

Title: Sitting Time and Its Interaction With Physical Activity in Relation to All-Cause and Heart Disease Mortality in U.S. Adults With Diabetes

Running Title: Sitting Time and Mortality in Diabetes

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Supplementary Materials

Supplementary Table S1. Assessment of Physical Activity and Sitting Time, NHANES 2007-2018

Supplementary Table S2. Number (%) of missing values in U.S. adults with diabetes, NHANES 2007–2018

Supplementary Table S3. Baseline characteristics of U.S. adults with diabetes according to physical activity and extreme sitting time categories, NHANES 2007-2018

Supplementary Table S4. Hazard ratios of all-cause mortality for sitting time stratified by different thresholds of physical activity in U.S. adults with diabetes, the National Health and Nutrition Examination Survey 2007-2018

Supplementary Table S5. Hazard ratios of heart disease mortality for sitting time stratified by different thresholds of physical activity in U.S. adults with diabetes, the National Health and Nutrition Examination Survey 2007-2018

Supplementary Table S6. Sensitivity analyses for the association of sitting time with all-cause mortality risk stratified by physical activity categories in U.S. adults with diabetes, NHANES 2007-2018

Supplementary Table S7. Sensitivity analyses for the association of sitting time with heart disease mortality risk stratified by physical activity categories in U.S. adults with diabetes, NHANES 2007-2018

Supplementary Figure S1. Flow chart illustrating the participant selection process, NHANES 2007-2018

Supplementary Table S1. Assessment of Physical Activity and Sitting Time, NHANES 2007-2018

Variable	Label	English Text
PAQ605	Vigorous work activity	Next I am going to ask you about the time {you spend/SP spends} doing different types of physical activity in a typical week. Think first about the time {you spend/he spends/she spends} doing work. Think of work as the things that {you have/he has/she has} to do such as paid or unpaid work, household chores, and yard work. Does {your/SP's} work involve vigorous-intensity activity that causes large increases in breathing or heart rate like carrying or lifting heavy loads, digging or construction work for at least 10 minutes continuously?
PAQ610	Number of days vigorous work	In a typical week, on how many days {do you/does SP} do vigorous-intensity activities as part of {your/his/her} work?
PAD615	Minutes vigorous-intensity work	How much time {do you/does SP} spend doing vigorous-intensity activities at work on a typical day?
PAQ620	Moderate work activity	Does {your/SP's} work involve moderate-intensity activity that causes small increases in breathing or heart rate such as brisk walking or carrying light loads for at least 10 minutes continuously?
PAQ625	Number of days moderate work	In a typical week, on how many days {do you/does SP} do moderate-intensity activities as part of {your/his/her} work?
PAD630	Minutes moderate-intensity work	How much time {do you/does SP} spend doing moderate-intensity activities at work on a typical day?
PAQ635	Walk or bicycle	The next questions exclude the physical activity at work that you have already mentioned. Now I would like to ask you about the usual way {you travel/SP travels} to and from places. For example to school, for shopping, to work. In a typical week {do you/does SP} walk or use a bicycle for at least 10 minutes continuously to get to and from places?
PAQ640	Number of days walk or bicycle	In a typical week, on how many days {do you/does SP} walk or bicycle for at least 10 minutes continuously to get to and from places?
PAD645	Minutes walk/bicycle for transportation	How much time {do you/does SP} spend walking or bicycling for travel on a typical day?
PAQ650	Vigorous recreational activities	The next questions exclude the work and transport activities that you have already mentioned. Now I would like to ask you about sports, fitness and recreational activities. In a typical week {do you/does SP} do any vigorous-intensity sports, fitness, or recreational activities that cause large increases in breathing or heart rate like running or basketball for at least 10 minutes continuously?
PAQ655	Days vigorous recreational activities	In a typical week, on how many days {do you/does SP} do vigorous-intensity sports, fitness or recreational activities?
PAD660	Minutes vigorous recreational activities	How much time {do you/does SP} spend doing vigorous-intensity sports, fitness or recreational activities on a typical day?
PAQ665	Moderate recreational activities	In a typical week {do you/does SP} do any moderate-intensity sports, fitness, or recreational activities that cause a small increase in breathing or heart rate such as brisk walking, bicycling, swimming, or volleyball for at least 10 minutes continuously?
PAQ670	Days moderate recreational activities	In a typical week, on how many days {do you/does SP} do moderate-intensity sports, fitness or recreational activities?
PAD675	Minutes moderate recreational activities	How much time {do you/does SP} spend doing moderate-intensity sports, fitness or recreational activities on a typical day?

PAD680	Minutes sedentary activity	The following question is about sitting at work, at home, getting to and from places, or with friends, including time spent sitting at a desk, traveling in a car or bus, reading, playing cards, watching television, or using a computer. Do not include time spent sleeping. How much time {do you/does SP} usually spend sitting on a typical day?
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Supplementary Table S2. Number (%) of missing values in U.S. adults with diabetes, NHANES 2007–2018

Characteristic	n	%
Age	0	0
Sex	0	0
Race/ethnicity	0	0
Educational attainment	12	0.2%
Family poverty income ratio	688	10.9%
Health insurance	5	0.1%
Smoking status	2	0.03%
Alcohol intake	668	10.5%
Moderate-to-vigorous physical activity	0	0
Healthy Eating Index 2015	802	12.7%
Sleep duration	26	0.4%
Body mass index	310	4.9%
Hypertension	0	0
Dyslipidemia	0	0
Diabetes duration	45	0.7%
Antidiabetic medications	0	0
History of cancer	0	0
History of cardiovascular disease	0	0

Supplementary Table S3. Baseline characteristics of U.S. adults with diabetes according to physical activity and extreme sitting time categories, NHANES 2007-2018

Characteristic ^b	Inactive ^a		Insufficiently active ^a		Active ^a	
	ST <4 h/d	ST ≥8 h/d	ST <4 h/d	ST ≥8 h/d	ST <4h/d	ST ≥8 h/d
Age, y	60.2 (0.7)	63.5 (0.5)	57.7 (1.2)	58.7 (0.9)	55.6 (0.5)	57.4 (0.6)
Age group						
<45 y	12.8 (49)	9.3 (88)	16.3 (29)	18.3 (52)	22.5 (159)	14.6 (110)
45 to 64 y	47.8 (252)	42.4 (409)	50.8 (117)	47.3 (162)	49.4 (436)	54.6 (368)
≥65 y	39.4 (242)	48.3 (637)	32.8 (88)	34.3 (160)	28.1 (305)	30.8 (235)
Female sex	60.7 (323)	52.7 (575)	60.4 (140)	45.6 (173)	42.0 (380)	36.3 (264)
Race/ethnicity						
Non-Hispanic White	38.9 (103)	70.4 (522)	30.4 (33)	63.4 (145)	49.4 (225)	67.4 (278)
Non-Hispanic Black	18.8 (122)	13.1 (292)	21.8 (59)	17.6 (116)	13.8 (189)	14.1 (203)
Hispanic	33.4 (266)	9.5 (220)	34.9 (112)	10.0 (64)	27.7 (386)	9.5 (133)
Other	8.9 (52)	7.0 (100)	12.9 (30)	9.0 (49)	9.1 (100)	9.0 (99)
family poverty income ratio						
≤1.30	36.6 (229)	25.5 (380)	37.6 (95)	19.1 (103)	27.4 (308)	17.3 (182)
>1.30 and ≤3.50	36.7 (179)	34.5 (402)	38.3 (78)	34.3 (126)	36.6 (327)	27.0 (230)
>3.50	12.1 (46)	32.6 (243)	12.1 (24)	39.9 (110)	25.4 (154)	50.0 (252)
Missing	14.6 (89)	7.5 (109)	11.9 (37)	6.7 (35)	10.6 (111)	5.7 (49)
Educational attainment						
<high school	46.0 (299)	25.5 (405)	42.2 (118)	12.9 (72)	26.9 (349)	10.3 (128)
High school graduate	24.1 (109)	24.8 (273)	23.6 (49)	21.7 (95)	28.9 (213)	20.4 (154)
>high school	29.9 (135)	49.6 (451)	34.3 (67)	65.2 (206)	43.9 (333)	69.2 (431)
Missing	0 (0)	0.2 (5)	0 (0)	0.2 (1)	0.3 (5)	0 (0)
Health insurance						
None	18.6 (107)	6.7 (98)	17.6 (47)	5.0 (26)	20.8 (210)	11.4 (102)

Private	45.3 (194)	55.0 (505)	43.3 (81)	65.3 (207)	49.0 (360)	63.0 (393)
Public/other	36.0 (241)	38.3 (531)	39.1 (106)	29.7 (141)	30.2 (330)	25.6 (218)
Missing	0.1 (1)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Smoking status						
Never	54.9 (325)	44.2 (521)	61.5 (142)	50.0 (185)	50.6 (477)	50.2 (347)
Former	29.1 (139)	39.5 (426)	25.5 (59)	37.9 (135)	28.4 (265)	35.8 (243)
Current	16.0 (79)	16.3 (187)	12.9 (33)	12.1 (54)	21.0 (157)	14.0 (123)
Missing	0 (0)	0 (0)	0 (0)	0 (0)	0.1 (1)	0 (0)
Alcohol intake						
Never	48.5 (292)	40.0 (515)	52.5 (128)	27.2 (140)	35.8 (355)	28.0 (233)
Moderate	35.9 (167)	42.6 (421)	34.2 (74)	58.4 (172)	46.2 (385)	62.4 (389)
Heavy	3.1 (12)	5.8 (55)	3.9 (7)	7.3 (23)	8.1 (57)	3.9 (34)
Missing	12.5 (72)	11.6 (143)	9.4 (25)	7.1 (39)	9.9 (103)	5.7 (57)
Body mass index categories						
<25 kg/m ²	12.1 (75)	8.3 (121)	18.9 (43)	7.1 (43)	16.0 (155)	9.8 (76)
25 to <30 kg/m ²	27.3 (170)	20.6 (263)	29.8 (69)	20.6 (82)	30.2 (289)	27.2 (190)
≥30 kg/m ²	55.7 (273)	62.6 (642)	48.8 (115)	68.8 (233)	51.4 (426)	61.1 (429)
Missing	5.0 (25)	8.5 (108)	2.5 (7)	3.6 (16)	2.4 (30)	2.0 (18)
Sleep duration						
<7 h/d	27.5 (178)	32.2 (373)	36.7 (77)	34.6 (142)	37.7 (336)	35.9 (273)
7-7.9 h/d	23.8 (117)	20.6 (210)	27.6 (64)	27.0 (89)	27.2 (222)	26.1 (173)
≥8 h/d	47.8 (244)	46.7 (546)	35.5 (92)	37.8 (141)	34.0 (336)	37.2 (265)
Missing	0.9 (4)	0.6 (5)	0.3 (1)	0.6 (2)	1.1 (6)	0.7 (2)
Healthy Eating Index 2015	52.5 (0.8)	52.9 (0.5)	54.9 (1.1)	53.6 (0.9)	55.0 (0.7)	54.6 (0.7)
Diabetes duration						
≤5 y	48.4 (257)	43.8 (485)	59.8 (129)	50.9 (172)	55.2 (473)	50.8 (350)
>5 and ≤10 y	16.9 (83)	14.6 (158)	16.8 (34)	15.1 (61)	16.5 (136)	17.7 (117)

>10 y	34.2 (198)	40.4 (477)	22.8 (69)	33.8 (140)	28.2 (288)	31.2 (243)
Missing	0.5 (5)	1.2 (14)	0.7 (2)	0.2 (1)	0.1 (3)	0.2 (3)
Diabetes medication						
None	38.2 (203)	32.5 (363)	49.3 (93)	36.2 (124)	43.7 (368)	39.4 (277)
Non-insulin agents	41.4 (238)	40.6 (467)	37.2 (104)	43.5 (172)	41.1 (388)	41.5 (291)
Insulin	20.4 (102)	26.8 (304)	13.6 (37)	20.3 (78)	15.2 (144)	19.1 (145)
Hypertension	78.7 (431)	83.8 (951)	66.6 (172)	77.0 (288)	69.5 (647)	73.0 (538)
Dyslipidemia	34.2 (180)	36.1 (384)	35.3 (75)	39.6 (125)	36.8 (315)	37.4 (255)
History of Cancer	11.6 (58)	15.7 (182)	5.4 (15)	17.1 (54)	10.5 (80)	15.0 (86)
History of Cardiovascular disease	24.5 (130)	36.9 (427)	14.9 (34)	22.5 (95)	14.1 (141)	22.6 (173)

^a Based on their moderate-to-vigorous physical activity levels, participants were categorized into inactive (<10 min/week), insufficiently active (10-149 min/week), and active (\geq 150 min/week).

^b Data were presented as weighted mean (SE) for continuous variables and weighted percentage (unweighted N) for categorical variables. Abbreviation: ST, sitting time. The differences in participant characteristics by extreme sitting time categories across different physical activity levels were determined by linear regression for continuous variables and Rao-Scott chi-square test for categorical variables.

Supplementary Table S4. Hazard ratios of all-cause mortality for sitting time stratified by different thresholds of physical activity in U.S. adults with diabetes, the National Health and Nutrition Examination Survey 2007-2018^a

	Sitting time, h/d				<i>P</i> for interaction
	<4	4 to <6	6 to <8	≥8	
No. of deaths	232	260	222	564	
Person-years of follow-up	11307	9092	5948	12660	
Threshold: 140 min/week of MVPA					
<140 min/week of MVPA	1 [Reference]	0.93 (0.72, 1.22)	1.16 (0.85, 1.58)	1.77 (1.44, 2.16)	
≥140 min/week of MVPA	1 [Reference]	1.03 (0.69, 1.53)	1.14 (0.70, 1.86)	1.20 (0.83, 1.75)	0.04
Threshold: 130 min/week of MVPA					
<130 min/week of MVPA	1 [Reference]	0.92 (0.71, 1.21)	1.14 (0.83, 1.55)	1.75 (1.43, 2.15)	
≥130 min/week of MVPA	1 [Reference]	1.03 (0.70, 1.53)	1.18 (0.73, 1.91)	1.22 (0.84, 1.76)	0.04
Threshold: 120 min/week of MVPA					
<120 min/week of MVPA	1 [Reference]	0.93 (0.71, 1.23)	1.06 (0.78, 1.44)	1.73 (1.41, 2.12)	
≥120 min/week of MVPA	1 [Reference]	1.02 (0.70, 1.49)	1.30 (0.82, 2.06)	1.25 (0.87, 1.80)	0.03
Threshold: 110 min/week of MVPA					
<110 min/week of MVPA	1 [Reference]	0.93 (0.71, 1.23)	1.05 (0.78, 1.43)	1.73 (1.41, 2.12)	
≥110 min/week of MVPA	1 [Reference]	1.02 (0.70, 1.49)	1.31 (0.83, 2.07)	1.24 (0.86, 1.79)	0.03
Threshold: 100 min/week of MVPA					
<100 min/week of MVPA	1 [Reference]	0.94 (0.71, 1.25)	1.05 (0.76, 1.46)	1.73 (1.40, 2.13)	
≥100 min/week of MVPA	1 [Reference]	0.98 (0.67, 1.44)	1.29 (0.82, 2.04)	1.25 (0.88, 1.80)	0.04
Threshold: 90 min/week of MVPA					
<90 min/week of MVPA	1 [Reference]	0.92 (0.69, 1.23)	1.02 (0.73, 1.43)	1.70 (1.38, 2.09)	
≥90 min/week of MVPA	1 [Reference]	1.00 (0.68, 1.47)	1.27 (0.82, 1.96)	1.27 (0.90, 1.79)	0.03
Threshold: 80 min/week of MVPA					
<80 min/week of MVPA	1 [Reference]	0.91 (0.68, 1.21)	1.00 (0.71, 1.42)	1.66 (1.35, 2.05)	

≥80 min/week of MVPA	1 [Reference]	1.02 (0.70, 1.50)	1.30 (0.85, 2.00)	1.30 (0.92, 1.83)	0.06
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^a Adjusted for age, sex, race/ethnicity, family-income-to-poverty ratio, education level, health insurance, BMI, cigarette smoking, alcohol consumption, Healthy Eating Index 2015, sleep duration, diabetes duration, antidiabetic medications, hypertension, dyslipidemia, cardiovascular disease, cancer, and continuous moderate-to-vigorous physical activity in the Cox proportional hazards model while accounting for the NHANES complex survey design.

Supplementary Table S5. Hazard ratios of heart disease mortality for sitting time stratified by different thresholds of physical activity in U.S. adults with diabetes, the National Health and Nutrition Examination Survey 2007-2018^a

	Sitting time, h/d				<i>P</i> for interaction
	<4	4 to <6	6 to <8	≥8	
No. of deaths	48	80	53	173	
Person-years of follow-up	11307	9092	5948	12660	
Threshold: 140 min/week of MVPA					
<140 min/week of MVPA	1 [Reference]	1.55 (0.86, 2.79)	1.29 (0.75, 2.23)	3.47 (1.99, 6.07)	
≥140 min/week of MVPA	1 [Reference]	1.74 (0.84, 3.59)	1.14 (0.51, 2.54)	0.89 (0.37, 2.14)	0.004
Threshold: 130 min/week of MVPA					
<130 min/week of MVPA	1 [Reference]	1.54 (0.86, 2.78)	1.28 (0.74, 2.22)	3.46 (1.98, 6.03)	
≥130 min/week of MVPA	1 [Reference]	1.72 (0.84, 3.56)	1.13 (0.51, 2.49)	0.92 (0.39, 2.18)	0.004
Threshold: 120 min/week of MVPA					
<120 min/week of MVPA	1 [Reference]	1.58 (0.87, 2.87)	1.18 (0.69, 2.00)	3.35 (1.92, 5.87)	
≥120 min/week of MVPA	1 [Reference]	1.70 (0.84, 3.47)	1.27 (0.63, 2.54)	1.12 (0.50, 2.52)	0.008
Threshold: 110 min/week of MVPA					
<110 min/week of MVPA	1 [Reference]	1.58 (0.87, 2.87)	1.18 (0.69, 2.00)	3.35 (1.92, 5.86)	
≥110 min/week of MVPA	1 [Reference]	1.71 (0.84, 3.48)	1.27 (0.64, 2.54)	1.12 (0.50, 2.52)	0.008
Threshold: 100 min/week of MVPA					
<100 min/week of MVPA	1 [Reference]	1.60 (0.87, 2.93)	1.19 (0.69, 2.03)	3.32 (1.89, 5.83)	
≥100 min/week of MVPA	1 [Reference]	1.62 (0.78, 3.33)	1.22 (0.61, 2.43)	1.22 (0.55, 2.70)	0.02
Threshold: 90 min/week of MVPA					
<90 min/week of MVPA	1 [Reference]	1.64 (0.89, 3.03)	1.23 (0.71, 2.11)	3.37 (1.91, 5.97)	
≥90 min/week of MVPA	1 [Reference]	1.59 (0.78, 3.28)	1.16 (0.58, 2.33)	1.24 (0.59, 2.60)	0.02
Threshold: 80 min/week of MVPA					
<80 min/week of MVPA	1 [Reference]	1.61 (0.87, 2.99)	1.22 (0.71, 2.10)	3.35 (1.89, 5.94)	

≥80 min/week of MVPA	1 [Reference]	1.60 (0.78, 3.29)	1.16 (0.58, 2.33)	1.24 (0.58, 2.61)	0.02
Threshold: 70 min/week of MVPA					
<70 min/week of MVPA	1 [Reference]	1.59 (0.86, 2.94)	1.21 (0.70, 2.07)	3.28 (1.85, 5.83)	
≥70 min/week of MVPA	1 [Reference]	1.62 (0.78, 3.34)	1.19 (0.60, 2.38)	1.30 (0.62, 2.74)	0.04
Threshold: 60 min/week of MVPA					
<60 min/week of MVPA	1 [Reference]	1.56 (0.85, 2.89)	1.20 (0.70, 2.08)	3.33 (1.90, 5.83)	
≥60 min/week of MVPA	1 [Reference]	1.62 (0.81, 3.25)	1.21 (0.61, 2.40)	1.32 (0.66, 2.64)	0.06

^a Adjusted for age, sex, race/ethnicity, family-income-to-poverty ratio, education level, health insurance, BMI, cigarette smoking, alcohol consumption, Healthy Eating Index 2015, sleep duration, diabetes duration, antidiabetic medications, hypertension, dyslipidemia, cardiovascular disease, cancer, and continuous moderate-to-vigorous physical activity in the Cox proportional hazards model while accounting for the NHANES complex survey design.

Supplementary Table S6. Sensitivity analyses for the association of sitting time with all-cause mortality risk stratified by physical activity categories in U.S. adults with diabetes, NHANES 2007-2018^a

	Sitting time, h/d				<i>P</i> for trend	<i>P</i> for interaction
	<4	4 to <6	6 to <8	≥8		
Sensitivity analysis 1 ^b						
Inactive	1 [Reference]	0.89 (0.60, 1.32)	0.91 (0.62, 1.33)	1.57 (1.20, 2.06)	<0.001	
Insufficiently active	1 [Reference]	0.57 (0.30, 1.09)	2.82 (1.30, 6.09)	1.94 (1.11, 3.37)	0.001	
Active	1 [Reference]	1.05 (0.69, 1.59)	0.99 (0.58, 1.70)	1.33 (0.89, 1.99)	0.18	0.03
Sensitivity analysis 2 ^c						
Inactive	1 [Reference]	0.99 (0.72, 1.35)	0.99 (0.67, 1.45)	1.80 (1.44, 2.26)	<0.001	
Insufficiently active	1 [Reference]	0.65 (0.35, 1.21)	2.86 (1.54, 5.30)	1.72 (1.00, 2.94)	0.005	
Active	1 [Reference]	1.07 (0.71, 1.62)	1.13 (0.68, 1.87)	1.26 (0.86, 1.84)	0.23	0.003

^a Adjusted for age, sex, race/ethnicity, family poverty income ratio, education level, health insurance, BMI, smoking status, alcohol intake, Healthy Eating Index 2015, sleep duration, continuous moderate-to-vigorous physical activity, diabetes duration, antidiabetic medications, hypertension, dyslipidemia, and history of cardiovascular disease or cancer in the Cox proportional hazards model and accounting for the NHANES complex survey design. Based on their moderate-to-vigorous physical activity levels, participants were categorized into inactive (<10 min/week), insufficiently active (10-149 min/week), and active (≥150 min/week).

^b Individuals died within the first two years of follow-up were excluded to limit reverse causation.

^c Multiple imputations were performed using the fully conditional specification method to generate five imputed datasets to account for missing values.

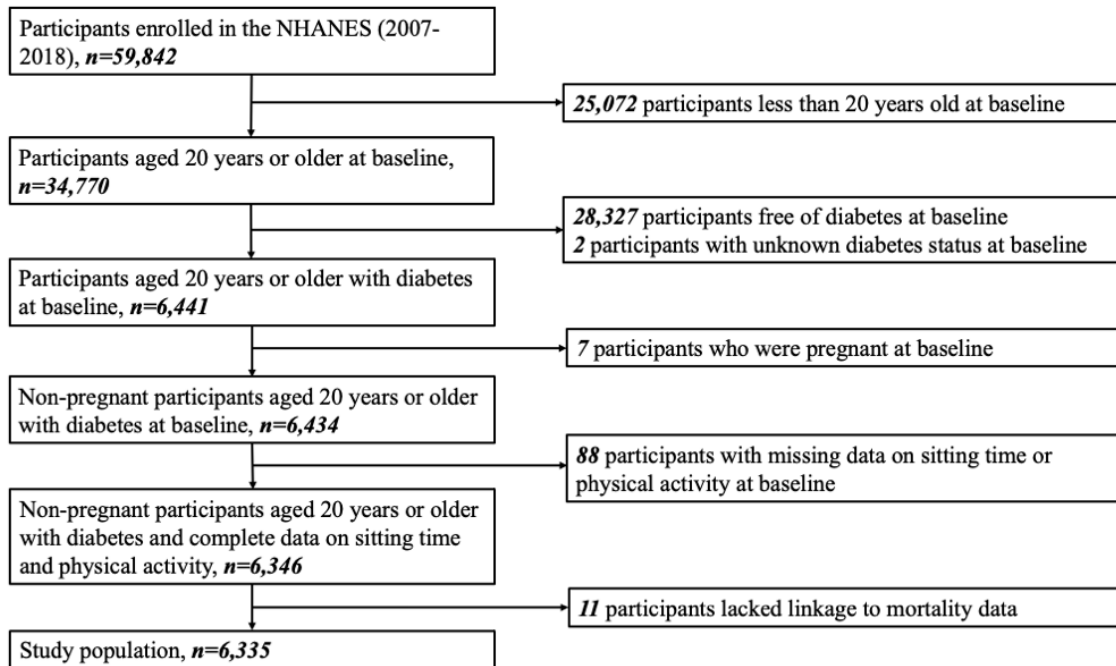
Supplementary Table S7. Sensitivity analyses for the association of sitting time with heart disease mortality risk stratified by physical activity categories in U.S. adults with diabetes, NHANES 2007-2018^a

		Sitting time, h/d				<i>P</i> for trend	<i>P</i> for interaction
		<4	4 to <6	6 to <8	≥8		
Sensitivity analysis 1 ^b							
Inactive or insufficiently active	1 [Reference]	1.38 (0.68, 2.82)	1.45 (0.80, 2.61)	3.48 (1.83, 6.65)	<0.001		
Active	1 [Reference]	1.73 (0.77, 3.87)	0.68 (0.25, 1.85)	0.90 (0.33, 2.45)	0.35	0.02	
Sensitivity analysis 2 ^c							
Inactive or insufficiently active	1 [Reference]	1.50 (0.85, 2.64)	1.26 (0.74, 2.14)	3.25 (1.88, 5.62)	<0.001		
Active	1 [Reference]	1.98 (0.89, 4.42)	1.05 (0.45, 2.47)	1.11 (0.46, 2.70)	0.58	0.009	

^a Adjusted for age, sex, race/ethnicity, family poverty income ratio, education level, health insurance, BMI, smoking status, alcohol intake, Healthy Eating Index 2015, sleep duration, continuous moderate-to-vigorous physical activity, diabetes duration, antidiabetic medications, hypertension, dyslipidemia, and history of cardiovascular disease or cancer in the Cox proportional hazards model and accounting for the NHANES complex survey design. Based on their moderate-to-vigorous physical activity levels, participants were categorized into inactive (<10 min/week), insufficiently active (10-149 min/week), and active (≥150 min/week).

^b Individuals died within the first two years of follow-up were excluded to limit reverse causation.

^c Multiple imputations were performed using the fully conditional specification method to generate five imputed datasets to account for missing values.



Supplementary Figure S1. Flow chart illustrating the participant selection process, NHANES 2007-2018