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Life satisfaction is a protective factor against the onset of Type 2 diabetes in men but not in women: findings from the MONICA/KORA cohort study

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What's new?

- There has been limited research on the prospective association between psychosocial well-being (particularly life satisfaction) and incident diabetes.
- This investigation is the first population-based study that directly focuses on the protective effect of life satisfaction against the onset of Type 2 diabetes.
- Life satisfaction may be a valuable asset in assessing risk of Type 2 diabetes and in the development of more effective prevention strategies to deter onset of diabetes.

Abstract

Aims

To investigate the association of high life satisfaction with incident Type 2 diabetes separately in men and women.

Methods

A longitudinal analysis was conducted among the 7107 participants (3664 men, 51.5%; 3443 women, 48.5%) aged 25–74 years (mean ± SD age 47.8 ±13.7 years) of two population-based MONICA/KORA surveys conducted in 1989–1995 and followed up until 2009. Life satisfaction was assessed using a one-

item instrument with a six-order response level, which was dichotomized into high vs medium or low. Sex-specific hazard ratios were estimated using Cox proportional hazards models.

Results

Crude incidence rates for Type 2 diabetes per 10 000 person-years were lower in participants with high than in those with medium or low life satisfaction (men: 57 vs 73; women: 37 vs 48). In men with high life satisfaction, there was a 27% risk reduction in incident Type 2 diabetes (hazard ratio 0.73, 95% CI 0.56–0.94; *P*=0.02) in a model adjusted for sociodemographic, behavioural and clinical risk factors. The association lost statistical significance after further adjusting for depressed mood (hazard ratio 0.79, 95% CI 0.61–1.03). Life satisfaction was not significantly associated with incident Type 2 diabetes in women.

Conclusion

Life satisfaction may be a valuable asset in assessing risk of Type 2 diabetes, especially in men, and in the development of more effective prevention strategies to deter onset of diabetes. More research is needed to investigate the underlying potential causal pathways that may link life satisfaction to the development of Type 2 diabetes.

Introduction

A significant volume of research has highlighted the association between psychosocial stress conditions and Type 2 diabetes [1,2]. There is also growing evidence showing that psychological well-being has a protective effect against premature mortality [3,4] and health adversities [5,6] and does not merely mark the absence of psychological distress; therefore, focus on psychological well-being should be equally considered.

Life satisfaction can be defined as an overall evaluation of a person's quality of life [7] and is one indicator of psychological well-being, which encompasses constructs such as hedonic well-being (feelings of happiness, life satisfaction), eudemonic well-being (purpose in life, personal growth), optimism, self-acceptance, positive relations with others, autonomy and environmental mastery [7,8]. Chen and Miller [9] suggest that being able to identify interesting and meaningful pursuits in life (and by extension being satisfied with life) enables individuals to deal effectively with challenges [9]. In addition, positive emotions and cognitions (e.g. life satisfaction) may motivate short-term behaviours in the context of long-term goals or provide the willpower needed to manoeuvre between conflicting goals [10].

Psychological well-being appears to have a protective effect against metabolic syndrome [11] and even diabetes. A recent investigation from the Whitehall II Study, including 7800 civil servants (70% men), showed that high life

satisfaction, along with emotional vitality, was associated with decreased odds of developing diabetes, after adjustment for common risk factors, including depressive symptoms [12]. The persistence of a psychological well-being effect, after adjustment for depressed mood, supports the idea that well-being stands independently from psychological distress. Further evidence for the association of life satisfaction with Type 2 diabetes comes from the large European Prospective Investigation into Cancer and Nutrition (EPIC) German Study in 50 358 participants [13]. The study found that being unsatisfied with life was associated with increased risk of Type 2 diabetes in an age-adjusted model in women only.

Given the scientific evidence, we aimed to investigate the longitudinal association of high life satisfaction with incident Type 2 diabetes in a large population-based study. We hypothesized that greater life satisfaction would be associated with a reduced risk of Type 2 diabetes. Considering the inconclusive evidence in the literature regarding the sex-specific effects of life satisfaction [13], we decided *a priori* to perform all analyses separately for men and women. Since the onset of Type 2 diabetes might be influenced by a variety of factors, we took special effort to control for potential confounding factors [14].

Methods

Setting, design and study population

The data of the present study were drawn from the Survey 2 (1989/1990) and Survey 3 (1994/1995) of the population-based Monitoring of Trends and Determinants in Cardiovascular Disease (MONICA) Augsburg studies, including 9404 individuals aged 25–74 years. Survey 2 and Survey 3 had participation rates of 76.9% and 74.9%, respectively [15].

For the present analysis, participants with prevalent diabetes at baseline (n = 465), without information on diabetes status at follow-up (n = 606) or with incomplete data on all covariates required for the main analyses (n = 1226) were excluded. In a dropout analysis of the excluded participants, no significant differences in age and other risk factors were observed. Consequently, the final study population was 7107 participants, as shown in Fig. 1. The study was approved by the ethics committee of the Bavarian Medical Association (Bayerische Landesärztekammer). Written informed consent was obtained from each study participant.

Exposure: life satisfaction

Life satisfaction was measured with a one-item instrument: 'How satisfied were you with your personal life in the last month?' Answer categories were: very satisfied (= 1); most of the time very satisfied (=2); usually satisfied (=3);

partially satisfied (=4); usually unsatisfied (=5); very unsatisfied (= 6) [4]. We created a variable with two categories: 'high' life satisfaction (scores 1 and 2) and 'medium or low' life satisfaction (scores 3–6) as suggested by previous studies [4,16,17].

Outcome: Type 2 diabetes

Incident cases of Type 2 diabetes were assessed within the framework of the Cooperative Health Research in the Region of Augsburg (KORA) using follow-up questionnaires [15]. Self-reported cases and the date of diagnosis were verified by assessing the medical history and physician's records. The hospital records of participants without a diagnosis of Type 2 diabetes at baseline who died during the follow-up period were reviewed and/or their physicians were contacted; therefore, only clinically confirmed Type 2 diabetes cases were included in the present investigation [18]. All incident cases that had been diagnosed up to 31 December 2009 were included.

Covariates

Baseline information was obtained in standardized personal interviews conducted by trained medical staff and a self-administered questionnaire. All participants additionally underwent an extensive medical examination including the collection of a blood sample and anthropometric measurement, which has been described elsewhere in detail [18–20].

Low education level was defined as having <12 years of schooling.

Behavioural risk factors

Someone who smoked cigarettes regularly or occasionally was considered a current smoker. Data regarding weekday and weekend consumption of alcohol was further categorized as 'high', 'low' and 'no' consumption [21]. A participant was classified as physically active if they regularly participated in sports during leisure time ≥1 h/week throughout the year, in both summer and winter.

Clinical risk factors

Study participants were considered to have a parental history of diabetes if at least one of their parents had diabetes. BMI was calculated as weight (kg)/height (m^2). Hypertension was based on blood pressure values ≥140/90 mmHg and/or use of an antihypertensive medication. Total cholesterol and HDL cholesterol were measured in mg/dl by enzymatic methods (CHOD-PAP; Boehringer-Mannheim, Mannheim, Germany). Dyslipidaemia was defined based on a total cholesterol/HDL cholesterol ratio ≥5.0.

Psychosocial risk factors

Sleep complaints were evaluated in the interview using the Uppsala Sleep Inventory by questions regarding difficulties initiating and maintaining sleep [22]. Depressed mood was assessed using the Depression and Exhaustion (DEEX) scale, consisting of eight items derived from the von Zerssen affective

symptom check list [23], leading to a Likert-like scoring range of 0–24 [24]. Depressed mood was categorized into the three categories of 'no/mild' (<8 for men, <10 for women), 'moderate' (8 to <15 for men, 10 to <16 for women) and 'severe' (≥15 for men, ≥16 for women), based on the median and 90th percentiles of the DEEX scale.

Statistical analyses

All analyses were performed separately for men and women. Means and percentages of baseline characteristics were computed for participants with high life satisfaction vs medium or low life satisfaction. Differences were tested using the chi-squared test; continuous variables were compared based on the *t*-test and the Wilcoxon–Mann–Whitney test. Different Cox proportional hazard models were used to estimate the association between high life satisfaction and risk of Type 2 diabetes and the effect was expressed using the hazard ratio (HR) with 95% CIs. Kaplan–Meier curves and log-rank tests were also generated. Model 0 included only life satisfaction as exposure. Model 1 added the factors age (continuous: 25–74 years) and survey (S2, S3). Model 2 additionally included parental history of diabetes (positive, negative), smoking status (current smoker, non-smoker), alcohol intake (categorical men: 0 g/day, 0.1–39.9 g/day, ≥ 40 g/day; categorical women: 0 g/day, 0.1–19.9 g/day, ≥ 20 g/day), physical activity (active, inactive), BMI (continuous: 16.4–55.3 kg/m^2), actual hypertension (yes, no) and dyslipidaemia (yes, no). Model 3 included all

previous factors plus level of education (low, high) and sleep complaints (yes, no). Model 4 added the factor depressed mood (yes, no) to model 3. The assumption of proportional hazards was assessed graphically by checking the log [–log (survival)] curves for parallelism. No severe deviations from parallelism were evident.

Furthermore, we calculated the population-attributable fraction (PAF) for life satisfaction and each cardiometabolic risk factor using unadjusted frequencies and the adjusted HR from an adapted model 3 (including only dichotomous variables). The PAF for each covariate and the incident Type 2 diabetes endpoints were calculated using the prevalence of the risk factor (p) and the relative risk or in this case, the adjusted HR from the Cox regression by applying the formula:

$$PAF = [(p * (RR–1)] / [p * (RR–1) + 1] * 100 \text{ [25]},$$

where RR is relative risk. It should be noted that by using adjusted HRs for relative risk in this formula, potential confounding in the PAF estimation is addressed in contrast to use of (crude) incidence ratios. In this study, the effect estimate PAF was framed to describe what would be observed in relation to incident Type 2 diabetes, if the population hypothetically did not have the exposure of high life satisfaction. The result of PAF calculation was only reported for the life satisfaction variable.

The influence of depressed mood in the association between life satisfaction and incident Type 2 diabetes was assessed via the introduction of an interaction term to the multivariable Cox regression analysis in a model fully-adjusted for age, survey, parental history of diabetes, smoking status, alcohol intake, leisure time physical activity, BMI, actual hypertension, dyslipidaemia and sleep complaints in the total population as well as sex-specific population.

As an additional sensitivity analysis, multivariable Cox proportional hazard models were employed in the total study population with additional adjustment for gender and an interaction term of gender*life satisfaction to account for the potential effect modification by sex. Multivariable Cox proportional hazard models were also repeated for the life satisfaction variable with three categories, with adjustment for all potential confounders.

Two-tailed *P* values < 0.05 were considered to be statistically significant. All statistical analyses were performed using SAS (v. 9.3, SAS Institute Inc., Cary, NC, USA).

The analyses and description in this article follow the STROBE guidelines for observational cohort studies.

Results

Baseline characteristics

Among the 7107 participants (3664 men, 51.5%; 3443 women, 48.5%) aged 25–74 years [median (interquartile range) 48 [36–59] years] at baseline, a total of 984 men (26.9%) and 873 women (25.3%) reported having high life satisfaction.

The baseline characteristics differed considerably between participants with high and medium/low life satisfaction, especially in women. In both sexes, participants with high life satisfaction were significantly more likely to be younger, have a higher education level, be more physically active and report fewer depressive symptoms and sleep complaints (Table 1). In addition, women with high life satisfaction overall had a lower BMI, consumed more alcohol and were less likely to have dyslipidaemia and actual hypertension. By contrast, men with high life satisfaction did not differ in regard to BMI, alcohol consumption, dyslipidaemia and hypertension. No significant differences were seen between life satisfaction categories with regard to smoking status and parental history of diabetes in either men or women (Table 1).

Incidence of Type 2 diabetes

A total of 568 cases (342 men, 226 women) of Type 2 diabetes were identified during a median (quartile 1; quartile 3) follow-up period of 14.2 (12.8; 18.9)

years. The incidence of Type 2 diabetes was lower in participants with high life satisfaction than in participants with medium or low life satisfaction. The crude incidence rate of Type 2 diabetes per 10,000 person-years was 57 in men with high life satisfaction and 73 in men with medium or low life satisfaction. The rates for women were 37 for those with high life satisfaction and 48 for those with medium or low life satisfaction.

Kaplan–Meier curves, stratified by life satisfaction for men and women, respectively are shown in Figs 2a and b. Study participants with high life satisfaction appeared to have a lower risk of Type 2 diabetes during follow-up. According to the log-rank tests, the differences were statistically significant only in men ($P = 0.05$).

Multivariate analyses

In a fully adjusted multivariable Cox proportional hazard model, there was a significant interaction between sex and life satisfaction (β estimate = –0.54. SE = 0.21, P for interaction term = 0.009), which provides further evidence for sex-specific analyses. Table 2 shows that in men, high life satisfaction was associated with a 22% reduced risk of subsequent Type 2 diabetes (model 0: HR 0.78, 95% CI 0.60–1.0; $P = 0.05$). After further adjustment for age, survey, parental history of diabetes, smoking status, alcohol intake, physical inactivity, BMI, hypertension and dyslipidaemia, a significant risk reduction of 28% was found (model 2: HR 0.72, 95% CI 0.56–0.93; $P = 0.01$). The association

remained significant after additional adjustment for low education and sleep complaints (model 3: HR 0.73, 95% CI 0.56–0.94; P = 0.02). After further adjusting for depressed mood, the association lost statistical significance (model 4: HR 0.79, 95% CI 0.61–1.03; P = 0.08).

In women, no significant associations between high life satisfaction and incident Type 2 diabetes (model 0: HR 0.78, 95% CI 0.57–1.07; P = 0.13; model 3: HR 1.23; 95% CI 0.87–1.71; P = 0.22) were found (Table S2).

Applying the PAF concept, we quantified the effect of life satisfaction on incident Type 2 diabetes. The analysis showed that the absence of high life satisfaction would account for a 6.4% increase of Type 2 diabetes cases among the men in the study population, with confounding factors taken into account.

Sensitivity analyses

The interaction term was not significant between life satisfaction and depressed mood (P=0.87 for total population, P=0.99 for men and P= 0.63 for women).

An additional sensitivity analysis was performed using the total sample population. High life satisfaction was associated with incident Type 2 diabetes in the total population but only in a fully adjusted multivariable Cox proportional hazard model (β = 0.36, SE = 0.17; P = 0.03) (Table S1).

Multivariable Cox proportional hazard models were repeated for the life satisfaction variable with three categories (high, medium and low). The analysis

yielded similar findings: a significantly decreased risk of Type 2 diabetes was found in men with high life satisfaction in a model adjusted for age, survey, parental history of diabetes, smoking status, alcohol intake, leisure time physical activity, BMI, actual hypertension, dyslipidaemia and sleep complaints (model 3: HR 0.61, 95% CI 0.42–0.88; $P < 0.01$). In contrast, no significant results were found for medium vs low life satisfaction. In women, none of the three categories of life satisfaction were significantly associated with incident Type 2 diabetes.

Discussion

Overall findings

The aim of the present study was to investigate the protective effect of life satisfaction on incident Type 2 diabetes in men and women. Our analyses showed high life satisfaction to be associated with a 27% decreased risk of onset Type 2 diabetes in men, independently of sociodemographic, behavioural and clinical risk factors. In contrast, in women, life satisfaction was not significantly associated with onset of Type 2 diabetes.

Our findings are consistent with the present literature showing protective effects of psychological well-being on diabetes [12,26,27] and with further studies linking life satisfaction with survival benefit [4], fewer mobility limitations [28] and decreased risk of dementia [29]. To our knowledge, the current

investigation is the first to demonstrate a protective effect of high life satisfaction on risk of incident Type 2 diabetes in men in a large community-dwelling population.

Sex-specific effects

Up to now, only one study has investigated the protective role of life satisfaction against incident diabetes. Boehm *et al.* [12] looked at several protective psychosocial factors in connection with diabetes in a sample of 7800 civil servants from the Whitehall II Cohort. The study showed that life satisfaction (odds ratio 0.85, 95% CI 0.76–0.95) and emotional vitality, but not optimism, were associated with reduced risk of physician-diagnosed diabetes. Contrary to our findings, no sex-specific effects were found in that study. Moreover, the effect of life satisfaction on incident diabetes was not attenuated significantly by the inclusion of depression in their model. Our results are also comparable to the findings of the large EPIC German Study which looked at the relationship between being unsatisfied with life and incidence of Type 2 diabetes, among other outcomes [13]. The authors found low life satisfaction to be inversely related to Type 2 diabetes in an age-adjusted model in women only. Sex-specific differences may mediate differential vulnerabilities concerning psychosocial conditions, so the contradictory findings regarding sex-specific effects of life satisfaction are unsatisfactory and deserve further investigation.

The present study found that life satisfaction was not associated with the onset of Type 2 diabetes in women. Although a definite explanation for this finding is not possible, it can be hypothesized that the sex-specific effects might be attributable to diverse health reporting behaviours. In general, men are more reluctant to admit symptoms of distress, while women tend to communicate better and sometimes over-report morbidity [30]; however, this is highly speculative, and our result could simply provide a first basis for a sex-specific difference in the relationship between high life satisfaction and incident Type 2 diabetes. Different biological vulnerability or different unmeasured lifestyle behaviours cannot be excluded as possible explanations for the sex-specific effects. It is worth noting that previous studies in the MONICA/KORA cohort found similar sex-specific effects: one study found life satisfaction to have beneficial influence on mortality in men only [4] and another found poor social network index to be associated with increased risk of Type 2 diabetes in men only [20].

Confounding factors

Notably, the effect of life satisfaction on incident Type 2 diabetes in the present study persisted even after adjustment for common sociodemographic, behavioural and clinical risk factors. Smoking and parental history of diabetes were the strongest risk factors, being associated with a twofold increased risk of developing Type 2 diabetes. Age, education level, BMI, hypertension,

dyslipidaemia and depressed mood were also significantly associated with increased risk of Type 2 diabetes, findings consistent with previous works [1,26]. The influence of life satisfaction became borderline non-significant in our study after further adjustment for depressed mood; however, a sensitivity analysis found no indication that depressed mood modified the effect of life satisfaction on incident Type 2 diabetes.

Potential pathways

The present investigation was not designed to study the underlying potential causal pathways that may lead to an independent association of life satisfaction and Type 2 diabetes. However, it is well established that psychological well-being may influence health through a behavioural pathway, increasing adherence to self-care behaviours [31]. In the present study, participants with high life satisfaction were significantly more likely to engage in physical activity, but no differences were observed with regard to smoking status. Moreover, people with greater psychological well-being were found to be more persistent in their goals and to have better coping strategies [32]; therefore, life satisfaction may enable people to deal more effectively with life challenges and this may lessen risk of Type 2 diabetes by diminishing the harmful biological and behavioural effects of psychosocial stress conditions [12]. Moreover, endocrine-based mechanisms, such as cortisol regulation and inflammation,

may be on the pathway between life satisfaction and Type 2 diabetes [33]. Further research is needed to address these hypotheses.

Strength and limitations

Strengths of the present study include its population-based prospective design, its large sample size, the long follow-up period and the availability of data on common risk factors for Type 2 diabetes. The MONICA/KORA cohort study provided a strong platform to analyse the association between psychosocial factors and Type 2 diabetes, as previously demonstrated [20], but the present study is the first to directly focus on the positive mental health aspect of life satisfaction against the onset of Type 2 diabetes.

All assessments were performed in a standardized manner and a very strict quality assessment. Moreover, all self-reported incident cases of Type 2 diabetes were verified by examination of hospital records or contacting the participant's treating physician.

The present study also has some limitations. All characteristics, including life satisfaction, were measured at a single point in time. As a consequence, changes in these characteristics throughout the follow-up period were not considered. The lack of information on dietary habits of participants is another major limitation. Moreover, the DEEX scale for depressed mood is less rigorous and may have introduced measurement error. Other potential sources of bias are the

624 participants without information on diabetes status at follow-up and who were not included in the analyses and the participants without diabetes who did in fact have undetected diabetes. Confounding by unmeasured variables cannot entirely be excluded. The study cohort is representative of the German population and may not be generalizable to other populations.

The use of a single-item measure for life satisfaction may also have introduced some imprecision, however, the factorial load in the total Satisfaction With Life Scale is very high (0.82 to 0.89) [4]. Moreover, in the present study, we used a dichotomized life satisfaction measurement, as also implemented by other studies [4,16,17]. The general consensus is that multiple-item measures, such as the 36-Item Short Form Survey Instrument (SF-36) or the Satisfaction With Life Scale (SWLS), with five items, have better psychometric properties than single-item measures, however, the single-item measures may be used because of the practical constraints of a large epidemiological study. Some researchers contend that Likert-type multi-item scales are superior to single-item scales in terms of predictive validity and reliability [34], but a number of studies have found that multi-item scales do not necessary outperform single-item scales under certain circumstances [35,36], and that single-item life satisfaction measures performed very similarly to the multi-item measure [37]. Single-item measures of life satisfaction might be very reliable, as shown in an analysis across four nationally representative panel studies with a combined sample size of >68 000

participants, in which the reliability estimates increased by an average of 16% when the multivariate model was used instead of the more standard univariate longitudinal model [38].

In summary, the present investigation is the first population-based study to directly focus on the protective effect of life satisfaction on onset of Type 2 diabetes and indicates that men with high life satisfaction are 27% less likely to develop Type 2 diabetes than men with medium or low life satisfaction. The findings suggest that life satisfaction has a protective role in the development of Type 2 diabetes, independently of common risk factors, and call for increased consideration of psychological well-being. The assessment of life satisfaction may be considered in the prediction of Type 2 diabetes risk in men, and positive psychological well-being interventions may be targeted at individuals at high risk as preventive measures.

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Competing interests

None declared.

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Supporting information

Table S1 β estimates (SE) and hazard ratios (95% CIs) for incident Type 2 diabetes in total population.

Table S2 Hazard ratios (95% CIs) for the association between life satisfaction and incident Type 2 diabetes in women.

FIGURE 1 Flowchart of the study population derived from the MONICA/KORA surveys.

FIGURE 2 (a) Kaplan–Meier curves stratified by life satisfaction in men (log-rank test: $P = 0.05$) (b) Kaplan–Meier curves stratified by life satisfaction in women (log-rank test: $P = 0.13$). LS, life satisfaction.

Table 1 Baseline risk factors according to life satisfaction (N = 7107)

	Men (n = 3664)			Women (n = 3443)		
	High, 26.9%	Medium or low, 73.1%	*P**	High, 25.3%	Medium or low, 74.7%	*P**
			Age, years			
Mean (±SD)	46.6 (±14.3)	49.0 (±13.9)	<.0001	43.2 (±13.3)	48.6 (±13.2)	<0.0001
Median (IQR)	46 (34–59)	49 (37–61)	<.0001	40 (32–53)	49 (38–59)	<0.0001
Education <12 years, *n* (%)	557 (56.6)	1702 (63.5)	0.0001	621 (71.1)	2056 (80.0)	<0.0001
Parental history of diabetes, *n*	178 (18.1)	457 (17.1)	0.46	178 (20.4)	532 (20.7)	0.85

(%)						
Current smoking, *n* (%)	278 (28.3)	824 (30.8)	0.15	183 (21.0)	582 (22.7)	0.30
Alcohol intake, *n* (%)			0.37			0.002
None	184 (18.7)	474 (17.7)		328 (37.6)	1141 (44.4)	
Low†	528 (53.7)	1403 (52.4)		365 (41.8)	981 (38.2)	
High‡	272 (27.6)	803 (30.0)		180 (20.6)	448 (17.4)	
Physical inactivity, *n* (%)	435 (44.2)	1517 (56.6)	<.000 1	423 (48.5)	1600 (62.3)	<0.00 01
		BMI, kg/m				
Mean (±SD)	27.2 (±3.7)	27.0 (±3.5)	0.18	25.1 (±4.3)	26.2 (±4.8)	<0.00 01
Median (IQR)	26.9 (24.8-29.1)	26.8 (24.6-29.1)	0.29	25.4 (21.9-27.2)	25.5 (22.7-28.9)	<0.00 01

Hypertension, *n* (%)	423 (43.0)	1208 (45.1)	0.26	199 (22.8)	832 (32.4)	<0.001
Dyslipidaemia, *n* (%)	448 (45.5)	1212 (45.2)	0.87	101 (11.6)	461 (17.9)	<0.001
Sleep complaints, *n* (%)	123 (12.5)	550 (20.5)	<0.001	118 (13.5)	704 (27.4)	<0.001
Depressed mood, *n* (%)	188 (19.1)	1187 (44.3)	<0.001	129 (14.8)	1105 (43.0)	<0.001

IQR, interquartile range.

*Unadjusted *P* value for differences between low/medium vs high life satisfaction categories; *t*-test/ Wilcoxon–Mann–Whitney test/chi-squared test.

†Low: 0.1–19.9 g/day for women and 0.1–39.9 g/day for men.

‡High: ≥20 g/day for women and ≥40 g/day for men.

Table 2 Hazard ratios (95% CIs) for incident Type 2 diabetes in men

Covariate	**Model 0**	**Model 1**	**Model 2**	**Model 3**	**Model 4**
	HR (95% CI)	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**
High life satisfaction	**0.78 (0.60–1.0)***	0.84 (0.65–1.08)	**0.72 (0.56–0.93)***	**0.73 (0.56–0.94)***	0.79 (0.61–1.03)
Age	-	1.05 (1.04–1.06)***	1.05 (1.04–1.06)***	1.05 (1.04–1.06)***	1.05 (1.04–1.06)***
Parental history	-	-	1.94 (1.52–2.48)***	1.95 (1.52–2.49)***	1.96 (1.53–2.51)***
Current smoking	-	-	2.05 (1.61–2.60)***	1.99 (1.57–2.53)***	1.98 (1.56–2.51)***
Alcohol intake					
Low vs none	-	-	0.90 (0.68-1.20)	0.92 (0.70–1.22)	0.93 (0.70–1.23)

High vs none	-	-	1.02 (0.75–1.39)	1.02 (0.75–1.39)	1.04 (0.76–1.41)
Physical inactivity	-	-	1.05 (0.84–1.32)	1.02 (0.82–1.29)	1.01 (0.80–1.27)
BMI	-	-	1.22 (1.19–1.25)***	1.22 (1.18–1.25)***	1.22 (1.19–1.25)***
Hypertension	-	-	1.63 (1.29–2.07)***	1.63 (1.29–2.06)***	1.66 (1.31–2.10)***
Dyslipidaemia	-	-	1.74 (1.38–2.20)***	1.76 (1.40–2.23)***	1.77 (1.40–2.24)***
Low education	-	-	-	1.51 (1.17–1.94)**	1.50 (1.16–1.92)**
Sleep complaints	-	-	-	1.09 (0.84–1.40)	0.98 (0.75–1.28)
Depressed mood	-	-	-	-	1.40 (1.11–1.76)**

HR, hazard ratio. *$P < 0.05$; ** $P < 0.01$; *** $P < .0001$.

Model 0: unadjusted; Model 1: adjusted for age and survey; Model 2: adjusted for age, survey, parental history of diabetes, smoking status, alcohol intake, leisure time physical activity, BMI, actual hypertension and dyslipidaemia; Model 3: adjusted for age, survey, parental history of diabetes, smoking status, alcohol intake, leisure time physical activity, BMI, actual hypertension, dyslipidaemia and sleep complaints; Model 4: adjusted for age, survey, parental history of diabetes, smoking status, alcohol intake, leisure time physical activity, BMI, actual hypertension, dyslipidaemia, sleep complaints and depressed mood.