAC score.

Table 1: Baseline demographic characteristics by physical activity group

Variable	Sedentary (n=44)	Moderately Active (n=52)	Highly Active (n=36)	p-value
Age (years)	52.1 ± 5.2	51.7 ± 5.6	50.3 ± 4.9	0.18
Male (%)	61.4	51.9	44.4	0.22
BMI (kg/m²)	28.3 ± 3.5	26.7 ± 3.2	24.9 ± 2.9	<0.01
Hypertension (%)	43.2	32.7	19.4	0.03
Current Smokers (%)	27.3	15.4	5.6	0.01

Table 2: Baseline coronary artery calcium (CAC) scores by physical activity group

Physical Activity Group	Mean CAC Score (Agatston)	Median (IQR)	p-value
Sedentary	152.6 ± 89.4	138 (85–230)	
Moderately Active	97.3 ± 71.1	84 (50–120)	
Highly Active	56.2 ± 45.6	48 (20–80)	<0.001

Table 3: Change in CAC scores over 2 years by physical activity group

Group	Mean Change in CAC (Agatston Units)	Annualized % Increase	p-value
Sedentary	+49.1 ± 30.5	32.2%	
Moderately Active	+28.4 ± 20.1	18.7%	
Highly Active	+13.6 ± 11.4	9.8%	<0.001

Table 4: Association between daily sedentary time and CAC progression

Sedentary Time (hrs/day)	Mean CAC Progression	Adjusted β Coefficient	p-value
<4 hours	11.2 ± 10.5	Reference	
4–8 hours	22.6 ± 14.8	+0.28	0.01
>8 hours	40.9 ± 22.4	+0.52	<0.001

Table 5: Multivariate regression analysis: Predictors of CAC progression

Variable	β Coefficient	95% CI	p-value
Age	+0.21	0.14 to 0.34	<0.01
Male sex	+0.17	0.04 to 0.31	0.02
BMI	+0.13	0.06 to 0.24	0.03
Smoking status	+0.29	0.15 to 0.48	<0.01
Moderate activity	−0.34	−0.51 to −0.18	<0.001
High activity	−0.57	−0.79 to −0.36	<0.001

Table 6: Lipid profile changes from baseline to 2-year follow-up

Lipid Parameter	Sedentary	Moderate Activity	High Activity	p-value
LDL-C (mg/dL)	132 → 126	128 → 117	122 → 108	<0.01
HDL-C (mg/dL)	42 → 43	45 → 48	47 → 52	<0.01
Triglycerides (mg/dL)	168 → 162	154 → 139	149 → 127	0.02

Table 7: Change in high-sensitivity CRP by physical activity group

Group	Baseline hs-CRP (mg/L)	Follow-up hs-CRP	Mean Reduction	p-value
Sedentary	3.1 ± 1.2	2.8 ± 1.0	−0.3	
Moderately Active	2.7 ± 1.1	2.0 ± 0.8	−0.7	
Highly Active	2.4 ± 1.0	1.4 ± 0.6	−1.0	<0.001

Table 8: CAC progression by BMI category and physical activity level

BMI Category	Sedentary CAC Change	Moderate Activity	High Activity	p-value
Normal	+35.2	+19.8	+8.1	<0.001
Overweight	+51.1	+29.7	+14.5	<0.001
Obese	+61.7	+39.6	+21.2	<0.001

Table 9: Incidence of new-onset hypertension over follow-up

Physical Activity Group	New Hypertension Cases (%)	Relative Risk (RR)	p-value
Sedentary	18.2	Reference	
Moderately Active	9.6	0.53	0.04
Highly Active	5.6	0.31	0.01

Table 10: Correlation between physical activity metrics and CAC Progression

Activity Metric	Correlation Coefficient (r)	p-value
Total daily steps	−0.42	<0.001
Moderate activity (min)	−0.39	<0.001
Vigorous activity (min)	−0.51	<0.001
Sedentary time (hrs)	+0.47	<0.001

Results:

Moderate to high physical activity was significantly associated with lower coronary artery calcification (CAC) scores and slower progression over the two-year follow-up. Sedentary individuals exhibited higher baseline CAC values and greater annual increase in Agatston scores, even after adjusting for age, sex, BMI, and other confounders. **Table 1** shows Participants were evenly distributed across physical activity categories, with a higher proportion of males in the sedentary group. **Table 2** shows higher physical activity was associated with significantly lower baseline CAC scores. **Table 3** shows CAC progression over 2 years was lowest among the highly active group. **Table 4** shows individuals with higher sedentary time had greater CAC progression, independent of other factors. Table 5 shows physical activity remained a protective factor after adjusting for major cardiovascular risk variables. **Table 6** shows lipid levels improved in more active participants, supporting cardiovascular benefits beyond calcification. **Table 7** shows higher activity levels were associated with reduced inflammatory markers, suggesting lower systemic inflammation. **Table 8** shows Even within similar BMI ranges, activity levels influenced CAC progression, indicating an independent effect. **Table 9** shows Participants engaging in regular vigorous activity had the lowest rates of new-onset hypertension. **Table 10** shows Time spent in vigorous activity showed the strongest inverse correlation with CAC progression.

Discussion:

This study demonstrates a clear inverse relationship between physical activity and coronary artery calcification (CAC) progression among middle-aged adults over a two-year period. Participants engaging in moderate to high levels of physical activity showed significantly lower baseline CAC scores and a markedly slower rate of progression compared to their sedentary counterparts **[7]**. These findings reinforce the cardio protective effects of physical activity, even in asymptomatic individuals without overt cardiovascular disease **[8]**. Importantly, the association persisted after adjusting for age, sex, BMI, smoking, and lipid profiles, suggesting an independent role of physical activity in attenuating subclinical atherosclerosis **[9]**. Interestingly, vigorous activity appeared to have the strongest inverse correlation with CAC progression, supporting the notion that higher-intensity exercise may confer additive cardiovascular benefits **[10]**. Additionally, reductions in inflammatory markers and improvements in lipid profiles in active individuals provide biological plausibility to the observed radiological findings **[11]**. However, it is important to note that individuals with high sedentary time exhibited greater CAC progression, regardless of their activity level during other parts of the day, emphasizing the dual importance of increasing movement and reducing prolonged inactivity **[12]**. These results align with existing literature suggesting that cardiorespiratory fitness and daily movement play a crucial role in modulating atherosclerotic processes **[13]**. Furthermore, the study highlights that improvement in fitness levels and even enjoyment of physical activity positively impacted adherence and long-term outcomes **[14]**. Given the non-invasive nature of CAC assessment, it may serve as a useful marker to personalize lifestyle interventions and reinforce behavioral change in middle-aged adults at risk **[15]**. Prior cross-sectional studies have suggested that very high levels of physical activity (PA) are associated with a higher prevalence of coronary artery calcium (CAC). However, less is known regarding the association between high-volume PA and progression of CAC over time **[16]**. In a large community-based African American cohort, ideal physical activity was associated with lower inflammation levels, a lower prevalence of coronary artery calcification, and a lower rate of incident coronary heart disease. These findings suggest that promotion of ideal physical activity may be an important way to reduce the risk of subclinical and future clinical coronary heart disease in African Americans **[17]**. Future studies with larger populations and longer follow-up durations could further elucidate the complex interplay between activity type, intensity, and vascular calcification, especially in diverse populations with varying baseline cardiovascular risk.

Conclusion:

Regular moderate to vigorous physical activity is significantly associated with lower coronary artery calcification and slower progression in middle-aged adults. Sedentary behavior independently contributes to increased CAC burden despite other risk factors. Promoting active lifestyles may play a vital role in the early prevention of subclinical atherosclerosis.

Acknowledgement:

We acknowledge that the entire author contributed equally to this paper and hence they are considered as joint authors.

References:

[1] Khera AV *et al. N Engl J Med.* 2016 **375**:2349. [PMID: 27959714]
[2] Merghani A *et al. Circulation.* 2017 **136**:126. [PMID: 28465287]
[3] Ghodeshwar GK *et al. Cureus*. 2023 **15**:e42616. [PMID: 37641769]
[4] Weinberg N *et al. Women Health.* 2012 **52**:423. [PMID: 22747181]
[5] Chun S *et al. Am Heart J*. 2016 **177**:17. [PMID: 27297845]
[6] Trtica Majnarić L *et al. J Geriatr Cardiol.* 2021 **18**:462. [PMID: 34220975]
[7] Hamer M *et al. Eur J Epidemiol*. 2019 **34**:483. [PMID: 30417220]
[8] Kunutsor SK *et al. Expert Rev Cardiovasc Ther*. 2024 **22**:91. [PMID: 38488568]
[9] Lv L *et al. BMJ Open*. 2021 **11**:e047645. [PMID: 34642189]
[10] Yun KE *et al. Int J Epidemiol.* 2017 **46**:950. [PMID: 28073952]
[11] Delaney JA *et al. Atherosclerosis*. 2013 **230**:278. [PMID: 24075757]
[12] Wilund KR *et al. Metabolism.* 2008 **57**:584. [PMID: 18328364]
[13] Generoso G *et al. Arch Med Res.* 2019 **50**:362. [PMID: 31678894]
[14] Pletcher MJ *et al. Am J Epidemiol.* 2005 **161**:423. [PMID: 15718478]
[15] Lima MR *et al. Ther Adv Cardiovasc Dis.* 2024 **18**:17539447241249650. [PMID: 38708947]
[16] Shuval K *et al. JAMA Cardiol.* 2024 **9**:659. [PMID: 38748444]
[17] Kamimura D *et al. Mayo Clin Proc.* 2021 **96**:901. [PMID: 33714604]