Center for Health Policy and Health Services
Research Articles

Center for Health Policy and Health Services
Research

4-22-2021

Weighing the Association Between BMI Change and Suicide Mortality

Leah M. Hecht

Hsueh-Han Yeh

Jordan M. Braciszewski

Lisa R. Miller-Matero

Anjali Thakrar

See next page for additional authors

Authors

Leah M. Hecht, Hsueh-Han Yeh, Jordan M. Braciszewski, Lisa R. Miller-Matero, Anjali Thakrar, Shivali Patel, Gregory E. Simon, Frances L. Lynch, Arne Beck, Ashli A. Owen-Smith, Rebecca C. Rossom, Beth E. Waitzfelder, Christine Y. Lu, Jennifer M. Boggs, and Brian K. Ahmedani

Weighing the Association Between BMI Change and Suicide Mortality

Leah M. Hecht, Ph.D., Hsueh-Han Yeh, Ph.D., Jordan M. Braciszewski, Ph.D., Lisa R. Miller-Matero, Ph.D., Anjali Thakrar, M.D., Shivali Patel, M.D., Gregory E. Simon, M.D., Frances L. Lynch, Ph.D., Arne Beck, Ph.D., Ashli A. Owen-Smith, Ph.D., Rebecca C. Rossom, M.D., Beth E. Waitzfelder, Ph.D., Christine Y. Lu, Ph.D., Jennifer M. Boggs, Ph.D., Brian K. Ahmedani, Ph.D.

Objective: Suicide rates continue to rise, necessitating the identification of risk factors. Obesity and suicide mortality rates have been examined, but associations among weight change, death by suicide, and depression among adults in the United States remain unclear.

Methods: Data from 387 people who died by suicide in 2000–2015 with a recorded body mass index (BMI) in the first and second 6 months preceding their death ("index date") were extracted from the Mental Health Research Network. Each person was matched with five people in a control group (comprising individuals who did not die by suicide) by age, sex, index year, and health care site (N=1,935).

Results: People who died by suicide were predominantly male (71%), White (69%), and middle aged (mean age=57 years) and had a depression diagnosis (55%) and chronic health issues (57%) (corresponding results for the control group: 71% male, 66% White, 14% with depression

diagnosis, and 43% with chronic health issues; mean age=56 years). Change in BMI within the year before the index date statistically significantly differed between those who died by suicide (mean change=−0.72±2.42 kg/m^2) and the control group (mean change=0.06±4.99 kg/m^2) (p<0.001, Cohen's d=0.17). A one-unit BMI decrease was associated with increased risk for suicide after adjustment for demographic characteristics, mental disorders, and Charlson comorbidity score (adjusted odds ratio=1.11, 95% confidence interval=1.05–1.18, p<0.001). For those without depression, a BMI change was significantly associated with suicide (p<0.001).

Conclusions: An increased suicide mortality rate was associated with weight loss in the year before a suicide after analyses accounted for general and mental health indicators.

Psychiatric Services 2021; 00:1−6; doi: 10.1176/appi.ps.202000475

Suicide ranks 10th among all-cause mortality in the United States, with suicide mortality rates on the rise within recent years (1). Mental health conditions, including depression, are associated with death by suicide, and severe depression nearly doubles the odds of suicide death (2). As both weight loss and weight gain constitute part of the diagnostic criteria for major depressive disorder, the potential arises for weight change to be associated with increased risk for suicide (3). Indeed, the odds of weight or appetite loss among individuals diagnosed as having major depressive disorder who died by suicide was nearly 2.6 times that of controls (i.e., those with depression but without weight or appetite loss) (4). Other research, however, has not found an association between weight loss and death by suicide during a 5-year follow-up among individuals with depression (5). Of note, these studies included only individuals with major depression. The need for research examining weight change and suicide mortality rates among larger, more representative

samples is supported by data that only 24% of those who died by suicide were diagnosed as having a mental health condition in the month before their death (6). Therefore, there is a need to identify suicide risk factors beyond

HIGHLIGHTS

- Analyses of two samples matched by several demographic characteristics found that in the year preceding a suicide, those who died by suicide had lost weight, and persons in the control group had gained weight.
- A decrease in body mass index among individuals without a diagnosis of depression was associated with an increased risk for suicide.
- Weight loss, along with other medical indicators, may be useful for assessing suicide risk, especially among persons at higher risk for suicide.

psychiatric diagnoses. Nonbiased (e.g., objective) physiological indicators, including weight change, may represent one such risk factor for suicide death.

Only one study to date has examined associations between weight change and suicide among a large sample in London, United Kingdom (7). In this study of 18,784 men over a 38-year period, 61 reported suicides occurred. Unexplained weight loss over the past year was associated with an elevated suicide risk. However, the study was limited in that unexplained weight loss was self-reported and therefore may have been biased, only men were included in the study, diagnoses of depression were not reported, and the study was conducted outside the United States. Indeed, there is a marked difference in the means used for suicide between individuals in the United Kingdom and the United States, with less lethal means being more commonly used in the United Kingdom (8). Therefore, the results of the London study (7) may not be generalizable to both men and women in the United States.

Further evidence for a potential link between weight change and suicide comes from the field of bariatric surgery. Among those who undergo bariatric surgery, which contributes to significant reductions in body weight, rates of suicide death are significantly higher than among those in the general population (9). Interestingly, however, obesity has been associated with decreased suicide risk in several but not in all studies (10). Thus, weight loss after bariatric surgery may have an effect that elevates suicide risk. Although existing evidence links specific populations (e.g., individuals with depression or those who have undergone bariatric surgery) with increased risk for suicide death, there is a need to further examine whether weight change is associated with variation in the risk for suicide death among the general population, including individuals with and without depression and other potential suicide risk factors. This study examined these associations while also accounting for the influence of demographic variables, mental or substance use disorder diagnoses such as depression, and medical conditions that may also be associated with the risk for suicide death.

METHODS

Study Sample
The study sample was drawn from a larger case-control project examining health care service utilization in the year before suicide (6). Patients had been served by eight large Mental Health Research Network (MHRN)-affiliated health care systems located across the United States, in Colorado, Georgia, Hawaii, Massachusetts, Minnesota, Michigan, Oregon, and Washington. All patients had insurance coverage provided by the health systems' affiliated health plans and had been health plan members for at least 10 months during the year before the index date (i.e., date of suicide death and the same date for the matched control group individuals). The combination of both health plan and health system membership data enabled comprehensive capture of both electronic health records and insurance claims data from within and outside of the health care system. Health plan membership included commercial, Medicaid, Medicare, and self-pay insurance plans, representing a diverse range of plans. Beginning with a full sample of individuals who died by suicide (N=3,117), we included only those who had vital records data for height and weight in the 0–6 months and in the 7–12 months preceding their death (N=387). Using the index date, we then matched each of these individuals with five control group individuals for age, sex, index year, and health care system site. A sample of 2,322 patients (387 who died by suicide and 1,935 control group individuals) was thereby obtained. Data were collected from January 2000 to September 2015 and analyzed in 2020. Institutional review board approval was obtained at each health system site, including Kaiser Permanente Colorado, Kaiser Permanente Washington, Kaiser Permanente Hawaii, Kaiser Permanente Northwest, Kaiser Permanente Georgia, Henry Ford Health System, HealthPartners, and Harvard Pilgrim Health Care.

Suicide death was identified by using *ICD-10* codes (X60–X84 and Y87.0) from official government death records matched to health system records and the definition and coding process developed by the Centers for Disease Control and Prevention. *ICD-9* diagnosis codes were extracted from the MHRN's Virtual Data Warehouse (VDW), a federated data model in each health system that includes a combination of electronic health records and insurance claims organized in the same format, by using identical variables and data definitions across sites. In addition, all data (e.g., encounters, pharmacy fills, diagnoses, demographic characteristics, and vital signs) are organized according to the same definitions across sites and are quality checked locally (11).

Patients' heights and weights were measured during clinical visits. Patients might have had multiple measurements during the year before the index date. The change in body mass index (BMI) was calculated by subtracting the closest measure to the index date (0–6 months) from the furthest measure in the 7–12 months before the index date. Mental and substance use disorder diagnoses were captured through *ICD-9* codes 290–319. Demographic information (e.g., age, sex, and race-ethnicity) was extracted from the VDW. For each person, estimated neighborhood income and neighborhood education were obtained from geocoded addresses and census block data. Finally, the Charlson Comorbidity Index provides a measure of health burden by weighting key indicators of conditions associated with post-hospitalization 1-year mortality (12). The Charlson scale was used to identify medical comorbid conditions such as cancer or other chronic diseases in the present study. The Charlson score was calculated by using *ICD-9* codes from clinical diagnoses in the year before the index date. Patients were categorized as either having (score of 1) or not having (score of 0) a comorbid condition.

Statistical Analyses

We conducted t tests and chi-square analyses to examine differences between people who died by suicide and people in the control group while accounting for all demographic, psychiatric, and chronic illness characteristics, as well as differences in BMI across various time points of the period preceding the index date. Conditional logistic regression was used to explore the relationship between a change in BMI over the earliest and latest recorded weights in the first and second 6 months preceding the index date and suicide death. These regression analyses included univariable and multivariable models with adjustments for age, sex, race-ethnicity, neighborhood poverty level, neighborhood educational level, mental health condition, and Charlson score. We also specified the linear combinations of BMI change and depression diagnosis, as well as BMI change and Charlson score, to test for statistical significance of the interaction effects. Analyses were conducted with SAS, version 9.4 (13).

RESULTS

Demographic characteristics of the patient sample are presented in Table 1. As age and sex were matched, the sample was predominantly male (71%) and 56–57 years old. In general, people who died by suicide were White (69%), had a diagnosis of depression (55%) or another mental or substance use disorder (23%), and a Charlson score >0 (57%), reflective of comorbid condition. Individuals who died by suicide and those in the control group differed significantly by race-ethnicity, mental or substance use disorder diagnosis, and comorbid condition. The two groups did not significantly differ in neighborhood poverty level or neighborhood education. An examination of the change in BMI during the previous year revealed a significant difference between the two groups, with those who died by suicide having lost on average 0.72 kg/m^2, whereas those in the control group gained on average 0.06 kg/m^2 (p<0.001); Cohen's d effect size for this association was 0.17. None of the individuals who died by suicide received bariatric surgery in the year before their death, and one individual in the control group had received bariatric surgery in the previous year.

An online supplement to this article includes a table comparing the demographic characteristics of individuals in both the suicide death and control groups to those in the entire population from which the study sample was drawn. Our subsample was older and had a higher percentage of female and White individuals, as well as higher levels of medical morbid conditions, mental and substance use disorder diagnoses, and diagnoses of depression than those in the entire sample of individuals who died by suicide. However, the individuals in our sample did not differ from those in the entire sample by neighborhood education level or neighborhood poverty level.

Univariable analyses revealed significant associations between our main outcome, suicide death, and BMI change, race-ethnicity, mental or substance use disorder diagnosis,

TABLE 1. Demographic characteristics of the study sample, by patient group[a]

Characteristic	Patients who died by suicide (N=387)		Patients in control group (N=1,935)		p
	N	%	N	%	
Age (M±SD)	57.2±19.9		56.0±19.8		
Sex					<.001
Female	111	29	555	29	
Male	276	71	1,380	71	
Race-ethnicity					<.001
White	265	69	1,281	66	
Non-White	46	12	410	21	
Unknown	76	20	244	13	
Neighborhood income					.862
Above low income	284	73	1,444	75	
Low income	33	9	162	8	
Missing	70	18	329	17	
Neighborhood education level					.684
≥25% college graduates	236	61	1,223	63	
<25% college graduates	135	35	631	33	
Missing	16	4	81	4	
Charlson Comorbidity Index score[b]					<.001
0	165	43	980	51	
>0	221	57	833	43	
Mental or substance use disorder diagnosis[c]					.004
No	298	77	1,608	83	
Yes	89	23	327	17	
Depression diagnosis					<.001
No	174	45	1,661	86	
Yes	213	55	274	14	
BMI difference in kg/m^2 (M±SD)[d]	−0.72±2.42		0.06±4.99		<.001

[a] Means were compared by t tests, and proportions were compared by chi-square tests.
[b] Charlson Comorbidity Index scores were calculated with ICD-9 codes from clinical diagnoses; the total score was categorized as a binary variable.
[c] ICD-9 codes 290–319, excluding depression diagnoses (ICD-9 codes 2962, 2963, 296.82, 2980, 3004, 301.12, 3090, 3091, 309.28, and 311).
[d] Difference was calculated by subtracting the body mass index (BMI) measured on the earliest date from the BMI measured on the last date before the index date (i.e., date of death by suicide or matching date for the matched control group individuals).

and comorbid condition (Table 2). After accounting for demographic predictors, mental or substance use disorder diagnosis other than depression, depression diagnosis, and comorbid conditions, the association between BMI change from the latest to most recent BMI measurement before the index date and suicide death remained statistically significant (adjusted odds ratio [AOR]=1.11, 95% confidence interval=1.05–1.18, p<0.001), such that a one-unit decrease in BMI was

TABLE 2. Logistic regression analysis of the effects of several general medical and demographic factors on suicide death

Variable	Univariate model			Multivariate model[a]		
	OR	95% CI	p	AOR	95% CI	p
BMI change[b]	1.07	1.04−1.11	<.001	1.11	1.05−1.18	<.001
White (reference: non-White)	1.81	1.29−2.52	.001	1.79	1.20−2.65	.004
Living in a poor neighborhood	1.04	0.70−1.54	.861	1.08	0.67−1.75	.741
Living in a neighborhood with lower college graduation	1.11	0.88−1.40	.382	1.02	0.78−1.35	.878
Comorbid condition	1.66	1.31−2.10	<.001	1.56	1.20−2.05	.001
Mental or substance use disorder diagnosis, excluding depression	1.48	1.13−1.93	.004	3.86	2.76−5.41	<.001
Depression diagnosis	7.69	6.03−9.79	<.001	11.65	8.63−15.72	<.001
Depression diagnosis × BMI change						
1-unit increase in BMI for patients with depression				0.92	0.82−1.03	.163
1-unit increase in BMI for patients without depression				0.89	0.81−0.98	.016
Comorbid condition × BMI change						
1-unit increase in BMI for patients with comorbid condition				0.90	0.85−0.96	.002
1-unit increase in BMI for patients without comorbid condition				0.89	0.81−0.98	.016

[a] Adjusted for all variables, plus index year, site, and days difference between BMI measurements. AOR, adjusted odds ratio.
[b] BMI, body mass index.

associated with a significantly increased risk for suicide death. The association between BMI change and risk for suicide differed between people with and without a diagnosis of depression. Among those with a depression diagnosis, BMI change and suicide death were not significantly associated with each other (p=0.098). In contrast, among those without depression, we detected a significant association between increased BMI change and decreased suicide risk (p<0.001) (Figure 1). To assess whether weight loss may have been due to the presence of medical conditions, we tested the interaction between Charlson score and BMI change. We observed a significant association between BMI change and suicide for both those with and without comorbid conditions (Table 2), suggesting that the association between BMI change and suicide was not restricted to individuals with a comorbid condition.

DISCUSSION

To our knowledge, this is the largest study of death by suicide as documented in medical records from the U.S. general population. After accounting for several demographic, medical, and psychiatric predictors, we found that weight loss in the preceding year is associated with suicide death. Consistent with previous statistics on suicide completion (1, 14), having a mental or substance use disorder diagnosis or comorbid condition independently increased the odds of suicide death. In the present study, those who died by suicide lost on average about a three-quarter BMI point in the year before their death, which roughly translates to a 4-pound weight loss. However, it should be considered that, from 1992 to 2010, the BMI of U.S. adults who initially had a weight within the normal range increased from 0.7 to 1.1 pounds and, among those who were initially overweight, from 0.4 to 1.3 pounds (15). In addition, those in the control group gained weight, on average, during the same period. Thus, the observed trend in weight loss among those who died by suicide contrasted both with those in the control group and with population-wide trends of increasing BMI in the United States. Additionally, our finding that individuals who died by suicide on average experienced weight

FIGURE 1. Mean changes in body mass index (BMI) among those who died by suicide and those in the control group, by depression diagnosis[a]
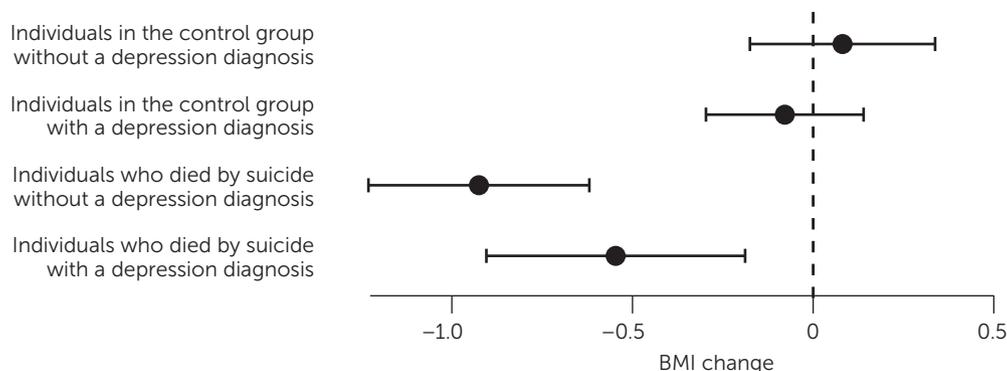
[a] Data are means; error bars indicate SE.

loss in the year before the suicide is consistent with research that BMI and suicide risk are inversely associated. Kaplan and colleagues (16) noted that each 5 kg/m^2 increase in BMI was associated with an up to 24% lower suicide risk.

The primary findings indicate that suicide death is associated with weight loss in the previous year before the suicide, with a significantly increased risk for suicide death for each one-unit decrease in BMI after adjustments for demographic, psychiatric, and comorbid conditions, although the magnitude of the effect of BMI change on suicide was relatively small. Notably, this association apparently was not accounted for by weight changes attributable to chronic medical conditions, because the BMI decrease was associated with increased risk for suicide regardless of the Charlson score. We note that weight and height are routinely measured at medical visits, making this information highly visible to medical providers (17). Measured vitals from which a BMI can be calculated provide a value that is not subject to bias associated with personal reporting of weight and height (18). Suicide screening has been shown to predict future suicide attempts and suicide deaths (19), illustrating the importance of routine screening, especially among individuals with weight loss.

Despite depression being most strongly associated with suicide death of all the predictors examined, only 55% of individuals who completed suicide were given a diagnosis of depression, and only 23% had a mental or substance use disorder diagnosis other than depression. Interestingly, our results revealed a significant association between weight change and suicide death only among those *without* a diagnosis of depression. One possible explanation for this observation is that depression can contribute to weight gain or weight loss, which, when considered together across individuals with depression, could obscure a potential association between suicide death and weight change. Additionally, consistent with previous research, antidepressant medications may attenuate weight change, as they can contribute to both weight loss and gain (20). However, the nonsignificant interaction between weight change and depression diagnosis should not be interpreted to mean that weight change is not pertinent among those with depression. Rather, it is possible that weight loss may confer a risk for depression.

The evidence presented here suggests an association between weight loss and suicide death, although causality could not be ascertained. One possibility is that the relationship is direct, with weight loss increasing the risk for suicide. For example, hormones, including ghrelin, may be responsible for the association between weight loss and suicide, as has been posited for those who have undergone bariatric surgery (9). Alternatively, it is possible that weight loss is a marker for the "true" cause of suicide. As such, weight change may be an "externalized" indicator of depressive symptoms or other mental health symptoms. Research has also found lower levels of triglycerides among those who attempted suicide (21), and triglyceride levels are shown to decrease with modest weight loss in overweight and obese individuals (22).

The strengths of this study include the large sample of individuals who died by suicide and vital measurements derived from reliable medical record data from health systems across the United States. Our results may inform clinical care by shedding light on the relevance of weight loss as a potential psychiatric marker for suicide. Additionally, the findings may be used to guide future studies that use predictive modeling of risk for suicide.

We note several limitations. People who died by suicide and people in the control group were included if they had at least two weight measurements in the year before the index date. However, the ability to determine the elapsed time between the measured weights could vary significantly across patients. Indeed, we found greater variability in BMI change as the number of elapsed days between weight measurements increased, which is to be expected. Therefore, future efforts to expand this study would benefit from a prospective study design to capture weight measurements at clinically relevant, potentially vulnerable time points for suicide across the life span, such as within 3 months of an emergency department visit or inpatient stay due to a mental health condition (23). Because we included only individuals with two or more health care visits in the previous year, it is important to also consider that these individuals may have been more engaged in their health care, which may have biased the findings. Indeed, the patients in our sample had higher levels of medical and psychological comorbid conditions.

Additionally, this study did not examine suicidal ideation or suicide attempts, which are associated with suicide death (2) as well as with weight control behaviors (24) and perceived weight status (25). Examining associations among objective weight change, suicidal ideation, and suicide attempts would be a valuable future research direction. Additionally, assessing whether weight loss was either intentional or unintentional could have implications for suicide risk and subsequent treatment, as demographic risk factors such as older age, poorer health status, and lower BMI are associated with both suicide and unintentional weight loss (26). Last, this study did not include use of antidepressant medication, which could have contributed to weight changes, and did not consider medical conditions that could contribute to edema, which has a small positive correlation with weight (27). Future studies should consider the potential influence of specific medical conditions and of antidepressant use, including medication type, dosage, and adherence, on the relationship between weight changes and suicide risk.

CONCLUSIONS

The findings of this study suggest that weight change is a physiological indicator that may be associated with

increased risk for suicide death, notably among those without a diagnosis of depression. Existing research has shown only a limited ability of clinicians to predict an individual's risk for suicide above the level of chance (28). The results of the present study suggest that in addition to considering other clinically relevant information, providers could use a patient's weight loss as a potential marker for suicide risk, especially among high-risk patients. Although it is unknown whether the rate of weight loss (e.g., abrupt vs. gradual) is pertinent, facilitating a referral for behavioral health treatment when weight loss is observed between two health care visits may help prevent suicide death.

AUTHOR AND ARTICLE INFORMATION

Henry Ford Health System Center for Health Policy and Health Services Research, Detroit (Hecht, Yeh, Braciszewski, Miller-Matero, Ahmedani); Henry Ford Health System Behavioral Health, Detroit (Hecht, Miller-Matero, Thakrar, Patel, Ahmedani); Kaiser Permanente Washington Health Research Institute, Seattle (Simon); Kaiser Permanente Northwest, Center for Health Research, Portland, Oregon (Lynch); Kaiser Permanente Colorado, Institute for Health Research, Denver (Beck, Boggs); Kaiser Permanente Georgia, Center for Research and Evaluation, Atlanta, and Department of Health Policy and Behavioral Sciences, Georgia State University School of Public Health, Atlanta (Owen-Smith); HealthPartners, Institute for Education and Research, Minneapolis (Rossom); Kaiser Permanente Hawaii, Center for Integrated Health Care Research, Honolulu (Waitzfelder); Department of Population Medicine, Harvard Medical School and Harvard Pilgrim Health Care Institute, Boston (Lu). Send correspondence to Dr. Hecht (lhecht1@hfhs.org).

REFERENCES

1. Hedegaard H, Curtin SC, Warner M: Suicide rates in the United States continue to increase. NCHS Data Brief 2018; 309:1–8
2. Hawton K, Casañas I Comabella C, Haw C, et al: Risk factors for suicide in individuals with depression: a systematic review. J Affect Disord 2013; 147:17–28
3. Diagnostic and Statistical Manual of Mental Disorders, 5th ed. Arlington, VA, American Psychiatric Publishing, 2013
4. McGirr A, Renaud J, Seguin M, et al: An examination of DSM-IV depressive symptoms and risk for suicide completion in major depressive disorder: a psychological autopsy study. J Affect Disord 2007; 97:203–209
5. Schneider B, Philipp M, Müller MJ: Psychopathological predictors of suicide in patients with major depression during a 5-year follow-up. Eur Psychiatry 2001; 16:283–288
6. Ahmedani BK, Simon GE, Stewart C, et al: Health care contacts in the year before suicide death. J Gen Intern Med 2014; 29:870–877
7. Elovainio M, Shipley MJ, Ferrie JE, et al: Obesity, unexplained weight loss and suicide: the original Whitehall study. J Affect Disord 2009; 116:218–221
8. Ajdacic-Gross V, Weiss MG, Ring M, et al: Methods of suicide: international suicide patterns derived from the WHO mortality database. Bull World Health Organ 2008; 86:726–732
9. Peterhänsel C, Petroff D, Klinitzke G, et al: Risk of completed suicide after bariatric surgery: a systematic review. Obes Rev 2013; 14:369–382
10. Klinitzke G, Steinig J, Blüher M, et al: Obesity and suicide risk in adults–a systematic review. J Affect Disord 2013; 145:277–284
11. Ross TR, Ng D, Brown JS, et al: The HMO Research Network Virtual Data Warehouse: a public data model to support collaboration. EGEMS 2014; 2:1049
12. Charlson ME, Pompei P, Ales KL, et al: A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987; 40:373–383
13. SAS: Version 9.4 of the SAS System for Windows [computer program]. Cary, NC: SAS Institute, 2013
14. Chesney E, Goodwin GM, Fazel S: Risks of all-cause and suicide mortality in mental disorders: a meta-review. World Psychiatry 2014; 13:153–160
15. Stenholm S, Vahtera J, Kawachi I, et al: Patterns of weight gain in middle-aged and older US adults, 1992–2010. Epidemiology 2015; 26:165–168
16. Kaplan MS, McFarland BH, Huguet N: The relationship of body weight to suicide risk among men and women: results from the US National Health Interview Survey Linked Mortality File. J Nerv Ment Dis 2007; 195:948–951
17. Lindh WQ, Pooler MS, Tamparo CD, et al: Delmar's Comprehensive Medical Assisting: Administrative and Clinical Competencies. Clifton Park, NY, Cengage Learning, 2013
18. Connor Gorber S, Tremblay M, Moher D, et al: A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obes Rev 2007; 8:307–326
19. Simon GE, Rutter CM, Peterson D, et al: Does response on the PHQ-9 Depression Questionnaire predict subsequent suicide attempt or suicide death? Psychiatr Serv 2013; 64:1195–1202
20. Alonso-Pedrero L, Bes-Rastrollo M, Marti A: Effects of antidepressant and antipsychotic use on weight gain: a systematic review. Obes Rev 2019; 20:1680–1690
21. da Graça Cantarelli M, Nardin P, Buffon A, et al: Serum triglycerides, but not cholesterol or leptin, are decreased in suicide attempters with mood disorders. J Affect Disord 2015; 172:403–409
22. Wing RR, Lang W, Wadden TA, et al: Benefits of modest weight loss in improving cardiovascular risk factors in overweight and obese individuals with type 2 diabetes. Diabetes Care 2011; 34:1481–1486
23. Simon GE, Johnson E, Lawrence JM, et al: Predicting suicide attempts and suicide deaths following outpatient visits using electronic health records. Am J Psychiatry 2018; 175:951–960
24. Crow S, Eisenberg ME, Story M, et al: Suicidal behavior in adolescents: relationship to weight status, weight control behaviors, and body dissatisfaction. Int J Eat Disord 2008; 41:82–87
25. Eaton DK, Lowry R, Brener ND, et al: Associations of body mass index and perceived weight with suicide ideation and suicide attempts among US high school students. Arch Pediatr Adolesc Med 2005; 159:513–519
26. Meltzer AA, Everhart JE: Unintentional weight loss in the United States. Am J Epidemiol 1995; 142:1039–1046
27. Webel AR, Frazier SK, Moser DK, et al: Daily variability in dyspnea, edema and body weight in heart failure patients. Eur J Cardiovasc Nurs 2007; 6:60–65
28. Franklin JC, Ribeiro JD, Fox KR, et al: Risk factors for suicidal thoughts and behaviors: a meta-analysis of 50 years of research. Psychol Bull 2017; 143:187–232