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Original Contribution

Cardiovascular Risk Factors, Depression, and Alcohol Consumption During Joblessness and During Recessions Among Young Adults in CARDIA

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Research has shown that recessions are associated with lower cardiovascular mortality, but unemployed individuals have a higher risk of cardiovascular disease (CVD) or death. We used data from 8 consecutive examinations (1985–2011) of the Coronary Artery Risk Development in Young Adults (CARDIA) cohort, modeled in fixed-effect panel regressions, to investigate simultaneously the associations of CVD risk factors with the employment status of individuals and the macroeconomic conditions prevalent in the state where the individual lives. We found that unemployed individuals had lower levels of blood pressure, high-density lipoprotein cholesterol, and physical activity, and they had significantly higher depression scores, but they were similar to their counterparts in smoking status, alcohol consumption, low-density lipoprotein cholesterol levels, body mass index, and waist circumference. A 1-percentage-point higher unemployment rate at the state level was associated with lower systolic (−0.41 mm Hg, 95% CI: −0.65, −0.17) and diastolic (−0.19, 95% CI: −0.39, 0.01) blood pressure, higher physical activity levels, higher depressive symptom scores, lower waist circumference, and less smoking. We conclude that levels of CVD risk factors tend to improve during recessions, but mental health tends to deteriorate. Unemployed individuals are significantly more depressed, and they likely have lower levels of physical activity and high-density lipoprotein cholesterol.

blood pressure; cardiovascular risk factors; recession; unemployment

Abbreviations: BMI, body mass index; CARDIA, Coronary Artery Risk Development in Young Adults; CES-D, Center for Epidemiologic Studies–Depression Scale; CI, confidence interval; CVD, cardiovascular disease; HDL, high-density lipoprotein; LDL, low-density lipoprotein; PAUW, physical activity unrelated to work.

At the individual level, job loss or income reductions are associated with an increase in adverse health behaviors, a deterioration of self-rated health, and higher morbidity and mortality (1–10). However, during recessions, when unemployment grows and income often decreases, there are improvements in major indicators of population health, including lower mortality, fewer symptoms of physical illness, and favorable changes in a number of health behaviors (11–21). This has been referred to as "the healthy recession paradox"(22).

These differential associations of macroeconomic fluctuations and individual-level economic shocks with health outcomes are puzzling, but known mechanisms could explain them (23–27). On one hand, individual-level job loss can result in stress, depression, and associated adverse health outcomes. On the other hand, economic recession could be linked not only to changes in consumption habits that might be harmful or beneficial to health but also to reduced work hours, increased time for social and physical activities, and reductions in industrial activity, atmospheric pollution, and motor vehicle traffic, all of which are beneficial for health. Elucidating the relative importance of these processes is essential for understanding the health effects of economic fluctuations. However, we are aware of only one study in which longitudinal individual-level data were linked to contextual macroeconomic data (20) so that the associations of health outcomes with individual-level and contextual economic conditions could be investigated simultaneously.

In this investigation, we used state-level macroeconomic data linked to longitudinal data from the Coronary Artery Risk Development in Young Adults (CARDIA) study to examine the associations of independent and interacting contextual and individual-level measures of economic conditions with several cardiovascular disease (CVD) risk factors.

METHODS

Data

We used data from the CARDIA study, a population-based prospective investigation of the determinants and evolution of CVD risk factors among young adults. The CARDIA study was initiated in 1985–1986 (year 0) with 5,115 subjects recruited from Birmingham, Alabama; Oakland, California; Chicago, Illinois; and Minneapolis, Minnesota. Recruited participants were aged 17–35 years, although the intended age range was 18–30 years. They were selected to be balanced on race (black or white), sex, education (high school or less and more than high school), and age (18–24 or 25–30 years) in each of the 4 sites (28). Participants were contacted yearly by telephone and examined in person at follow-up examinations. The 7 follow-up examinations included in this investigation were conducted in 1987–1988 (year 2), 1990–1991 (year 5), 1992–1993 (year 7), 1995–1996 (year 10), 2000–2001 (year 15), 2005–2006 (year 20), and 2010–2011 (year 25), with retention rates of 91%, 86%, 81%, 79%, 74%, 72%, and 72% of the surviving cohort, respectively (Web Table 1, available at https://academic.oup.com/aje). Details on the CARDIA study design and measurement are provided elsewhere (28).

As main covariates, we used the employment status of the CARDIA participants and the contextual unemployment rate. Employment status was obtained from the answer to the question "Are you unemployed, laid off or looking for work?" (year 0) or "Are you unemployed or laid off?" (all other years).

As a measure of the macroeconomic context, following prior investigations (14, 29), we used the state unemployment rate (from the Bureau of Labor Statistics) corresponding to the year and state in which the CARDIA participant was living when an examination took place. Geocodes for residential addresses of the CARDIA participants were available for baseline, 7-, 10-, 15-, 20-, and 25-year follow up, so the analyses included only observations for these years. Although CARDIA participants lived in just 4 states at year 0, they were distributed over a total of 44 states at year 10 and all 50 states at year 25. The longitudinal nature and geographic dispersal of the sample therefore provides substantial variation in state indicators.

We investigated the following 15 continuous CVD risk factors as outcomes: systolic and diastolic blood pressure (mm Hg); alcohol consumption (mL/day); total physical activity and physical activity unrelated to work (PAUW), measured in "exercise units" roughly equivalent to kilocalories of weekly energy expenditure (30) (further details on these variables are provided in the Web Appendix 1); depressive symptoms, as measured by the Center for Epidemiologic Studies–Depression Scale (CES-D); plasma high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, total cholesterol, and triglyceride levels; and 5 anthropometric measures (body mass index (BMI), waist circumference, and 3 skinfold measurements (triceps, suprailiac, and subscapular)).

We also analyzed 2 categorical outcomes, smoking status (current smoker vs. nonsmoker), and the presence or absence of metabolic syndrome (see Web Appendix 1 for definition).

Income information in CARDIA was collected in categories, which makes adjustment for inflation very difficult. Information on education is available, but because individuals recruited for CARDIA were at least 18 years old in the first examination, we assumed the level of education attainment would not change for most participants or would change at most once in the whole follow-up period. For these reasons, we opted to not include income and education in the analysis.

Statistical approach

We modeled repeated measurements of CVD risk factors as a function of individual-level characteristics, including individual employment status, and contextual economic conditions, proxied by the state unemployment rate. We used panel fixed-effect models (11, 16–18, 31–34) to estimate the association of a within-person change in employment status or exposure to state unemployment levels with within-person change in outcomes. We included a fixed effect for each individual in order to account for all time-invariant individual-level confounders, as well as fixed effects for time (year) and state to account for state-invariant time-varying confounders (or time trends) and time-invariant state-level confounders, respectively.

Our model (Table 1, upper section) is of the form:

$$F_{it} = \beta_0 A_{it} + \alpha_i + \beta_1 E_{it} + \beta_2 U_{jt} + \Psi_t + \Sigma_j + \varepsilon_{it}, \quad (1)$$

where F_{it} is the risk factor level for person i at year t, A_{it} is the person's age, α_i is a fixed effect for each individual, E_{it} is the time-varying employment status (1 for unemployed individuals at the time of the interview; 0 for all others), U_{jt} is the unemployment rate of state j where individual i was living at year t, Ψ_t and Σ_j are fixed effects for year t and state j, and ε_{it} is the error term.

To assess the robustness of results to alternative ways of accounting for time trends and to improve the efficiency of the estimates, we also fitted the model (Table 1, lower section),

$$f_{it} = \beta_0 A_{it} + \alpha_i + \beta_1 E_{it} + \beta_2 u_{jt} + \Psi_t + \varepsilon_{it}, \quad (2)$$

in which f_{it} and u_{jt} are, respectively, the deviations of the dependent variable and the state unemployment rate from a nonlinear Hodrick-Prescott trend, computed with a smoothing parameter $\gamma = 100$. Models of this kind, in which the time series that form the panel are detrended by nonlinear procedures, have been shown to be more efficient in estimating macroeconomic effects on mortality (14). The inclusion of the detrended unemployment rate makes the state fixed effect redundant (that is, Σ_j in equation (1)); therefore, that fixed effect is excluded from the model. However, the year fixed effects are retained to adjust for time effects affecting all states (14). We found that the standard model and the nonlinear model yielded very similar results in terms of statistical significance of the estimates, but the sizes of the estimates differed. We present the results of both types of model. Because the models with nonlinear detrending theoretically yield more accurate parameter estimates, we used them as the best estimate of the size of the association.

For analyzing categorical outcomes—smoking status and the metabolic syndrome—we used the logistic regression analogues of equations (1) and (2) (Table 2, upper and lower sections).

Potential differences in the association between individual-level unemployment and the outcomes according to levels of contextual unemployment were examined by including interactions between contextual unemployment and individual unemployment in the model.

Robust standard errors were computed, accounting for the autocorrelation implied by repeated observations in each individual.

RESULTS

The mean age of the CARDIA participants increased from 24.9 years in the mid-1980s (year 0) to 50.2 years in year 25 (Web Table 1). Notably, the proportion of participants with education beyond high school rose from 30.7% at baseline to 58.8% in year 25. The proportion unemployed oscillates over time, showing levels consistent with the changing macroeconomic conditions (as indicated by the state unemployment rates, Web Table 1, bottom). The proportion unemployed among CARDIA participants at baseline is 2 or 3 times greater than the unemployment rate in each of the 4 original states, consistent with the overrepresentation in the CARDIA cohort of young individuals and black persons, who both have higher unemployment rates than the general adult population.

Mean systolic and diastolic blood pressure, BMI, and waist circumference generally increased across the visits, while the proportion of current smokers declined. Depression scores and physical activity also declined, although less consistently. Alcohol consumption, LDL, and HDL did not show consistent trends.

If all 5,115 individuals in the original CARDIA cohort had been examined in the 7 follow-up examinations, a total of 8 × 5,115 = 40,920 observations would have been available for our analyses. Because of attrition and death, our samples were much smaller, but all regressions except one included over 19,000 observations (Tables 1 and 2).

We report here only the results for 10 continuous outcomes (Table 1): systolic and diastolic blood pressure, total physical activity, PAUW, depression scores, alcohol consumption, HDL, LDL, BMI, and waist circumference. The other 5 continuous variables we investigated did not reveal any statistically significant associations.

We found that older age was consistently and significantly associated with higher levels of HDL and BMI (Table 1; for results from additional models, see Web Table 2) but not with higher blood pressure or consumption of alcohol. Older age was associated with marginally significant declines in both total physical activity and PAUW.

All models showed that being unemployed was significantly associated with higher levels of depressive symptoms and lower levels of physical activity (Table 1). Compared with their counterparts, the unemployed participants had lower levels of systolic blood pressure (mean difference = 0.48 mm Hg, 95% confidence interval (CI): 0.83, 0.13) and diastolic blood pressure (mean difference = 0.26 mm Hg, 95% CI: 0.53, 0.01) and lower levels of HDL cholesterol (mean difference = −0.61, 95% CI: 0.30, 0.92). Being unemployed was associated with a lower consumption of alcohol—although this was not significant in our main model—but was not associated with different levels of LDL, BMI, or waist circumference.

Higher levels of the state unemployment rate were significantly associated with lower levels of both systolic and diastolic blood pressure, with systolic blood pressure declining 0.41 mm Hg (95% CI: 0.65, 0.17) per each percentage-point increase in the state unemployment rate (Table 1, lower section). State unemployment was also significantly associated with higher depression scores: A 1-percentage-point increase in the unemployment rate was associated with a 0.2-unit increase in the CES-D score of depressive symptoms (Table 1). Higher levels of unemployment were significantly associated with lower levels of waist circumference (with a decrease of 0.34 cm (95% CI: 0.20, 0.48) per 1-percentage-point increase in unemployment), but no associations were observed for BMI. The state unemployment rate was not associated with alcohol consumption or with levels of LDL. In contrast, higher state unemployment was associated with higher physical activity: A 1-percentage-point increase in the unemployment rate was associated with an increase of 14.3 points (95% CI: 9.2, 19.4) in total physical activity and 12.8 points (95% CI: 8.2, 17.4) in PAUW (Table 1, lower section).

Individual-level unemployment was not associated with current smoking, but higher state unemployment was associated with lower odds of smoking (odds ratio = 0.86, 95% CI: 0.75, 1.00, Table 2).

With one exception, models to explore potential interactions produced nonsignificant results (Web Appendix 1, Web Table 2).

Because we investigated the associations of the employment status of individuals and the state unemployment rate with a total of 15 outcomes, we performed a Bonferroni-Holm correction. After correction, all the statistically significant results for the state unemployment rate remained at the 95% level of confidence, but many of the associations of individual unemployment were no longer significant (Table 1).

DISCUSSION

Our results provide valuable insights into the health consequences of changes in macroeconomic conditions or in the employment status of individuals. Results of this longitudinal cohort study show that when the economy slows down (as indexed by rising unemployment rates), both systolic and diastolic blood pressure decrease, the level of physical activity increases, smoking becomes less frequent, and depression scores tend to slightly increase. Conversely, during economic expansions, both systolic and diastolic blood pressure increase, physical activity declines, smoking increases, and depression scores fall. In economic terminology, blood pressure and smoking are procyclical variables, increasing during the expansion phase of the business cycle, while depression symptoms and physical activity are countercyclical, increasing during recessions.

To our knowledge, only one previous study reported an association of macroeconomic conditions with blood pressure. An Icelandic study found that the 2008 financial crisis was associated with higher levels of blood pressure, but this result was based only on the comparison of prevalences of self-reported hypertension in 2 surveys in 2007 and 2009 (35). In contrast, our findings—based on longitudinal data over a 25-year period and measurements of blood pressure—show that systolic and

Table 1. Mean (Standard Error) Changes in Cardiovascular Risk Factors Associated With Changes in Age, Individual-Level Unemployment, and State-Level Unemployment[a], Coronary Artery Risk Development in Young Adults, 1985–2011

Covariate	Dependent Variable									
	Systolic BP (*n* = 23,700 Observations)	**Diastolic BP (*n* = 23,698 Observations)**	**Physical Activity (*n* = 23,679 Observations)**	**PAUW (*n* = 23,578 Observations)**	**CES-D (*n* = 14,435 Observations)**	**mL/day Alcohol (*n* = 20,148 Observations)**	**HDL (*n* = 19,584 Observations)**	**LDL (*n* = 19,437 Observations)**	**BMI (*n* = 23,652 Observations)**	**Waist Circumference (*n* = 23,293 Observations)**
Models With Fixed Effect for Year, State, and Individual										
Age	0. 14 (0.24)	−0.01 (0.21)	−8.0[b] (4.7)	−7.6[b] (4.3)	−0.13 (0.18)	0.11 (0.49)	0.46[c] (0.23)	0.77 (0.53)	0.12[b] (0.07)	0.26 (0.16)
Unemployed	−0.77[d] (0.24)	−0.31 (0.19)	−11.1[c,e] (4.7)	−10.8[c,e] (4.3)	1.43[f] (0.22)	−0.99[b] (0.56)	−0.45[c,e] (0.23)	0.04 (0.51)	−0.11 (0.07)	−0.04 (0.16)
State unemployment rate	−0.27[f] (0.07)	−0.27[f] (0.06)	6.8[f] (1.6)	6.2[f] (1.5)	0.12[c] (0.06)	0.09 (0.15)	−0.26[f] (0.08)	0.26 (0.18)	−0.03 (0.02)	−0.13[c] (0.05)
Models With Fixed Effect for Year and Individual and With HP-Detrended Dependent Variable and State Unemployment Rate										
Age	0.19 (0.18)	0.12 (0.15)	−6.5[b] (3.57)	−5.8[b] (3.3)	0.03 (0.12)	−0.06 (0.35)	0.36[b] (0.21)	0.38 (0.39)	0.10[c] (0.05)	0.23[c] (0.10)
Unemployed	−0.48[d,e] (0.18)	−0.26[b] (0.14)	−9.0[c,e] (3.5)	−7.9[c,e] (3.3)	0.60[f] (0.15)	−0.64 (0.46)	−0.61[f] (0.16)	0.59[b] (0.35)	−0.03 (0.04)	0.00 (0.10)
HP-detrended state unemployment rate	−0.41[f] (0.12)	−0.19[b] (0.10)	14.3[f] (2.5)	12.8[f] (2.3)	0.23[d] (0.09)	0.12 (0.21)	−0.07 (0.10)	0.05 (0.24)	−0.04 (0.03)	−0.34[f] (0.07)

Abbreviations: BMI, body mass index; BP, blood pressure; CES-D, Center for Epidemiologic Studies–Depression Scale; HDL, high-density lipoprotein cholesterol; HP, Hodrick-Prescott; LDL, low-density lipoprotein cholesterol; PAUW, physical activity unrelated to work.

[a] The data presented are parameter estimates and robust standard errors, clustered for individuals, in parentheses after the parameter estimate.

[b] $P < 0.1$.

[c] $P < 0.05$.

[d] $P < 0.01$.

[e] $P > 0.05$ only after the Bonferroni-Holm adjustment.

[f] $P < 0.001$.

Table 2. Odds Ratio for Being a Smoker Associated With Age, Individual Unemployment, and State-Level Unemployment Rate in 2 Types of Fixed-Effect Models[a], Coronary Artery Risk Development in Young Adults, 1985–2011

Covariate	OR	95% CI
Fixed Effects for Years and States		
Age	0.88	0.71, 1.11
Unemployed	0.94	0.77, 1.17
State unemployment rate	0.92[b]	0.86, 1.01
State Unemployment Rate, HP-Detrended (γ = 100), and Fixed Effects for Years		
Age	0.87	0.70, 1.08
Unemployed	1.00	0.81, 1.23
HP-detrended state unemployment rate	0.86[c]	0.75, 1.00

Abbreviations: CI, confidence interval; γ, smoothing parameter; HP, Hodrick-Prescott; OR, odds ratio.

[a] Smoking status modeled as 0 if the person reported never being a smoker or no longer being a smoker, and 1 if the respondent reported being a smoker at that time. CI was computed from robust standard errors clustered for individuals; regressions included fixed effects for individuals and included 23,228 observations.

[b] $P < 0.1$.

[c] $P < 0.05$.

diastolic blood pressure are procyclical (i.e., increase during economic expansions and decrease during recessions). Given that high blood pressure is a risk factor for CVD, the tendency of blood pressure to diminish during recessions could be one of the mechanisms explaining why CVD deaths tend to be less frequent during economic downturns (12, 18, 29). Certainly, the increase in blood pressure associated with a 1-percentage-point increase in the state unemployment rate is small, but macroeconomic fluctuations often imply changes of several percentage points in the unemployment rate. Furthermore, small changes in blood pressure at the population level can imply substantive changes in the risk of development of CVD in the entire population (36).

Tax statistics reveal that cigarette sales evolve procyclically, increasing during expansions (37), and survey data have also shown that cigarette smoking tends to increase when the economy expands (26). Overall, our results confirm that changes in smoking levels are likely one of the mechanisms explaining procyclical variations in mortality. Smoking has long-term effects on health that can take years to develop, but it can also have immediate effects by increasing the risk of acute cardiovascular or respiratory illness that leads to death (38, 39).

We found no associations of individual or contextual unemployment with alcohol consumption, blood lipids, or metabolic syndrome. Based on these results, these variables are unlikely to be intermediate variables explaining the connection between macroeconomic fluctuations and changes in mortality. Procyclical changes in alcohol consumption have been suggested as one potential mechanism leading to procyclical mortality (11, 26). However, our results do not provide support for this mechanism.

We found that total physical activity and PAUW decreased in unemployed individuals but increased when the state unemployment did. Indeed, physical activity is the only risk factor for CVD for which we found opposite associations for individual-level and state-level unemployment. If most physical activity were work-related, one would expect to see lower levels in unemployed persons and lower levels during recessions, because physical exertion at work is very likely linked to total hours at the job, and overtime is more common during economic expansions. However, we found that both total activity and PAUW increased during recessions but were lower in the unemployed than in the employed.

Using data from the American Time Use Surveys, Colman and Dave (40) found that recreational exercise increased during recessions. However, they also concluded that total exertion, which supposedly quantifies the health-inducing effect of physical activity, decreased in the working-age population during recessions, because it is 95% work-related.

Colman and Dave used American Time Use Surveys data for the years 2003–2010, which encompassed only one business cycle, and their models did not include time trends at the national or state level. Individual employment status was not included in their models, and they assumed that individuals freely choose how to use their time, so that they might exercise less during periods of economic expansion when the so-called opportunity cost of leisure is higher because of higher wages. A different and probably more realistic explanation of increased exercise during recessions is that overtime and regular working hours are procyclical, so that they fall in economic downturns (37). Thus employed individuals would have more time to exercise when the economy is depressed. Furthermore, overexertion during work is likely to covary with overtime and rhythm of worth, procyclically, and individuals who overexert themselves at work might be less likely to exercise during nonworking hours. The increase in both total physical activity and PAUW that we observed during periods of lower state unemployment is consistent with these explanations.

In our study, unemployed individuals had lower levels of both total physical activity and PAUW—although these results were no longer significant with the Bonferroni-Holm adjustment—and higher scores of depressive symptoms than their counterparts. These findings could be linked; other research has shown that depression is associated with decreased physical activity (41). We did not find that the unemployed smoked more, had higher blood pressure, had higher prevalence of metabolic syndrome, or drank more. Indeed, they appeared to drink less alcohol and have lower blood pressure than those who were employed or not looking for work, although they also had lower HDL cholesterol—these results were not significant after the Bonferroni-Holm correction. One could speculate that higher levels of depression, less physical activity, and lower levels of HDL might contribute to the increased risk of CVD and premature death observed in unemployed individuals in other studies (10, 20). In reference to the Bonferroni-Holm correction, we present it as additional information, but we note that it is far from being an accepted standard, and concrete applications of it have been considered statistically unsound in many scientific fields (42, 43).

Ruhm (26) found that periods of recession increase the level of depressive symptoms in the population. Our results are consistent with Ruhm's finding, and we also found that unemployed individuals have a significantly increased level of depressive symptoms. The mean CES-D score in the US population (44) and in the CARDIA cohort (Web Table 1) is about 10, and a score of 16 has been used as the cutoff point indicating clinical depression, although some authors recommend higher cutoff points of 20 or 22 (41, 44). If 0.23 (Table 1, lower section) is an acceptable estimate of the association of state-level unemployment with depressive symptoms, a severe economic downturn like the Great Recession (2008–2009), which raised the unemployment rate by as much as 13 percentage points in some states, would raise the mean score of depressive symptoms in the population by 1 or 2 points. Independently, being unemployed raises an individual's depression score by 0.6 points. Because depressive symptoms are positively associated with suicide, these associations could in part explain the observation that suicides tend to fall during economic expansions and rise in recessions (11–18, 45–49).

A limitation of the present study is the lack of investigation of lagged effects. The fixed-effect analyses allowed us to determine whether change in the unemployment variables (at the individual or contextual level) was related with contemporaneous change in the outcomes. A major strength of this approach is that it controls for all time-invariant confounders. However, we were unable to investigate lagged effects, thus, for example, we do not know whether the unemployed develop a higher or lower BMI 1 year after becoming unemployed. The structure of CARDIA data does not allow for that kind of investigation. It would be possible to model outcomes as a function of state unemployment rates in the year or 2 years preceding a CARDIA examination. However, CARDIA data do not tell us where individuals were living 1 or 2 years before the examination or whether they were unemployed at the time. Using finite mixture methods, Deb et al. (50) found an important increase in BMI and alcohol consumption in fractions of approximately 16% and 10%, respectively, of those who had become unemployed because of a plant closure 1 or 2 years earlier. Unfortunately we were unable to investigate these lagged effects with our data.

Overall, our investigation shows that recessions are linked to lower blood pressure, less smoking, higher levels of physical activity, smaller waists (although not in unemployed individuals; see Web Table 2), and higher depression scores. On the other hand, at the individual level, being unemployed is associated with lower blood pressure, less alcohol intake, lower levels of physical activity and HDL, and higher levels of depression. While the associations at the individual level can involve causality in both directions (5, 7), given that a third variable (such as a previous health condition) could be the cause of both effects, the association of changes in CVD risk factors with macroeconomic changes indexed by the rate of unemployment suggests causality just in one direction, because it would be hard to argue that changes in blood pressure or the frequency of smoking can have an effect on the economy or that a third variable is causing both effects.

Taken together, our results indicate that risk factors for CVD, except for depressive symptoms, tend to decline during economic recessions. This decline in CVD risk factors during recessions could help to explain the procyclical oscillation of CVD mortality. Future research replicating our findings and attempting to understand the drivers of these patterns is warranted.

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