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RESEARCH ARTICLE

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One-year weight change and long-term sickness absence in professional firefighters

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Background: Little is known about the association between weight change (particularly moderate weight loss, 5-10% in initial weight) and long-term sickness absence (LSA) in working populations.

Methods: Three hundred and forty professional firefighters reported their current and past (1 year ago) weights in a cross-sectional survey, along with their LSA experience due to a severe accident, injury, or illness during the previous 12 months.

Results: The prevalence of LSA was 14.7%. In the non-smoking male firefighters, the prevalence of LSA was 3.4% in those with moderate weight loss over the past year; 13.3% in those who maintained their weight; and 21.7% in those who gained their weight moderately: gamma coefficient, 0.44 (95%CI: 0.05, 0.66). The linear association remained significant after further controlling for age and alcohol consumption. And it was similar across the adiposity strata (normal weight, overweight, and obesity) of the firefighters 1 year ago.

Conclusions: One-year weight loss was associated with decreased risk of LSA in professional firefighters.

KEYWORDS
illness, injury, obesity, weight gain, weight loss

1 | INTRODUCTION

Obesity (body mass index [BMI], ≥30 kg/m^2)[1] prevalence has doubled worldwide since 1980. In 2014, about 50% of the world's adult population is overweight or obese.[2] Obesity is a major risk factor for several non-communicable diseases such as hypertension, coronary heart disease, osteoarthritis, dyslipidemia, Type II diabetes, some cancers as well as increased mortality.[1,3–5] Given the current global obesity epidemic, medical, and public health experts recommend weight loss of ≥5% for overweight (BMI, 25.0-29.9 kg/m^2) individuals with additional cardiovascular disease (CVD) risk factors and obese individuals.[6] It is well documented that modest weight loss (ie, 5-10% in initial weight) through healthy behaviors among overweight with additional CVD risk factors and obese adults produces a clinically meaningful reduction in biological CVD risk factors.[6–11]

However, despite strong evidence for the longitudinal association between obesity and long-term sickness absence (LSA) in working populations,[12–16] little is known about the association between weight change, particularly moderate weight loss and LSA (eg, >14 days per year) in working populations.[16,17] LSA comprises a third of the total days lost due to sickness absence and up to 75% of total sickness absence costs in the United Kingdom (UK).[18] The annual costs of sickness absence to UK employers and the State were estimated to be £ 21 billion for sick pay, associated costs, and health-related benefits.[19]

Only one study[17] has examined the association between weight change and LSA in 4164 (709 males) Finnish workers. As expected, the risk for LSA was lowest in female workers who had been normal-weight (BMI, 18.5-24.9 kg/m^2) at baseline and maintained weight (weight change <5% in initial weight) during the 3-year follow-up period, while it was highest in female workers who had been obese at baseline and gained weight (≥5% in initial weight) during the follow-up period. There was no difference in LSA between the above two groups in male workers in the study. Also, it was not clear in the study whether weight loss, compared to weight gain and weight maintenance, decreases the risk for LSA in both male and female workers. Furthermore, little is known about whether the association between weight gain and LSA is contingent upon the baseline BMI-based adiposity status (normal-weight, overweight, and obesity) of the workers. All of those issues in the study became more complicated due to its one critical methodological limitation: the authors could not make a distinction between intentional and unintentional weight loss,

which is very important in examining and interpreting the association between weight loss and health-related outcomes.[20] For example, unintentional weight loss due to illness or health problems likely increases the risk for LSA. Thus, it can distort the association of intentional weight loss with LSA (eg, a null or counterintuitively positive association). In addition, medical and public health experts recommend intentional weight loss through healthy behaviors as a way of reducing the risk for overweight or obesity.

About 1.2 million male firefighters are among the heaviest occupational groups in the United States (US)[21–23] and are at high risk for on-duty CVD mortality[24,25] and work-related injuries.[26,27] No studies have examined LSA among firefighters in the US. The aim of this study is twofold: (1) whether 1-year weight change, including moderate weight loss, is associated with 1-year prevalence of LSA in professional firefighters; and (2) whether it differs by their adiposity status 1 year ago. In this paper, firefighters were mostly males and firefighters who lost weight due to illness or health problems (unintentional weight loss) were excluded from analyses.

2 | METHODS

2.1 | Background—FORWARD study

The main purpose of the Firefighter Obesity Research: Workplace Assessment to Reduce Disease (FORWARD) study[22] was to identify occupational and behavioral risk factors for obesity in firefighters who work for a fire department in Southern California. The FORWARD study had strong support from both the fire department and a local union of the International Association of Fire Fighters (IAFF). The FORWARD study was approved by the Institutional Review Board (IRB) of the University of California, Irvine. All firefighters in this study were fully informed of the study and signed written informed consent forms. Phase I of the study involved developing a firefighter-specific work and health questionnaire (called hereafter the FORWARD study questionnaire) through four focus groups with 20 firefighters from January to April 2011.[28,29] Phase II of the study involved a cross-sectional survey using the FORWARD study questionnaire. Altogether, 365 firefighters (356 males and 9 females) participated in the survey (participation rate, 84% of the 436 firefighters) when they visited a clinic for their wellness and fitness (WEFIT) medical examinations at a university clinic between May 2011 and December 2012.

2.2 | Firefighters for the current study (340 firefighters)

Among the 365 firefighters who participated in the FORWARD study survey, we excluded the firefighters who were rookies (having <1 year of employment at the fire department) ($N = 3$), who lost ≥4.4 kg because of illness or health problems during the past 12 months ($N = 7$), or who did not have valid information on the study variables ($N = 16$). Thus, 340 firefighters (332 males and 8 females) were included in the current study for analyses (Table 1).

2.3 | One-year weight change

Firefighters reported their current (at Time 2:T2) weight and height in the FORWARD questionnaire survey during their WEFIT medical examinations. They also reported their weight 1 year ago (at Time 1: T1) in the same questionnaire. The 1-year relative weight change (%) was calculated as follows: $([Weight_{T2} - Weight_{T1}]/[Weight_{T1}]) \times 100$. It was then divided into the following three groups for analyses in line with the previous study by Roos et al[17]: weight loss (≥5%) group ($N = 32$); weight maintenance group (no weight change or marginal [<5%] weight changes) ($N = 278$), and weight gain (≥5%) group ($N = 30$). There were only three firefighters who had lost >10% of their weight and only three firefighters who had gained >10% of their weight over the past year: a sensitivity analysis with and without those six firefighters confirmed that the results were the same. Thus, hereafter, the above weight loss and gain groups in the current study will be called interchangeably with "moderate" (5-10%) weight losers and gainers, respectively.

The adiposity status (normal-weight, overweight, or obesity) of the firefighters 1 year ago was determined by the BMI values based on the self-reported weight at T1 and self-reported height at T2. In the current study, overweight was defined with the BMIs of 27.5-29.9 kg/m^2 rather than the standard definition of overweight of BMIs of 25.0-29.9 kg/m^2 because the narrower definition of overweight was significantly associated with biological CVD risk factors (high cholesterol and high low-density lipoprotein cholesterol) in the firefighters of the current study.[30] Moderate weight loss is recommended for overweight individuals with additional CVD risk factors.[6] Also, BMI-based overweight prevalence with the narrower definition was more comparable with the prevalence by waist circumference and body fat percent.[30] Obesity was defined with BMI ≥30 kg/m^2 as recommended by the World Health Organization.[1] Firefighters also reported in the FORWARD questionnaire whether they had experienced a significant weight loss (≥4.4 kg) by diet, exercise, or change of lifestyle during the past 12 months.

During WEFIT medical examinations, each firefighter's weight and height were also assessed by an experienced exercise physiologist based on a standard assessment protocol.[30] The self-reported weight, height, and BMI values at T2 in the FORWARD questionnaire were all significantly ($P < 0.001$) correlated with those clinically measured during WEFIT medical examinations: Spearman correlations were 0.99 and 0.98, and 0.98, respectively.

2.4 | LSA

The 1-year experience (prevalence) of LSA was measured with one question (Yes/No) in the FORWARD study questionnaire: "In the past year, I suffered a severe accident, injury, or illness that resulted in more than four shifts off." According to the standard work schedule of the firefighters, they are supposed to work ten or eleven 24-h shifts per month.[22,31] Missing more than four shifts in the firefighters of the current study is approximately equivalent to a sickness absence of 2 or more weeks in non-shift 8-h workers.

TABLE 1 Distributions of study variables and the one-year prevalence of long-term sickness absences (LSA) in firefighters ($N = 340$)

Study variables	Category	Subcategory	Distribution of study variables (%) among 340 firefighters	LSA (%)
Sociodemographic	Age	25-44	55.3	12.2*
		45-64	44.7	17.8*
	Sex	Men	97.6	14.5
		Women	2.4	25.0
	Race/Ethnicity	Non-Hispanic white	82.1	14.0
		Hispanic/Asia/others	17.9	18.0
	Marital status	Married or living with partner	78.5	14.7
		Others	21.5	15.1
	Education	Some college or high school	52.5	15.2
		College or graduate school	47.5	14.3
	Job title	Firefighters/engineers	70.6	14.2
		Captains/chiefs	29.4	16.0
Health-related behaviors	Exercise at work	≥2 days/week	87.3	13.9
		≤1 day/week	12.7	20.5
	Exercise during leisure time	≥2 days/week	72.2	13.9
		≤1 day/week	27.8	17.0
	High-fiber fruits/vegetable consumption	High (5-6 servings/day)	13.5	13.0
		Low (0-4 servings/day)	86.5	15.0
	Smoking or consumption of tobacco products	Yes	9.4	28.1**
		No	90.6	13.3**
	Alcohol consumption	No	13.2	6.7*
		Moderate	83.8	15.4*
		Heavy	2.9	30.0*
Sleep and health status	Sleep hours at fire station	2.5-<5 h	15.4	13.7
		5-6 h	62.2	17.0
		>6-8.5 h[a]	22.4	9.5
	Sleep hours at home	4-<7 h	18.8	14.5
		7 or 8 h	72.1	14.3
		>8 to 10 h	8.5	13.3
	Psychological distress	Low (GHQ ≤ 1)	77.1	14.9
		High (GHQ ≥ 2)	22.9	14.1
	Hypertension	No	89.3	14.9
		Yes	10.7	13.9
	Overweight or obese at T1	No (BMI, 18.5-27.4 kg/m^2)	54.0	13.7
		Yes (BMI ≥ 27.5 kg/m^2)	46.0	16.1

GHQ, general health questionnaire; BMI, body mass index; T1, 1 year ago.
[a]One firefighter reported 10 h of sleep.
*$P < 0.20$, **$P < 0.05$, and ***$P < 0.01$ at Chi-square test.

Self-reported LSA was compared with the administrative staffing record of the fire department (ie, whether a firefighter called in sick two 24-h shifts off in a row during the same 12-month period as referred to in the questionnaire). The comparison was conducted by one fire department staff member, independent of the university research team, in June 2016. Among the 50 firefighters who had reported LSA in the FORWARD study survey, the comparison could be done for the 40 firefighters who were still working at the fire department in June 2016. Thirty-seven out of the 40 (92.5%) self-reported LSA cases were confirmed in the administrative record as the cases occurred during the 12-month time period.

2.5 | Covariates

Socio-demographic characteristics of the firefighters (age, sex, race/ethnicity, education, and job title [firefighters/firefighter apparatus engineers vs captains/chief]) were assessed with the FORWARD study questionnaire. Working conditions, health-related behaviors,

and health conditions were also assessed with the questionnaire; these included working conditions (number of 24-h shifts in the past month [1 item], number of calls on a typical 24-h shift [1 item], perceived organizational support [2 items], physical job demands [1 item], job control [5 items], psychological job demands [5 items], extrinsic effort [2 items], and reward [4 items]); Health-related behaviors (exercise [ie, moderate or vigorous level of physical activity for more than 30 min] at fire station [1 item] or during leisure-time [1 item], consumption of high-fiber fruits and vegetables [1 item], smoking or consumption of tobacco products [1 item], sleep hours at fire station [1 item], and sleep hours at home [1 item]); and psychological distress (measured with the standard 12-item General Health Questionnaire [GHQ]).[32] The GHQ items were scored according to the 0-0-1-1 scoring formula and the high psychological distress group was defined as those with GHQ scores of ≥2.[33] More detailed information about the above questionnaire items was presented elsewhere.[30] The information on blood pressure (clinically assessed), the use of anti-hypertensive medications, and alcohol consumption was extracted by the research team staff from firefighters' WEFIT medical examination records. Hypertension was defined according to the JNC-7 classification.[34,35]

2.6 | Statistical analyses

The distributions of the 1-year prevalence of sickness absence and weight change were examined. The univariate associations between sickness absence and study variables except 1-year weight change were examined with Chi-squared test. The univariate linear association between 1-year weight change and LSA was examined using Goodman and Kruskal's gamma coefficients due to the very few ($N < 5$) firefighters who experienced LSA in the moderate weight losers and the ordinal characteristics (with categories of weight loss, weight maintenance, and weight gain) of the 1-year weight change variable. The association was examined in the whole sample and also three subsamples by the adiposity status of the firefighters at T1. The 95% confidence interval (CI) of a gamma coefficient was calculated based on the 10 000 bootstrap samples using the SPSS program (version 23.0). Due to the small sample size of female firefighters ($N = 8$), the multivariate analyses were restricted to male firefighters with both partial gamma coefficients and Cox's proportional hazards models[36] including the variables that were at least marginally significant ($P < 0.20$) in the univariate analyses.

3 | RESULTS

3.1 | One-year prevalence of LSA and one-year weight change

The 1-year prevalence of LSA was 14.7% (50 out of 341 firefighters). The means (± standard deviations) of the self-reported weights and BMIs of the firefighters slightly increased over the past year: 88.93 (± 12.57) kg and 27.43 (± 3.23) kg/m^2 at T1, and 89.01 (± 12.29) kg and 27.47 (± 3.21) kg/m^2 at T2, respectively. None of the firefighters were under-weight (BMIs <18.5 kg/m^2) at both T1 and T2. The total prevalence of overweight and obese firefighters (BMIs ≥27.5 kg/m^2) also slightly increased over the past year from 42.1% to 44.7%. There was a significant correlation between self-reported weights at T1 and T2: $r = 0.95$ ($P < 0.001$). There was also a significant correlation between calculated BMIs at T1 and T2: $r = 0.94$ ($P < 0.001$).

The mean (95%CI) of the 1-year change in relative weight were 0.19 (−0.23, 0.60)%. There was a significant individual-level variation in the 1-year weight change among the firefighters: 9.4% were moderate weight losers; 81.8% were weight maintainers (28.5%, marginal weight loss; 15.0%, no weight change; and 38.2%, marginal weight gain); and 8.8% were moderate weight gainers (Table 2). By self-report, 85 firefighters (25%) said that they had experienced a significant weight loss (>4.4 kg) by diet, exercise, or change of lifestyle during the past 12 months. Significant weight loss was self-reported by 93.8%, 18.0%, and 16.7% of the firefighters categorized as moderate weight losers, weight maintainers, and moderate weight gainers, respectively (gamma coefficient, −0.75, $P < 0.001$) (Table 2).

3.2 | Univariate association between one-year weight change and LSA

Among the 340 firefighters, the prevalence of LSA was 6.3% in the moderate weight losers; 14.7% in the weight maintainers; and 23.3% in the moderate weight gainers: gamma coefficient was 0.36 (95%CI: 0.00-0.66) (Table 2). When the data were stratified by the adiposity status of the firefighters at 1 year ago, a similar pattern was also observed in all three subgroups of the firefighters: normal-weight, overweight, and obese firefighters. The difference in the prevalence of LSA between the weight losers and the other two groups of firefighters was greater in the firefighters who had been normal-weight than in the firefighters who had been overweight or obese: 13.1-22.2 % versus 3.9-16.1% (Table 2).

On the other hand, the prevalence of LSA was higher at least at the marginal level of significance ($P < 0.20$) in the older firefighters, current smokers or users of tobacco products, heavy alcohol drinkers, and female firefighters (Table 1). It did not vary much by other study variables, including the working conditions and other health-related behaviors. LSA was more prevalent in the firefighters who had been overweight or obese 1 year ago than in the firefighters who had been normal-weight 1 year ago; however, the difference were small.

3.3 | Multivariate association between one-year weight change and LSA

Multivariate analyses were restricted to the non-smoking male firefighters ($N = 300$) after excluding female firefighters ($N = 8$) and male smokers ($N = 32$) (Table 3). Among male smokers, the prevalence of LSA was 50% (1/2), 25% (6/24), and 33% (2/6) in the weight loss, weight maintenance, and weight loss groups, respectively: gamma coefficient, −0.02 (95%CI: −1.00, 0.77).

There was a significant linear association between weight change and LSA in the non-smoking male firefighters: gamma coefficient, 0.44 (95%CI: 0.05, 0.73) (Table 3 and Fig. 1). After further controlling for

TABLE 2 One-year weight change and one-year prevalence of long-term sickness absence (LSA) in firefighters (*N* = 340)

Firefighters	Three groups of relative weight change over the past year	Number of firefighters	One-year prevalence of LSA: *N* (%)	Significant weight loss (≥4.4 kg) by diet, exercise, or change of lifestyle during the past 12 months: *N* (%)
All (*N* = 340)	Modest weight losers (≥5%)[a]	32	2 (6.3%)	30 (93.8%)
	Weight maintainers	278	41 (14.7%)	50 (18.0%)
	Modest weight gainers (≥5%)[b]	30	7 (23.3%)	5 (16.7%)
	Gamma coefficient (95%CI)		0.36 (0.00, 0.66)	−0.75 (−0.93, −0.55)
[c]Normal-weight firefighters at T1 (*N* = 197)	Modest weight losers	13	0 (0.0%)	12 (92.3%)
	Weight maintainers	166	23 (13.9%)	21 (12.7%)
	Modest weight gainers	18	4 (22.2%)	2 (11.1%)
	Gamma coefficient (95%CI)		0.48 (0.03, 0.76)	−0.76 (−1.00, −0.41)
[d]Overweight firefighters at T1 (*N* = 82)	Modest weight losers	8	1 (12.5%)	8 (100.0%)
	Weight maintainers	67	11 (16.4%)	16 (23.9%)
	Modest weight gainers	2	7 (28.6%)	1 (14.3%)
	Gamma coefficient (95%CI)		0.27 (−0.49, 0.84)	−0.83 (−1.00, −0.44)
[e]Obese firefighters at T1 (*N* = 61)	Modest weight losers	11	1 (9.1%)	10 (90.9%)
	Weight maintainers	45	7 (15.6%)	13 (28.9%)
	Modest weight gainers	5	1 (20.0%)	2 (40.0%)
	Gamma coefficient (95%CI)		0.26 (−0.52, 0.88)	−0.66 (−1.00, −0.22)

T1, 1 year ago.
[a]Three firefighters lost weight more than 10%.
[b]Three firefighters gained weight more than 10%.
[c]BMIs, 18.5 to <27.5 kg/m^2.
[d]BMIs, 27.5 to <30.0 kg/m^2.
[e]BMIs, ≥30 kg/m^2.

age and alcohol consumption, gamma coefficient slightly increased to 0.49 (95%CI: 0.11, 0.78) (Table 3). LSA was about four times (*PR* = 3.94, *P* = 0.177) and six times (*PR* = 6.31, *P* = 0.093) more prevalent in the weight maintainers and the moderate weight gainers groups, respectively, than in the moderate weight losers. The multivariate association between weight change and LSA was slightly stronger in the firefighters who had been normal-weight than in the firefighters who had been overweight/obese firefighters: gamma coefficients 0.56 versus 0.44 (Table 3).

4 | DISCUSSIONS

There was a significant linear association between self-reported 1-year weight change and 1-year prevalence of LSA in a group of professional firefighters from Southern California. LSA was least prevalent in the firefighters who lost weight (mostly 5-10% in their initial weight) through exercise, diet, or a lifestyle change. By contrast, it was most prevalent in the firefighters who gained weight over the past year. This pattern was generally similar across the adiposity strata of the firefighters 1 year ago, although slightly stronger in the normal-weight firefighters on year ago. This study suggests that weight gain prevention and moderate weight loss through healthy behaviors may reduce the risk for LSA in professional firefighters.

4.1 | Comparisons with previous studies

In this study on a group of predominantly male professional firefighters, the risk for LSA was greater in the moderate weight gainers than in the weight maintainers over the past year. This agree with the finding of the previous study in female workers,[17] however, in previous study, no association was shown for male workers. In addition, this is the first observational study of clearly showing that moderate weight loss through a health-related lifestyle change (eg, exercise, diet) is associated with a lower risk for LSA, compared to weight maintenance and moderate weight gain in working populations. It was not able to be appropriately tested in the previous study[17] due to its lack of information on the intentionality and methods of weight loss. Three weight/obesity intervention studies[37–39] have examined the impact of weight loss (or BMI decrease) on total sickness absence (not specifically LSA) over 1 or 2 years. However, the results of the studies have been inconsistent: a significant decrease in sickness absence[38]; a non-significant decrease[37]; and a significant increase.[39]

Several mechanisms may explain the reduced risk of LSA with moderate weight loss in the firefighters. For example, moderate

TABLE 3 One-year weight change and one-year prevalence of long-term sickness absence (LSA) in non-smoking male firefighters (*N* = 300)

Male firefighters	Three groups of relative weight change over the past year	One-year prevalence of LSA	[e]Multivariate prevalence ratio (95%CI)
All (*N* = 300)	Modest weight losers (≥5%)[a]	3.4% (1/29)	1.00
	Weight maintainers	13.3% (33/248)	3.94 (0.54-28.83)[f]
	Modest weight gainers (≥5%)[b]	21.7% (5/23)	6.31 (0.74-54.04)[g]
	Gamma coefficient (95%CI)	0.44 (0.05, 0.73)	0.49 (0.11, 0.78)
[c]Normal-weight firefighters at T1 (*N* = 173)	Modest weight losers	0.0% (0/12)	N/A
	Weight maintainers	12.8% (19/148)	1.00
	Modest weight gainers	23.1% (3/13)	1.60 (0.47-5.44)
	Gamma coefficient (*P* value)	0.55 (0.04, 0.81)	0.56 (−0.01, 0.85)
[d]Overweight or obese firefighters at T1 (*N* = 127)	Modest weight losers	5.9% (1/17)	1.00
	Weight maintainers	14.0% (14/100)	2.31 (0.30-17.60)
	Modest weight gainers	20.0% (2/10)	4.12 (0.37-46.58)
	Gamma coefficient (*P* value)	0.35 (−0.22, 0.81)	0.44 (−0.19, 0.92)

T1, 1 year ago; CI, confidence interval; NA, not applicable.
[a]Three firefighters lost weight more than 10%.
[b]Three firefighters gained weight more than 10%.
[c]BMIs, 18.5 to < 27.5 kg/m^2.
[d]BMIs ≥27.5 kg/m^2.
[e]Controlled for age and alcohol consumption.
[f]*P* = 0.177.
[g]*P* = 0.093.

weight loss in the firefighters may improve their biological CVD risk profiles,[6,7,40,41] postural stability, or biomechanical load on body joints,[42–45] or mental health including stress, fatigue, and vitality.[46,47]

This study also provides rich information on 1-year self-reported weight change among professional firefighters. In this study, on average, self-reported weight of firefighters increased over the past year only by 0.08 kg (equivalent to 0.2 pounds). It is much smaller than the weight increase (0.8-1.9 pounds per year) estimated from a 5-year follow-up study in Massachusetts professional firefighters during the years, 1996-2001[48] and a 7-year follow-up study in Florida professional firefighters during the years, 1984-1991.[49] The difference in the weight increase between the current study and two previous studies may be explained by their different study time periods. Obesity prevalence in US male adult populations increased rapidly between 1980 and 1999; however, in more recent years, it has only slightly increased.[50] Also, it may be explained by the general health promoting effects of the firefighter WEFIT program which has been implemented in the fire department of the current study since 2004. The prevalence of obesity was significantly lower in US fire departments having a good WEFIT program than in US fire departments without the program.[51] On the other hand, this study indicates that the weights of some professional firefighters can change substantially over 1 year: 18% (about 9% each) of the firefighters lost or gained weight of ≥5% over the past year. This is similar to the result from a US general population: 20% of US male adults reported weight loss or weight gain of >5% during the past 12 months.[52]

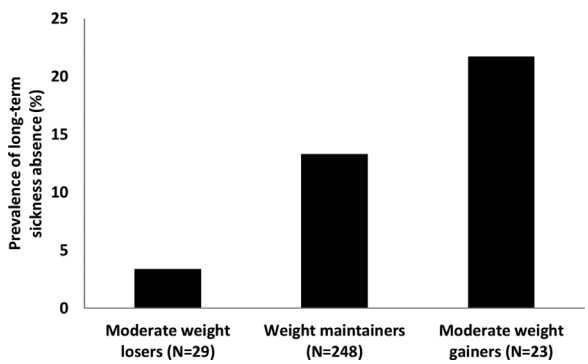

FIGURE 1 The 1-year prevalence of long-term sickness absence (LSA) by 1-year weight change among 300 non-smoking male professional firefighters. Gamma coefficient, 0.44, *P* = 0.04

As consistent with the previous studies in other working populations,[13,53,54] age and smoking were identified as risk factors for LSA among the firefighters. Heavy alcohol drinkers (<3% among the firefighters) had higher prevalence of LSA, compared to non-drinkers. Adverse working conditions were not associated with LSA. However, it should be cautiously interpreted due to the following two reasons. In the current study based on a single occupation, there was little variation in adverse working conditions such as job control, job demands, and social support at work, job insecurity, and job rewards among the firefighters.[28] In addition, information on adverse working conditions was available at only one-time (at T2) in the current study. Thus, the current study is limited in examining the impact of adverse working conditions on LSA among professional firefighters.

4.2 | Implications for the prevention of LSA

The 1-year prevalence of LSA, including both work-related and non-work-related LSA, in the current study was 14.7% (14.7 cases per 100

firefighters). This is higher than the annual incidence rate of non-fatal work-related injuries and illnesses with lost workdays in US firefighters (4.8 cases per 100 firefighters) and US general working population (1.2 cases per 100 workers) from the 2012 national survey of occupational injuries and illnesses.[55] Despite the well-known underreporting of work-related injuries and illnesses (up to 50%) in the national survey,[56] this implies that the total costs of LSA to individual firefighters, their families, fire departments, and society would be substantial and greater than those of work-related sickness absence alone.

This study also implies that moderate weight loss through healthy behaviors and weight maintenance may reduce the risk for LSA among professional firefighters. If confirmed in future studies, weight management would be a realistic and promising way to address LSA among professional firefighters, given the current high prevalence of obesity and work-related injuries and lack of long-term successful obesity intervention studies among US firefighters.[57] More efforts should be made to improve weight management through healthy behaviors among US firefighters. At the same time, firefighter stakeholders should address many additional 24-h shifts per month and prolonged sedentary work that has been identified as important occupational risk factors for obesity and stress-related overeating behaviors in firefighters.[57]

The multivariate linear association between weight change and LSA was generally similar across the adiposity strata of the firefighters 1 year ago. This suggests that moderate weight loss through health behaviors as well as weight maintenance may be recommendable to all firefighters, including normal-weight firefighters, particularly they are not engaged in health-related behaviors.

4.3 | Limitations

There are two limitations in the current study. First, the information on weight change and LSA in the current study was self-reported in a cross-sectional survey. However, as presented before, most of self-reported LSA cases were confirmed with administrative records. Also, self-reported current weight was validated against clinically measured one. On the other hand, self-reported past (1 year ago) weight and 1-year weight change may be vulnerable to recall bias. But, in a Danish study,[58] 1-year recalled weight was very highly correlated with measured weight. In addition, there was a very high correlation (Spearman correlation, 0.8) between 5-year self-reported and measured weight changes in a US population.[59] In the US study, there was also a high level of agreement on the three categories of the weight change (moderate weight loss, weight maintenance, and moderate weight gain) as in the current study between the self-reported and measured weight changes: weighted kappa, 0.58, and agreement percent, 82%. Thus, the impact of the use of self-reported weight change on the findings of the current study, if any, would not be substantial. Second, reverse causation between moderate weight gain and LSA cannot be completely ruled out in the current study. Some qualitative investigations[60,61] in drivers and low-wage workers suggest that illness and injury may make it difficult for some workers to maintain or adopting healthy behaviors (eg, exercise). However, no empirical epidemiological evidence exists in the literature for supporting the causal direction from LSA to moderate weight gain over 1 year. In contrast, strong epidemiological evidence in the literature points to the causal direction from obesity or weight gain to LSA.[12–16] Also, in the current study, firefighters who had been overweight or obese firefighters experienced more LSA, albeit not statistically significant, over 1 year than those who had been normal-weight firefighters. Thus, reverse causation between moderate weight gain and LSA seems to have played a minor role, if any, in the current study. On the other hand, it should be emphasized that reverse causality between moderate weight loss and LSA is very unlikely. Most of the moderate weight losers in the current study lost their weight through healthy behaviors and the firefighters who lost weight due to health problems were excluded from analyses. More future studies based on a longitudinal cohort or intervention study design are warranted to confirm the association between weight change (in particular, moderate weight loss) and LSA in working populations. Future longitudinal or intervention studies should collect more detailed information on weight change (intentionality and methods) and LSA (causes, timing and duration, and impact on weight) using more objective and multiple measures.

AUTHOR'S CONTRIBUTION

BC conceived and wrote this manuscript.

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ETHICS APPROVAL AND INFORMED CONSENT

The protocol of this study was approved by the Institutional Review Board (IRB) of the University of California, Irvine. All firefighters in this study were fully informed of the study and signed written informed consent forms.

DISCLOSURE (AUTHOR)

The author declares that there is no conflict of interest.

DISCLOSURE BY AJIM EDITOR OF RECORD

Steven Markowitz declares that he has no conflict of interest in the review and publication decision regarding this article.

DISCLAIMER

The contents of this paper are solely the responsibility of the author and do not necessarily represent the official views of the CDC/NIOSH.

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