

Supplemental Material

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Appendix. Methods

Data collection and measurements

Baseline examinations were collected by face-to-face interviews along with a structured questionnaire, anthropometric measurements and blood sampling. The in-person interview was conducted by trained study personnel, and the information collected included sociodemographic characteristics, lifestyle factors and self-reported medical history and current medications.

Smoking and Drinking

The frequency of smoking or drinking was recorded. Current smokers were defined as participants who had regularly smoked at least seven cigarettes per week in the past 6 months. Likewise, Current drinkers were defined as participants who had drunk once per week regularly in the past 6 months.

Diet quality

A validated food frequency questionnaire was used to collect the dietary habits of participants over the past 12 months. The healthy diet score included the following four parts: fish, 2 or more 3.5-oz servings/week; fruits and vegetables, ≥ 4.5 cups/day; sweets/sugar-sweetened beverages, 450 kcal/week; and soy protein, ≥ 25 g/day. Two or more healthy diet scores were defined as a healthy diet, while the left was defined as an unhealthy diet.

Measurements

Anthropometric measurements were taken with participants wearing light clothing and no shoes. Height was measured using a calibrated stadiometre with subjects standing fully upright with heels together. Weight was measured using a calibrated scale that was carefully zeroed before each measurement. Body mass index (BMI) was calculated as weight in kilogrammes divided by height in metres squared (kg/m^2).

An automated electronic device (OMRON Model HEM-752 FUZZY; Omron Co) was used to measure systolic BP (SBP) and diastolic BP (DBP) three times after a rest of at least 5 min, and the average of three readings was used in the analysis. Hypertension was defined as SBP ≥ 130 mmHg and/or DBP ≥ 80 mmHg and/or use of antihypertensive medications.

All participants were asked to fast overnight for ≥ 10 h before blood samples were taken. A standard Oral glucose tolerance test (OGTT) was conducted, and fasting and 2-hour post-load plasma glucose (2h-PG) concentrations were measured at the relevant local hospitals. Serum samples were aliquoted into 0.5-mL Eppendorf tubes within 2 h shipped by air in dry ice to the central laboratory located at Shanghai Institute of Endocrine and Metabolic Diseases, which is certified by the College of American Pathologists (CAP). The level of haemoglobin A1c (HbA1c) was determined by the method of high-performance liquid chromatography (VARIANT II and D-10Systems; Bio-Rad).

Lipid profiles including total cholesterol (TC), low-density lipoprotein cholesterol (LDL-c), high-density lipoprotein cholesterol (HDL-c) and triglycerides (TGs) were measured with an autoanalyser (Abbott Laboratories, IL, USA). Insulin resistance was evaluated using the homeostatic model (HOMA-IR), and the value was calculated as $\text{FPG (mmol/L)} \times \text{Fasting Insulin (mU/L)} / 22.5$.

Definition of CKD severity

According to Kidney Disease Improving Global Outcomes 2012 recommendations. GFR contains a 5-stage classification (G1 to G5), while ACR was classified into 3 categories (A1 to A3) as shown below. Participants with G1–2 and A1 were defined at low risk for CKD; Participants with G1–2 and A2, or G3a and A1 were defined at moderate risk for CKD; Participants with G1–2 and A3, or G3a and A2, or G3b and A1 were defined at high risk for CKD; Participants with G4–5 and A1, or G3b–5 and A2, or G3a–5 and A3 were defined at very high risk for CKD. We combined the moderate-risk and high-risk group into moderate-to-high-risk group in the current analysis.

		ACR Categories (mg/g)			
		A1	A2	A3	
		<30	30-300	>300	
GFR Categories (ml/min per 1.73 m ²)	G1	≥90	low risk	moderate risk	high risk
	G2	60-89	low risk	moderate risk	high risk
	G3a	45-59	moderate risk	high risk	very high risk
	G3b	30-44	high risk	very high risk	very high risk
	G4	15-29	very high risk	very high risk	very high risk
	G5	<15	very high risk	very high risk	very high risk

Supplemental Table 1. ORs and 95% CIs of associations between 1-hour units of sleep, sitting, walking and MVPA with two separate categories of CKD, from single activity, partition, and substitution models. (A) abnormal ACR. (B) decrease eGFR.

Behavioral Patterns								
A. abnormal ACR								
Multi-variable model^a	sleep		sit		walk		MVPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single^b	1.05 (1.03 1.06)	<.001	1.02 (1.01 1.03)	<.001	1.00 (0.98 1.02)	0.809	1.01 (0.99 1.02)	0.322
Partition^c	1.05 (1.03 1.06)	<.001	1.02 (1.01 1.03)	<.001	1.00 (0.98 1.02)	0.932	1.01 (0.998 1.02)	0.116
Substitution^d								
replace sleep	/	/	0.98 (0.96 0.99)	0.004	0.96 (0.93 0.98)	<.001	0.96 (0.95 0.98)	<.001
replace sit	/	/	/	/	0.98 (0.96 1.00)	0.053	0.99 (0.97 1.004)	0.144
replace walk	/	/	/	/	/	/	1.01 (0.99 1.03)	0.433
B. decreased eGFR								
Multi-variable model^a	sleep		sit		walk		MVPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single^b	1.04 (1.01 1.07)	0.008	1.05 (1.03 1.07)	<.001	0.98 (0.94 1.02)	0.316	0.94 (0.91 0.98)	0.001
Partition^c	1.04 (1.01 1.07)	0.006	1.05 (1.03 1.07)	<.001	0.99 (0.95 1.03)	0.638	0.95 (0.92 0.99)	0.006
Substitution^d								
replace sleep	/	/	1.01 (0.98 1.05)	0.500	0.95 (0.91 0.999)	0.044	0.92 (0.88 0.96)	<.001
replace sit	/	/	/	/	0.94 (0.90 0.98)	0.005	0.90 (0.87 0.94)	<.001
replace walk	/	/	/	/	/	/	0.96 (0.91 1.01)	0.129

Abbreviations: OR, odds ratio; CI, confidence interval; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio; CKD, chronic kidney disease; MVPA, moderate-to-vigorous physical activity; single, single models; partition, partition models; substitution, isotemporal substitution models.

- a. All models were adjusted for age(continuous variable), gender(male or female), education level(<9 years or \geq 9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).
- b. Single models tested the total associations of each physical activity, unadjusted for other physical activities.
- c. Partition models tested the unique associations of each physical activity, adjusted for all other physical activities.
- d. Isotemporal substitution models tested the substitution associations of each physical activity, holding total time constant.

Supplemental Table 2. ORs and 95% CIs of associations between 1-hour units of sleep, sitting, walking and MVPA with decreasing CKD severity, from single, partition, and substitution models. (A) moderate-to-high-risk group (low-risk group as reference) (B) very-high-risk group (low-risk group as reference).

Behavioral Patterns								
A. moderate-to-high-risk group (low-risk group as reference)								
Multi-variable model^a	sleep		sit		walk		MVPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single^b	1.04 (1.03 1.06)	<.001	1.03 (1.02 1.04)	<.001	1.00 (0.98 1.02)	0.758	1.01 (0.996 1.02)	0.221
Partition^c	1.05 (1.03 1.06)	<.001	1.03 (1.02 1.04)	<.001	1.00 (0.98 1.02)	0.943	1.01 (1.00 1.02)	0.051
Substitution^d								
replace sleep	/	/	0.98 (0.97 0.999)	0.038	0.96 (0.94 0.98)	<.001	0.97 (0.95 0.99)	<.001
replace sit	/	/	/	/	0.97 (0.96 0.99)	0.009	0.99 (0.97 0.999)	0.041
replace walk	/	/	/	/	/	/	1.01 (0.99 1.03)	0.312
B. very-high-risk group (low-risk group as reference)								
Multi-variable model^a	sleep		sit		walk		MVPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single^b	1.09 (1.03 1.15)	0.003	1.06 (1.02 1.11)	0.002	0.98 (0.91 1.06)	0.576	0.89 (0.82 0.96)	0.002
Partition^c	1.09 (1.03 1.15)	0.002	1.06 (1.02 1.10)	0.003	1.00 (0.92 1.08)	0.928	0.89 (0.83 0.97)	0.004
Substitution^d								
replace sleep	/	/	0.97 (0.91 1.04)	0.397	0.91 (0.83 1.002)	0.055	0.82 (0.74 0.90)	<.001
replace sit	/	/	/	/	0.94 (0.87 1.02)	0.143	0.84 (0.78 0.92)	<.001
replace walk	/	/	/	/	/	/	0.90 (0.80 1.002)	0.054

Abbreviations: OR, odds ratio; CI, confidence interval; CKD, chronic kidney disease; MVPA, moderate-to-vigorous physical activity; single, single models; partition, partition models; substitution, isotemporal substitution models.

- a. All models were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥ 9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).
- b. Single models tested the total associations of each physical activity, unadjusted for other physical activities.
- c. Partition models tested the unique associations of each physical activity, adjusted for all other physical activities.
- d. Isotemporal substitution models tested the substitution associations of each physical activity, holding total time constant.

Supplemental Table 3. ORs and 95% CIs of associations between 1-hour units of sleep, sitting, walking, LTPA and OPA with two separate categories of CKD, from single, partition, and substitution models in working population. (A) abnormal ACR. (B) decrease eGFR.

Behavioral Patterns										
A. abnormal ACR										
Multi-variable model ^a	sleep		sit		walk		LTPA		OPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single ^b	1.07 (1.04 1.10)	<.001	0.98 (0.96 0.995)	0.015	1.00 (0.97 1.03)	0.959	0.94 (0.89 0.99)	0.027	1.02 (1.001 1.03)	0.031
Partition ^c	1.07 (1.03 1.10)	<.001	0.98 (0.96 1.001)	0.061	1.00 (0.97 1.03)	0.960	0.94 (0.89 0.996)	0.035	1.02 (0.999 1.03)	0.059
Substitution ^d										
replace sleep	/	/	0.92 (0.89 0.95)	<.001	0.94 (0.90 0.98)	0.001	0.88 (0.83 0.94)	<.001	0.95 (0.92 0.98)	0.004
replace sit	/	/	/	/	1.02 (0.99 1.05)	0.274	0.96 (0.90 1.02)	0.162	1.03 (1.01 1.06)	0.004
replace walk	/	/	/	/	/	/	0.94 (0.88 1.003)	0.060	1.02 (0.98 1.05)	0.351
replace LTPA	/	/	/	/	/	/	/	/	1.08 (1.02 1.14)	0.012
B. decreased eGFR										
Multi-variable model ^a	sleep		sit		walk		LTPA		OPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single ^b	1.00 (0.92 1.08)	0.950	1.03 (0.98 1.10)	0.262	1.05 (0.97 1.14)	0.233	1.03 (0.89 1.19)	0.693	0.96 (0.91 1.01)	0.141
Partition ^c	1.01 (0.92 1.09)	0.914	1.03 (0.97 1.09)	0.328	1.06 (0.98 1.15)	0.172	1.04 (0.89 1.21)	0.638	0.96 (0.91 1.02)	0.168
Substitution ^d										
replace sleep	/	/	1.03 (0.93 1.13)	0.624	1.05 (0.94 1.18)	0.370	1.03 (0.87 1.22)	0.715	0.96 (0.87 1.06)	0.407
replace sit	/	/	/	/	1.03 (0.93 1.13)	0.579	1.01 (0.86 1.18)	0.934	0.94 (0.87 1.01)	0.071
replace walk	/	/	/	/	/	/	0.98 (0.83 1.16)	0.814	0.91 (0.82 1.01)	0.064

replace LTPA	/	/	/	/	/	/	/	/	0.93 (0.79 1.09)	0.369
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Abbreviations: OR, odds ratio; CI, confidence interval; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio; CKD, chronic kidney disease; LTPA, leisure-time moderate-to-vigorous physical activity; OPA, occupational moderate-to-vigorous physical activity; single, single models; partition, partition models; substitution, isothermal substitution models.

- a. All models were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable) , HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).
- b. Single models tested the total associations of each physical activity, unadjusted for other physical activities.
- c. Partition models tested the unique associations of each physical activity, adjusted for all other physical activities.
- d. Isothermal substitution models tested the substitution associations of each physical activity, holding total time constant.

Supplemental Table 4. ORs and 95% CIs of associations between 1-hour units of sleep, sitting, walking and LTPA with two separate categories of CKD, from single, partition, and substitution models in unemployed population. (A) abnormal ACR. (B) decrease eGFR.

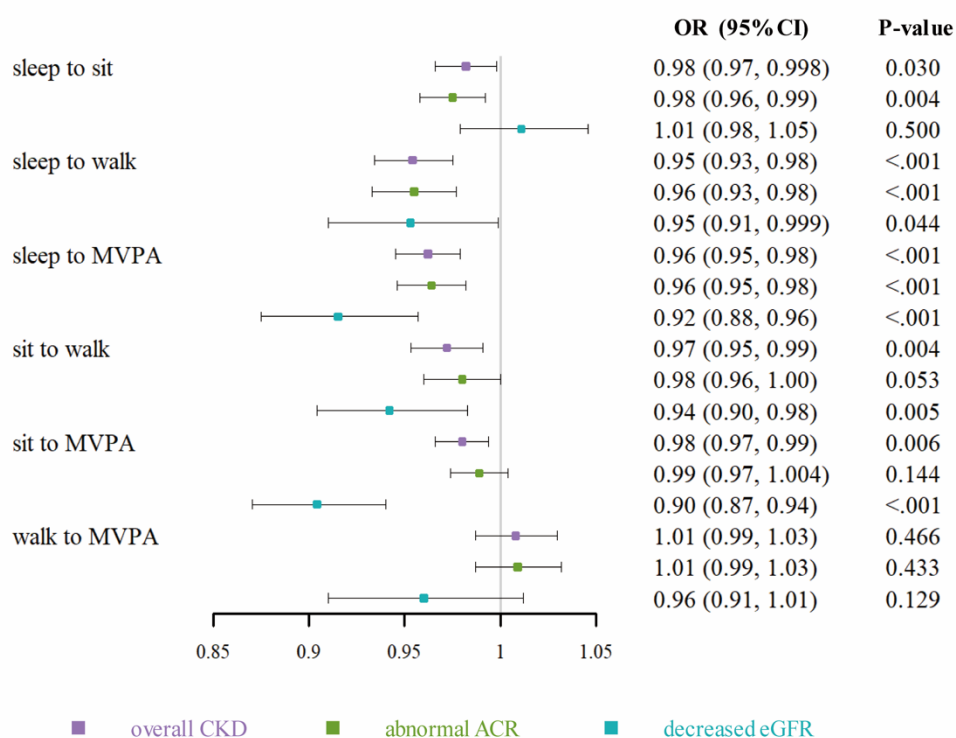
Behavioral Patterns								
A. abnormal ACR								
Multi-variable model ^a	sleep		sit		walk		LTPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single ^b	1.04 (1.02 1.05)	<.001	1.04 (1.03 1.05)	<.001	0.99 (0.97 1.02)	0.436	0.91 (0.87 0.95)	<.001
Partition ^c	1.04 (1.02 1.05)	<.001	1.04 (1.03 1.05)	<.001	1.00 (0.97 1.02)	0.699	0.91 (0.87 0.95)	<.001
Substitution ^d								
replace sleep	/	/	1.00 (0.98 1.03)	0.681	0.96 (0.93 0.99)	0.009	0.88 (0.84 0.92)	<.001
replace sit	/	/	/	/	0.96 (0.93 0.98)	0.001	0.88 (0.84 0.92)	<.001
replace walk	/	/	/	/	/	/	0.92 (0.87 0.97)	0.001
B. decreased eGFR								
Multi-variable model ^a	sleep		sit		walk		LTPA	
	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
Single ^b	1.04 (1.01 1.08)	0.003	1.05 (1.03 1.07)	<.001	0.97 (0.93 1.01)	0.174	1.00 (0.93 1.07)	0.894
Partition ^c	1.05 (1.02 1.08)	0.003	1.05 (1.03 1.08)	<.001	0.98 (0.94 1.02)	0.300	1.01 (0.94 1.08)	0.875
Substitution ^d								
replace sleep	/	/	1.01 (0.97 1.04)	0.735	0.93 (0.89 0.98)	0.011	0.96 (0.89 1.04)	0.296
replace sit	/	/	/	/	0.93 (0.89 0.97)	0.002	0.96 (0.89 1.03)	0.212
replace walk	/	/	/	/	/	/	1.03 (0.95 1.12)	0.495

Abbreviations: OR, odds ratio; CI, confidence interval; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio; CKD, chronic kidney disease; LTPA, leisure-time moderate-to-vigorous physical activity; single, single models; partition, partition models; substitution, isotemporal substitution models.

- a. All models were adjusted for age(continuous variable), gender(male or female), education level(<9 years or \geq 9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).
- b. Single models tested the total associations of each physical activity, unadjusted for other physical activities.
- c. Partition models tested the unique associations of each physical activity, adjusted for all other physical activities.
- d. Isotemporal substitution models tested the substitution associations of each physical activity, holding total time constant.

Supplemental Figure 1. The association of reallocating 1-hour units of sleep, sitting, walking and MVPA with overall CKD, abnormal ACR and decreased eGFR.

CKD outcomes

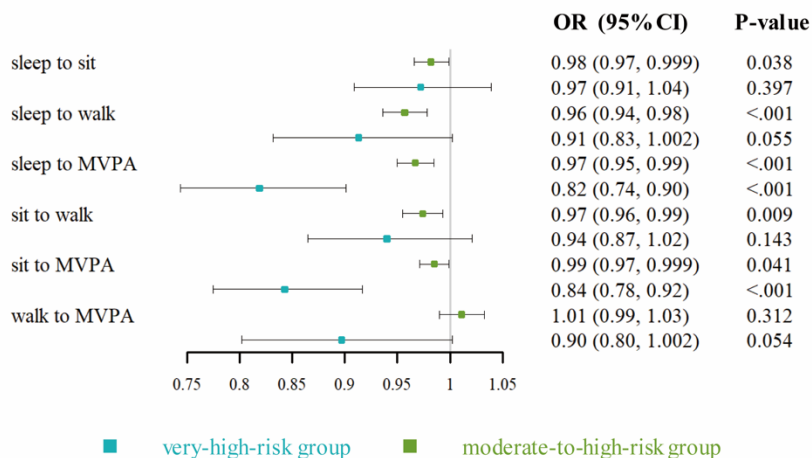


Abbreviations: OR, odds ratio; CI, confidence interval; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio; CKD, chronic kidney disease; MVPA, moderate-to-vigorous physical activity;

ORs were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).

Supplemental Figure 2. The association of reallocating 1-hour units of sleep, sitting, walking and MVPA with decreasing CKD severity in moderate-to-high-risk group and very-high-risk group (low-risk group as reference).

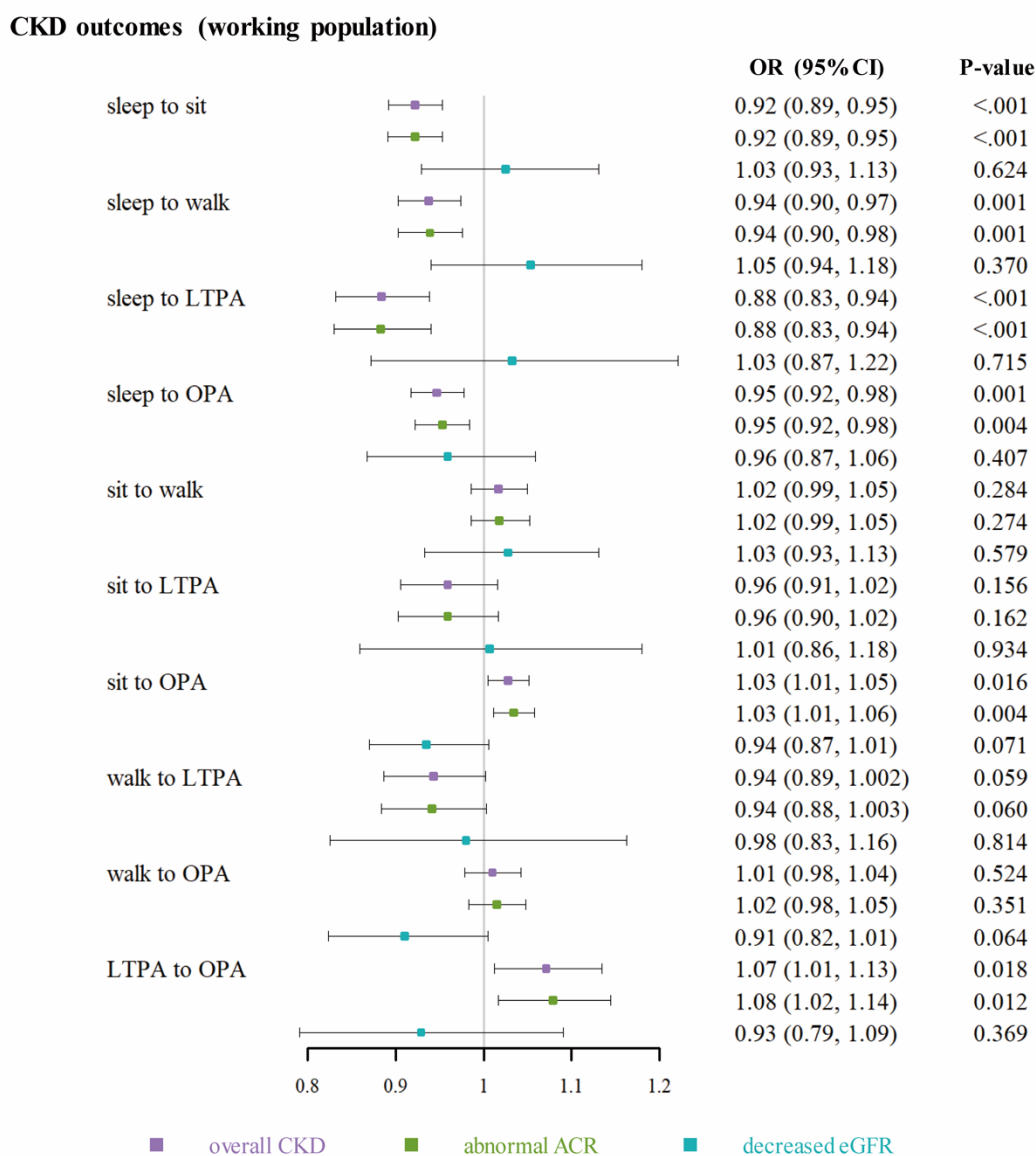
Reduction of CKD severity



Abbreviations: OR, odds ratio; CI, confidence interval; CKD, chronic kidney disease; MVPA, moderate-to-vigorous physical activity.

ORs were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).

Supplemental Figure 3. The association of reallocating 1-hour units of sleep, sitting, walking, LTPA and OPA with overall CKD, abnormal ACR and decreased eGFR in working population.

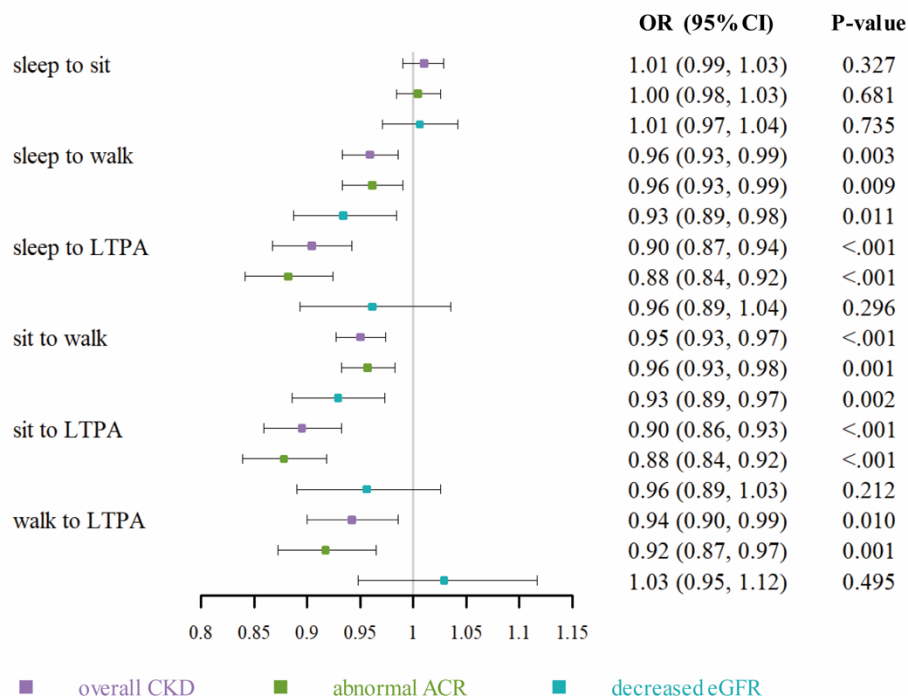


Abbreviations: OR, odds ratio; CI, confidence interval; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio; CKD, chronic kidney disease; LTPA, leisure-time moderate-to-vigorous physical activity; OPA, occupational moderate-to-vigorous physical activity.

ORs were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).

Supplemental Figure 4. The association of reallocating 1-hour units of sleep, sitting, walking and LTPA with overall CKD, abnormal ACR and decreased eGFR in unemployed population.

CKD outcomes (unemployed population)



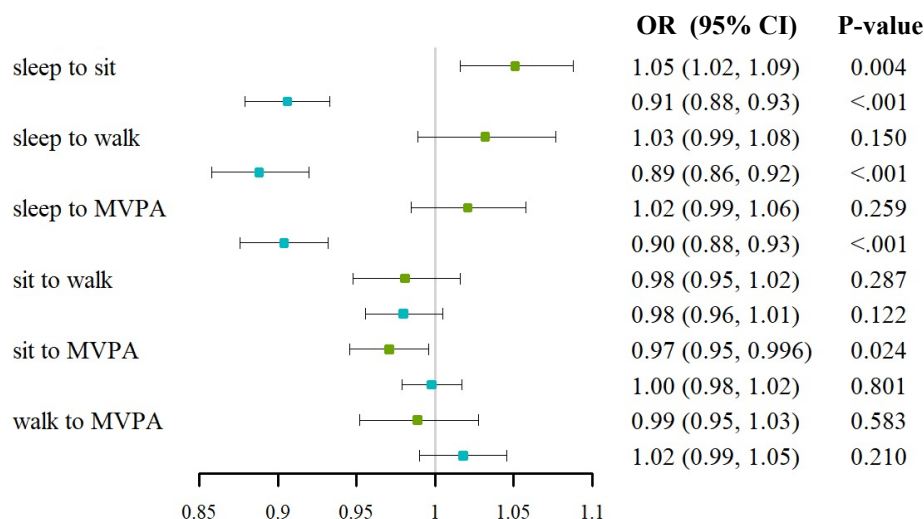
Abbreviations: OR, odds ratio; CI, confidence interval; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio; CKD, chronic kidney disease; LTPA, leisure-time moderate-to-vigorous physical activity.

ORs were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).

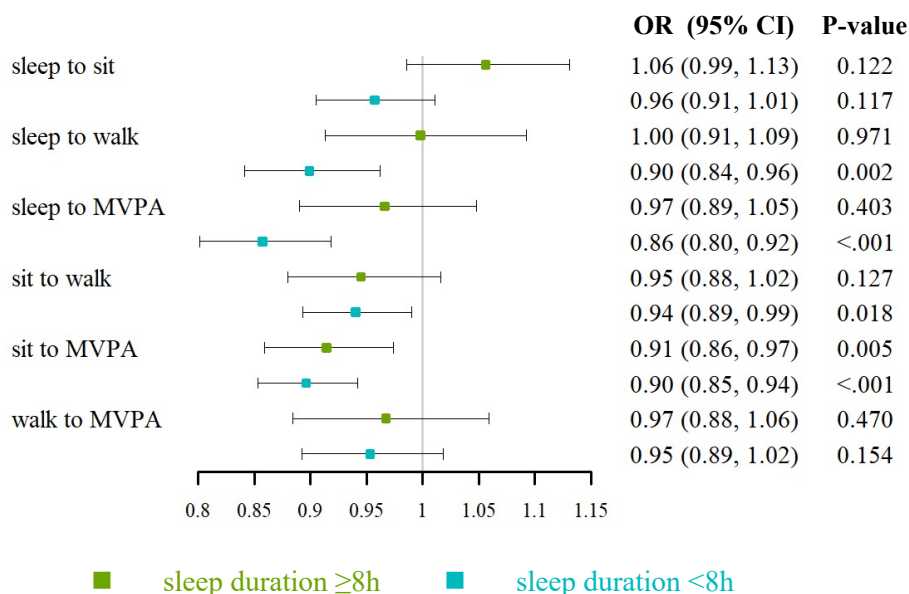
Supplemental Figure 5. The association of reallocating 1-hour units of sleep, sitting, walking and MVPA with abnormal ACR and decreased eGFR stratified by sleeping duration.

(A) ORs (95%CI) for abnormal ACR. (B) ORs (95%CI) for decreased eGFR.

A. Abnormal ACR



B. Decreased eGFR



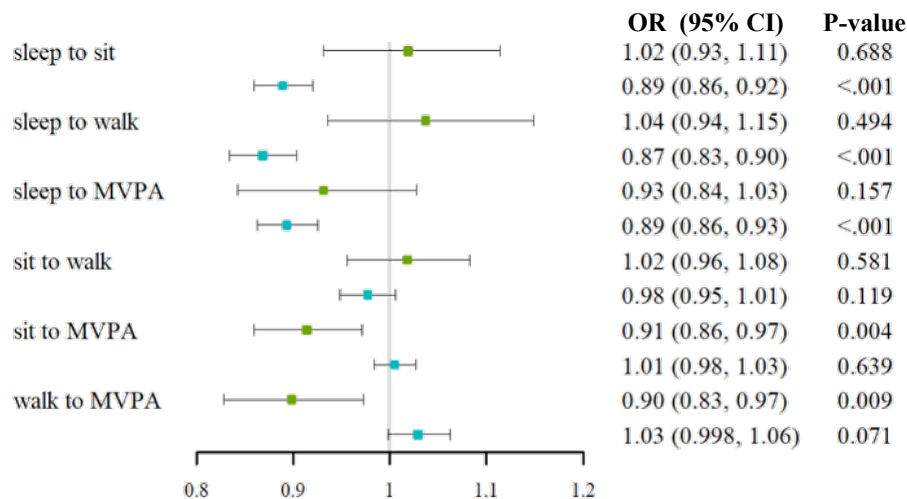
Abbreviations: OR, odds ratio; CI, confidence interval; MVPA, moderate-to-vigorous physical activity; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio.

ORs were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).

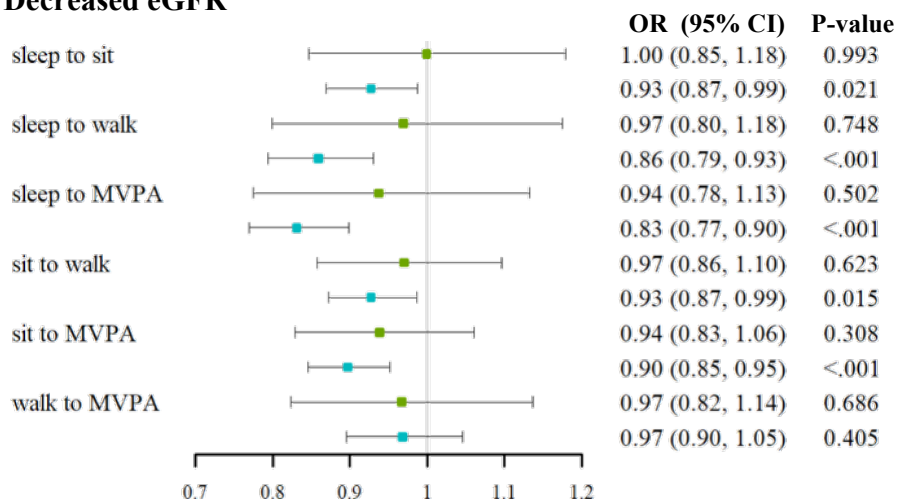
Supplemental Figure 6. The association of reallocating 1-hour units of sleep, sitting, walking and MVPA with abnormal ACR and decreased eGFR in long-sleepers further stratified by bedtime.

(A) ORs (95%CI) for abnormal ACR. (B) ORs (95%CI) for decreased eGFR.

A. Abnormal ACR



B. Decreased eGFR



■ bedtime before 23:00 ■ bedtime after 23:00

Abbreviations: OR, odds ratio; CI, confidence interval; MVPA, moderate-to-vigorous physical activity; eGFR, estimated glomerular filtration rate; ACR, albumin/creatinine ratio.

ORs were adjusted for age(continuous variable), gender(male or female), education level(<9 years or ≥9 years), smoking(current or not), alcohol drinking(current or not), diet quality(healthy or unhealthy), BMI (continuous variable), HbA1c (continuous variable), systolic blood pressure (continuous variable), diastolic blood pressure (continuous variable), hypoglycemic drugs (use or not) and antihypertensive drugs (use or not).