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Association between Cardiovascular Diseases and Knee Osteoarthritis

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Abstract

Context: Cardiovascular diseases (CVDs) such as ischemic heart diseases, heart failure, and stroke are the leading causes of morbidity and mortality (almost 30% of deaths) worldwide. Sociodemographic and clinical factors, such as obesity, diabetes, depressive symptoms, and physical inactivity, as factors behind the risk of CVDs.

Aims: This study aims to identify the factors behind the risk of CVDs in people with or at high risk for Knee Osteoarthritis (OA).

Settings and Design: The baseline data (2004–2006) of a total of 4674 persons with or at high risk for knee OA aged 45–79 years from the Osteoarthritis Initiative (OAI).

Methods and Material: This study adopted a cross-sectional study. Baseline data (2004–2006) from the Osteoarthritis Initiative were analyzed to determine the sociodemographic and clinical factors behind CVDs in 4674 persons.

Statistical Analysis Used: The Kolmogorov-Smirnov test was used to assess the data normality for continuous parameters.

Results: The results indicate 178 (62%) participants with age ≥65 years also had CVDs ($p < .0001$). Male gender had OR = 2.97 for heart attack and OR = 2.53 for heart failure making the implied probability of 33.7% and 39.5% respectively ($p < 0.05$). The OR and implied probability of diabetes and obesity for heart failure were 1.81 (55.2%) and 2.20 (45.5%) respectively ($p<0.05$).

Conclusions: These findings provide a rationale for further investigation of those factors behind the risk of CVDs in cross-sectional studies among this population.

Keywords: diabetes, heart attack, heart failure, physical inactivity, stroke

1. Introduction

Knee Osteoarthritis (OA) is the most common arthritis disease in the knee that degenerates the tissues that protect the joints and bones, which results in producing bone spurs (Sheth & Foran, n.d.). It is more prevalent in the older population; however, it may occur at a young age as well. Whereas, the prevalence of people over the age of 60 years, based on gender shows that women have more OA in common i.e., 20% as compared to men who make up 10% of the total population worldwide (Hiligsmann et al., 2013). According to the World Health Organization, cardiovascular diseases such as ischemic heart disease, heart failure, and stroke are the leading causes of death (almost 30% of deaths) worldwide (Wang, 2016). Hall, Stubbs, Mamas, Myint, and Smith (2016) found a strong association between OA and CVD, while people with OA were 3 times more at risk for CVDs, in their meta-analysis including 32 million participants. Likewise, Veronese et al. (2022), found the presence of OA to be a significant indicator of high risk of cardiovascular mortality. Research has been showing the increased risk of CVD among people with OA, indicating multiple moderating factors including old age, sedentary behavior, obesity, depression, and hypertension (Fernandes & Valdes, 2015; Hunter & Felson, 2006; Lawrence et al., 1998; Veronese et al., 2016). Similarly, results of studies conducted by Veronese et al. (2018b) and Veronese et al. (2016) depicted in their study that women have been found to have a significant association between OA and CVD.

Moreover, to specify the type of OA and its association with CVD, Park et al., (2023) showed that people with knee OA who exercise regularly had no increased risk of CVDs as compared to those who did not exercise, indicating

the moderating effect of physical activity between knee OA and CVD. Hence, it gives a direction to the preventive measures for the OA and consequently lessens the probability of CVDs. According to Roos and Arden (2016), primary prevention strategies are to reduce the chances of exposure to precipitating factors, e.g., refraining from getting a knee injury and obesity at a young age. Additionally, for cases with a high risk of knee OA, monitoring and treatment of risk factors is important to detect it at an early stage and subsequently prevent it from further progress.

Notably, longitudinal studies have been conducted to analyze the link between OA and CVDs, having contrasting results though. One large cohort study didn't find any association between the variables even after adjusting the status of disability (Hoeven et al., 2015b). Additionally, the specific affected site of OA has not been focused much on a relationship with CVDs. Also, moderating and mediating factors have rarely been focused to explore the association between knee OA and CVDs. Therefore, this study aims to conduct a cross-sectional study to analyze whether the presence or being at high risk of OA with a specified affected site i. e., knee, has increased risk of CVDs. Also, this study examines multiple patient-related characteristics such as sociodemographic, lifestyle, and clinical factors to examine mediating and moderating factors. If these characteristics are found associated with CVDs and are found modifiable, then the interventions could be planned accordingly. Besides, the data of this study is comprised of people belonging to different backgrounds, which would make the findings more generalizable and applicable. Further, this study explores the old data, which would provide a new direction to investigate the association between knee OAs and CVDs highlighting the similarities and differences with the recent studies, along with retrospectively contributing to the relevant literature.

2. Subjects and Methods

The data for this study was extracted from Osteoarthritis Initiative (OAI). The OAI is a publicly and privately financed, multicenter, cross-sectional, and observational study, that operates with the motive of providing resources to contribute to the knowledge of prevention and treatment of knee OA. The baseline data (2004–2006) of a total of 4674 persons with or at high risk for knee OA aged 45–79 years were used in this cross-sectional study. All OAI data are available for public access at the National Institute of Health-hosted website (Osteoarthritis Initiative). The study was performed by the ethical standards of the Declaration of Helsinki (1964) and its subsequent amendments.

The Committee of Human Research at the four clinical sites (Baltimore, MD; Pittsburgh, PA; Pawtucket, RI; and Columbus, OH) and coordinating site (i.e., University of California, San Francisco) has approved the OAI study protocol. All the participants gave written informed consent at the time of original OAI data acquisition. The accessed data were de-identified.

A total of 4674 men and women, irrespective of race/ethnicity were classified into two groups based on their CVDs status at baseline: i.e., with CVDs (n = 287) and without CVDs (n = 4387). OA is a type of arthritis that causes pain and stiffness in the joint due to inflammation caused by degeneration and eventual loss of joint cartilage (Abramoff & Caldera, 2018). Participants excluded were with no pain or stiffness, no radiographic findings of OA, and no risk factors for OA either in the knee in the past year covered in the control sub-cohort (n = 122).

Sociodemographic, lifestyle, and clinical variables from the OAI dataset were included to explore the association with the risk of CVDs. Dichotomized sociodemographic parameters, such as age (≥65 [vs.] <65 years), gender (man vs. woman), race (Caucasian vs. African American/Asian/other non-white), education (primary school/less vs. high school/more), and marital status (married vs. unmarried/divorced/widows) were included. We included only one dichotomized lifestyle factor of smoking status (current/former smoker vs. never). The clinical variables and confounding factors, such as hypertension, diabetes, depressive symptoms, body mass index (BMI), and physical activity levels, were incorporated. Other confounding factors such as the severity of OA and concomitant therapies including anti-inflammatory and analgesic medication were not incorporated.

Hypertension was defined as systolic and diastolic blood pressure of ≥130/≥80 mm Hg (Carley & Whelton, 2018). Charlson Comorbidity Index (CCI) was used to assess diabetes status by a self-administered question: have diabetes (high blood sugar)? If persons responded to 'yes, they were classified as having diabetes. Prior research has reported the validity and reliability of using the CCI (Schneider, Pankow, Heiss, & Selvin, 2012). Waite et al. (1994) found high inter-rater reliability with 58% of agreement among 5 raters, whereas Atherly et al. (2004) showed significant validity with r = .56. As an indicator of having depressive symptoms, we used a score ≥16 on the Center for Epidemiological Studies Depression Scale (CESD) (Barlow & Wright, 1998). The CESD has been reported to have good sensitivity and specificity and high internal consistency (Lewinsohn, Seeley, Roberts, & Allen, 1997). The BMI was calculated as weight in kilograms (kg) divided by the square of height in meters (m2). Pietrobelli et al. (1998) reported a strong significant validity range from .79 to .83. The participants were divided

into two groups: non-obese (BMI <30 kg/m2) and obese (BMI ≥30 kg/m2) (Weir & Jan 2021).

Physical activity level was assessed using the Physical Activity Scale for the Elderly (PASE) (Bolszak, Casartelli, Impellizzeri & Maffiuletti, 2014). PASE consists of a 12-item questionnaire for measuring self-reported physical activity over the previous seven days in three life domains (leisure, household, and occupational activities). According to the previous study (Stehling et al., 2010), the computed median PASE score for all participants was 151.5. Participants were divided into two groups based on their physical activity level at baseline: physically active (PASE score: ≥150) and physically inactive (PASE score: <150). A similar classification was used in other studies (Stehling et al., 2010). The reliability and validity of PASE were found to be significant with r = .75 (Washburn, Smith, Jettey, & Janney, 1993) and r = .43 (Dinger, Oman, Taylor, Vesely & Able, 2004) respectively.

Cardiovascular diseases, such as heart attack, heart failure, and stroke status, were assessed at baseline using the self-administered CCI questionnaire. The primary outcome of interest was the risk of CVDs in persons with or at high risk for knee OA. CVDs defined as the presence of heart attack, heart failure, or stroke.

The Kolmogorov-Smirnov test was used to assess the data normality for continuous parameters. Descriptive statistics, such as means and standard deviations for continuous variables, frequency, and percentages for dichotomized variables, were presented for the total sample and both groups: with and without CVDs. Independent sample t-tests and chi-square tests were applied to assess significant differences between the groups. The prevalence of heart attack, heart failure, and stroke was plotted according to the sociodemographic, lifestyle, and clinical factors.

Logistic regression analysis was used to investigate the association of sociodemographic (age ≥65 years, men, Caucasians, high school/more, and married), lifestyle (current/former smoker), and clinical factors (hypertension, diabetes, depressive symptoms, obesity, and physical inactivity) with CVDs, such heart attack, heart failure, and stroke in persons with or at high risk for knee OA. Odds ratios (ORs) and 95% confidence intervals (CIs) were computed. The logistic regression models were applied using separate models for each factor of sociodemographic, clinical, and lifestyle, as a predictor (i.e., the models did not examine the effects of multiple predictors simultaneously). Sensitivity analyses were conducted for sub-cohort groups, including those with and at high risk for knee OA separately. All the investigations were completed using SAS version 9.4 for Windows (SAS, Institute, Inc., Cary, NC, USA). A p-value < 0.05 was rated statistically significant.

3. Results

Figure 1 shows the flow chart of the participants included in this study. Of the 4796 participants, a total of 122 were excluded because they did not have knee OA or were not at high risk for knee OA. Thus, 4674 persons with or at high risk for knee OA were incorporated. Out of 4674 persons, 287 people had CVDs (6.1%), whereas 4387 individuals did not have CVDs (93.9%) at baseline.

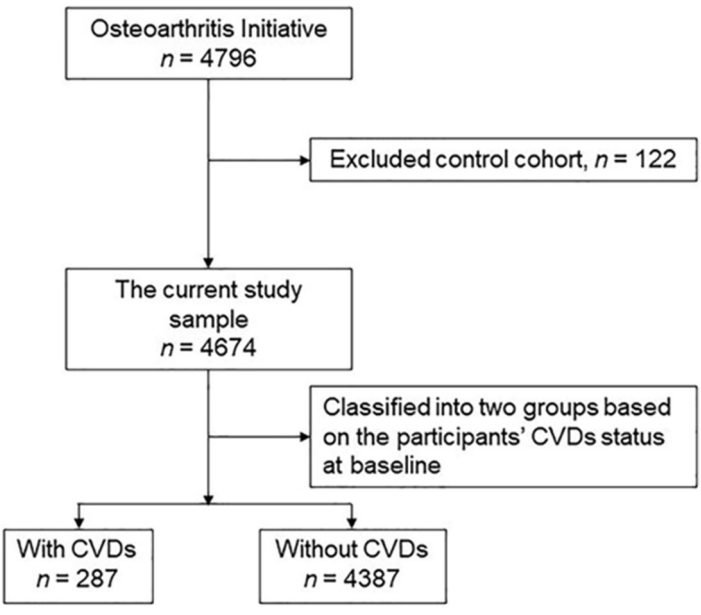

Figure 1. The flow of the study sample. CVDs, cardiovascular diseases (heart attack, heart failure, and stroke)

The characteristics of participants with and without CVDs are summarized in Table 1. Compared to the people without CVDs, those with CVDs were significantly associated with women's (53.7%) and age of 65 years or above (62%). The majority of those with CVDs were current/former smokers (56.8%) and were significantly associated with hypertension (5.6%), diabetes (16.4%), depressive symptoms (16.7%), and physical inactivity (63.8%). The average PASE score in individuals with CVDs was 136 ± 76.7.

Table 1. Socio-demographic and clinical characteristics according to cardiovascular diseases

Characteristic	Total n = 4674	With CVDs n = 287 (6.1)	Without CVDs n = 4387 (93.9)	P
Age, mean (SD)	61.2 (9.1)	66.4 (8.8)	61 (9.0)	<.0001
Age group				<.0001
<65 years	2871 (61.4)	109 (38)	2762 (63)	
≥65 years	1803 (38.6)	178 (62)	1625 (37)	
Sex				<.0001
Men	2729 (58.4)	133 (46.3)	2596 (59.2)	
Women	1945 (41.6)	154 (53.7)	1791 (40.8)	
Race				.028
White or Caucasians	3677 (78.7)	76 (26.5)	921 (21)	
Block or African American/Asian/American/Asian/another non-white	997 (21.3)	211 (73.5)	3466 (79)	
Education level				.006
Primary school or less	770 (16.5)	64 (22.3)	706 (16.1)	
High school or more	3904 (83.5)	223 (77.7)	3681 (83.9)	
Marital status				.105
Married	3119 (66.7)	108 (37.6)	1447 (33)	
Unmarried/divorced/widow	1555 (33.3)	179 (62.4)	2940 (67)	
Smoking status				.001
Non-smoker	2421 (52.6)	123 (43.2)	2298 (53.2)	
Current/former smoker	2182 (47.4)	162 (56.8)	2020 (46.8)	
Hypertension, >130/>80mm Hg	223 (4.8)	16 (5.6)	207 (4.7)	.509
Diabetes	361 (7.9)	46 (16.4)	315 (7.4)	<.0001
Depressive symptoms				.0002
No (CESD<16)	4198 (89.8)	239 (83.3)	3959 (90.2)	<.0001
Yes (CESD≥16)	476 (10.2)	48 (16.7)	428 (9.8)	
Body Mass Index (BMI), kg/m2				.012
Non-obese (BMI<30)	2913 (62.3)	159 (55.4)	2754 (62.8)	
Obese (BMI≥30)	1761 (37.7)	128 (44.6)	1633 (37.2)	0.117
BMI, mean (SD)	4190 (92.1)	29.6 (4.8)	28.6 (4.8)	.001
Physical activity (PASE)				<.0001
Active (PASE≥150)	2313 (49.5)	104 (36.2)	2209 (50.3)	
Inactive (PASE<150)	2361 (50.5)	183 (63.8)	2178 (49.7)	
PASE, mean (SD)**	223 (5.7)	136 (76.7)	161 (82.7)	<.0001

Note. CVDs= cardiovascular diseases; CESD= Center for epidemiological studies depression; PASE= physical activity scale for the Elderly.

Figure 2 illustrates the prevalence of heart attack, heart failure, and stroke according to the socio-demographic, lifestyle, and clinical variables. The prevalence of heart attacks was high in older adults (age ≥65 years) (1.4%), women (1.3%), and Caucasians (1.5%). Also, the prevalence of heart attack was high in those who had high school or above education (1.6%), were married (1.3%), were current/former smokers (1.3%), had diabetes (1.7%), and had depressive symptoms (1.8%). The prevalence of heart failure was high in individuals with hypertension (2%). Old age (age ≥65 years), male gender, Caucasian ethnicity, high school/more education, married marital status, being current/former smoker, having hypertension, diabetes, depressive symptoms, obesity, and physical inactivity had a very high prevalence of stroke which ranged from 1–3.4 percent.

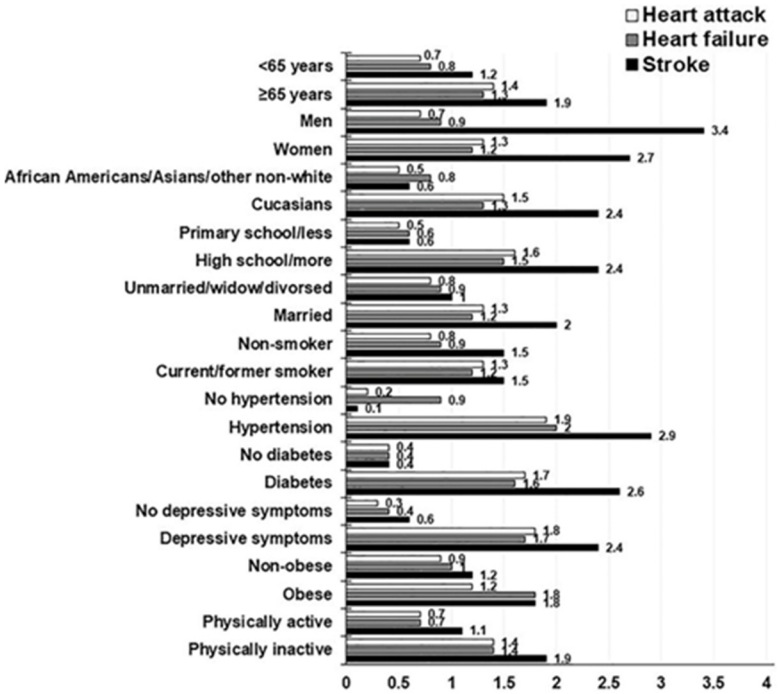

Figure 2. Distribution of cardiovascular diseases (CVDs) according to sociodemographic, lifestyle, and clinical factors. Here horizontal x-axis denotes the prevalence percentage for CVD (heart attack, heart failure, and stroke), and the vertical y-axis denotes sociodemographic, lifestyle, and clinical factors

Table 2 depicts the association of sociodemographic, lifestyle, and clinical factors with the CVDs among people "with knee OA" and "at high risk of knee OA". The age ≥65 years significantly ($p = .05$) and ($p < .0001$) had at least twice the odds for all CVDs, among both "with knee OA" and "at high risk of knee OA" respectively. Similarly, among people with knee OA and at high risk of knee OA, the male gender had significantly ($p < .050$) more than twice the odds of having both heart attack and heart failure. Diabetes had significantly ($p < .05$) more than twice the odds of having a heart attack and heart failure among people with knee OA, whereas, among people at high risk of knee OA, diabetes had significantly ($p < .05$) twice the odds of having a stroke. Moreover, having depressive symptoms was significantly associated ($p < .05$) with more than twice the odds for both heart failure and stroke among people at high risk of knee OA. Also, obesity also significantly ($p < .05$) increases twice the odds of having a heart attack among people with knee OA as well as at high risk of knee OA. Besides, marital status, race, smoking, physical inactivity, and hypertension do not cause a significant impact on CVDs.

Table 2. Logistic regression models for predicting the risk of cardiovascular diseases in people "with knee osteoarthritis" and "at high risk for knee osteoarthritis"

Variable	Heart attack		Heart failure		Stroke	
	OR (95% CI)	P	OR (95% CI)	P	OR (95% CI)	P
With knee osteoarthritis						
Older age (≥65 years)	2.19 (1.00–4.93)	.050	2.49 (1.23–5.05)	.010	2.50 (1.30–4.80)	.005
Man	3.22 (1.38–7.51)	.006	2.05 (1.02–4.12)	.045	1.16 (0.61–2.19)	.651
Caucasians	0.97 (0.39–2.42)	.944	0.80 (0.37–1.73)	.573	0.96 (0.45–2.04)	.917
High school/more	0.55 (0.23–1.31)	.178	0.89 (0.41–1.96)	.789	1.32 (0.59–2.97)	.498
Married	0.59 (0.28–1.39)	.226	0.58 (0.28–1.20)	.141	1.16 (0.57–2.33)	.685
Current/former smoker	1.70 (0.76–3.82)	.195	1.22 (0.63–2.38)	.552	1.16 (0.63–2.14)	.632
Hypertension	0.79 (0.17–3.78)	.772	0.36 (0.46–2.75)	.322	0.37 (0.50–2.78)	.334
Diabetes	3.14 (1.35–7.32)	.008	2.51 (1.15–5.45)	.020	0.94 (0.35–2.54)	.907
Depressive symptoms	1.12 (0.38–3.29)	.842	1.86 (0.80–4.29)	.148	2.19 (0.97–4.92)	.059
Obese	2.44 (1.03–5.82)	.043	1.18 (0.59–2.34)	.641	0.88 (0.47–1.65)	.691
Physical inactive	1.52 (0.65–3.57)	.338	1.81 (0.86–3.81)	.118	1.67 (0.85–3.27)	.137
At High Risk of knee osteoarthritis						
Older age (≥65 years)	4.92 (2.68–9.02)	<.0001	2.49 (1.38–4.50)	.0026	2.81 (1.76–4.47)	<.0001
Man	2.89 (1.65–5.05)	.0002	2.89 (1.60–5.21)	.0004	1.42 (0.91–2.23)	.119
Caucasians	0.91 (0.45–1.82)	.789	0.35 (0.19–0.65)	.090	0.99 (0.56–1.79)	.999
High school/more	0.76 (0.39–1.45)	.399	0.61 (0.32–1.15)	.128	0.77 (0.45–1.32)	.349
Married	0.77 (0.43–1.37)	.381	0.91 (0.49–1.68)	.760	0.88 (0.55–1.41)	.609
Current/former smoker	1.40 (0.83–2.35)	.203	1.55 (0.88–2.70)	.127	1.01 (0.66–1.54)	.978
Hypertension	2.20 (0.89–5.43)	.087	0.52 (0.12–2.27)	.390	1.27 (0.49–3.27)	.620
Diabetes	1.18 (0.53–2.59)	.680	1.65 (0.77–3.55)	.198	2.10 (1.13–3.89)	.019
Depressive symptoms	1.35 (0.55–3.28)	.508	2.24 (1.03–4.84)	.040	3.14 (1.77–5.57)	<.0001
Obese	2.30 (1.37–3.87)	.002	1.26 (0.71–1.22)	.425	1.11 (0.70–1.75)	.661
Physical inactive	1.53 (0.88–2.65)	.128	1.60 (0.89–2.87)	.114	1.14 (0.73–1.77)	.572

4. Discussion

This large population-based cohort study has identified the factors predictable of CVDs in people with or at high risk for knee OA. In people with or at high risk for knee OA, or for knee OA only; age 65 years or above was a predictor for heart attack, heart failure, and stroke. Male gender predicted both heart attack and heart failure among people with knee OA and at high risk of knee OA. While, diabetes was a predictor for having a heart attack and heart failure among people with knee OA, whereas, among people at high risk of knee OA, diabetes only predicted stroke. In addition, obesity was a predictor for heart attack for people with as well as at high risk of knee OA, and depressive symptoms were a predictor for heart failure and stroke among people at high risk of knee OA.

Older age, being a man, and diabetes are known risk factors for CVDs in the general population (Matsushita et al., 2020), and these risk factors are significant predictors of CVDs in the current study. Contrary to our results, women but not men who were diagnosed with hip or knee OA or with knee OA only developed CVDs (Hoeven et al., 2015a; Schieir, Hogg-Johnson, Glazier, & Badley, 2016). In those two studies (Veronese et al., 2016; Hoeven et al., 2015a), the mean ages of their participants were about 76 and 73 years, respectively. However, the participants in our study were younger, and their mean age was 61 years. Generally, hormonal changes following the postmenopausal stage and having OA predisposed women to be at higher risk of CVDs when compared to men. In comparison, younger men are at a higher risk of CVDs when compared to younger women (Fernandes & Valdes, 2015). In our study, 34 men aged < 65 had a heart attack, heart failure, or both diseases, whereas 28 women aged

<65 had a heart attack, heart failure, or both disorders. In addition, the number of women who had knee OA and CVDs was 341 (Veronese et al., 2016), and the number of women who had knee OA and calcified coronary artery was 870. In these two studies (Veronese et al., 2016; Hoeven et al., 2015a), the number of men was less when compared to women. Notably, the number of men who had knee OA and CVDs was 227 (Veronese et al., 2016), and the number of men who had knee OA and calcified coronary artery was 799 (Hoeven et al., 2015a). However, the number of men who had CVDs in our study is 154, and it was higher than the number of women who had CVDs, which is 133.

Moreover, we included people who had knee OA or were at high risk for knee OA, while other studies included people who had a confirmed diagnosis of OA (Veronese et al., 2016; Hoeven et al., 2015a). However, they did not specify the affected joints and included people with total joint replacement; thus, this study gave additional results by comparing the prediction for people with knee OA and people at high risk of knee OA.

In the current study, diabetes was a predictor for heart attack and heart failure in people with knee OA and a predictor for stroke in people who were at high risk for knee OA. OA is highly prevalent among people with diabetes (Piva et al., 2015). Diabetes is an independent risk factor for CVDs in the general population (King & Grant, 2016), and this risk could be increased in people with or at high risk for knee OA. Therefore, attention should be paid to controlling diabetes among people with or at high risk for knee OA.

Interestingly, the results of this study show that hypertension was not a significant predictor for heart attack, heart failure, and stroke. Knee OA has been linked with hypertension and diabetes, which are influential risk factors for CVDs in the general population (Oparil, Zaman, & Calhoun, 2003; Kim et al., 2016; Veronese et al., 2018a). However, in the current study, only 5.6% of participants who had CVD were hypertensive. In addition, we utilized the definition from the new blood pressure guidelines (systolic blood pressure is ≥ 130, and diastolic blood pressure is ≥80 mm Hg), which might weaken the association between blood pressure and CVDs. It has been reported that as blood pressure goes higher, the risk for CVDs would increase (Carey & Whelton, 2018). Physical inactivity was only a significant predictor for heart failure in the current study ($p = .036$). The mean of PASE for participants who had CVDs was 136 minutes/week, which indicates being physically inactive. People with knee OA are physically inactive because they might have difficulty walking, or they might try to avoid the pain which is caused by OA. Thus, it is essential to implement appropriate interventions to increase physical activity among people with or at high risk for knee OA.

In this study, depressive symptoms were a predictor of heart failure and stroke in those who were at high risk for knee OA. People with hip or knee OA suffer from depression due to fatigue and disability secondary to OA pain (Hawker et al., 2011). Similarly, Zheng et al. (2021) found a link between knee OA and the likelihood of catching up with depression. Thus, this indicated that depressive symptoms might play a mediating factor, resulting in physical inactivity and obesity in people with OA and subsequently increasing the risk of developing CVD. In the current study, we did not investigate the fatigue or disability levels of the participants; thus, we could not elucidate these associations.

The current study has a large sample size as one of the strengths of the study because it provided more reliable and precise results. Moreover, this study included multiple patient-related factors as predictors, which broadened the generalizability and applicability of the findings. The results drawn using patient-related variables are useful in designing interventions to prevent CVDs. Additionally, the data of the study comprised a heterogeneous population, which enhanced the horizon for understanding the association of knee OA with CVDs and subsequently increased the generalizability. Replication of this study is suggested to further explore the mediating as well as the moderating factors between knee OA and CVDs while considering the transparency and clarity of the study. Besides, the study explored the old data, which provided a direction to investigate the association between knee OAs and CVDs while highlighting the similarities and differences with the recent studies. Also, the interventions for the now elderly population could be modified according to the associated factors with CVD which were found in the cohort group who were the middle-aged population during the studied timeline. In addition, insights from this research will add up to the relevant literature in a retrospective manner.

However, there are several limitations to be mentioned. First, it is a cross-sectional study which does not imply causality. Second, we only included those who had or were at high risk for knee OA; thus, the results could not be generalized to those who have OA in other joints. Also, we did not have a control group. We did not control for how many joints were affected, and we did not control for medications since some of the anti-inflammatory drugs for OA could lead to CVDs (Fernandes & Valdes, 2015). Other CVDs were not included in this analysis such as peripheral vascular diseases as they were not collected at the OAI baseline. Confounding factors such as the severity of OA and concomitant therapies including anti-inflammatory and analgesic medication were not

incorporated. Lastly, the analysis data is old and lacks physiological parameters and serum biochemical data. Therefore, future study with physiological parameters and confounding factors incorporated is recommended.

5. Conclusion

This study has explored the association between various variables including sociodemographic, lifestyle, and clinical factors, and CVDS among people with knee OA and at high risk of knee OA. The study reported that age, gender, depressive symptoms, diabetes, and obesity were significant predictors of CVD among people with or at high risk of knee OA. The findings of this research help design interventions to prevent CVDs by targeting the identified risk factors.

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Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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