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Associations between stressful life events and diabetes: Findings from the China Kadoorie Biobank study of 500,000 adults

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ABSTRACT

Aims/Introduction: Evidence has shown that stressful life events are associated with the development of diabetes, yet studies in mainland China are scarce. In the present study, we explored the associations between cumulative and specific stressful life events and the prevalence of diabetes in Chinese adults.

Materials and Methods: The cross-sectional data were from the China Kadoorie Biobank study, which enrolled approximately 500,000 adults aged 30–79 years from 10 diverse regions of China. Logistic regression models were used to calculate the adjusted odds ratio (OR) and the 95% confidence interval (CI).

Results: Of the 473,607 participants, 25,301 (5.34%) had type 2 diabetes (2.68% clinically-identified and 2.66% screen-detected). Participants who experienced one and two or more stressful life events were 1.10-fold (OR 1.10, 95% CI 1.05–1.16) and 1.33-fold (OR 1.33, 95% CI 1.13–1.57) more likely to have type 2 diabetes. Three categories of work-related events (OR 1.15, 95% CI 1.01–1.31), as well as family-related events (OR 1.11, 95% CI 1.06–1.18) and personal-related events (OR 1.18, 95% CI 1.03–1.36), were associated with an increased likelihood of type 2 diabetes. Regarding the specific life events, the ORs of loss of job or retirement, as well as major conflict within family, death or major illness of other close family member and major injury or traffic accident, were 1.24 (95% CI 1.02–1.52), 1.24 (95% CI 1.08–1.43), 1.13 (95% CI 1.06–1.20) and 1.20 (95% CI 1.01–1.43), respectively.

Conclusions: The present study showed that cumulative and specific stressful life events were significantly associated with an increased prevalence of diabetes.

INTRODUCTION

The global prevalence of diabetes has been growing markedly. It is estimated by the International Diabetes Federation that 425 million people worldwide had diabetes in 2017, and the number has been projected to rise to 629 million in 2045[1]. In China, the age-standardized prevalence of total diabetes was estimated to be 9.7%, accounting for 92.4 million adults[2]. To respond to the major public health problem of the worldwide diabetes epidemic, it is of great importance to identify risk factors for the development of diabetes. The pathogenesis of diabetes is complex, and a solid body of evidence has confirmed numerous traditional biological and behavioral risk factors, including inflammatory markers[3], overweight and obesity[4], active smoking[5], and television viewing[6].

In addition to these risk factors for diabetes, several types of psychological factors such as depression[7], psychological distress[8,9] and personality traits[10], have also been implicated in diabetes development. Psychological stress, including stressful life events exposure, was suggested to play a role in the development of diabetes[11,12]. To date, most research in this emerging field is mainly on work-related stress (e.g., long working hours, job strain)[13,14], yet the role of stressful life events on diabetes has been less studied and demonstrated. In the Hoorn Study, Mooy *et al.*[15] found that individuals experiencing stressful life events had an increased prevalence of undetected type 2

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diabetes, and the more events reported, the higher the prevalence of diabetes. Findings from a nationally representative longitudinal survey showed that personal-related stress increased the likelihood of the onset of type 2 diabetes in Australian adults[16]. Similarly, the Copenhagen City Heart Study also showed that the accumulation of major life events in both private and work domains was a risk factor for developing type 2 diabetes[17]. However, not all research has found a consistent association between stressful life events exposure and diabetes development. For example, a recent case–control study by Rasouli *et al.* pointed out that there was no association between experience of any specific serious life events and type 2 diabetes risk[18]. Also, the Whitehall II study showed non-significant associations of the number of non-work life events with incident diabetes in both sexes[19].

However, relevant evidence on the role of stressful life events in diabetes development among the Chinese population is lacking. To fill this knowledge gap, we carried out a detailed analysis of cross-sectional data from the China Kadoorie Biobank study, a population-based study of 500,000 people enrolled from 10 geographically defined regions of China. The primary objective of the present study was to explore the possible associations between the cumulative and specific stressful life events and the prevalence of diabetes in Chinese adults.

METHODS

Study design and participants

The present analysis is based on baseline interviews of the China Kadoorie Biobank study, which was carried out in 10 geographically defined regions (5 urban and 5 rural) of China between 2004 and 2008[20–22]. In total, 512,891 adults aged 30–79 years were recruited. For the present analysis, we excluded those who had a history of coronary heart disease (n = 15,472), stroke/transient ischemic attacks (n = 8,884), tuberculosis (n = 7,660), psychiatric disorders (n = 1,906), head injury (n = 5,653) and/or cancer (n = 2,577). Finally, 473,607 participants were included in the present analysis. At the baseline survey, relevant data on sociodemographic factors (e.g., education level, occupation, household income), lifestyle factors (e.g., smoking, alcohol drinking, physical activity) and medical history (e.g., coronary heart disease, stroke/transient ischemic attacks) were collected face-to-face with a computerized questionnaire. Bodyweight, standing height and waist circumference (WC) were undertaken by trained health workers. Body mass index (BMI; kg/m^2) was calculated as the weight divided by the square of standing height. The China Kadoorie Biobank study abided by the Declaration of Helsinki, and written informed consent was obtained from all participants.

Outcome and exposure

Type 2 diabetes was the outcome of interest and consisted of two distinct parts: clinically-identified type 2 diabetes and screen-detected type 2 diabetes. Specifically, clinically-identified type 2 diabetes was defined as having a self-reported physician diagnosis of diabetes with an age of onset of ≥30 years. Screen-detected type 2 diabetes was defined as having a non-fasting blood glucose level ≥11.1 mmol/L or a fasting blood glucose ≥7.0 mmol/L, but no prior diagnosis of diabetes.

The main exposure in the current study was stressful life events. At baseline, participants were asked to recall whether they have experienced the 10 major events in their life over 2 years preceding the survey date. According to the Cobb-Clark and Schurer classifications[23], we divided the 10 life events into three categories: (i) work-related events, namely loss of job or retirement, business bankruptcy, loss of income or living on debt; (ii) family-related events, including major conflict within the family, death or major illness of spouse or other close family member; and (iii) personal-related events, including marital separation or divorce, victim of violence, major injury or traffic accident, or major natural disaster. To study the association between the accumulation of stressful life events and type 2 diabetes, the number of stressful life events experienced in the past 2 years was grouped as zero, one and two or more.

Covariates

Sociodemographic factors (age, sex, marriage status, education level, occupation, household income), BMI, WC, lifestyle factors (smoking, alcohol drinking, physical activity) and medical history (family history of diabetes, hypertension), all collected at baseline, were chosen as the potential confounders. Marriage status (married, widowed/separated/divorced, never married), education level (no formal school, primary school, middle school, high school, college/university), occupation (agriculture and related, factory worker, unemployed/retired, others), household income (<20,000 Yuan, 20,000–35,000 Yuan, ≥35,000 Yuan), smoking (never, occasional, current regular) and alcohol drinking (never, occasional, current regular) were included in the analyses. To quantify the amount of physical activity, metabolic equivalent tasks (METs-h/day) were used. The continuous variables of BMI and WC, and dichotomous variables of family history of diabetes and hypertension were also included in the analyses.

Statistical analysis

Continuous variables were compared by the Kruskal–Wallis test, and categorical variables were compared using the linear-by-linear association χ^2-test. The associations between stressful life events and type 2 diabetes were investigated in four multivariable logistic regression models, and the possible effects were shown with odds ratios (ORs) and their 95% confidence intervals (CIs). In model 1, only age and sex were adjusted. In model 2, additional factors of marriage status, education level, occupation, household income and family history of diabetes were included. Model 3 adjusted for model 2 plus lifestyle behaviors, including smoking status, alcohol consumption and physical activity. Model 4 adjusted for model 3 plus BMI, WC and hypertension. To assess the robustness of the findings, sensitivity analyses with clinically-identified type 2 diabetes cases

and screen-detected type 2 diabetes cases were carried out, respectively. Meanwhile, to explore whether there were differences in the associations between stressful life events and type 2 diabetes stratified by sex, area and age, we also constructed repeated analyses with the same models in each subgroup. All analyses were carried out using SAS statistical package (version 9.2; SAS Institute, Inc., Cary, NC, USA).

RESULTS

The present study consisted of 473,607 participants (40.49% men, mean age 51.47 ± 10.52 years). Overall, 25,301(5.34%) participants had type 2 diabetes. Of which, 12,714 clinically-identified cases and 12,587 screen-detected cases accounted for 2.68 and 2.66%, respectively. The baseline characteristics stratified by the number of stressful life events experienced in the past 2 years are shown in Table 1. According to analyses, differences between the two groups with or without stressful life events were observed regarding age, sex, marriage status, education level, occupation, smoking, alcohol drinking, BMI, WC, physical activity, family history of diabetes and hypertension.

Table 2 shows the adjusted ORs of diabetes for cumulative and specific stressful life events experienced 2 years before baseline. Experiencing one and two or more stressful life events was associated with a significant 10% (OR 1.10, 95% CI 1.05–1.16) and 33% (OR 1.33, 95% CI 1.13–1.57) greater likelihood of diabetes in the full-adjusted model, respectively. Then, the three categories of work-related events (OR 1.15, 95% CI 1.01–1.31), as well as family-related events (OR 1.11, 95% CI 1.06–1.18) and personal-related events (OR 1.18, 95% CI 1.03–1.36) were positively associated with an increased likelihood of diabetes. Regarding the specific stressful life events, loss of job/retirement (OR 1.24, 95% CI 1.02–1.52), as well as major conflict within family (OR 1.24, 95% CI 1.08–1.43), death/major illness of other close family member (OR 1.13, 95% CI 1.06–1.20) and major injury or traffic accident (OR 1.20, 95% CI 1.01–1.43) were significantly associated with a higher likelihood of diabetes. The sensitivity analyses carried out on clinically-identified type 2 diabetes cases showed that these associations were largely unchanged (Table S1), whereas in screen-detected type 2 diabetes cases, these associations appeared to be non-significant (Table S2).

Table 3 showed the adjusted ORs of diabetes for stressful life events stratified by sex, area and age in the fully adjusted model (the results in other models are shown in Tables S3,S4,S5). The statistically significant relationship between the number of stressful life events and diabetes was still observed in women and rural area. The marginally significant increased ORs of diabetes for business bankruptcy were seen in women and urban area. Both family-related events and specific events of death/major illness of other close family member were positively associated with diabetes in both sexes, rural area and age groups of 30–40 or 40–60 years. Major conflict within the family was positively associated with diabetes in men, urban area and age group of >60 years. The significantly increased ORs of diabetes for personal-related events were observed in men and rural area. Specifically, the likelihood of diabetes was higher in men with marital separation/divorce and in rural area with major injury/traffic accident. To explore the possible reasons for the varied associations stratified by sex, area and age, we also carried out an analysis on the distribution of life events in the current study and the results are shown in Table S6.

DISCUSSION

Based on >500,000 adults aged 30–79 years from 10 diverse regions in China, the findings from the present study suggested that cumulative stressful life events experienced in the preceding 2 years were positively associated with diabetes prevalence, and a dose–response trend was observed. Specifically, certain work-, family- and personal-related life events, respectively, were significantly associated with an increased likelihood of diabetes. These associations remained significant after adjusting for potential confounders, such as smoking, BMI and hypertension. After sensitivity analyses, the effects of stressful life events were robust in clinically-identified type 2 diabetes cases, whereas they appeared to be null in screen-detected type 2 diabetes cases. When stratified by sex, area and age, the associations of cumulative and specific stressful life events with the diabetes prevalence were different in each subgroup. To our knowledge, this is the first study to attempt to show whether experienced stressful life events were associated with diabetes development in Chinese adults.

Although there have been large differences in the items of stressful life events measurement, study design, sampling and population across studies, the present results reinforced the findings of an elevated likelihood of diabetes with cumulative stressful life events in previous literature. In the Hoorn Study of a mixed rural and urban population, the authors showed that participants experiencing three or more non-work stressful life events compared with those with less than three events were 1.7-fold more likely to have undetected type 2 diabetes, after adjusting for confounders[15]. Consistent findings from a Danish longitudinal study called the Copenhagen City Heart Study also suggested that the accumulation of three or more stressful life events in both the private and work domains were associated with a significantly elevated risk of developing type 2 diabetes, whereas experiencing only one or two events was not[17]. Furthermore, a recent American prospective cohort study of middle-aged adults confirmed the adverse impact of stressful life events on the incidence of type 2 diabetes, with findings that all levels of cumulative stressful life events (1–4+) resulted in an increased risk of type 2 diabetes onset[24].

When exploring the associations between stressful life events and diabetes, we also evaluated the specific life events individually. On the basis of final analyses, we found that the life events including loss of job or retirement, as well as death or major illness of other close family member, and major injury or traffic accident were positively associated with an increased prevalence of diabetes. Similar research on exposure to specific life events

Table 1 | Baseline characteristics stratified by the number of stressful life events experienced in the past 2 years

	No. stressful life events experienced in the past 2 years			*P
	0	1	≥2	
Sample size, *n* (%)	434,843 (91.82)	35,929 (7.59)	2,835 (0.59)	
Age (years)	51.49 ± 10.54	51.29 ± 10.33	50.23 ± 9.84	<0.001
Sex, *n* (%)				
Male	177,000 (40.70)	13,746 (38.26)	998 (35.20)	<0.001
Female	257,843 (59.30)	22,183 (61.74)	1,837 (64.80)	
Marriage status, *n* (%)				
Married	399,646 (91.91)	29,277 (81.49)	1,943 (68.54)	<0.001
Widowed/separated/divorced	32,075 (7.38)	6,370 (17.73)	873 (30.79)	
Never married	3,122 (0.71)	282 (0.78)	19 (0.67)	
Education level, *n* (%)				
No formal education	81,552 (18.75)	6,893 (19.19)	603 (21.27)	<0.001
Primary school	140,356 (32.28)	11,107 (30.91)	918 (32.38)	
Middle school	123,665 (28.44)	10,190 (28.36)	803 (28.32)	
High school	64,965 (14.94)	5,636 (15.69)	400 (14.11)	
College/university	24,305 (5.59)	2,103 (5.85)	111 (3.92)	
Occupation, *n* (%)				
Agriculture and related	188,153 (43.27)	14,711 (40.94)	1,202 (42.40)	<0.001
Factory worker	64,740 (14.89)	4,738 (13.19)	292 (10.30)	
Unemployed/retired	74,134 (17.05)	6,943 (19.32)	574 (20.25)	
Others	107,816 (24.79)	9,537 (26.55)	767 (27.05)	
Household income, *n* (%)				
<20,000 Yuan	12,037 (2.77)	1,764 (4.91)	260 (9.17)	0.975
20,000–35,000 Yuan	342,736 (78.82)	28,878 (80.37)	2,308 (81.41)	
≥35,000 Yuan	80,070 (18.41)	5,287 (14.72)	267 (9.42)	
Smoking category, *n* (%)				
Never	305,549 (70.27)	25,354 (70.57)	2,012 (70.97)	<0.001
Occasional	19,346 (4.45)	1,703 (4.74)	140 (4.94)	
Current regular	109,948 (25.28)	8,872 (24.69)	683 (24.09)	
Alcohol category, *n* (%)				
Never	206,323 (47.45)	17,103 (47.60)	1,409 (49.70)	<0.001
Occasional	145,917 (33.56)	12,459 (34.68)	970 (34.22)	
Current regular	82,603 (18.99)	6,367 (17.72)	456 (16.08)	
Body mass index (kg/m^2)	23.62 ± 3.35	23.51 ± 3.34	23.27 ± 3.31	<0.001
Waist circumference (cm)	80.10 ± 9.67	79.49 ± 9.59	78.63 ± 9.54	<0.001
Physical activity, *n* (%)				
Low	101,032 (23.23)	8,412 (23.41)	703 (24.80)	<0.001
Middle	220,271 (50.66)	18,065 (50.28)	1369 (48.29)	
High	113,540 (26.11)	9,452 (26.31)	763 (26.91)	
Family history of diabetes, *n* (%)				
No	385,050 (88.55)	30,955 (86.16)	2,445 (86.24)	<0.001
Yes	28,167 (6.48)	2,989 (8.32)	233 (8.22)	
Hypertension, *n* (%)				
No	39,2051 (90.16)	32,174 (89.55)	2,536 (89.45)	<0.001
Yes	42,792 (9.84)	3,755 (10.45)	299 (10.55)	

*For continuous and categorical variables, differences between the two groups with or without stressful life events were compared using Kruskal–Wallis test and linear-by-linear association χ^2-test, respectively.

has yielded findings consistent with the present findings. For example, a large-scale collaborative cohort study of 266,848 Australians reported that diabetes was more prevalent in people who were retired or unemployed, compared with those who were in paid work[25]. Müller *et al.*[26] also declared that high neighborhood unemployment was independently associated with an elevated risk of type 2 diabetes. With similar life event items, findings from a study undertaken in Belgrade, Serbia, were consistent with the present study, showing that experiences of death of a close family member and traffic accident

Table 2 | Adjusted odds ratios of diabetes for stressful life events experienced in the past 2 years

	Total/cases	Models			
		Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
No. stressful life events[†]					
1	35929/2046	1.09 (1.04–1.14)*	1.08 (1.02–1.13)*	1.08 (1.03–1.14)*	1.10 (1.05–1.16)*
≥2	2835/166	1.20 (1.02–1.41)*	1.28 (1.09–1.51)*	1.28 (1.08–1.51)*	1.33 (1.13–1.57)*
Specific stressful life events (yes vs no)					
Work-related events	5386/272	1.15 (1.02–1.30)*	1.19 (1.04–1.35)*	1.16 (0.98–1.27)	1.15 (1.01–1.31)*
Loss of job/retirement	2065/115	1.46 (1.21–1.77)*	1.37 (1.12–1.66)*	1.18 (0.97–1.43)	1.24 (1.02–1.52)*
Business bankruptcy	1103/56	1.16 (0.88–1.52)	1.24 (0.94–1.63)	1.25 (0.95–1.65)	1.24 (0.94–1.64)
Loss of income/living on debt	2406/113	0.97 (0.80–1.17)	1.05 (0.86–1.28)	1.02 (0.83–1.25)	1.05 (0.85–1.29)
	30281/1807	1.10 (1.04–1.15)*	1.08 (1.03–1.14)*	1.09 (1.04–1.15)*	1.11 (1.06–1.18)*
Family-related events					
Major conflict within family	4031/230	1.10 (0.96–1.26)	1.12 (0.97–1.29)	1.15 (0.99–1.32)	1.24 (1.08–1.43)*
Death/major illness of spouse	4093/295	0.92 (0.82–1.04)	0.94 (0.82–1.07)	0.93 (0.81–1.06)	0.93 (0.81–1.06)
Death/major illness of other close family member	22925/1326	1.13 (1.07–1.20)*	1.10 (1.03–1.17)*	1.12 (1.05–1.18)*	1.13 (1.06–1.20)*
Personal-related events	5071/245	1.09 (0.96–1.24)	1.12 (0.98–1.29)	1.14 (1.00–1.31)*	1.18 (1.03–1.36)*
Marital separation/divorce	1228/53	1.27 (0.96–1.67)	1.25 (0.94–1.68)	1.26 (0.94–1.69)	1.30 (0.96–1.75)
Victim of violence	626/30	1.06 (0.73–1.54)	1.03 (0.70–1.53)	1.06 (0.72–1.57)	1.09 (0.73–1.61)
Major injury/traffic accident	2843/150	1.09 (0.92–1.29)	1.14 (0.96–1.35)	1.16 (0.98–1.38)	1.20 (1.01–1.43)*
Major natural disaster	445/14	0.67 (0.39–1.15)	0.78 (0.46–1.34)	0.83 (0.49–1.43)	0.86 (0.50–1.48)

[†]Without any stressful life events provided as the reference group. *Significant results. Model 1 adjusted for age and sex; model 2 adjusted for model 1 plus socioeconomic status including marriage status, education level, occupation, household income and family history of diabetes; model 3 adjusted for model 2 plus the health behaviors including smoking status, alcohol consumption and physical activity; model 4 adjusted for model 3 plus body mass index, waist circumference and hypertension. CI, confidence interval; OR, odds ratio.

were significantly positively related to type 2 diabetes. Meanwhile, other studies found that losing a child[27] and experiencing injurious trauma[28] were significantly associated with an elevated likelihood of having diabetes. In addition, the present study also showed a significant positive association between major conflict within the family and diabetes development; however, this did not remain with the life event item of frequent quarrels between brothers or sisters in another study[29]. Further studies are warranted to elucidate the role of specific life events on diabetes development, and the particular life event involving conflict within the family requires further investigation.

When stratified by demographic characteristics of sex, area and age, the current study showed that the associations between stressful life events and diabetes development were different in each subgroup. Totally, these associations tended to be significant in the rural area and younger age (<60 years) groups of adults. Consistently, a recent meta-analysis reported that the association between the work stress of long working hours and diabetes was evident in the low socioeconomic status group, but was null in the high socioeconomic status group[13]. Rasouli *et al.* found no significant association between experience of any specific serious life events and type 2 diabetes risk in older people[18]. As for sex, however, a similar trend was not found on both sides, and we suggested that the significant associations shown in men and women varied in the types of life events experienced. For example, the associations tended to be significant in men experiencing family conflict, as well as marital problems (e.g., separation, divorce), and in women experiencing business bankruptcy. With regard to the possible reasons, the present findings could be partly accounted for by the demographic distribution of stressful life events, as we showed in Table S6. Relevant literature has consistently shown that younger age and lower socioeconomic status groups of adults experienced more stressful life events, whereas there were sex differences in the types of life events exposure[30]. In the current study, we also carried out an analysis on the demographic distribution of life events, showing consistent findings that stressful life events were reported more by those living in rural areas and adults in younger age groups. In addition, we also found sex differences in the exposure rate of life events, except for four events of loss of income or living on debt, as well as marital separation or divorce, victim of violence and natural disaster. Obviously, the present findings on the distribution of marital problems (e.g., separation, divorce) and family conflict events by sex were not in line with their significant associations with diabetes in men. As for the potential reason for the significant association between marital problems and diabetes in the current study, according to a prior study[31], the higher sensitivity to the effect of divorce or separation in men might be considered.

Table 3 | Adjusted odds ratios of diabetes for stressful life events stratified by sex, area and age in the fully adjusted model

	Men OR (95% CI)	Women OR (95% CI)	Urban area OR (95% CI)	Rural area OR (95% CI)	Age 30–40 years OR (95% CI)	Age 40–60 years OR (95% CI)	Age >60 years OR (95% CI)
No. stressful life events[†]							
1	1.13 (1.04–1.23)*	1.07 (1.00–1.14)*	1.03 (0.96–1.10)	1.18 (1.10–1.28)*	1.22 (0.97–1.55)	1.08 (1.01–1.15)*	1.01 (0.92–1.10)
≥2	1.29 (0.97–1.72)	1.32 (1.07–1.62)*	1.23 (0.98–1.53)	1.40 (1.09–1.80)*	2.25 (1.30–3.88)*	1.19 (0.97–1.46)	1.03 (0.73–1.45)
Specific stressful life events (yes vs no)							
Work-related events	1.09 (0.89–1.33)	1.07 (0.90–1.27)	1.05 (0.90–1.24)	1.10 (0.87–1.38)	0.94 (0.53–1.67)	0.98 (0.85–1.14)	0.85 (0.61–1.20)
Loss of job/retirement	1.13 (0.88–1.47)	0.91 (0.67–1.25)	1.05 (0.86–1.29)	0.53 (0.19–1.43)	0.74 (0.30–1.85)	0.91 (0.74–1.13)	0.70 (0.34–1.48)
Business bankruptcy	1.24 (0.79–1.92)	1.43 (1.00–2.05)*	1.62 (1.00–2.60)*	1.28 (0.90–1.82)	0.38 (0.05–2.72)	1.33 (0.96–1.83)	1.45 (0.79–2.65)
Loss of income/living on debt	0.94 (0.65–1.36)	1.08 (0.84–1.38)	0.95 (0.72–1.25)	1.12 (0.82–1.52)	1.57 (0.76–3.24)	0.95 (0.75–1.21)	0.68 (0.41–1.13)
Family-related events	1.12 (1.03–1.23)*	1.10 (1.03–1.17)*	1.04 (0.97–1.12)	1.20 (1.11–1.31)*	1.40 (1.10–1.79)*	1.12 (1.05–1.20)*	1.01 (0.92–1.10)
Major conflict within family	1.36 (1.06–1.74)*	1.19 (0.99–1.41)	1.31 (1.09-1.58)*	1.12 (0.89–1.41)	1.67 (0.97–2.89)	1.12 (0.92–1.35)	1.35 (1.07–1.72)*
Death/major illness of spouse	1.02 (0.76–1.36)	0.90 (0.77–1.05)	0.98 (0.82–1.16)	0.83 (0.66–1.04)	0.79 (0.19–3.37)	0.89 (0.71–1.12)	0.90 (0.76–1.07)
Death/major illness of other close family member	1.11 (1.01–1.23)*	1.12 (1.04–1.21)*	1.01 (0.93–1.10)	1.29 (1.18–1.41)*	1.41 (1.08–1.84)*	1.14 (1.06–1.23)*	1.00 (0.90–1.12)
Personal-related events	1.28 (1.04–1.58)*	1.16 (0.96–1.39)	1.10 (0.91–1.33)	1.32 (1.09–1.61)*	1.48 (0.93–2.36)	1.06 (0.90–1.25)	1.17 (0.88–1.56)
Marital separation/ divorce	1.52 (1.01–2.29)*	1.05 (0.68–1.63)	1.18 (0.85–1.65)	1.10 (0.57–2.12)	1.44 (0.65–3.17)	0.89 (0.62–1.29)	1.64 (0.76–3.55)
Victim of violence	0.95 (0.47–1.94)	1.31 (0.81–2.11)	1.02 (0.54–1.90)	1.31 (0.79–2.19)	2.44 (0.87–6.84)	1.06 (0.66–1.73)	0.88 (0.35–2.23)
Major injury/traffic accident	1.27 (0.97–1.67)	1.19 (0.95–1.49)	1.10 (0.85–1.43)	1.38 (1.09–1.75)*	1.11 (0.51–2.37)	1.14 (0.92–1.42)	1.26 (0.91–1.75)
Major natural disaster	1.11 (0.51–2.40)	0.78 (0.36–1.66)	0.82 (0.36–1.88)	0.98 (0.48–2.00)	1.92 (0.45–8.17)	0.96 (0.52–1.76)	0.24 (0.03–1.77)

[†]Without any stressful life events provided as the reference group. *Significant results. Fully adjusted model: adjusted for age, sex, marriage status, education level, occupation, household income, family history of diabetes, smoking status, alcohol consumption, physical activity, body mass index, waist circumference and hypertension. OR, odds ratio; CI, confidence interval.

Although the evidence on the association between stressful life events – especially the specific events – and diabetes was limited, possible mechanisms accounting for the stress–diabetes link have been extensively studied and were hypothesized to be involved in detrimental lifestyle behaviors, and endocrine abnormalities through the neuroendocrine system and chronic inflammatory process[32–35].

There were strengths in the present study. This was the first study to explore the possible associations between stressful life events and the development of diabetes in Chinese adults. The study had several other strengths, including the large sample size, good quality of data collected, and availability of clinically-identified and screen-detected diabetes.

However, the study also had some limitations. First, with a cross-sectional study design, the causality of the associations between stressful life events and diabetes could not be identified according to the current analysis. Second, the number of specific life events was relatively small, which would decrease the statistical power to explore their associations with diabetes. Third, the sensitivity analyses only with screen-detected type 2 diabetes cases showed that the effects of stressful life events were erratic and appeared to be null, which might affect the reliability of the present findings.

In summary, the results of the present study showed that cumulative and specific stressful life events were significantly associated with an increased prevalence of diabetes.

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DISCLOSURE

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1 | Sensitivity analyses only with clinically-identified type 2 diabetes cases.
Table S2 | Sensitivity analyses only with screen-detected type 2 diabetes cases.
Table S3 | Adjusted odds ratios of diabetes for stressful life events stratified by sex.
Table S4 | Adjusted odds ratios of diabetes for stressful life events stratified by area.
Table S5 | Adjusted odds ratios of diabetes for stressful life events stratified by age.
Table S6 | Comparison of stressful life events distribution regarding sex, area and age.