

Distribution of socioeconomic status and its association with type 2 diabetes mellitus in China rural area: Henan Rural Cohort study

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Abstract

Background

The measures of socioeconomic status (SES) differed across divergent researches and rare of them focused on rural population. This research, thus, presented a novel measure of SES among rural population and then estimated its association with type 2 diabetes mellitus (T2DM).

Methods

All participants were farmer and enrolled from the Henan Rural Cohort study. SES of individual was assessed by SES-score, a composite index derived from three SES-related indicators (education level, average monthly income, and marital status). Binary logistic regression was employed to examine the independent association between SES-score and T2DM as well as the combined effects of SES and age on T2DM. To detect the gender differences, all analyses were stratified by gender.

Results

Among 39259 rural participants, the means (SDs) SES-score of total population, men, and women were 3.47 (1.54), 3.72 (1.49), and 3.31 (1.57), respectively. The SES-score decreased with age and men always had a higher score than women. The prevalence of T2DM decreased with increasing SES-score among women (14.87–4.47%, $P_{\text{trend}} < 0.001$), while an inverse trend was observed among men (6.59–9.87%, $P_{\text{trend}} < 0.001$). Adjusted ORs (95% CIs) for prevalent T2DM, per unit increase, were 1.07 (1.03, 1.12) in men and 0.96 (0.93, 0.99) in women. Old men with high SES and old women with low SES were vulnerable to T2DM.

Conclusions

Men had a higher SES-score than women in rural areas, and this gap increased with age. The association between SES and T2DM was differed by gender.

Trail Registration:

The Henan Rural Cohort Study has been registered at Chinese Clinical Trial Register (Registration number: ChiCTR-OOC-15006699). Date of registration: 06 July, 2015. <http://www.chictr.org.cn/showproj.aspx?proj=11375>

Introduction

As a serious and chronic condition, type 2 diabetes mellitus (T2DM) was a prominent threat to global health that respected neither countries nor nations.¹ According to International Diabetes Federation, approximately 463 million people worldwide were subjected to T2DM and most of them came from low- and middle-income countries.² In China, with unexpected socioeconomic transition, the prevalence of T2DM increased continuously and had no plateau or inflection point.³ In addition to traditional risk factors including obesity, unhealthy lifestyle and age, economic factors also had a profound impact on prevalent T2DM.⁴

Socioeconomic status (SES), a multidimensional concept which represented the individual position in social structure, had undefined compositions and measures in different researches due to limitedly available data.⁵ In addition to the traditional compositions of SES such as education, income, and occupation,⁶ some novel indicators were also generally accepted. Early study conducted in 2013, in which low SES was defined as receiving social assistance and high SES as having more possibility to get primary care.⁷ More recently, a study in Brazil indicated that race was also a proxy of SES.⁸ Instead of integrating the various indicators for a comprehensive index, all studies aforementioned estimated the SES by separate factors. Considering that complex factors regarding SES were generally but imperfectly correlated, these inappropriate methods may lead to potential bias.⁹ Thus, a composite SES index was proposed.¹⁰

Over the past few years, abundant researches regarding the association between SES and T2DM had an inconsistent conclusion in China.¹¹ Conducted in Jilin, a cross-section study found high education level and family income correspond to low prevalent T2DM.¹² While in old population, Liu found high education level was positively associated with prevalent T2DM.¹³ Additionally, gender-difference in association between SES and T2DM was also pronounced. Previous research had indicated that high SES was associated with increased prevalence of T2DM among men, with the opposite pattern observed among women.¹⁴ Due to the aging and rapid urbanization, the SES pattern had saliently changed in rural China. However, most of these researches regarding SES focused on urban population and the current evidence on rural population was limited. Therefore, conducted in rural population, the aims of this study were to estimate the distribution of SES with a composite index and further explore its association with T2DM.

Methods

Study participants

The Henan Rural Cohort Study was a representative sample of the rural population in China, in which permanent residents aged from 18 to 79 years were recruited from five administrative districts of Henan province (Yuzhou, Suiping, Tongxu, Xinxiang, and Yima). All participants in this cohort were farmers and the baseline survey were conducted from July 2015 to September 2017. With a response rate of 93.7% (41893 invitations), a total of 39259 participants (15490 men and 23769 women) were included in this research via multistage stratified cluster sampling. More details of this cohort have been previously reported.¹⁵ It should be noted that all participants were included to calculate SES-score, while only 39196 participants were enrolled to assess the association between SES and T2DM, since 63 participants without information of T2DM.

The Henan Rural Cohort Study has been registered at Chinese Clinical Trial Register (Registration number: ChiCTR-OOC-15006699). For this study, ethical approval was received from Zhengzhou University Life Science Ethics Committee (Code: [2015] MEC (S128)) and each process was carried out in accordance with principles of the Declaration of Helsinki. Before the research commenced, all participants were required to sign the informed consent and each research promised to use the information for scientific research only.

Data collection

As described previously, information regarding participants' demographic characteristics and lifestyle were collected via face-to-face interviews and structured questionnaire by well-trained staffs. Briefly, age was a continuous variable and divided into six subgroups (18-, 30-, 40-, 50-, 60-, and 70- years) in following analyses. The body mass index (BMI) was calculated by height and weight, which were measured to the nearest 0.1 cm and 0.1 kg (with light clothes and shoes off) through standard measuring equipment, respectively. Additionally, smoking status was classified as never smoking, former smoking, and current smoking; drinking status was categorized as never drinking, former drinking, and current drinking. In accordance with International Physical Activity Questionnaire (IPAQ), physical activity was divided into three levels (low, moderate, and high).¹⁶

T2DM

T2DM was defined as FPG \geq 7.0 mmol/L or previously diagnosed with T2DM by a physician or had taken hypoglycemic drugs in the last two weeks.¹⁷

Measure of SES

Based on previous study and the special population, SES in this research consisted of three aspects including educational level (Educational score), average monthly income (Income score), and marital status (Marital score). Educational level was divided into four categories (illiteracy, primary, junior high school, and senior high school or above), which were scored as 0, 1, 2, and 3, respectively. Average monthly income was divided into four levels (< 500, 500-, 1000-, and 2000- RMB) and scored as 0, 1, 2, and 3, respectively. Regarding marital status, widowed, divorced, separated and single were scored as 0, while married or cohabiting were scored as 1. The detailed definition was summarized in *Supplementary table 1*. Personal SES was assessed with SES-score, which was calculated as follows:

SES-score = Educational score + Income score + Marital score

SES-score ranged from 0 to 7, which 0 represented the worst-off group and 7 represented the best-off group. Participants were divided into four groups according to SES-score quartiles (Q1: 0–2; Q2: 3; Q3: 4; and Q4: 5–7). The detailed distribution and classification of

SES-score were described in *Supplementary Fig. 1*.

Statistical analysis

Quantitative variables such as age, BMI, and SES-score were described as mean \pm standard deviation (SD) and intergroup differences were detected by *t* tests, while categorical variables were presented as frequency with percentage and the intergroup associations were compared through Chi squared tests. The change of SES-score with age was stratified by gender in six age groups. Binary logistic regression was used to assess the association between SES and T2DM as well as the combined effect of SES and age on T2DM after adjusting age, BMI, smoking status, drinking status, and physical activity. Furthermore, in order to verify the robustness of our results, total SES-score was classified into four categories to make further analyses.

All analyses were conducted via Statistical Package for the Social Sciences version 24.0 (IBM-SPSS Inc, Armonk, NY) and R software version 4.0.3. All *P*-values were two-tailed and 0.05 was considered significant.

Results

Characteristics of study participants

Among 39259 participants (15490 men and 23769 women), the mean (SD) of age was 55.60 (12.19) years and men were approximately 1.68 years older than women ($P < 0.001$). Overall, a total of 3708 (9.46%) were identified with T2DM while the significant variation in T2DM across gender was not detected ($P = 0.068$). The mean (SD) SES-score was 3.47 (1.54) for all participants and men (3.72 ± 1.49) was significantly higher than women (3.31 ± 1.57). In both income score and marital score, the significant difference between men and women was not observed (both $P > 0.05$), while men (1.78 ± 0.86) had a saliently higher score than women (1.39 ± 0.96) in educational score. Some salient differences in lifestyle were also observed between men and women (all $P < 0.001$). Men tended to smoke (47.91%), drink (41.74%), and have high physical activity (36.54%), while women prefer to have moderate physical activity (44.18%) and be never smoking (99.63%) or drinking (97.14%). More detailed information is presented in Table 1.

Table 1
Baseline characteristics of study participants stratified by gender.

Variable	Overall	Men	Women	P
	(N = 39259)	(N = 15490)	(N = 23769)	
Age (year, mean \pm SD)	55.60 \pm 12.19	56.61 \pm 12.30	54.93 \pm 12.07	< 0.001
Educational level (n, %)				< 0.001
Illiteracy	6535(16.65)	1325(8.55)	5210(21.92)	
Primary	11037(28.11)	3905(25.21)	7132(30.01)	
Junior high school	15643(39.85)	7158(46.21)	8485(35.70)	
Senior high school or above	6044(15.40)	3102(20.03)	2942(12.38)	
Average monthly income (RMB, n, %)				< 0.001
<500	14014(35.70)	5603(36.17)	8411(35.39)	
500-	12907(32.88)	4928(31.81)	7979(33.57)	
1000-	9412(23.97)	3672(23.71)	5740(24.15)	
2000-	2926(7.45)	1287(8.31)	1639(6.90)	
Marital status (n, %)				0.010
Single/widowed/separated/divorced	4016(10.23)	1554(10.03)	2462(10.36)	
Married/cohabiting	35243(89.77)	13936(89.97)	21307(89.64)	
Smoking status (n, %)				< 0.001
Never	28580(72.8)	4899(31.63)	23681(99.63)	
Former	3192(8.13)	3169(20.46)	23(0.10)	
Current	7487(19.07)	7422(47.91)	65(0.27)	
Drinking status (n, %)				< 0.001
Never	30347(77.3)	7257(46.85)	23090(97.14)	
Former	1832(4.67)	1768(11.41)	64(0.27)	
Current	7080(18.03)	6465(41.74)	615(2.59)	
Physical activity (n, %)				< 0.001
Low	12715(32.39)	5527(35.68)	7188(30.24)	
Moderate	14805(37.71)	4303(27.78)	10502(44.18)	
High	11739(29.90)	5660(36.54)	6079(25.58)	
T2DM (n, %)	3708(9.46)	1411(9.13)	2297(9.68)	0.068
BMI (kg/m ² , mean \pm SD)	24.83 \pm 3.57	24.55 \pm 3.48	25.02 \pm 3.61	< 0.001
Educational score	1.54 \pm 0.94	1.78 \pm 0.86	1.39 \pm 0.96	< 0.001
Income score	1.03 \pm 0.95	1.04 \pm 0.96	1.03 \pm 0.93	0.104
Marital score	0.90 \pm 0.30	0.90 \pm 0.30	0.90 \pm 0.30	0.296
SES-score (mean \pm SD)	3.47 \pm 1.54	3.72 \pm 1.49	3.31 \pm 1.57	< 0.001
The detection of T2DM was conducted in 39196 participants.				

Significant variation of SES by gender is further summarized in Fig. 1. From the total perspective, SES-score decreased with increasing age and 40–50 years was a plateau in this trend. Irrespective of age, men always had a higher SES-score than women. This gap changed divergently in different aspects. In education domain, the gap among gender increased with age and vigorously varied among old population (60+ years). However, this trend reversed in income domain and gender gap of SES vanished among old population. Additionally, an inverted U-shaped curve, in which people aged 30- and 40- years had the best marital score, was detected in marital domain. Findings also showed that young women might have a higher marital score than men, whereas this disparity was reversed with age.

Association between socioeconomic status and T2DM

Supplementary table 2 depicts the changes in the prevalence of T2DM with SES-score in different genders. From 14.87–4.47% ($P_{\text{trend}} < 0.001$), the prevalence of T2DM among women maintained a continuing decrease with increasing SES-score, while an inverse trend was observed in men (from 6.59–9.87%, $P_{\text{trend}} < 0.001$).

The results of binary logistic regression are detailed in Table 2. Compared with illiteracy, junior high school (OR = 1.36, 95%CI from 1.08 to 1.70) and senior high school or above (OR = 1.46, 95%CI from 1.14 to 1.88) had higher prevalence of T2DM in men, whereas had lower prevalence of T2DM in women (OR = 0.78, 95%CI from 0.69 to 0.89; OR = 0.68, 95%CI from 0.55 to 0.83, respectively). After adjustment, the significant association between income and T2DM was not detected in each group (all $P > 0.05$). Married or cohabiting weakly corresponded with high prevalence of T2DM among men (OR = 1.24, 95%CI from 1.01 to 1.53), while the similar association was not observed among women ($P > 0.05$). With regard to SES-score, the adjusted ORs (95%CI) in per score increase were 1.07 (1.03, 1.12) in men and 0.96 (0.93, 0.99) in women.

Table 2
Odds ratios and 95% confidence intervals of different SES indexes for T2DM.

Variable	Total		Men		Women	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Educational level ^a						
Illiteracy	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Primary	0.79(0.72–0.86)	0.91(0.83–1.00)	1.21(0.96–1.52)	1.22(0.97–1.54)	0.76(0.68–0.85)	0.93(0.83–1.04)
Junior high school	0.56(0.51–0.62)	0.86(0.77–0.95)	1.14(0.92–1.42)	1.36(1.08–1.70)	0.44(0.39–0.50)	0.78(0.69–0.89)
Senior high school or above	0.52(0.46–0.59)	0.89(0.78–1.02)	1.21(0.95–1.54)	1.46(1.14–1.88)	0.31(0.26–0.38)	0.68(0.55–0.83)
Average monthly income (RMB) ^a						
<500	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
500-	0.93(0.86–1.01)	1.00(0.92–1.09)	0.97(0.85–1.11)	1.00(0.88–1.15)	0.91(0.82–1.01)	0.99(0.89–1.11)
1000-	0.92(0.84–1.00)	1.04(0.94–1.14)	0.91(0.79–1.06)	1.00(0.86–1.17)	0.92(0.82–1.04)	1.05(0.93–1.19)
2000-	0.86(0.74–0.99)	1.05(0.90–1.22)	0.93(0.75–1.16)	1.10(0.88–1.38)	0.81(0.66–0.99)	0.98(0.80–1.22)
Marital status ^a						
Single/widowed/separated/divorced	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
Married/cohabiting	0.99(0.89–1.11)	1.15(1.03–1.29)	1.28(1.05–1.56)	1.24(1.01–1.53)	0.87(0.76–0.99)	1.15(1.00–1.32)
SES-score ^b	0.87(0.85–0.89)	1.00(0.97–1.02)	1.01(0.97–1.05)	1.07(1.03–1.12)	0.79(0.77–0.82)	0.96(0.93–0.99)
^a Traditional measurement of SES: educational level, average monthly income and marital status were jointly included in model.						
^b SES-score was alone included in model.						
Model 1: Unadjusted.						
Model 2: Adjusted by age, BMI, smoking status, drinking status, and physical activity.						

Summarized in Fig. 2, the results of sensitive analyses present a similar situation. The association between SES-score and T2DM was not detected in total population but caught in both different genders. Adjusted ORs (95%CI) for prevalent T2DM, comparing Q4 vs Q1, were 1.31 (1.10, 1.57) in men and 0.79 (0.68, 0.91) in women.

Figure 3 graphically presents the combined effect of total SES-score and age on T2DM. With age increasing, the prevalence of T2DM increased in each SES-score. Old men with high SES-score and old women with low SES-score were vulnerable to T2DM.

Discussion

This study was an up-to-date complement to literatures regarding the SES of rural population. Because all participants were farmer in this research, a new measure of SES was proposed. With few exceptions, the results unequivocally showed that SES of men, however defined, was higher than women in each age group among rural population. This disparity increased with age. Additionally, increasing age corresponded to decreasing SES and the old one had the worst SES-score. Divergent associations between SES and T2DM across gender were also caught in this research. SES was positively associated with prevalent T2DM in men but negatively in women.

In analyses stratified by gender, we observed men always had a higher SES-score than women among rural population. Virtually, previous study had indicated that sizeable gender gap in SES remained to data in all countries, which would take 99.5 years to close even at a fast rate.¹⁸ In rural China, with the widely available of base education, the education level had a great improvement, especially for women.¹⁹ In our research, thus, the gender gap in education was only salient in old people, who did not or limitedly enjoy the free education benefits. Although the popularization of gender equality ideology has been proposed, influenced by the traditional culture preference for men, women still earned on average 20% less than men on an hourly basis.^{20,21} The limited mechanization or services resources of housework in rural areas forced women to do most of housework, which fueled markedly increased the gender gap in income.²² With age increasing, both old men and women may drop out of the labor market, so this gap in income would close and was not observed in our results among old participants. In China, the legal age for marriage is 20 for women but 22 for men, which may account for the higher marital SES-score in youth women. However, due to the longer life expectancy of women,²³ old women were more likely to lose their partner than old men. Thus, the gender gap in marital status reversed with age.

Gender difference in association between SES and T2DM had been pronounced early.²⁴ In this research, we found T2DM was more prevalent among low-SES group in women, whereas an opposite pattern was observed in men. Irrespective of disease and the measure of SES, previous studies conducted in China also observed the similar situation.^{25,26} In rural areas, due to the limited medical resource, higher income group had more access to higher quality medical services.^{27,28} And the high education status may increase the awareness of diseases and thus made individuals maintain a healthy lifestyle.²⁹ It was reasonable to indicate that high SES would correspond to the decreased prevalence of T2DM among rural women. Considering that men provided the main source of household income in rural China, one of the reasons for the divergent association among men could be attributed to the psychological stress.^{30,31} Additionally, due to men with high SES were more likely to drink or smoke, the impact of SES on T2DM may be covered by unhealthy lifestyles.^{32,33}

Considering marriage or remarriage usually cost an enormous amount of money in rural areas and thus people with low SES would not have a wonderful marriage, marital status was regarded as an indicator of SES-score in this research.³⁴ Compared with educational level, the association between T2DM and income was more confusing and not significantly detected after adjustment with various variables. This could be attribute to the collinearity, which meant the correlation among education, income, and marital status were moderate but significant.³⁵ Another possible explanation was that educational level was more strongly associated with individuals' health-promoting behaviors than income.³⁶

Despite diverse sources and divergent measurements of SES, the consistent overall view was that low SES group cost more in T2DM care due to the inadequate management of T2DM.³⁷ These extra costs plunge low-SES group into a vicious cycle of further economic burden and limited management, resulting in more economic hardship.³⁸ Considering SES may virtually pattern all health behaviors, it is our desire that results published here would stimulate private sectors to act. Increasing the publicity of gender equality ideology as well as making practical policies to improve the SES of women were advisable ways to maintain social harmony in rural China. With regard to T2DM prevention, gender-specific strategies should be an integral component. For men, more concentration should be attached to their lifestyles, while for women, more allowance should be provided.

Our findings may provide a complement to literature regarding the association between SES and T2DM among rural population. Although the large sample size and an appropriate measurement of SES made our results more convincing, some limitations should be noted. Firstly, only three economy-related indicators were included in SES-score, which may not accurately represent the SES of individuals. Secondly, the score of each level in three compositions was equivalent, while the effect of each level may be complicated in different conditions. Thirdly, because all participants in this research were farmers, this new measurement of SES could not be generalized for urban population. Moreover, the cross-sectional study could only provide an association but a causation. Therefore, further investigations are warranted to confirm the extensibility of our findings.

In conclusion, via a new measurement of SES, this study observed a gender gap in SES among rural population. Men always had a higher SES-score than women and this gap increased with age. The association between SES and T2DM differed qualitatively between men and women. Old men with high SES and old women with low SES were two vulnerable subgroups for T2DM.

Declarations

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Competing interests

The authors declared no conflict of interest.

Availability of data and material

The data analyzed during current study are available from the corresponding author on reasonable request.

Code availability

Not applicable.

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Authors' contributions

WX conceived and designed the study. NK, XL, WL and ZH analyzed the data. WL, ZH, NK and YH drafted the manuscript. ZH, XW and CW collected data. YH, LW, XD, CW and YL provided technical direction and writing assistance in the preparation of this manuscript. All authors critically revised the manuscript and approved the final version for publication.

Ethics approval and consent to participate

Ethics approval was obtained from the “Zhengzhou University Life Science Ethics Committee”, and written informed consent was obtained for all participants. Ethics approval code: [2015] MEC (S128).

Consent for Publication

Not applicable.

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Figures

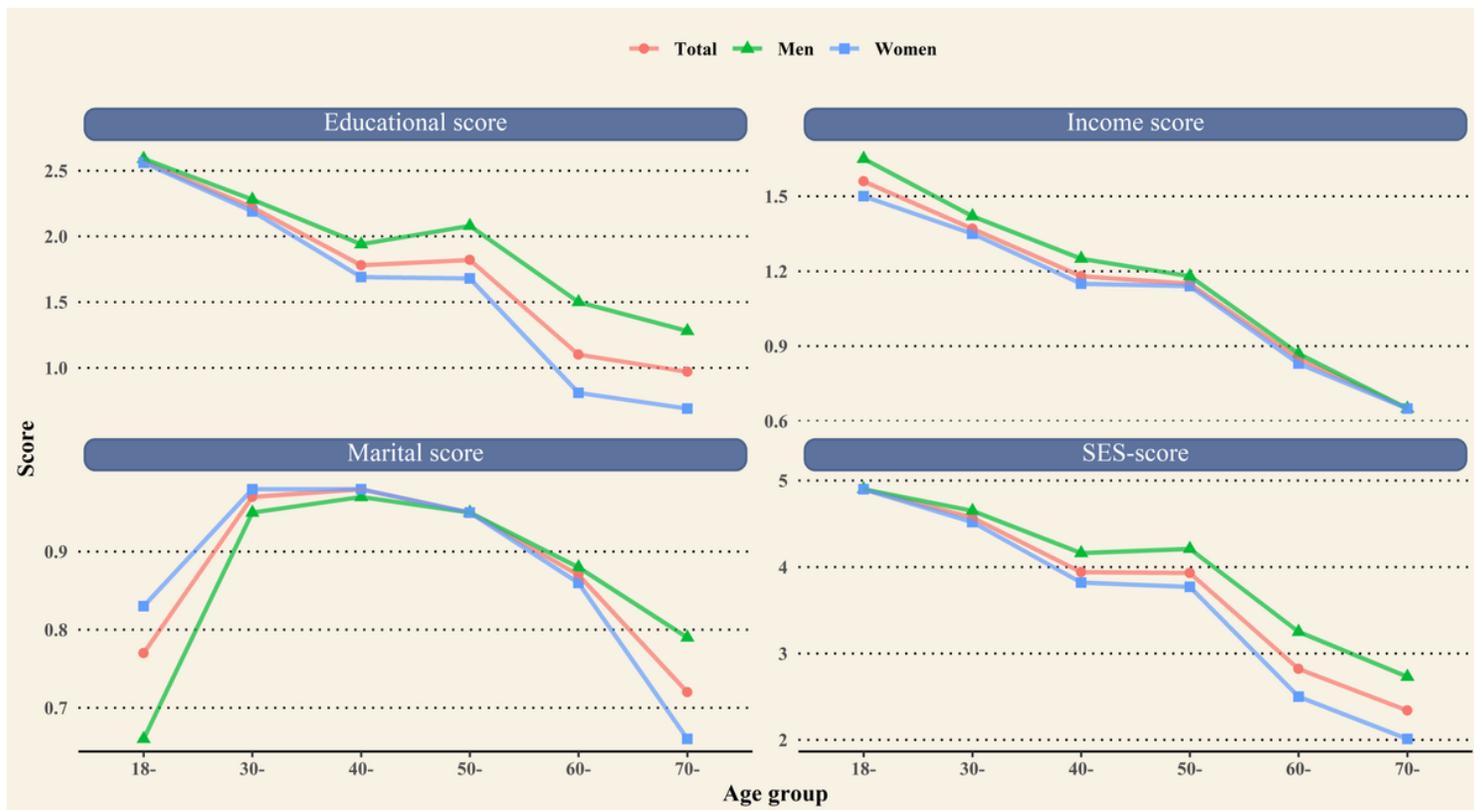


Figure 1

The change of SES-score with age stratified by gender.

Variable	Population	OR (95% CI)	Prevalence (%)
Total			
Q1	10732	Ref.	12.40 ●
Q2	9408	0.95(0.87-1.05)	9.57 ●
Q3	8918	0.93(0.84-1.03)	5.70 ●
Q4	10201	0.95(0.85-1.06)	7.20 ●
P_{trend}		0.238	
Men			
Q1	2906	Ref.	8.73 ●
Q2	3470	1.23(1.04-1.46)	9.59 ●
Q3	3376	1.23(1.03-1.47)	6.60 ●
Q4	4299	1.31(1.10-1.57)	8.98 ●
P_{trend}		0.006	
Women			
Q1	6482	Ref.	13.95 ●
Q2	5021	0.90(0.80-1.02)	9.56 ●
Q3	4791	0.85(0.74-0.97)	7.67 ●
Q4	5143	0.79(0.68-0.91)	5.81 ●
P_{trend}		0.001	

Figure 2

Odds ratios of T2DM according to various SES subgroups. (Model was adjusted by age, BMI, smoking status, drinking status and physical activity.)

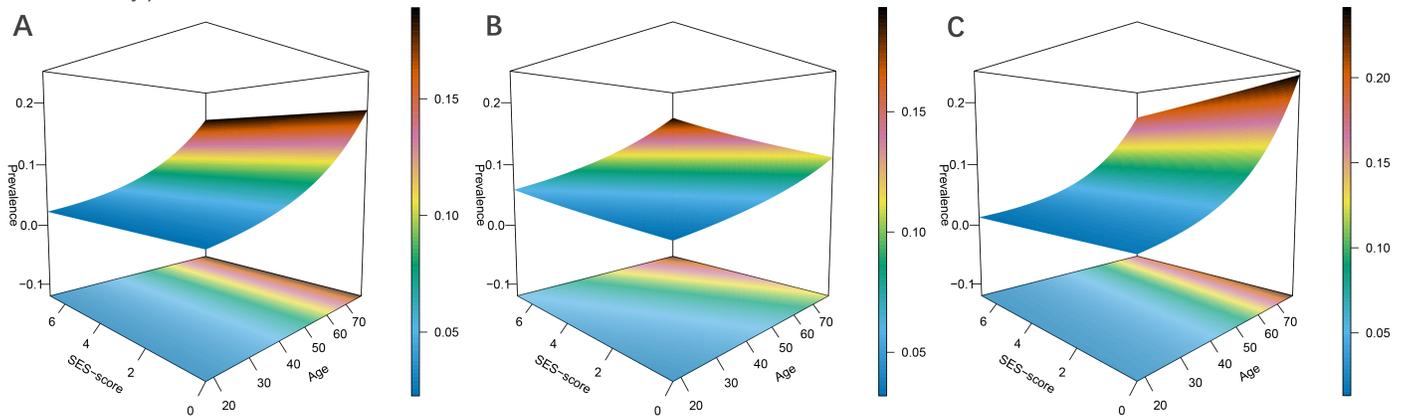


Figure 3

The combined effects of SES and age on T2DM. (A was in total population; B was in men; C was in women.)

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