

CVD risk from prolonged occupational sitting attenuated by additional physical activity – Evidence from a prospective cohort of 481,688 Asian adults

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Abstract

Background

For the first time, the 2020 WHO guidelines on physical activity recommend reducing sedentary behaviors due to their health consequences. Less is known on the effect of prolonged occupational sitting, especially in the context of low physical activity engagement.

This study aims at quantifying cardiovascular risk associated with prolonged occupational sitting and determining the additional amount of physical activity that may be needed to attenuate it.

Methods

A cohort comprising 481,688 participants in a health surveillance program in Taiwan was followed between 1996 and 2017, collecting data on occupational sitting time, leisure-time physical activity (LTPA) habits, lifestyle, and metabolic parameters. The all-cause and expanded cardiovascular disease (CVD + diabetes mellitus + kidney disease) mortality associated with three occupational sitting volumes (mostly sitting, alternating sitting and non-sitting, mostly non-sitting) was analyzed applying multivariate Cox regression models to calculate the hazard ratios (HRs) for all participants and by subgroups, including five levels of LTPA. Deaths in the first two years of follow-up were excluded to avoid reverse causality.

Results

The study recorded 26,257 deaths during a mean follow-up period of 12.85 years. Individuals mostly sitting at work had a higher mortality risk than those mostly non-sitting, both from all causes (HR: 1.16, 95% CI: 1.11-1.20) and from expanded CVD (HR: 1.46, 95% CI: 1.35-1.58), after adjusting for gender, age, education, smoking, drinking, and body mass index. Individuals alternating sitting and non-sitting at work did not experience increased risk for all-cause mortality, compared to individuals mostly non-sitting at work (HR: 1.01, 95% CI: 0.97-1.05), but did experience higher risk of deaths due to expanded CVD (HR: 1.13, 95% CI: 1.04-1.23). Individuals engaged in low (15-29 min/day) or no (<15 min/day) LTPA, who mostly sit at work, would need to increase their LTPA by 15 and 30 minutes respectively to reduce their risk of mortality to that of similarly inactive individuals who mostly do not sit at work.

Conclusions

As part of modern lifestyles, prolonged occupational sitting is considered normal and has not received due attention, even though its deleterious effect has been largely proved. Alternating sitting and non-sitting at work, as well as an extra 15 to 30 min/day of LTPA, can attenuate the harms of prolonged occupational sitting. Thus, emphasizing the associated harms and suggesting workplace system changes could help the society to de-normalize this common behavior, similarly to the process of de-normalizing smoking.

Condensed Abstract

Competency in medical knowledge

Individuals who mostly sit at work face increased mortality risk, compared to individuals who mostly do not sit at work. Alternating sitting and non-sitting at work or engaging in an additional 15 to 30 mins of leisure-time physical activity can reduce workers' mortality risk to that of individuals who mostly do not sit at work.

Translational outlook

By de-normalizing prolonged occupational sitting, with behavioral and system change efforts similar to those made to de-normalize smoking, we can achieve a paradigm shift and hopefully reverse the current perception of sedentary lifestyles, both at work and during leisure time.

Introduction

Modern lifestyles have become increasingly sedentary,¹ and prolonged sitting is currently so pervasive that most people perceive it as part of normal life,² despite the fact that, with some exceptions,³ the scientific literature agrees on its deleterious effects. For the first time in 2020, the WHO guidelines on physical activity recommend reducing sedentary behaviors due to its health consequences,⁴ which accords with similar recent physical activities guidelines published in the USA in 2018,⁵ and UK in 2019,⁶ that also discourage prolonged sitting. However, this guidance can be difficult to adhere to, particularly in workplace settings where not sitting is not well supported.

Few studies have specifically examined prolonged occupational sitting. However, several studies have found increased mortality among prolonged sitters from all causes,^{7–11} as well as from cardiovascular disease (CVD),¹² cancer,^{13,14} and diabetes.^{15,16} For example, a cohort study of more than 200,000 individuals in Australia found a dose-response relationship between prolonged sitting and all-cause mortality, with increased risk among individuals with more hours per day of prolonged sitting.⁸ Similarly, a meta-analysis of six studies found increased risk for all-cause mortality with increased prolonged sitting.⁹ On the other hand, associations between prolonged sitting and health outcomes have not been consistently demonstrated. Prospective studies have generally found that prolonged sitting increases the risk of diabetes mellitus, for example, but not cancer.¹⁷ Similarly, an analysis found that associations between prolonged sitting and health outcomes are dependent on gender.¹⁸ It is not necessarily clear, overall, if the adverse health effects associated with prolonged sitting necessarily translate to occupational settings. In addition, the health risks of prolonged sitting have been shown to be independent of leisure-time physical inactivity.^{19,20} Working long hours shares some similarities with prolonged sitting in terms of health impacts. For instance, some studies have found similar dose-response relationships between working long hours and increased incidence in coronary heart disease and stroke.^{21,22} Thus, one would expect similar, if not worse health consequences for prolonged occupational sitting; nonetheless, the evidences of harms associated with working long hours in a sitting position are less consistent.^{17,23}

Another important issue is the amount of leisure-time physical activity (LTPA) needed to offset or attenuate the health repercussions of prolonged occupational sitting. For example, A meta-analysis by Ekelund and colleagues concluded that the risk of prolonged sitting could be eliminated with 60–75 min/day of exercise,²⁰ approximately 4–5 times more than the current WHO recommendation.²⁴ It is unclear, however, whether this level of offset can be reasonably achieved or whether the findings would hold using different approaches.

In this study, we aim to (1) understand the health risks of prolonged sitting on all-cause and CVD mortality, and (2) quantify the amount of LTPA needed to mitigate the risks for individuals mostly sitting at work to the level of those alternating sitting and non-sitting or mostly non-sitting at work.

Methods

Study Population and General Data Collection

Our cohort included 481,688 individuals aged 20 years and older who participated in an annual to bi-annual standard medical screening program in Taiwan run by a private firm, MJ Health Management Institution, between 1996 and 2017. Most of the participants were outwardly healthy, and followed for a mean period of 12.85 years (standard deviation = 5.67 years), which equates to 6,186,949 person-years at follow-up.

At each visit, participants completed a self-administered questionnaire on their medical history and lifestyle risk factors, and specimens for biological tests were collected. Previous studies have described in more detail the entire program, as well as the data collection methods.^{25,26}

Measurement of Prolonged Occupational Sitting, Physical Activity, and Adverse Health Outcomes

The occupational sitting status of each participant was categorized into three groups: mostly sitting, alternating sitting and non-sitting, mostly non-sitting; based on the answer to the following question included in the above-mentioned questionnaire: "What is your level of activity at work?". The response options included: "mostly sitting", "mostly sitting and standing performing repetitive motions in the course of work", "standing and walking around most of the time".

The LTPA status was determined through two multiple-choice questions. The first asked the participants to classify all their weekly LTPAs in the last month into four intensity categories: light (e.g., walking), moderate (e.g., brisk walking), medium vigorous (e.g., jogging), or highly vigorous (e.g., running). The second required the participants to indicate the weekly duration of each LTPA in the last month. Further details can be found in Wen et al (2011).²⁵ Based on their answers, participants were classified into five LTPA groups by metabolic equivalent of task (MET)-hour/week: inactive (<3.75 MET-hour/week or <15 min/day), low –i.e. engaged in low LTPA- (3.75-7.49 MET-hour/week or 15-29 min/day), medium (7.50-16.49 MET-hour/week or 30-59 min/day), high (16.5-25.49 MET-hour/week or 60-89 min/day), and very high (≥ 25.5 MET-hour/week or ≥ 90 min/day).

The codification proposed by Ainsworth and colleagues was adopted.²⁷

Deaths were ascertained by linking each participant's identification number to the Taiwan National Death Registry, excluding the first two years of the follow-up period to avoid reverse causality (i.e., sicknesses or poor health causing a sedentary lifestyle). Along with all-cause mortality, we focused on the so-called expanded CVD (CVD + diabetes + kidney disease) mortality, to account for the tendency of physicians in Taiwan to enter diabetes as the underlying cause of death in the death certificates.²⁸⁻³¹

Statistical Analysis

First, we fit Cox proportional hazards models to obtain hazard ratios for all-cause and expanded-CVD mortality relative to a reference of mostly non-sitting. Then, we repeated this analysis by separately stratifying to men, women, individuals aged < 60 years, individuals aged \geq 60 years, smokers, never-smokers, individuals with body mass index (BMI) \geq 25, individuals with BMI \geq 30, hypertensive, and diabetics. Finally, we fit a Cox model between occupational sitting status and LTPA to obtain hazard ratios of sitting-LTPA groups relative to the reference of mostly sitting and no LTPA. We also used the model to identify the amount of exercise needed to offset the risk from sitting. The models were adjusted for gender, age, education, smoking, drinking, and BMI. P-values of less than 0.05 were considered as significant.

The statistical analysis was performed using SAS version 9.4.

Results

A majority (60.2%, 290,075) of participants (Table 1) were in the mostly sitting group, while 10.7% (51,403) were in the non-sitting group and 29.1% (140,210) in the alternating sitting and non-sitting group. Physical activity varied across sitting groups, with 47.5% of the mostly sitting group describing themselves as physically inactive, compared to 51.7% in the alternating sitting and non-sitting group, and 57.2% in the mostly non-sitting group. People in the mostly sitting group tended to be younger and more educated (college or higher: 49.4% vs. 23.3% in the alternating sitting and non-sitting group and 18.0% in the mostly non-sitting group), had fewer lifestyle risks like smoking (17.7% vs. 25.0% and 33.9%) or drinking (6.3% vs. 9.2% and 14.8%), and were less likely to be overweight or obese (BMI \geq 25 kg/m²: 25.6% vs. 28.1% and 30.2%) or hypertensive (systolic blood pressure \geq 140mmHg: 16.3% vs. 18.1% and 20.4%).

During the entire follow-up period of 12.85 years (Table 2) the study recorded 26,257 deaths, 57.3% of which occurred among individuals mostly sitting at work (15,045). The number of deaths attributable to expanded CVD was 7,563, with 61.7% of these occurring in the mostly sitting group (61.7%). After adjusting for gender, age, education, smoking, drinking, and BMI, individuals mostly sitting at work had a higher risk of dying by all causes (HR: 1.16, 95% CI: 1.11-1.20) and expanded CVD (HR: 1.46, 95% CI: 1.35-1.58), compared with the mostly non-sitting group. Significantly higher risks were estimated in the alternating sitting and non-sitting group only for expanded CVD (HR: 1.13, 95% CI: 1.04-1.23).

In all the subgroup analyses, individuals mostly sitting at work exhibited higher all-cause mortality risk, compared to mostly non-sitting at work counterparts. We observed significant increased risk among men (HR: 1.13, 95% CI: 1.08-1.19) and among women (HR: 1.21, 95% CI: 1.12-1.31), among people younger than 60 (HR: 1.21, 95% CI: 1.14-1.28) and among people older than 60 (HR: 1.57, 95% CI: 1.49-1.66), among smokers (HR: 1.14, 95% CI: 1.08-1.20) and among never smokers (HR: 1.17, 95% CI: 1.11-1.24), and among people with chronic conditions. No significant differences were observed between the alternating sitting and non-sitting group and the mostly non-sitting group (Table 2).

A similar pattern was found for expanded CVD mortality, as mostly sitting at work was associated with significantly higher mortality risk among men (HR: 1.42, 95% CI: 1.29-1.55), women (HR: 1.42, 95% CI: 1.22-1.66), individuals aged < 60 years (HR: 1.67, 95% CI: 1.47-1.90), individuals aged \geq 60 years (HR: 1.94, 95% CI: 1.76-2.15), smokers (HR: 1.43, 95% CI: 1.28-1.59), never-smokers (HR: 1.47, 95% CI: 1.31-1.65), and, as before,

among people with chronic conditions. In this case, some significant differences were also detected in the alternating sitting and non-sitting group, with higher mortality risks among men (HR: 1.14, 95% CI: 1.03-1.26), individuals aged < 60 years (HR: 1.21, 95% CI: 1.06-1.38), individuals aged ≥ 60 years (HR: 1.14, 95% CI: 1.02-1.27), never-smokers (HR: 1.15, 95% CI: 1.02-1.30), and overweight individuals (HR: 1.17, 95% CI: 1.02-1.34) (Table 2).

Finally, as displayed in Figure 1, the all-cause mortality risk in the three occupational sitting groups was analyzed across the five levels of LTPA, using the model with the inactive/mostly sitting group as the reference. At each LTPA level from “inactive” to “high”, individuals mostly sitting at work show significantly higher risks than those alternating sitting and non-sitting, as well as than those mostly non-sitting, while the HRs estimated for these latter two groups are quite similar. At very high LTPA, no substantial differences can be observed between mostly sitting (HR: 0.65, 95% CI: 0.59-0.71), alternating sitting and non-sitting (HR: 0.64, 95% CI: 0.57-0.72), and mostly non-sitting (HR: 0.75, 95% CI: 0.66-0.85).

Individuals mostly sitting at work who engaged in low LTPA are less at risk than the reference group (HR: 0.92, 95% CI: 0.87-0.96), but more at risk than individuals alternating sitting and non-sitting engaged in the same LTPA level (HR: 0.79, 95% CI: 0.75-0.84) and more at risk than individuals mostly non-sitting engaged in no (HR: 0.83, 95% CI: 0.78-0.87) and low (HR: 0.82, 95% CI: 0.74-0.90) LTPA. Only at medium LTPA, the risk for individuals mostly sitting at work becomes similar (HR=0.86, 95%CI, 0.82-0.90) to that of individuals alternating sitting and non-sitting and to that of individuals mostly non-sitting at no and low LTPA. At medium, high, and very high LTPA the HRs estimated for the alternating sitting and non-sitting group are quite like those estimated for the mostly non-sitting group, ranging between 0.65 and 0.75. To reach the same risk, individuals mostly sitting at work need to engage in very high LTPA.

Discussion

We found that individuals who mostly sit at work had higher mortality risks than those who mostly do not sit at work. This finding held across numerous subpopulations considered in the analysis, including those defined by gender, age, smoking, BMI, and pre-existing health conditions. For example, the risk for all-cause mortality was higher among smokers who mostly sat at work than among smokers who mostly did not sit at work. Our study finds that alternating sitting and non-sitting or increasing LTPA can alleviate harms associated with prolonged occupational sitting. For example, individuals who alternated sitting and non-sitting at work had a 13% reduction in risk for all-cause mortality compared to individuals who mostly sat at work. In addition, we found that the risk for all-cause mortality among individuals who mostly sat at work but had high LTPA was comparable to the risk among individuals who mostly did not sit at work but had low LTPA.

Few studies have specifically examined risks associated with prolonged occupational sitting.^{17,23} However, our findings are in line with several other studies showing increased risk for mortality among individuals who experienced prolonged sitting in general.^{7,20,32} The 1.15 hazard ratio for all-cause mortality, comparing 8-11 hours of prolonged sitting to less than 4 hours of prolonged sitting, reported in a recent cohort study by Eklund and colleagues,²⁰ is remarkably similar to our observed hazard ratio of 1.16 comparing individuals who mostly sit at work to individuals who mostly do not sit at work. Further, despite meaningful differences in approach, our study is consistent with the above-mentioned meta-analysis in suggesting that detrimental effects of

prolonged sitting can be offset by physical activity. Overall, our findings from a large prospective cohort help to strengthen the increasingly accumulating evidence on the association between sedentary lifestyle and health risks. Prior studies have showed harms associated with total sitting times,^{8,10,11} TV watching times,^{13,33} and leisure time mainly spent sitting.¹² As previously noted, evidence on the health risks associated with occupational sitting does exist but is less evident as the heterogeneity of study designs and measures makes it difficult to draw definitive conclusions.^{10,17}

Several explanations have been proposed to explain the harms of prolonged sitting, including a lack of exercise of the large muscles in the lower limbs and trunk with increased blood flow to lower extremities, as well as the presence of a biomarker for low-grade inflammation,^{34,35} that can lead to reduced insulin action,³⁶ diabetes, obesity, metabolic syndrome,³⁷ and reduced kidney function.^{38,39} Since individuals working long hours often share many characteristics with those who have a sedentary life style, not surprisingly a similar amplification of CVD risks has been reported in a number of studies.^{15,21,22,40}

Our findings have several implications in terms of possible interventions for reducing the risks associated with prolonged occupational sitting. First, the attenuated risk among individuals who alternate sitting and non-sitting at work suggests that in addition to increasing LTPA volume, negative health consequences can also be reduced by taking breaks, which might be prompted by mobile phones, wearable devices,⁴¹ or employer-designed break times. The former option has been formally explored with prospective experimental studies that have provided considerable evidence of positive effects of breaking up prolonged sitting time on metabolic outcomes.⁴² Practical solutions such as standing tables and activity-permissive workstations can also reduce occupational sedentary time effectively, without compromising work performance.⁴³ Second, while the health risks of prolonged occupational sitting could be detrimental for those who are also physically inactive, it is reassuring to find that those risks could be offset by only 30 min/day of exercise. Time for such exercise could be facilitated by employers with, for example, designated areas for engaging in LTPA or optional group activities.

Strengths and Limitations

This study has a number of strengths. First, it is based on a large single cohort, with prolonged occupational sitting and amount of physical activity defined consistently for the entire cohort, which is in contrast to the heterogeneity often encountered in pooled studies.^{19,20} Second, the metric used to express the volume of physical activity, namely MET-h/week, is difficult to collect but has been shown to be valid in a highly cited publication.²⁵ Third, study subjects had a complete medical examination including biological data, which made possible to adjust for possible confounders. Fourth, we were able to link the data to the national death registry and excluded individuals who died within the first two years of entry into the cohort to eliminate those with pre-existing health conditions, thus minimizing the potential for reverse causation.

The present study has also some important limitations. First, prolonged occupational sitting and physical activity were both self-reported, so data could be biased. Participants tend to provide what they perceive to be desired answers, indicating they exercise more and sit less than what would be measured by an objective method.⁴⁴ However, the participants were asked as many as 100 questions during their check-ups, making

over- or under-reporting less likely. Second, the fact that the participants paid out of pocket for their health check-ups may have attracted individuals with higher socio-economic status (SES). However, the risks were calculated based on internal comparison of subgroups, thus minimizing the effect of SES. Third, while we have three categories of prolonged occupational settings to demonstrate a dose-response effect, a precise quantification of the number of hours spent sitting at work every day was not available.

Conclusion

The risks associated with prolonged occupational sitting are serious and can be minimized via alternating sitting and non-sitting or by additional physical activity. While comparisons between prolonged sitting and smoking are controversial,⁴⁵ we argue that the comparison is useful to at least emphasize the normalization of the risk behavior and the opportunities for change, at individual and system levels. In occupational settings, the opportunities for system change to reduce risks are numerous and include allowance for more frequent breaks, provision of standing desks, or designated workplace areas for physical activity.

Declarations

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Conflict of interest

None declared.

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Tables

Table 1 Distribution of socio-demographic characteristics, smoking and drinking, LTPA, and metabolic indicators by occupational sitting status.

		Total		Mostly sitting		Alternating sitting and non-sitting		Mostly non-sitting	
		N	(%)	N	(%)	N	(%)	N	(%)
Age	20-39	286,867	(59.6)	178,913	(61.7)	82,060	(58.5)	25,894	(50.4)
	40-59	147,257	(30.6)	83,620	(28.8)	44,482	(31.7)	19,155	(37.3)
	60 or above	47,564	(9.9)	27,542	(9.5)	13,668	(9.7)	6,354	(12.4)
Sex	Men	225,611	(46.8)	128,404	(44.3)	64,141	(45.7)	33,066	(64.3)
	Women	256,077	(53.2)	161,671	(55.7)	76,069	(54.3)	18,337	(35.7)
Education	Middle school or lower	93,260	(19.6)	37,911	(13.2)	36,038	(26.1)	19,311	(38.3)
	High school	99,827	(21.0)	46,309	(16.2)	39,500	(28.6)	14,018	(27.8)
	Junior college	99,166	(20.9)	60,726	(21.2)	30,435	(22.0)	8,005	(15.9)
	College or higher	182,806	(38.5)	141,500	(49.4)	32,236	(23.3)	9,070	(18.0)
Smoking status	Never-smoker	338,745	(72.4)	216,833	(76.6)	93,362	(69.1)	28,550	(57.6)
	Ex-smoker	28,306	(6.1)	16,071	(5.7)	8,038	(5.9)	4,197	(8.5)
	Current smoker	100,611	(21.5)	50,019	(17.7)	33,775	(25.0)	16,817	(33.9)
Drinking status	Non-drinker	373,541	(81.2)	235,079	(84.2)	104,659	(78.8)	33,803	(69.9)
	Moderate drinker	49,679	(10.8)	26,338	(9.4)	15,934	(12.0)	7,407	(15.3)
	Regular drinker	37,080	(8.1)	17,625	(6.3)	12,287	(9.2)	7,168	(14.8)
Leisure-time physical activity	Inactive	235,021	(49.8)	135,378	(47.5)	71,025	(51.7)	28,618	(57.2)
	Low	125,734	(26.6)	81,556	(28.6)	34,367	(25.0)	9,811	(19.6)
	Medium	70,196	(14.9)	44,312	(15.6)	19,787	(14.4)	6,097	(12.2)
	High	26,120	(5.5)	15,552	(5.5)	7,643	(5.6)	2,925	(5.8)
	Very high	15,000	(3.2)	7,965	(2.8)	4,433	(3.2)	2,602	(5.2)
Body mass index	<18.5	43,080	(8.9)	27,930	(9.6)	11,659	(8.3)	3,491	(6.8)
	18.5-24.9	309,346	(64.2)	187,863	(64.8)	89,111	(63.6)	32,372	(63.0)
	25-29.9	108,616	(22.6)	62,252	(21.5)	33,214	(23.7)	13,150	(25.6)
	30 or above	20,463	(4.2)	11,891	(4.1)	6,193	(4.4)	2,379	(4.6)
Systolic blood pressure	<140 mmHg	398,343	(82.7)	242,655	(83.7)	114,796	(81.9)	40,892	(79.6)
	≥140 mmHg or on medication	83,345	(17.3)	47,420	(16.3)	25,414	(18.1)	10,511	(20.4)
Fasting blood sugar level	<126 mg/dL	458,481	(95.2)	276,273	(95.2)	133,544	(95.2)	48,664	(94.7)
	≥126 mg/dL or	23,207	(4.8)	13,802	(4.8)	6,666	(4.8)	2,739	(5.3)

	on medication				
Total cholesterol	<240 mg/dL	426,931 (88.7)	257,678 (88.9)	124,016 (88.5)	45,237 (88.1)
	>=240 mg/dL or on medication	54,487 (11.3)	32,258 (11.1)	16,114 (11.5)	6,115 (11.9)

Table 2 Overall and by subgroup Cox regression analysis output.

Population		All-cause			Expanded CVD		
		Deaths	HR	[95% CI]	Deaths	HR	[95% CI]
All participants	Mostly sitting	15,045	1.16	[1.11, 1.20]	4,646	1.46	[1.35, 1.58]
	Alternating sitting and non-sitting	7,257	1.01	[0.97, 1.05]	1,928	1.13	[1.04, 1.23]
	Mostly non-sitting	3,955		Ref.	962		Ref.
Men	Mostly sitting	8,077	1.13	[1.08, 1.19]	2,426	1.42	[1.29, 1.55]
	Alternating sitting and non-sitting	3,658	1.01	[0.96, 1.06]	946	1.14	[1.03, 1.26]
	Mostly non-sitting	3,084		Ref.	726		Ref.
Women	Mostly sitting	6,968	1.21	[1.12, 1.31]	2,220	1.42	[1.22, 1.66]
	Alternating sitting and non-sitting	3,599	1.03	[0.95, 1.12]	982	1.06	[0.91, 1.25]
	Mostly non-sitting	871		Ref.	236		Ref.
Age<60	Mostly sitting	5,563	1.21	[1.14, 1.28]	1,288	1.67	[1.47, 1.90]
	Alternating sitting and non-sitting	3,665	1.01	[0.95, 1.07]	787	1.21	[1.06, 1.38]
	Mostly non-sitting	1,962		Ref.	409		Ref.
Age≥60	Mostly sitting	9,482	1.57	[1.49, 1.66]	3,358	1.94	[1.76, 2.15]
	Alternating sitting and non-sitting	3,592	1.06	[1.00, 1.12]	1,141	1.14	[1.02, 1.27]
	Mostly non-sitting	1,993		Ref.	553		Ref.
Smokers	Mostly sitting	5,561	1.14	[1.08, 1.20]	1,675	1.43	[1.28, 1.59]
	Alternating sitting and non-sitting	2,671	1.01	[0.95, 1.07]	653	1.09	[0.97, 1.23]
	Mostly non-sitting	2,190		Ref.	503		Ref.
Never-smokers	Mostly sitting	8,737	1.17	[1.11, 1.24]	2,722	1.47	[1.31, 1.65]
	Alternating sitting and non-sitting	4,180	1.02	[0.96, 1.08]	1,165	1.15	[1.02, 1.30]
	Mostly non-sitting	1,560		Ref.	391		Ref.
BMI≥25	Mostly sitting	5,835	1.13	[1.06, 1.21]	2,061	1.50	[1.32, 1.71]
	Alternating sitting and non-sitting	2,805	0.98	[0.91, 1.05]	867	1.17	[1.02, 1.34]
	Mostly non-sitting	1,350		Ref.	363		Ref.
BMI≥30	Mostly sitting	995	1.20	[1.01, 1.42]	376	1.47	[1.07, 2.00]
	Alternating sitting and non-sitting	436	0.96	[0.80, 1.16]	147	1.08	[0.77, 1.51]
	Mostly non-sitting	184		Ref.	57		Ref.
Hypertensives	Mostly sitting	8,418	1.21	[1.14, 1.28]	3,253	1.42	[1.28, 1.57]
	Alternating sitting and non-	3,599	1.01	[0.95,	1,275	1.08	[0.97,

	sitting		1.08]		1.20]
	Mostly non-sitting		Ref.		Ref.
Diabetics	Mostly sitting	1,749		567	
	Alternating sitting and non-sitting	3,531	1.20 [1.09, 1.32]	1,693	1.47 [1.27, 1.71]
	Mostly not	1,298	0.97 [0.88, 1.08]	539	1.04 [0.88, 1.23]
	Mostly non-sitting	608	Ref.	233	Ref.

Figures

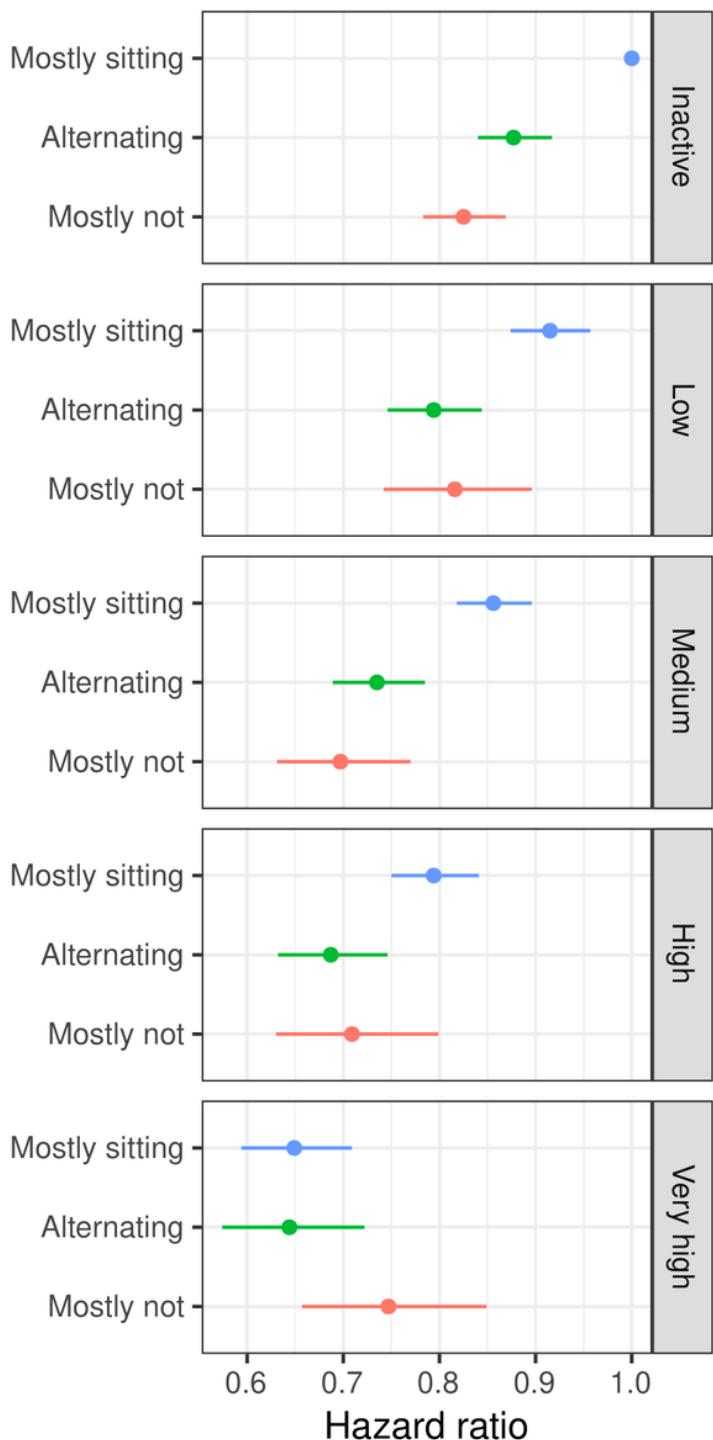


Figure 1

Cox regression analysis output by occupational sitting status and LTPA.