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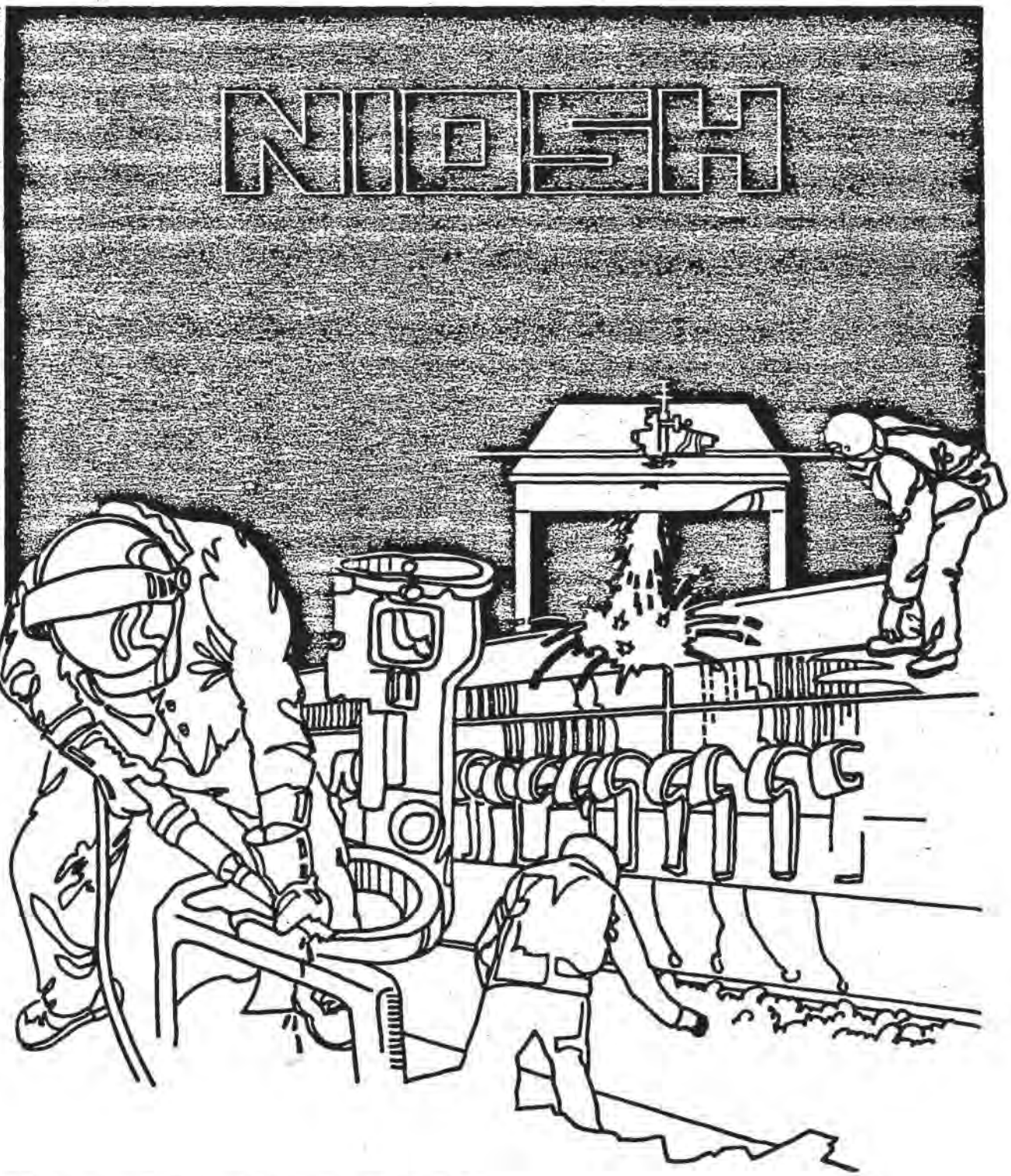

Health Hazard Evaluation Report

HETA 81-299-1201
UNITED STATES STEEL COMPANY-SOUTHWORKS
CHICAGO, ILLINOIS

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial nygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

HETA 81-299-1201
OCTOBER 1982
UNITED STATES STEEL COMPANY - SOUTHWORKS
CHICAGO, ILLINOIS

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I. SUMMARY

On April 27, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from the United Steel Workers of America, Local Union 65, to evaluate carbon monoxide (CO) exposure in the soaking pit area of the 52"-54" Mill at United States Steel Company - Southworks, Chicago, Illinois. The request reported irritability and personality changes among employees in this area. The soaking pits use a fuel mixture containing blast furnace gas (approximately 26% CO) to re-heat steel ingots for processing.

In July 1981, NIOSH investigators conducted an initial survey. In October 1981, a combined environmental and medical survey measured airborne levels of carbon monoxide (CO) using continuous monitors and personal breathing zone samplers. Additionally, pre- and post-shift blood samples for carboxyhemoglobin (COHb) concentration were collected and medical questionnaires were administered to the 22 employees working on three work shifts.

Eight-hour time weighted average (TWA) concentrations of CO in personal samples were below the NIOSH recommended standard of 35 parts of contaminant per million parts of air (ppm). Concentrations ranged from 2 ppm to 15 ppm, with a mean of 7.6 ppm. Concentrations in area samples showed instantaneous levels ranging as high as 50 ppm, but these reflected only brief excursions.

All blood COHb levels were found to be within the normal range except for one smoker and one non-smoker whose levels were found to be slightly elevated in both the pre- and post-shift samples. The post-shift blood COHb levels did not show a significant increase. No significant correlation was found between COHb levels or reported symptomatology and job title, work shift, or years of employment in the area. As expected, elevated COHb levels were found to be significantly associated with the smoking of cigarettes.

On the basis of the data obtained in this investigation, NIOSH has determined that no hazard from carbon monoxide exposure existed at the time of this survey. Furthermore, no evidence was found to document the existence of chronic effects from carbon monoxide exposure in this group of workers. In order to reduce the possibility of future exposures, recommendations are included in the full body of the report.

KEYWORDS: SIC 3312, Soaking Pits, Carbon Monoxide, Carboxyhemoglobin

II. INTRODUCTION

On April 27, 1981, a representative of the United Steel Workers of America, Local 65, requested a NIOSH health hazard evaluation to evaluate carbon monoxide (CO) exposure in the soaking pit area of the 52"-54" Mill at United States Steel Company - Southworks, Chicago, Illinois. The request reported worker complaints of personality changes and irritability. This area had recently been cited by the Occupational Safety and Health Administration (OSHA) for high CO levels and acute CO intoxications had been documented.

On July 9, 1981, NIOSH investigators conducted an initial survey of the facility. This included separate opening conferences with representatives of management and the union, followed by a walk-through inspection of the soaking pit area. On October 8, 1981 a combined environmental and medical survey was conducted during which ambient levels of CO were measured using continuous monitors, personal breathing zone air samples were collected, pre- and post-shift blood samples were taken, and medical questionnaires were administered to the employees.

III. BACKGROUND

Since 1930, soaking pit operations have been conducted in the 52"-54" Mill in a section of the building measuring 75' by 700'. The process involves reheating (called "soaking" - no chemical cleaning is involved) 15 ton carbon steel ingots for processing in the adjacent rolling mill. There are a total of 9 soaking pits in the area, 7 of which are usually operational. One administrative and seven production employees, including two heaters, two crane operators, one pit recorder, one dispatcher, and one ingot buggy operator, work on each shift. There are a total of four crews which work five 8-hour shifts per week during full production.

Steel ingots are brought into the mill by the ingot buggy and placed in each pit by overhead cranes. The top of each pit is closed and a fuel composed of blast furnace gas (containing approximately 26% CO), natural gas, and air is used to heat the ingots. "Forter boxes" are used to periodically shift the gases from one side of the pit to the other to allow even heating of the ingots. The heated ingots are then removed by crane and placed on rollers that transfer them to the adjacent rolling mill.

The craneman is located in a crane cab near the roof of the building. The ingot buggy operator is located in a control room from which he operates the buggy by remote control. Located above the pits are the recorder, who monitors heating times, and the heater who directs the movement and placement of the steel ingots. The dispatcher is located in the main office in the center of the building where he monitors production data.

General ventilation is supplied by several area fans and outdoor air which moves freely across the partially open walls and ceiling of the building. Self-contained breathing apparatus are available for

emergencies, and portable CO monitors are used to assess CO levels during maintenance and repair work. Stationary CO monitors are also present throughout the soaking pit area with alarms set at 200 ppm. Monitors are checked weekly, and there is a once a week drill on emergency procedures for gas intoxication.

In October 1980, an incident during which a worker lost consciousness, led to citations being issued by OSHA. Subsequently, repairs were made to forter boxes in the area.

IV. EVALUATION DESIGN AND METHODS

In order to assess the possibility of excess levels of CO in the soaking pit area, and the possibility of acute and/or chronic CO toxicity among the employees, a combined environmental and medical survey was conducted on October 8, 1981.

A. Environmental

Personal samples were collected for five workers on each of two shifts. Samples were collected near the breathing zone of the employees using a battery powered sampling pump operating at approximately 20 cubic centimeters of air per minute (cc/min) attached via tygon® tubing to a direct reading Drager Long Term Detector Tube for CO (50/a-L). Concentration determinations were made by visual observation of the length of stain on each tube at the end the sampling period. Other information pertinent to sample collection is provided in Table 1.

Three locations in the soaking pit area were selected for the placement of continuous monitors (Ecolyzer CO Analyzers, Series 2000, equipped with strip chart recorders). These monitors were used for determining the fluctuations in ambient CO concentrations throughout the soaking pit area.

B. Medical

All production employees working in this area over a 24 hour period (3 shifts) were interviewed utilizing a standardized questionnaire and had blood drawn for COHb levels before and after work. The questionnaire solicited information on the workers' employment, medical histories and previous episodes of acute overexposure to CO. In addition, the employees were questioned on the frequency of their experience with a list of symptoms, including headaches, nausea and vomiting, sleep disorders, depression, anorexia and weight changes.

Prior to drawing the pre-shift blood sample, information was secured from cigarette smokers as to the time since the last cigarette, and from all workers as to the time it took to get to work in order to estimate the time spent in traffic.

V. EVALUATION CRITERIA

A. Environmental Criteria

NIOSH recommends that employee exposure to carbon monoxide (CO) be limited to 35 parts of contaminant per million parts of air (ppm) averaged over a work shift of up to 10 hours a day, 40 hours per week for a working lifetime, with a ceiling limit of 200 ppm. This latter value is to limit carboxyhemoglobin formation to 5% in a worker engaged in sedentary activity at a normal altitude. The current OSHA standard is 50 ppm as an 8-hour TWA.[1]

B. Toxicity

1. Acute Effects

Carbon monoxide combines with hemoglobin to form carboxyhemoglobin (COHb) which interferes with the bloods' ability to carry oxygen to the tissues. Inhalation of CO may cause headache, nausea, dizziness, weakness, rapid breathing, unconsciousness, and death. High concentrations may be rapidly fatal without significant warning symptoms. Exposure to CO may aggravate heart and artery disease in those with pre-existing conditions. The effects are more severe in people who are working hard or in places where the temperature is high.[1]

2. Chronic Effects

In The Diseases of Occupations, Hunter states simply, "There is no such condition as chronic CO poisoning".[2] However, studies done in Scandinavia in the 1940's suggest that chronic CO intoxication may indeed exist. During the years 1939 - 1945, the Scandinavian countries were using producer gas in internal combustion engines due to a shortage of liquid fuel. A number of studies were done at that time to better understand chronic CO poisoning. Problems with these studies included different diagnostic criteria, lack of environmental data, and control for smoking. In addition, these studies conflicted in their description and diagnosis of the disease.

In 1961, Lindgren published a study in which he looked at 970 workers with exposure to CO, and 432 controls. Medical histories and current symptoms were listed. A physical examination, ECG, and blood tests for hemoglobin and carboxyhemoglobin (COHb) were performed. For a smaller group, he also did an EEG and psychometric testing. Smoking patterns were found to be the same for cases and controls. He found a significant excess in the frequency of headaches in the exposed group. All other tests showed no significant differences between the cases and controls. He concluded that there was no evidence of chronic CO poisoning in these workers, and that the headaches were a sign of intermittent acute exposures.[3]

However, there was a big difference between the number of shift workers and day workers in cases and controls which may have a significant effect on the test parameters. In addition, the COHb levels suggest there may have been exposed individuals in the "unexposed" group and that the difference in CO exposure in the exposed group was quite wide.

Since Lindgren's study, only two other epidemiologic studies have addressed the issue of chronic CO poisoning. The first was a study published in 1972 in the U.S.S.R. that examined 286 garage workers. Their conclusions were that both neurologic and cardiac effects could be identified in these workers and that these effects were due to chronic CO poisoning. These effects included complaints of frequent headaches, slowness of autonomic reflexes, depressed corneal reflexes, neurasthenia, increased blood pressure, and T wave abnormalities on EKG.[4]

In the second study, published in 1973 in Czechoslovakia, 157 workers employed in jobs with potential CO exposure were compared with ninety controls matched for age and sex. Significant increases in nausea, depression, anorexia, and weight changes were found. Moderate excesses in some neurological signs and abnormalities in EEG's were also found in the chronically exposed group. Despite the lack of control for smoking habits, the authors concluded that the study suggested the existence of chronic CO poisoning as a clinical entity.[5]

A number of other studies in the last 15 years have investigated particular affects of CO exposure on behavior.[6-13] These studies have been both in laboratory settings and in occupational environments. The types of behavioral measures used can be broadly categorized into tests of vigilance; i.e., time estimation, tracking and visual discrimination, and tests of motor function; i.e., driving performance. The results of these studies have not been consistent. Therefore, the human health effects of chronic CO exposure remain in dispute.

VI. RESULTS

A. Environmental

Of the ten personal breathing zone, full-shift air samples collected, no CO levels were detected above 15 ppm, which is below the NIOSH recommended standard of 35 ppm. The concentrations in these samples ranged from 2 ppm to 15 ppm, with a mean of 7.6 ppm. Data provided by the continuous air monitors indicated only brief excursions in CO concentrations to the concentration of approximately 50 ppm.

B. Medical

We were fortunate to have the complete cooperation of all workers in the area; thus, blood samples were obtained from everyone and questionnaires were filled out by all. The same person interviewed all workers; thus, there are no differences due to different interviewers. It was found that most workers had worked in the soaking pit area for a number of years; thus, any effects of chronic CO poisoning would be more likely to be evident than if relatively new workers in the area had been studied.

Of the twenty male and two female subjects tested over the three shifts, ten were black, ten were white, and two were Hispanic; two were under age of 25, 12 were between the ages 26 - 45, and 3 were over 55 years old; eighty-two percent had worked at the plant longer than 5 years and

77% had worked in the pit area for over 5 years. All but 3 of these employees had been at their present job for 1 year or more (Table 2). Eleven (50%) of the employees were current smokers.

Fifty-nine percent of the employees had greater than one symptom "more than three days out of every week", while 36% had no symptoms. Of the 18 symptoms listed, weight fluctuation was the most commonly noted, with 50% listing either a weight gain or a weight loss. The second most common complaint was headache in seven cases (32%). Four stated they only got the headache at work while three got headaches at work and at other times (Table 3).

No significant correlation was found between number of symptoms and the blood CO levels (Table 4). In addition, although all pit recorders reported at least one symptom and shifts two and three had more workers reporting problems than shift one, no signicant correlation was found between number of symptoms and shift or job title .

There was a significant inverse correlation between number of symptoms and age ($p<0.05$). Those between ages 26-45 years were more likely to have symptoms than those over 45 years of age. In addition, those who worked at the plant for 6-20 years were more likely to have symptoms than those who had worked greater than 20 years.

Of the pre-shift blood COHb levels, 91% of the 11 non-smokers had 2% or less, and 91% of the 11 smokers had 10% or less. These levels are considered normal. The post-shift blood CO levels showed a slight shift to higher levels. The matched pair t-test was used to test the significance of the differences between blood COHb levels before and after work, and no significant trend was noted (Table 5).

Current smoking practice was correlated with significantly increased COHb levels both before and after shift ($p<0.05$).

There was no significant trend of COHb levels among the various job titles, shifts, years at the plant, years in pit area, or CO concentrations detected in personal air sampling, nor were there significant correlations between symptoms, medical problems, or previous episodes of carbon monoxide overexposure.

The symptoms of these workers were analyzed for symptom complexes that might denote low dose CO poisoning. The four symptoms identified in the Czechoslovakia study as most commonly associated with chronic low dose CO exposure were anorexia, weight change, depression and sleep disturbance.[4] The Scandinavian studies of the 1940's described fatigue, headache and dizziness as the most common symptoms in low dose exposure.[2] Only four(18%) of the 22 employees had four or more of these symptoms.

VII. DISCUSSION AND CONCLUSIONS

There was no evidence of CO overexposure to workers in the 52"-54" mill soaking pit area at the time of this study. All personal air sampling

results for CO were below the NIOSH recommended standard. No significant trend in before and after work blood COHb levels was found, and no significant trend in symptoms was noted.

No evidence of any chronic effects of employee exposure to CO were noted during the survey. However, this conclusion must be viewed in light of the small number of workers examined, the limited time frame of the evaluation, and the possibility that some of the affected workers may have moved to other areas of the plant.

VIII. RECOMMENDATIONS

Since the hazard from acute exposures to CO can pose immediate threats to the lives and health of the employees, the company should continue to strictly adhere to a strong program regarding the safety of the workers in this area. Areas of this program which should be stressed include:

1) Periodic and accurate calibration and testing of stationary monitors and alarms. Employee complaints of malfunctioning equipment (many of which were noted during the survey) should be investigated promptly.

2) Periodic examinations and preventive maintenance of the gas delivery system in order to protect against the possibility of gas leaks.

3) Continued training of the production and maintenance employees in the hazards of CO, the proper use of personal protective equipment, and first aid procedures which might be necessary in the event of an emergency.

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XI. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Division of Standards Development and Technology Transfer, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. United States Steel Company, Southworks
2. United Steel Workers, Local Union 65
3. NIOSH, Region V
4. OSHA, Region V

For the purpose of informing affected employees, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE 1

RESULTS OF PERSONAL SAMPLES COLLECTED FOR CARBON MONOXIDE EXPOSURE

JOB TITLE	WORK SHIFT	SAMPLE TIME (Minutes)	SAMPLE VOLUME (Liters)	TWA* CONCENTRATION CO (ppm)
Heater	1	465	6.95	5
Recorder	1	485	7.76	10
Craneman	1	467	6.67	3
Ingot Bugg	1	424	7.17	2
Heater	1	420	6.39	13
Craneman	2	496	4.28	5
Heater	2	464	6.93	11
Heater	2	468	6.13	15
Recorder	2	457	5.94	10
Ingot Bugg	2	459	4.59	2

TWA*- Time weighted average

TABLE 2

DEMOGRAPHIC INFORMATION

		N	%
AGE:			
	<25	2	9
	26-45	12	55
	>45	8	36
SEX:			
	MALE	20	91
	FEMALE	2	9
RACE:			
	BLACK	10	45
	HISPANIC	2	10
	WHITE	10	45
YEARS IN PIT AREA:			
	<5	4	18
	6-10	8	36
	11-20	5	23
	>20	40	18
YEARS AT PRESENT JOB:			
	<5	12	55
	6-10	6	27
	11-20	3	14
	>20	1	5

TABLE 3

SYMPTOMS

	N	%
Frequency:		
No symptoms	8	36
One symptom	1	5
Greater than one symptom	13	59
Type of Symptoms:		
Weight loss or gain	11	50
Headache	7	32
Nervousness	5	23
Personality Change	5	23
Nausea	4	18
Irritability	4	18
Disturbed sleep	4	18
Tiredness	4	18
Depression	4	18
Poor appetite	3	13
Dizziness	3	13
Difficulty concentrating	3	13
Abdominal pain	3	13
Sweating	3	13
Difficulty remembering	2	09
Trouble controlling emotions	2	09
Vomiting	1	04
Chest pain	1	04

TABLE 4

SYMPTOMS BY COHb LEVEL

BEFORE WORK

	COHb Level	
SYMPTOMS	<2	>2
Less than 1	6	3
Greater than 1	6	7

Chi Square/Fishers Exact p=0.3
Odds Ratio= 2

AFTER WORK

	COHb Level	
SYMPTOMS	<2	>2
Less than 1	5	4
Greater than 1	6	7

Chi Square/Fishers Exact p=0.5
Odds Ratio = 1.4

TABLE 5

CARBOXYHEMOGLOBIN LEVELS

	CoHb %	N	%
Before work:			
	0-2.0	12	55%
	2.01-5.00	6	27%
	5.01-10.00	3	14%
	10.00-15.00	1*	5%
After work:			
	0-2.0	10	45%
	2.01-5.00	6	27%
	5.01-10.00	5	23%
	10.00-15.00	1*	5%
Change:			
	Negative change	8	36%
	0-1.00	11	50%
	>1.00	3	14%

*Smoker.

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