American Journal of Health Promotion
2018, Vol. 32(4) 971-978

DOI: 10.1177/0890117116671537
journals.sagepub.com/home/ahp
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Identification of Undiagnosed Hyperlipidemia: Do Work Site Screening Programs Work?

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Abstract

Purpose: We evaluated the rate of hyperlipidemia identified during workplace screening in previously undiagnosed individuals, the association between workplace hyperlipidemia screening and use of medical care during follow-up, and changes in lipid profile among individuals with hyperlipidemia at screening.

Design: Nonexperimental longitudinal study.

Setting: Employees who participated in a workplace health screening.

Participants: A total of 18 993 individuals from 39 self-insured employers in the United States.

Measures: Total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and triglycerides were measured during screening. A claims-based algorithm was used to identify hyperlipidemia cases.

Analysis: Discrete-time survival analysis was used to estimate monthly rates of new hyperlipidemia diagnoses or prescriptions. Paired *t* tests were used to evaluate 1-year changes in lipid profile.

Results: A total of 1872 (9.9%) individuals had hyperlipidemia at screening. Among all individuals, a significantly greater rate of new hyperlipidemia diagnoses was observed during the first month after screening, compared to the 3 months before screening (odds ratio [95% CI]: 2.99 [2.66-3.36]). Among the 987 individuals who were followed up 1 year later, significant improvements were observed in total cholesterol ($-8.5\% \pm 13.6\%$) and LDL levels ($-10.2\% \pm 19.3\%$).

Conclusion: Workplace health screenings in an insured population were associated with a subsequent increase in physician visits and prescriptions for hyperlipidemia. After 1 year, significant improvements in total cholesterol and LDL levels were observed among individuals who screened positive for hyperlipidemia.

Keywords
hyperlipidemias, workplace, screening, prevention research, population health

Purpose

In the United States, nearly 1 in 3 adults have hyperlipidemia.[1] Hyperlipidemia is a major risk factor for coronary artery disease, a leading cause of death attributed to approximately US$204 billion annually in direct and indirect costs.[1] From early adulthood to midlife, men are more likely to have hyperlipidemia compared to women, who have lower mean total cholesterol levels but higher levels of low-density lipoprotein (LDL). However, women are at greater risk after menopause, when LDL lowering effects of endogenous estrogen are reduced.[2] African Americans are less likely to have hyperlipidemia when compared to whites,[3] likely due to genetic factors,[4] although the former group is at a higher risk for cardiovascular disease.[5]

Cholesterol screening can effectively identify individuals with hyperlipidemia who may then be recommended for appropriate treatments such as modification of lifestyle factors and/or pharmaceutical intervention. The US Preventative Services Task Force recommends screening for individuals at high risk, due to family history or other comorbid conditions, men 35 years or older, and women 45 years or older.[6] However, screening for younger populations may also be warranted, as increasing evidence suggests that even in early adulthood, cardiovascular risk factors including hyperlipidemia are associated with coronary artery disease in later decades.[7] Despite these recommendations, nearly a third of cases of hyperlipidemia

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remain undiagnosed. Between 1999 and 2006, the prevalence of undiagnosed hyperlipidemia was estimated at over 8% of the US adult population.[3] While cholesterol screening through routine physician office visits may identify undiagnosed individuals, hyperlipidemia tends to be asymptomatic; it increasingly affects young people who may not consider themselves at risk and may see doctors infrequently. Thus, while some undiagnosed cases may be attributed to a lack of health insurance, as many as half of insured adults with hyperlipidemia are unaware of their condition.[8]

Workplace health screenings can be an effective alternative for administering hyperlipidemia testing, with increasing numbers of employers offering such programs. Existing research suggests substantial savings associated with workplace wellness programs that include screenings for various risk factors including hypertension, hyperlipidemia, and obesity.[9,10] However, few studies have evaluated the effectiveness of workplace screenings as an impetus for undiagnosed individuals to utilize available health-care resources and improve health outcomes. Moreover, while studies exist to describe the prevalence of undiagnosed hyperlipidemia in the general population, little is known about the prevalence in employed populations. The objectives of this study were to evaluate (1) the rate of hyperlipidemia diagnosed in undiagnosed individuals during workplace screening, (2) the association between screening and subsequent claims-based hyperlipidemia diagnosis or treatment initiation for hyperlipidemia, and (3) the changes in lipid profile among individuals with hyperlipidemia 1 year following the screening.

Methods

Design

Workplace screenings were conducted by licensed clinical staff, including registered nurses, emergency medical technicians, and paramedics. Screenings were voluntary and the measurement of lipid profiles was approved by the self-insured employers on a company-wide basis. Levels of total cholesterol, LDL, high-density lipoprotein (HDL), and triglycerides (TG) were measured from fasting finger-stick samples. Individuals were considered to have hyperlipidemia at screening if they had a total cholesterol level of at least 240 mg/dL or an LDL level of at least 160 mg/dL, levels classified as "high" by the National Heart, Lung, and Blood Institute.[11] Screening results were presented in the form of a personal report and those individuals classified as having hyperlipidemia received health education advice and referral to wellness programs and health-care providers for follow-up. Follow-up screenings occurred approximately 1 year later.

Sample

Individuals in this study were employees of 39 employers located throughout the United States. Employers represented a diverse group of industries and employees resided in all 50 states. All employers were self-insured, requiring them to manage the health plans and bear financial risk, as opposed to fully insured employers who pay fixed rates to insurance carriers to both manage plans and bear risk. The employers used various regional and national health plans and pharmacy benefit managers, which included both for- and nonprofit organizations. Both health maintenance organizations and preferred provider plans were represented. Medical and pharmacy claims data were provided directly by health-care plans. The study sample comprised individuals who attended a workplace screening between January 1, 2012, and December 31, 2014, and were continuously enrolled in their health-care plan from 15 months before through 3 months after the screening date. Of the 42 064 individuals who were screened, 23 071 met 1 or more exclusion criteria and were therefore excluded from the final sample. There were 11 325 individuals with a history of hyperlipidemia during the 12 months prior to the observation period, defined as 3 months prior to and after the screening date (Figure 1), 15 196 did not have total cholesterol and/or LDL measured at the screening, 18 were missing zip code information, and 7 were less than 18 years of age, and 96 individuals had a history of end-stage renal disease (these individuals are a unique population who are likely not attending workplace screening as a routine preventive measure). The final sample comprised 18 993 participants.

Measures

Covariates were chosen a priori based on risk factors known to be or plausibly associated with hyperlipidemia in prior literature. Age was calculated from date of birth recorded in claims data. Body mass index (BMI, kg/m^2) was calculated from height and weight measured during the workplace screening (<22, 22-24.9, 25-29.9, $\geq$30, missing indicator [17%]). In an effort to adjust for socioeconomic factors, zip-code-level variables were derived from the US Census Bureau data, including the proportion of rural or urban residences within a zip code.[12] Data from the 2013 American Community Survey were used to measure zip-code-level distribution of race, educational attainment, and median income.[13]

For the first objective, comorbidities were measured based on administrative claims over the 12-month period prior to screening. For the second objective, the 12-month period prior to the observation period was used. Claims-based diagnosis of hyperlipidemia was based on (1) the presence of an *International Classification of Diseases, Ninth Revision* (*ICD-9*) diagnosis code (272.0-272.4), (2) at least 1 prescription fill for a 3-hydroxy-3-methyl-glutaryl-coenzyme A (HMG-CoA) reductase inhibitor, or (3) at least 1 prescription fill for other antihyperlipidemia drugs. Hypertension was based on the presence of at least 1 diagnosis code (*ICD-9*: 401-401.9). Diabetes was measured similarly, based on *ICD-9* diagnosis codes (250.xx, 357.2x, 362.0x, 366.41, 648.0x).

Analysis

To evaluate the rate of hyperlipidemia diagnosed in asymptomatic individuals during workplace screening (objective 1), hierarchical logistic regression models at the individual and zip code

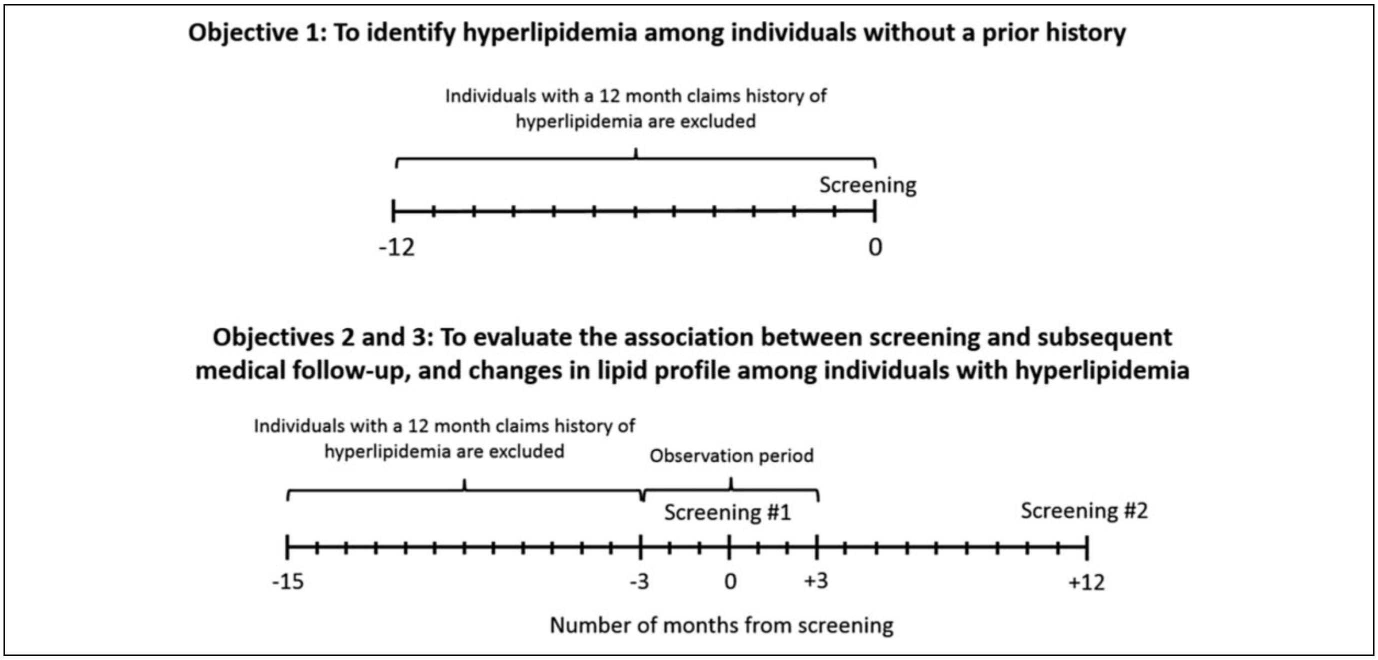

Figure 1. Time line for study objectives. For objective 1, a 12-month claims history was used to identify and exclude individuals with a history of hyperlipidemia. For objective 2, new cases of hyperlipidemia were monitored for a 6-month observation period (3 months before and after screening), using the 12 months prior to this observation period to identify and exclude individuals with a history of hyperlipidemia. For objective 3, individuals were followed up 1 year until a second work site screening.

level were used to evaluate the association between risk factors and hyperlipidemia at screening. To evaluate the association between workplace screening and subsequent claims-based hyperlipidemia diagnosis (objective 2), discrete time survival analysis was utilized.[14] Three odds ratios (ORs) were estimated, approximating the incidence rate of a claims-based hyperlipidemia diagnosis for each consecutive 1-month period after screening (month 1, month 2, and month 3) compared to the 3-month period before screening. For individuals with multiple screenings, only the first screening was used. Two models were assessed: a model that adjusted for demographic factors (age, gender) and employer as well as a full model that further adjusted for zip-code-level variables (education, median income, and race), BMI, rural residence, hypertension, and diabetes. A random effect for zip code was used to account for correlation of residuals from geographic clustering and to improve estimates of standard errors when using aggregate data.[15] A secondary analysis was conducted by additionally adjusting for duration of employment (above or below the median of 4.6 years) to assess for possible selection effects. Finally, descriptive statistics using paired *t* tests were also conducted to evaluate any changes in lipid profile among a subset of individuals who attended a second workplace screening approximately 1 year after the first (objective 3).

All analyses were performed using SAS 9.4 (SAS Institute Inc, Cary, North Carolina). This study was conducted using de-identified data obtained through Health Advocate, Inc, received and managed in compliance with the Health Insurance Portability and Accountability Act of 1996[16] and therefore, approval from the institutional review board was not required.

Results

Sample Characteristics

Characteristics of the 18 993 individuals in the study population are presented in Table 1. The mean age was 44.3 ± 10.5 and women made up 53.2% of the population. A total of 1872 (9.9%) individuals without a prior history of claims-based hyperlipidemia were found to have hyperlipidemia during screening. Mean levels for their lipid profiles were 258.2 ± 26.2 mg/dL for total cholesterol, 164.9 ± 26.4 mg/dL for LDL, 59.2 ± 20.8 mg/dL for HDL, and 169.4 ± 116.7 mg/dL for TG. For individuals not classified as having hyperlipidemia, mean levels were 182.5 ± 28.3 mg/dL for total cholesterol, 104.3 ± 25.4 mg/dL for LDL, 55.9 ± 16.8 mg/dL for HDL, and 113.9 ± 70.9 mg/dL for TG.

Table 2 shows the results from a multivariate hierarchical logistic model evaluating the association between several risk factors and hyperlipidemia at screening. Age was significantly associated with a greater odds of hyperlipidemia (OR [95% CI]: 35-49 years vs 18-34 years = 1.40 [1.21-1.61], 50-64 years vs 18-34 years = 2.30 [1.98-2.67], ≥65 years vs 18-34 years = 1.79 [1.18-2.74]). Women were, on average, less likely than men to have hyperlipidemia at screening (OR [95% CI]: 0.90 [0.81-1.00]). In addition, African Americans had on average a lower odds of hyperlipidemia compared to whites (OR [95% CI]: 0.50 [0.33-0.76]). Finally, increasing BMI was associated with higher odds of hyperlipidemia (OR [95% CI]: <18.5 kg/m^2 vs 18.5-24.9 kg/m^2= 0.65 [0.31-1.33], 25-29.9 kg/m^2 vs 18.5-24.9 kg/m^2= 1.68 [1.45-1.95], ≥30 kg/m^2 vs 18.5-24.9 kg/m^2= 1.78 [1.52-2.07]).

Table 1. Sample Characteristics.[a]

Individual-level characteristics	
Age, years, mean ± SD	43.3 ± 10.5
Female, n (%)	10 096 (53.2%)
Body mass index, kg/m², n (%)[b]	
<18.5	192 (1.2%)
18.5-24.9	4903 (31.4%)
25-29.9	5617 (36.0%)
≥30	4909 (31.4%)
Hypertension, n (%)[c]	2122 (11.2%)
Coronary artery disease, n (%)[c]	97 (0.5%)
Diabetes, n (%)[c]	492 (2.6%)
Hyperlipidemia at screening, n (%)	1872 (9.9%)
Rural residence, n (%)	2594 (13.7%)
Zip-code-level characteristics	
Education, median (IQR)	
Less than high school	9.5% (5.7%-15.1%)
High school or equivalent	27.0% (19.5%-33.9%)
Some college	29.1% (24.2%-33.5%)
College degree	29.2% (19.2%-43.2%)
Race, median (IQR)	
Non-Hispanic white	76.1% (55.3%-87.4%)
African American	4.1% (1.2%-13.0%)
Asian/Pacific Islander	2.8% (1.0%-6.0%)
Hispanic	7.3% (3.4%-17.0%)
Other	2.2% (1.5%-3.1%)
Median income, median (IQR)	US$57 622 (US$45 161-US$75 313)

Abbreviations: IQR, interquartile range; SD, standard deviation.
[a]N = 18 993.
[b]Includes nonmissing values.
[c]12-month claims history.

Table 2. Association Between Demographic Factors and Hyperlipidemia at Screening.[a,b,c]

	Odds Ratio (95% CI)	*P* Value
Age, years		
18-34 (ref.)	–	–
35-49	1.40 (1.21-1.61)	<.001
50-64	2.30 (1.98-2.67)	<.001
≥65	1.79 (1.18-2.74)	.007
Female	0.90 (0.81-1.00)	.04
Education, zip code %		
Less than high school	1.97 (0.34-11.47)	.45
High school or equivalent (ref.)	–	–
Some college	0.85 (0.23-3.14)	.81
College degree	1.17 (0.54-2.53)	.70
Median income, in zip code		
Quintile 1 (ref.)	–	–
Quintile 2	0.96 (0.80-1.16)	.68
Quintile 3	0.99 (0.81-1.21)	.93
Quintile 4	0.99 (0.79-1.24)	.92
Quintile 5	0.87 (0.67-1.13)	.29
Race, zip code %		
Non-Hispanic white (ref.)	–	–
African American	0.50 (0.33-0.76)	.001
Asian/Pacific Islander	1.08 (0.43-2.74)	.87
Hispanic	0.66 (0.38-1.17)	.16
Other	2.38 (0.27-21.21)	.44
Body mass index, kg/m²		
<18.5	0.65 (0.31-1.33)	.24
18.5-24.9 (ref.)	–	–
25-29.9	1.68 (1.45-1.95)	<.001
≥30	1.78 (1.52-2.07)	<.001
Rural residence	1.05 (0.89-1.23)	.60

Abbreviation: 95% CI, 95% confidence interval; LDL, low-density lipoprotein.
[a]Defined as total cholesterol ≥240 or LDL ≥160.
[b]N = 18 374.
[c]All variables were placed into the same model. Also adjusted for hypertension, diabetes, and employer.

Association Between Workplace Screening and Subsequent Claims-Based Hyperlipidemia Diagnosis

Table 3 reports the association between workplace screening and rates of new claims-based hyperlipidemia diagnoses or initiation of antilipid therapy after screening. Full model results are described here, since results were consistent between the demographic-adjusted model and the full model adjusted for age, gender, education, race, median income, BMI, rural residence, hypertension, diabetes, and employer. There was a marked increase in both claims-based hyperlipidemia diagnoses and prescriptions after screening (Figure 2). In the first month after workplace screening, compared to the 3-month period before screening, there was a significantly higher rate of new hyperlipidemia diagnoses (OR [95% CI]: 2.99 [2.66-3.36]). Rates of new cases significantly decreased in the third month after screening (OR [95% CI]: 0.78 [0.65-0.94]), reflecting the expected post-screening depletion of at-risk individuals. In a secondary analysis of all individuals, a longer duration of employment was not significantly associated with the rate of hyperlipidemia diagnosis after screening (OR [95% CI]: above vs below median duration of employment = 0.96 [0.82-1.11]). Among individuals who had hyperlipidemia at screening, rates of new diagnoses significantly increased during the first and second months after screening compared to the 3-month period before screening (OR [95% CI]: month 1 vs 3 months prior to screening = 7.61 [5.00-11.60]; month 2 vs 3 months prior to screening = 2.31 [1.29-4.14]). For month 3 vs 3 months prior to screening, there was no significant difference in diagnoses after screening.

We also investigated individuals who were not found to have hyperlipidemia at screening. The results were qualitatively similar, although the rate of new diagnoses in the first month after screening compared to the 3-month period prior to screening was lower, compared to the rate observed in all individuals (OR [95% CI]: 2.26 [1.97-2.59]. Moreover, since this subcohort did not include individuals identified as having hyperlipidemia at screening, the at-risk population depleted more rapidly, as evidenced by the rate of new diagnoses in the second and third months, compared to the 3-month period prior to screening (OR [95% CI]: month 2 vs 3 months prior to screening = 0.79 [0.65-0.96]; month 3 vs 3 months prior to screening = 0.67 [0.54-0.83]).

One Year Changes in Lipid Profile Among Individuals With Hyperlipidemia at Screening

Among the 1872 individuals who had hyperlipidemia based on their lipid profile at screening, 987 (52.7%) had a second lipid

Table 3. Association Between Workplace Screening and Hyperlipidemia Diagnosis or Prescription After Screening.[a]

	Model 1		Model 2	
	Odds Ratio (95% CI)[b]	*P* Value	Odds Ratio (95% CI)[b]	*P* Value
All individuals (N = 18 993)				
Month 1	2.93 (2.61-3.28)	<.001	2.99 (2.66-3.36)	<.001
Month 2	0.96 (0.81-1.13)	.62	0.98 (0.83-1.16)	.80
Month 3	0.76 (0.63-0.92)	.004	0.78 (0.65-0.94)	.008
Individuals with hyperlipidemia at screening (N = 1872)				
Month 1	7.37 (4.85-11.21)	<.001	7.61 (5.00-11.60)	<.001
Month 2	2.23 (1.24-3.99)	.007	2.31 (1.29-4.14)	.005
Month 3	1.54 (0.81-2.94)	.19	1.59 (0.83-3.04)	.16
Individuals without hyperlipidemia at screening (N = 17 121)				
Month 1	2.21 (1.93-2.53)	<.001	2.26 (1.97-2.59)	<.001
Month 2	0.77 (0.63-0.94)	.01	0.79 (0.65-0.96)	.02
Month 3	0.65 (0.53-0.81)	<.001	0.67 (0.54-0.83)	<.001

Abbreviations: 95% CI, 95% confidence interval; BMI, body mass index.

[a]Model 1: adjusted for age, gender, employer; Model 2: adjusted for age, gender, education (zip code %), median income in zip code, race (zip code %), BMI, rural residence, hypertension, diabetes, employer.

[b]Odds of a hyperlipidemia diagnosis or prescription in each month after screening compared to the 3-month period before screening.

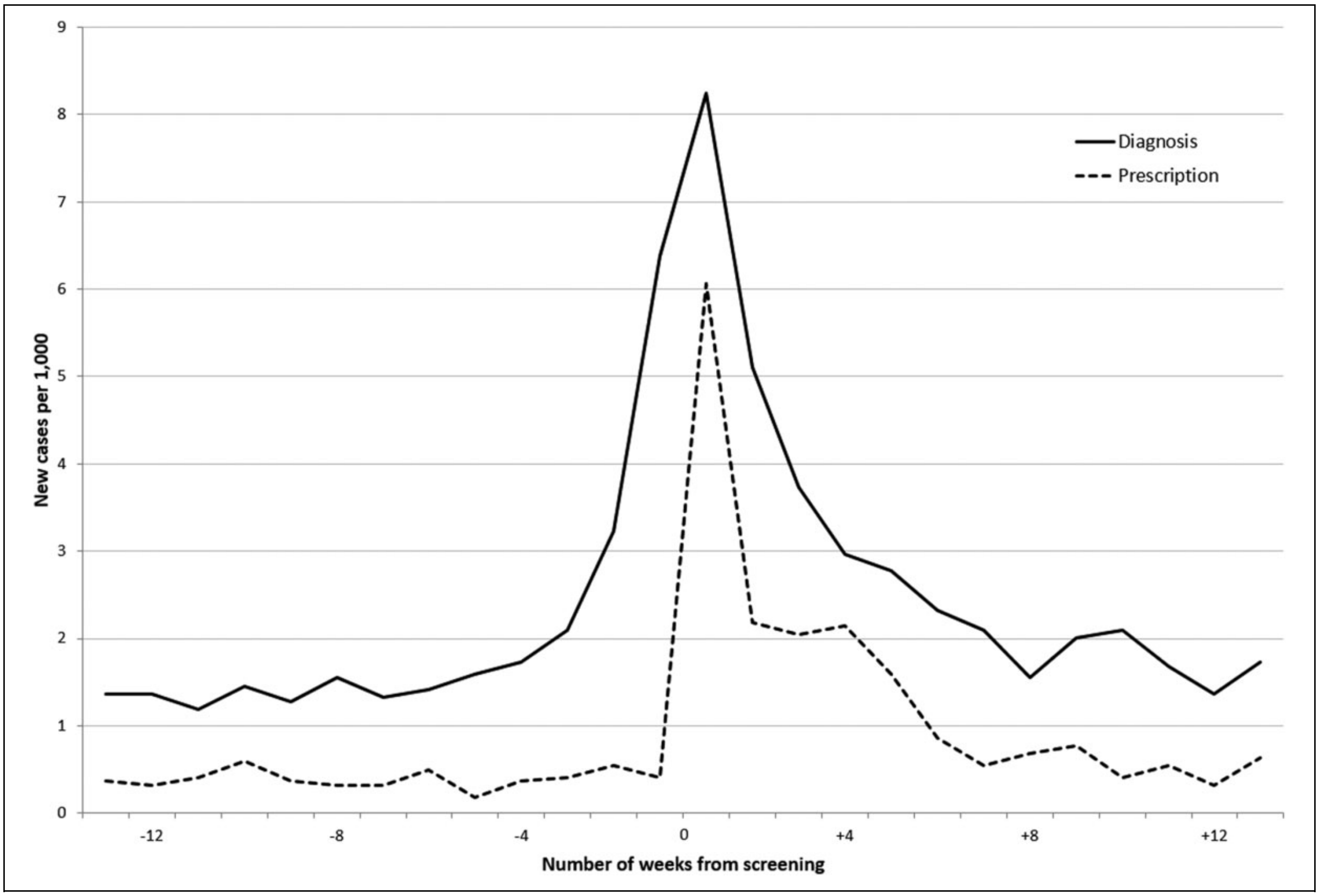

Figure 2. New hyperlipidemia diagnoses and prescriptions among all individuals without a prior claims history of hyperlipidemia during the 12 months before the observation period.

profile measured at a workplace screening approximately 1 year later. For differences in baseline measurements, Table 4 shows that individuals with a second lipid profile were significantly more likely to have a lower BMI ($P = .01$), live in a rural residence ($P < .001$), be white ($P < .001$), and have a lower median income ($P = .02$), while they were significantly

Table 4. Sample Characteristics of Individuals With Hyperlipidemia at Screening (n = 1872).

	Individuals With 1 Year Follow-Up	Individuals Without 1 Year Follow-Up	*P* Value
Individual-level characteristics			
Age, years, mean ± SD	46.3 ± 10.1	45.9 ± 10.1	.34
Female, n (%)	492 (49.9%)	437 (49.4%)	.84
Body mass index,[a] kg/m^2, n (%)[b]	28.4 ± 5.2	29.1 ± 5.3	.01
Hypertension, n (%)[a]	99 (10.0%)	90 (10.2%)	.92
Diabetes, n (%)[a]	16 (1.6%)	16 (1.8%)	.76
Rural residence, n (%)	182 (18.4%)	110 (12.4%)	<.001
Zip-code-level characteristics			
Education, median (IQR)			
Less than high school	11.2% ± 7.6%	11.6% ± 8.2%	.57
High school or equivalent	27.0% ± 11.2%	27.2% ± 10.0%	.42
Some college	28.9% ± 7.5%	28.6% ± 6.5%	.06
College degree	32.9% ± 18.3%	32.5% ± 16.6%	.65
Race, median (IQR)			
Non-Hispanic white	72.4% ± 22.4%	68.6% ± 23.6%	<.001
African American	7.7% ± 12.9%	10.7% ± 14.7%	<.001
Asian/Pacific Islander	4.7% ± 7.0%	4.9% ± 6.4%	<.001
Hispanic	12.6% ± 14.7%	13.3% ± 15.7%	.17
Other	2.7% ± 3.3%	2.5% ± 1.7%	.70
Median income, median (IQR)	US$60 623 ± US$21 285	US$63 085 ± US$23 014	.02

Abbreviations: IQR, interquartile range, SD, standard deviation.
[a]12-month claims history.
[b]Includes nonmissing values.

less likely to be African American (*P* < .001) or Asian/Pacific Islander (*P* < .001). At the second screening, improvements were observed in total cholesterol and LDL (mean ± standard deviation [SD], percentage change: total cholesterol = −8.5% ± 13.6%, LDL = −10.2% ± 19.3%, *P* < .001 for both). Levels of HDL and TG did not change in a clinically meaningful magnitude (HDL = −2.2% ± 16.0%, TG = 2.6% ± 44.1%, *P* < .001 for both).

Discussion

In a population of 18 993 individuals having employer-sponsored health insurance, 1872 (9.9%) individuals without a prior claims history of hyperlipidemia were identified as having hyperlipidemia at screening. In addition, we found that workplace health screenings were associated with a significant subsequent increase in claims-based diagnosis and treatment initiation for hyperlipidemia. Finally, the cohort of individuals who had hyperlipidemia at screening experienced significant improvements in total cholesterol and LDL levels after 1 year.

The rate of undiagnosed hyperlipidemia in this study is slightly higher than the estimated rates of undiagnosed hyperlipidemia in the general population between 1999 and 2006,[3] raising concerns of worsening underdiagnosis of this asymptomatic cardiovascular disease risk factor. Consistent with the current understanding of the epidemiology of hyperlipidemia in the United States, individuals who had hyperlipidemia at screening were more likely to be older, male, and have a higher BMI than individuals who did not have hyperlipidemia at screening. The oldest individuals (≥65 years) had a lower risk for hyperlipidemia, which may reflect transition from commercial insurance coverage to Medicare or more vigilant screening for hyperlipidemia in the older adults. African Americans, although at greater risk for cardiovascular disease, were found to be, on average, less likely to have hyperlipidemia at screening, a finding consistent with prior studies.[3]

With the demonstrated improvements in both LDL and total cholesterol levels, our findings provide evidence of quantifiable improvements in lipid profile sustained after workplace screening. Although we observed an increase in claims-based evidence of treatment for hyperlipidemia treatment, we were unable to evaluate what other particular factors, such as lifestyle interventions, personalized incentives such as gym memberships, or improved access to providers, had the strongest association with improvements in lipid levels. Prior studies suggest that knowledge of one's lipid profile alone can motivate individuals to make lifestyle changes to lower cholesterol levels.[17,18] The majority of prior studies longitudinally assessing lipid profile were randomized trials of lifestyle interventions. One prior observational study in a work site setting observed a 4.1% decrease in total cholesterol after 12 months of a cholesterol education program,[19] lower than the 8.5% reduction observed in the present study. Changes in lipid profile observed in our study were more comparable to changes reported in randomized trials of lifestyle interventions in workplace settings.[20-23] Over follow-up periods ranging from 6 to 12 months, these studies reported 6% to 12% decreases in total cholesterol, 9% to 13% decreases in LDL, and nonsignificant changes in levels of HDL and TG.[20-23] Workplace screening may be particularly important for hyperlipidemia because it increasingly affects younger individuals, carries considerable risk for cardiovascular morbidity, and an increased risk of mortality in individuals with existing morbidity.[24] Furthermore, pharmacologic therapies available have been shown to improve cardiovascular risk in this population and are able to reduce the risk in a relatively rapid time frame. The extent to which individuals maintained the improvements in lipid profile beyond the second screening remains to be seen.

As the increasing burden of chronic diseases becomes more evident,[25] growing emphasis has been placed on primary prevention, targeting biometric risk factors such as hyperlipidemia. Alternative methods of accessing health care, such as workplace screenings, telemedicine, retail clinics, and urgent care centers are rapidly growing. These methods along with policy changes, such as Medicaid expansion and other provisions of the Affordable Care Act, may address some gaps in access to health care, contributing to the overall chronic disease burden.[26,27] For employed individuals, workplace screenings can provide a convenient option to screen populations less likely to be seen through physician office visits (eg, younger men) for typically asymptomatic risk factors, which may otherwise remain undiagnosed.[28]

Workplace screenings may be an important part of a larger strategy to reduce future disease burden by providing an impetus for employed individuals to seek care. Self-insured employers may have particular motivation to improve the health of their employees for cost savings. Prior reports also suggest that workplace health screenings, when integrated into larger wellness programs, have the potential for significant sustained health benefits and economic savings that will likely accumulate over time.[29,30] On the other hand, prior studies also suggest that the effectiveness of workplace wellness programs varies based on factors such as employer leadership, incentivization, and follow-up evaluation.[29,31] These factors should be considered in the design and implementation of wellness programs to achieve optimal health and economic benefits to both employers and employees.

Strengths of this study include the large diverse sample recruited from multiple employers in a variety of industries and the incorporation of both biometric and claims data. Moreover, the majority of prior studies have evaluated either the ability of screening to identify cases of hyperlipidemia or the effect of screening on lipid profile, but few have assessed both aims in the same population. To our knowledge, this is also the first study to characterize the prevalence of undiagnosed hyperlipidemia in an employed population.

Because this is an observational study, there are limitations. First, factors unmeasured in administrative claims data may result in unmeasured confounding. For example, although fully adjusted models included employer as a covariate, this may not fully capture more detailed employer-level differences such as the degree of incentivization for participating in wellness programs. However, fully adjusted models had larger magnitudes of association compared to demographic-adjusted models, suggesting any residual confounding may be attenuating observed associations. A 1-year claims history may not be sufficient to exclude all prevalent cases of hyperlipidemia. However, the large increase in new hyperlipidemia cases after screening cannot be entirely attributed to misclassified prevalent cases. Moreover, workplace screening may serve as an effective impetus to seek treatment regardless of current hyperlipidemia status, as seen in the cohort that was found to have normal lipid levels at screening. Since the response rate for the 1-year follow-up was low, there may be selection bias from differential loss to follow-up. Though duration of employment was not significantly associated with hyperlipidemia diagnosis after screening, other selection effects may be present in a sample comprising individuals who volunteered for the screenings. For example, those individuals who volunteered may have been more likely to engage in health-promoting behavior or have greater access to health care. Results may also not be generalizable to a fully insured population, where the employer does not bear financial risk for health-care costs and the employee population may be systematically different.

Workplace health screenings in an insured population were associated with a subsequent increase in physician visits and prescriptions for hyperlipidemia. An improvement in lipid profile 1 year later was also observed among individuals identified as having hyperlipidemia at screening. The high rate of new diagnoses of hyperlipidemia highlights the importance of screening, even among individuals with insurance. Studies of linked databases that follow individuals over time are needed to further evaluate long-term health and economic outcomes of screening programs.

So What? Implications for Health Promotion Practitioners and Researchers

What is already known on this topic?

Hyperlipidemia is a relatively common and asymptomatic condition in the employed population. Work site health screenings may be able to identify individuals with hyperlipidemia who do not consider themselves at risk and see physicians infrequently.

What does this article add?

Workplace screenings in an insured population were associated with a subsequent increase in physician visits and prescriptions for hyperlipidemia, underscoring the importance of screening, even among insured individuals. At 1-year follow up, significant improvements in both total cholesterol and LDL levels were observed among individuals identified as having hyperlipidemia at screening.

What are the implications for health promotion practice or research?

Work site health screenings may be able to identify individuals with hyperlipidemia who do not consider themselves at risk and see physicians infrequently. Workplace screening can provide a convenient option to identify asymptomatic risk factors among populations less likely seen through physician office visits.

Declaration of Conflicting Interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: One author of this study (AKK) is affiliated with Health Advocate and 2 authors (VB, IY) are affiliated with West. These corporate affiliations did not affect the academic integrity of the study or the submission of this report in any manner.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

1. Mozaffarian D, Benjamin EJ, Go AS, et al. Heart disease and stroke statistics—2015 update: a report from the American Heart Association. *Circulation*. 2015;131(4):e29-e322.
2. Ghosh M, Galman C, Rudling M, Angelin B. Influence of physiological changes in endogenous estrogen on circulating PCSK9 and LDL cholesterol. *J Lipid Res*. 2015;56(2):463-469.
3. Fryar CD, Hirsch R, Eberhardt MS, Yoon SS, Wright JD. *Hypertension, High Serum Total Cholesterol, and Diabetes: Racial and Ethnic Prevalence Differences in U.S. Adults, 1999-2006. NCHS Data Brief, No 36*. Hyattsville, MD: National Center for Health Statistics; 2010.
4. Ferrer-Admetlla A, Liang M, Korneliussen T, Nielsen R. On detecting incomplete soft or hard selective sweeps using haplotype structure. *Mol Biol Evol*. 2014;31(5):1275-1291.
5. Kurian AK, Cardarelli KM. Racial and ethnic differences in cardiovascular disease risk factors: a systematic review. *Ethn Dis*. 2007;17(1):143-152.
6. Helfand M, Carson S. *Screening for Lipid Disorders in Adults: Selective Update of 2001 US Preventive Services Task Force Review* [Internet]. Rockville, MD: Agency for Healthcare Research and Quality (US); 2008 Jun. (Evidence Syntheses, No. 49).
7. Tran DM, Zimmerman LM. Cardiovascular risk factors in young adults: a literature review. *J Cardiovasc Nurs*. 2015;30(4):298-310.
8. Ayanian JZ, Zaslavsky AM, Weissman JS, Schneider EC, Ginsburg JA. Undiagnosed hypertension and hypercholesterolemia among uninsured and insured adults in the Third National Health and Nutrition Examination Survey. *Am J Public Health*. 2003;93(12):2051-2054.
9. Baicker K, Cutler D, Song Z. Workplace wellness programs can generate savings. *Health Aff (Millwood)*. 2010;29(2):304-311.
10. Baxter S, Sanderson K, Venn AJ, Blizzard CL, Palmer AJ. The relationship between return on investment and quality of study methodology in workplace health promotion programs. *Am J Health Promot*. 2014;28(6):347-363.
11. National Heart Lung and Blood Institute. High Blood Cholesterol: What You Need To Know. Web site. http://www.nhlbi.nih.gov/health/resources/heart/heart-cholesterol-hbc-what-html. Published May 2001. Updated June 2005. Accessed August 1, 2016.
12. United States Census Bureau. Urban Area Relationship Files. Web site. https://www.census.gov/geo/maps-data/data/relationship.html. Published May 2014. Updated February 2015. Accessed August 7, 2015.
13. United States Census Bureau. American Community Survey. Web site. http://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml. Published February 2013. Accessed July 27, 2015.
14. Judith D. Singer, John B. Willett. It's about time: using discrete-time survival analysis to study duration and the timing of events. *J Educ Behav Stat*. 1993;18(2):155-195.
15. Rothman KJ, Greenland S, Lash TL. *Modern epidemiology*. 3rd ed. Philadelphia: Wolters Kluwer Health/Lippincott Williams & Wilkins; 2008.
16. 104th Congress. The Health Insurance Portability and Accountability Act of 1996 (HIPAA). *Public Law 104-191*. Vol 110 STAT. 1936; 1996.
17. Aubin M, Godin G, Vezina L, Maziade J, Desharnais R. Hypercholesterolemia screening. Does knowledge of blood cholesterol level affect dietary fat intake? *Can Fam Physician*. 1998;44:1289-1297.
18. Barratt A, Reznik R, Irwig L, et al. Work-site cholesterol screening and dietary intervention: the Staff Healthy Heart Project. Steering Committee. *Am J Public Health*. 1994;84(5):779-782.
19. Perovich SJ, Sandoval WM. Outcomes of a worksite cholesterol education program over a 5-year period. *J Am Diet Assoc*. 1995;95(5):589-590.
20. Allen JC, Lewis JB, Tagliaferro AR. Cost-effectiveness of health risk reduction after lifestyle education in the small workplace. *Prev Chronic Dis*. 2012;9:E96.
21. Bloch MJ, Armstrong DS, Dettling L, Hardy A, Caterino K, Barrie S. Partners in lowering cholesterol: comparison of a multidisciplinary educational program, monetary incentives, or usual care in the treatment of dyslipidemia identified among employees. *J Occup Environ Med*. 2006;48(7):675-681.
22. Fielding JE, Mason T, Kinght K, Klesges R, Pelletier KR. A randomized trial of the IMPACT worksite cholesterol reduction program. *Am J Prev Med*. 1995;11(2):120-123.
23. Fritsch MA, Montpellier J, Kussman C. Worksite wellness: a cholesterol awareness program. *AAOHN J*. 2009;57(2):69-76; quiz 77-68.
24. Nelson RH. Hyperlipidemia as a risk factor for cardiovascular disease. *Prim Care*. 2013;40(1):195-211.
25. Bodenheimer T, Chen E, Bennett HD. Confronting the growing burden of chronic disease: can the US health care workforce do the job? *Health Aff (Millwood)*. 2009;28(1):64-74.
26. Sommers BD, Gunja MZ, Finegold K, Musco T. Changes in self-reported insurance coverage, access to care, and health under the Affordable Care Act. *JAMA*. 2015;314(4):366-374.
27. Mehrotra A, Lave JR. Visits to retail clinics grew fourfold from 2007 to 2009, although their share of overall outpatient visits remains low. *Health Aff (Millwood)*. 2012;31(9):2123-2129.
28. Legorreta AP, Schaff SR, Leibowitz AN, van Meijgaard J. Measuring the effects of screening programs in asymptomatic employees: detection of hypertension through worksite screenings. *J Occup Environ Med*. 2015;57(6):682-686.
29. Soeren M, Liu H, Caloyeras J, et al. *Workplace Wellness Programs Study: Final Report*. Santa Monica, CA: RAND Corporation; 2013.
30. Bolnick H, Millard F, Dugas JP. Medical care savings from workplace wellness programs: what is a realistic savings potential? *J Occup Environ Med*. 2013;55(1):4-9.
31. Tryon K, Bolnick H, Pomeranz JL, Pronk N, Yach D. Making the workplace a more effective site for prevention of noncommunicable diseases in adults. *J Occup Environ Med*. 2014;56(11):1137-1144.