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IMPACT OF DAILY STOCK MARKET VOLATILITY ON HEART ATTACK IN THE UNITED STATES

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Abstract

Background: Based on previous research revealing an association between stock volatility and cardiovascular mortality in the Asian population, we hypothesize that a similar correlation exists between stock market volatility and the increased risk of heart attack in the United States (US).

Objective: We aimed to investigate the association between daily stock volatility and population-level heart attack in the US (2005–2022).

Methods: Time-series analysis and generalized linear regression were used to examine the association between the daily volatility of Dow Jones Industrial Average (DJI) and the heart attack prevalence in the community population and the prevalence of coronary artery disease (CAD, including ischemic heart disease and myocardial infarction) in the hospital emergency department (ED) patients. The community-based data (2005–2022) were from the Behavioral Risk Factor Surveillance System (BRFSS) and the ED-based data (2013–2021) were from the National Hospital Ambulatory Medical Care Survey (NHAMCS).

Results: There were an average of 34 days (range: 0–126 days) having a large DJI volatility amplitude (>=2%) annually from 2005 to 2022. Given an increase of 50 days with a large DJI volatility, the prevalence of CAD in ED patients increased by 11.6% in the current year, and the point prevalence of heart attack in the community population decreased by 4.4% in the next year.

Conclusions: The large stock volatility could increase the risk of heart attack in the US population, and bring more CAD patients in ED visits. Consequently, in the community, the surviving patients with heart attack become less shortly afterwards.

Keywords: *stock market volatility, heart attack, time-series analysis, generalized linear regression model*

Background

Heart disease remains to be the leading cause of death in the United States, even though the overall number of people at risk and dying from heart conditions have decreased in the past century (Benjamin et al.,

2019; Martin et al., 2024). Furthermore, it is also a global concern as heart disease has contributed to over half of the global mortality (Yusuf et al., 2001). Among the many causes for heart disease, research has revealed that psychosocial stress indeed plays a role in causing the development of heart diseases. Psychosocial factors – including depression, anxiety, and low social status – and emotional stress are seen to have an association with an increased risk in obtaining cardiovascular disease and a worsened prognosis (Ladwig et al., 2014). Therefore, it is critical to identify those human behaviors that increase the psychosocial stress in daily life, which would be helpful for the development of preventive strategies for heart disease.

Previous studies have indicated that many factors can increase the psychosocial stress in our daily life, such as work stress and natural disasters (Kario, 1998). Evidence also shows that exposure to stock in a turbulent stock market significantly increases the level of anxiety disorder (Qin et al., 2019). Furthermore, a recent study in China suggests that a ten percentage point decrease in daily market returns has an association with an approximately 35 million increase in renminbi (RMB), the Chinese currency, in national medical expenses related to emergency room services (Agarwal et al., 2024). Among the emergency room visits by patients, cardiovascular diseases (e.g., heart attack) and mental disorders are common causes for those visits. In addition, a few studies in Asia have also demonstrated that stock market volatility can lead to an increase of cardiovascular mortality (Agarwal et al., 2024; Lian, 2020; Lian et al., 2020; Ma et al., 2010; Qin et al., 2019). Thus, a causal chain can be presumed that a turbulent stock market causes stress and anxiety, which increases the onset of cardiovascular diseases and even the death rate.

However, limited information currently exists about this sort of association between stock market volatility and heart disease in the United States (US). The stock market in the US and the characteristics of the American population differ greatly from those in Asia. Therefore, it is unclear if the association observed in Asia also exists in the US. Thus, our study aims to investigate the association between daily stock market volatility and population-level heart attack in the US.

Methods

Study design

An observational study was implemented to examine the association between the daily volatility of the Dow Jones Industrial Average (DJI) stock and heart disease prevalence in the US utilizing the national databases. It is also considered as an ecological study as this research was to understand the relationship between exposure and outcome at a population level (rather than an individual level).

The exposure, the daily DJI volatility, was defined as the ratio of the daily range of DJI price to the daily close price. Two outcomes were evaluated in this study including: 1) the prevalence of coronary artery disease (CAD) in the hospital emergency department (ED) patients in the US, and 2) the prevalence of heart attack in the US community population.

Data source

The data of heart attack in the community (between 2005 and 2022) were extracted from the Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is the nation's premier system of health-related telephone surveys that collect state data about U.S. residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services. The BRFSS completes more than 400,000 adult interviews each year, making it the largest continuously conducted health survey system in the world (*About BRFSS*, n.d.).

For convenience, CAD is used to represent these heart diseases: coronary artery disease, ischemic heart disease, and myocardial infarction in this study. The hospital ED data for patients with CAD extracted from the National Hospital Ambulatory Medical Care Survey (NHAMCS) were only available between 2013 and 2021. The NHAMCS collected and released high quality, objective, reliable information about how hospital-based ambulatory medical care services were provided and used in the United States. To collect NHAMCS data, information was manually taken from medical records (*National Hospital Ambulatory Medical Care Survey | NHAMCS*, 2024).

The daily stock market data of DJI between 2005 and 2022 were pulled from Ya-

hoo Finance (https://finance.yahoo.com/quote/%5EDJI/history/).

Statistical methods

A time-series analysis was employed to explore the correlation pattern between the number of days per year having large daily DJI volatility () and the prevalence of heart attack in the US community population. The prevalence of heart attack was a point prevalence of heart attack at the time when the annual BRFSS survey was conducted. Similarly, this method was also used to explore the correlation pattern between the number of days per year having large daily DJI volatility and the prevalence of CAD in the US hospital ED patients. The prevalence of CAD was a period (annual) prevalence of CAD based upon the data collected in the NHAMCS.

In the time-series analysis, a cross correlation function (CCF) was used to identify the lags of *exposure* (the number of days per year having large daily DJI volatility) that might be useful predictors of *outcome* (e.g., the prevalence of heart attack). If a bar on CCF plots extends beyond the significance bounds, it indicates a significant correlation at that lag. When the lag is negative, it is said that the *exposure* in the past (e.g., last year) may have a correlation with the current *outcome*.

A generalized linear regression (Gaussian distribution with a log link) was used to further examine the correlation patterns found by the time-series analyses. The model estimate and p-value were reported. All analyses of this study were completed using R statistical software (version 4.3.3).

Results

Descriptive analysis

The year of 2008 had the most days (126 days) having large daily DJI volatility (), followed by the year of 2009 (94 days). The years of 2010, 2011, 2018, 2020, and 2022 had a range of 25 to 75 days with large daily DJI volatility. Less than 25 days having large daily DJI volatility appeared in the rest of years between 2005 and 2022.

The prevalence of CAD in the hospital ED patients was in the range of 5.6% to 6.8%, and the prevalence of heart attack in the community population was in the range of 4.0% to 4.6%. Both prevalence varied over time during the study period.

Time-series analysis

As shown in Figure 1, a bar extends beyond the upper significance bound at the lag of 0. It indicates that the prevalence of CAD in the hospital ED patients was positively correlated with the number of days having large DJI volatility in the same year. In other words, the higher the number of days having large DJI volatility in a year was, the higher the prevalence of CAD in the hospital ED patients in the same year would be.

In contrast, a bar extends beyond the lower significance bound at the lag of –1 (Figure 2). It indicates that the prevalence of heart attack in the community population was negatively correlated with the number of days having large DJI volatility in the previous year. That is to say, the higher the number of days having large DJI volatility in the current year was, the lower the prevalence of heart attack in the community population in the next year would be.

Regression model

The generalized linear regression model further confirmed the positive correlation between the CAD prevalence in the hospital ED patients and the number of days having large DJI volatility in the same year (Figure 3). The CAD prevalence in hospital ED patients went up by 11.6% given an increase of 50 days having a large DJI volatility in the same year.

The regression model also demonstrated the negative correlation between the prevalence of heart attack in the community population and the number of days having large DJI volatility in the previous year (Figure 4). The heart attack prevalence dropped by 3% given an increase of 50 days having a large DJI volatility in the previous year. That is to say, the heart attack prevalence in the community population may drop by 3% in the next year if there is an increase of 50 days having a large DJI volatility in the current year.

Discussion

Our study revealed that there is a positive correlation between the number of CAD patients and days with a high number of DJI stock volatility in the same year while there is a negative correlation between the number of community members with a heart attack history and the number of days with a high number of DJI stock volatility in the

past year. The positive correlation shows that more patients with CAD went to the emergency departments of hospitals in the year where there were more days having a large DJI volatility in the US. This result, which is that the CAD prevalence in ED patients increased by 11.6% with an increase of 50 days of having a large DJI volatility, is interpreted as this fact that these patients who are admitted to the ED are likely to have a heart attack history and also have a high risk of death due to being admitted again for heart problems, and this all occurs in the same year that the number of days with a high stock market volatility increased. Therefore, the high likelihood of death for these patients results in a decreased amount of people in the community who have a heart attack history, explaining the negative correlation seen with the prevalence of heart attack in the American community and the number of days with a high DJI stock volatility in the previous year.

Our findings in the American population are consistent with what the previous studies reported in the Asian population. Lian et al. (Lian, 2020) conducted a meta-analysis and evaluated the short-term effect of stock volatility and cardiovascular mortality in the Asian population, which revealed that every 100-point increase (the moving average for the past 120 hours) in the stock market brought about 4.4% (95%CI, 1.1% to 7.7%) increases in cardiovascular mortality (Lian et al., 2020). This finding that stock volatility may adversely affect cardiovascular health was mainly based upon the studies conducted in the Asian cities of Shanghai, Singapore, Guangzhou and Taishan (Ma et al., 2010). The results in those Asian studies can help us to explain why a large DJI volatility causes more deaths than usual among patients with heart conditions in the US and lead to a lower prevalence of heart attack in the American community population in the next year.

As we all know, stock market volatility is one of stressful events. Previous studies have demonstrated that stressful environmental occurrences can cause an increased risk of heart attack, coronary artery disease, and other heart diseases. For instance, chronic work stress is revealed to have an association with CAD with a particularly strong association with patients over the age of 50. This is partly due to the effect of chronic work stress on health behaviors and metabolic syndrome (Vrijkotte et al., 2000). Characteristics of high work stress are also associated with increased risk of heart disease (Chandola et al., 2008). Musey et al. found that this type of psychological stress is commonly found in patients who are undergoing an evaluation for acute cardiovascular events (Musey Jr et al., 2019). A similar result is found by Edmondson et al. where an increase of recurrent cardiac events and mortality has been seen in patients having clinically significant posttraumatic stress disorder symptoms that are induced by acute coronary syndromes (Edmondson et al., 2012). Similarly, environmental stress such as earthquakes can lead to cardiovascular diseases that may even persist in the following weeks of the event (Kario, 1998).Thus, it is understandable that a large daily volatility in the stock market can cause an unexpected stress that increases the risk of CAD and heart attack.

In the US, sixty-two percent of adults invested in the stock market in 2024 (*Share of Americans Investing in Stocks 2024*, 2024). Although it is not possible to stop people from investing in the stock market completely, educational intervention may be useful in the risk management of heart attack. The most important one for them is to fully understand the risk of stock investment before entering the stock market. For the elderly people with heart conditions, and other community members who also have a history of heart diseases, investing in the stock market on their own is not recommended, but they may hire a financial advisor or explore other more conservative ways for their wealth management if needed.

It should be noted that there are a few limitations in this study. First, with the data that was given, this study was only able to analyze the data within a limited time frame (2005–2022 for BRFSS and 2013–2021 for NHAMCS). Second, the analysis for this study was based on population-level data only. The absence of individual-level data causes us to be unable to know that those with risk from the stock volatility are the ones who are actually getting the disease. Third, other risk factors of heart attack (e.g., smoking, drinking alcohol, family history) were not assessed or controlled in this ecological study.

Figure 1. *Correlation pattern between the CAD prevalence in the hospital ED patients and the number of days per year having large DJI volatility (equal or greater than 2%)*

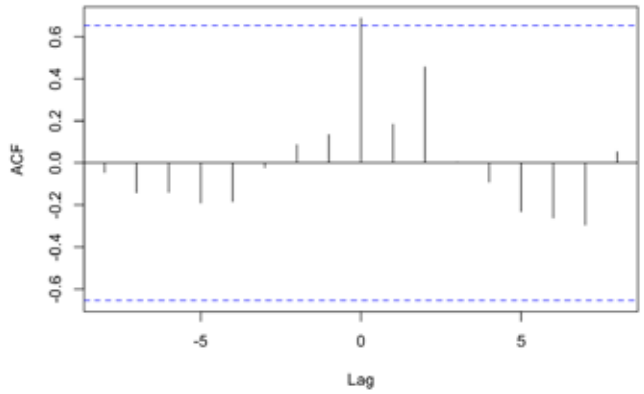


Figure 2. *Correlation pattern between the heart attack prevalence in the community population and the number of days per year having large DJI volatility (equal or greater than 2%)*

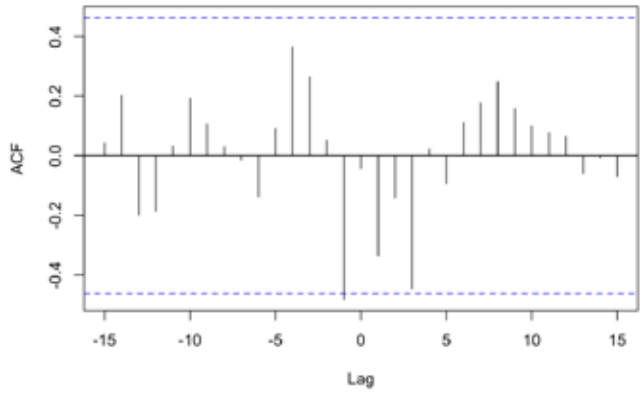


Figure 3. *Regression model examining the association between the CAD prevalence in the hospital ED patients and the large DJI volatility (equal or greater than 2%) in the same year*

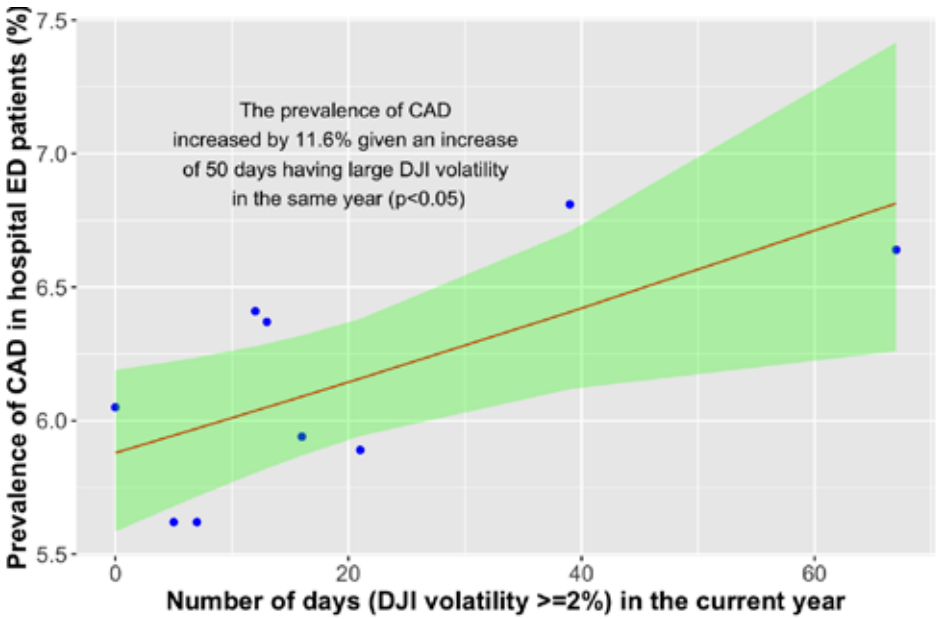
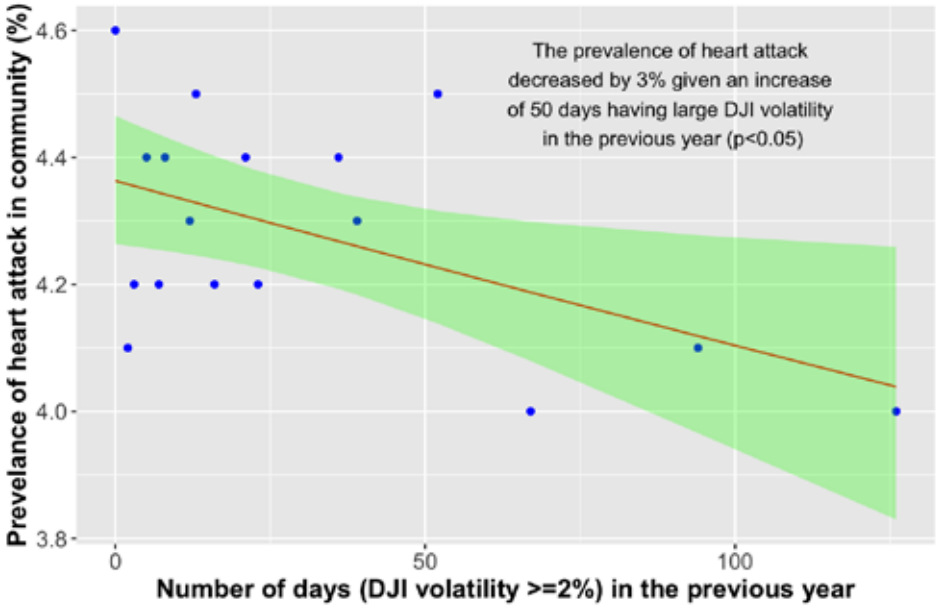


Figure 4. *Regression model examining the association between the heart attack prevalence in the community population and the large DJI volatility (equal or greater than 2%) in the previous year*



Conclusion

Our results reveal that stock market volatility is associated with an increased risk of heart attack in the US. We believe that this finding greatly adds to the knowledge in public health as it introduces a possible association and risk that may not have been noticed before. As a result of knowing this information, it is recommended that an educational intervention of stock and heart attack should be taken in the community, especially for the population with heart conditions. We also recommend for such community members to find an alternative method for investment instead of investing stocks on their own.

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