

## **Weekly hours of informal caregiving and work and risk of cardiovascular disease**

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## **Abstract**

**Background:** Little is known on the association between weekly hours of informal caregiving and risk of cardiovascular disease (CVD). The objective of the present study was to investigate the individual and joint effects of weekly hours of informal caregiving and paid work on the risk of cardiovascular disease (CVD).

**Methods:** Pooled analysis with data from the Swedish Longitudinal Occupational Survey of Health and the Whitehall II study. In total 1,396 informal caregivers in gainful employment. Informal caregiving defined as care for an aged or disabled relative. The outcome was CVD cases during 10 years follow-up. Analyses were adjusted for age, sex, children, marital status, and occupational grade.

**Results:** There were 59 cases of CVD. Informal caregivers providing care >20 hours weekly were at higher risk of CVD compared to those providing care 1-8 hours weekly (hazard ratio=2.63, 95% CI:1.20; 5.76), irrespectively of weekly work hours. In sensitivity analyses, we found this risk to be markedly higher among long-term caregivers (6.17, 95% CI:1.73;22.1) compared to short-term caregivers (0.89, 95% CI:0.10;8.08). Caregivers working  $\geq$ 55 hours weekly were at higher risk of CVD (2.23, 95% CI:1.14;4.35) compared to those working 35-40 hours weekly. Furthermore, those providing care >8 hours and working  $\leq$ 40 hours weekly had a higher risk of CVD compared to those providing care 1-8 hours and working  $\leq$ 40 hours (3.23, 95% CI:1.25;8.37).

**Conclusion:** Many weekly hours of informal caregiving may pose a higher risk of CVD **as opposed to few weekly hours**, irrespectively of weekly work hours. This, association seemed to be driven by those providing long-term care.

**Keywords:** *Cardiovascular disease, informal caregiving, work hours, pooled analysis*

## **Introduction**

Informal caregiving, defined as unpaid care for elderly or disabled family members, is common in working age (1–3). Helping those in need is meaningful to most people, and informal caregiving saves the health-care system considerable expenses in terms of relieving formal caregiving services (4). However, informal caregiving may lead to an emotional and physical burden for the caregiver (3,5). Furthermore, chronic stress from caregiving (6) may lead to a dysregulation of the cardiovascular system via a hyper activation of the hypothalamic-pituitary-adrenal axis (7). It has therefore been hypothesized that informal caregiving may increase the risk of cardiovascular disease (CVD) (8–10).

In order to initiate preventive strategies to reduce health consequences of informal caregiving, it becomes important to unveil certain conditions under which caregiving becomes a stress burden with consequences for health. Caregiving hours may be used as an indicator of intensity, but only few studies have addressed the relationship between caregiving hours and risk of CVD. A study based on the US Nurses' Health Study showed that women providing spousal care for  $\geq 9$  hours weekly had a higher risk of CHD compared to non-caregivers (11). Additionally, results indicate that weekly hours of caregiving had a greater impact on risk of CHD compared to perceived stress from caregiving (11). However, Nurses' Health Study only included female nurses, which may limit generalizability to the general working population. In another study among British civil servants, an association between informal caregiving and CHD was found only for caregivers in poor health (12). In an additional analysis, they find no increased risk of CHD in those providing  $\leq 5$  hours or  $> 5$  hours of weekly care compared to non-caregivers. However, dividing at 5 hours weekly may not capture those with high intensity caregiving, i.e. many weekly hours.

The previous literature is limited by having non-caregivers as the reference, since being a non-caregiver does not include the mental burden of caregiving responsibilities, which caregivers have to face regardless of whether they provide caregiving for one or 30 hours weekly. By only including caregivers, we will be able to thoroughly investigate the contribution of weekly hours of caregiving. This is highly relevant in terms of designing support systems aimed at relieving some of the caregiving burden.

A further limitation in previous research on caregiving and CVD risk relates to the double burden from informal caregiving and paid work. Work stress and long working hours are independent risk factors for CHD (13–15) and it is important to recognize that work and family life are strongly intertwined and should not be treated separately in relation to health consequences (16–18). In support of this, several studies have shown that spillover between work and family life may be associated with low self-reported health (19–22).

Presently, we sought to investigate the individual and joint effects of weekly hours of informal caregiving and paid work on the risk of CVD, in informal caregivers in gainful employment.

## **Methods**

This is a multi-cohort study pooling individual level data from the Swedish Longitudinal Occupational Survey of Health (SLOSH) (23) and the Whitehall II study from the UK (24). SLOSH is an open cohort and comprises 40,877 individuals, representative of the Swedish workforce. Whitehall II includes 10,308 British civil servants from 20 London-based departments. Year 2008 was the baseline in SLOSH (response rate 61%), and years 1991-1993 were the baseline in Whitehall II (response rate 87%). The total study population encompassed 1,396 informal caregivers **in gainful employment** (Appendix A). The cohorts has been approved by the appropriate ethics committees and participants have given consent to be included.

### *Weekly hours of informal caregiving and paid work*

Informal caregiving was in both cohorts assessed by asking whether participants provided care for an aged or disabled relative. We included only those who answered “yes”. We categorized weekly hours of caregiving in three groups; 1-8 hours (reference), 9-20 hours and >20 hours (11). In Whitehall II, we had additional information on long-term caregiving, distinguishing those who provided informal care 2-3 years following baseline (long-term caregivers) from those provided care at baseline only (short-term caregivers) (9,12).

For weekly work hours, individuals in SLOSH were asked how many hours they worked each week, and in Whitehall II individuals were asked how many hours they worked on a normal workday. To harmonize this information, we multiplied daily work hours in Whitehall II by five, based on the assumption that individuals in the civil service work five days a week. Weekly work hours were categorized as <35 hours, 35-40 hours (reference), 41-54 hours, and  $\geq 55$  hours per week (13,25).

We investigated the joint effect of weekly hours of informal caregiving and paid work more thoroughly by dividing participants into four mutually exclusive groups: 1) Those providing care 1-8 hours and working  $\leq 40$  hours weekly, 2) Providing care 1-8 hours and working  $>40$  hours weekly, 3) Providing care  $>8$  hours and working  $\leq 40$  hours weekly, and 4) Providing care  $>8$  hours and working  $>40$  hours weekly.

#### *Ascertainment of cardiovascular disease*

We used register-based information on diagnosis of CVD defined according to the 10<sup>th</sup> edition of the International Classification of Disease (26). CVD encompassed diagnoses CHD (ICD-10 codes I20-I25) and stroke (ICD-10 codes I60-I63). Individuals with a CVD diagnosis at baseline were excluded from the study.

#### *Covariates*

Confounding and mediating variables related to CVD were identified based on prior knowledge and using the method of directed acyclic graphs (Appendix B). Confounding variables included age, sex, children (yes, no), marital status (yes, no), and occupational grade (low wage and manual laborers, lower non-manual and midlevel managers, and upper non-manual workers and managing staff). Smoking and BMI **measured at baseline**, were most likely mediating factors on the causal pathway from workload of caregiving and work and risk of CVD (27), and were only adjusted for in a sensitivity analysis.

#### *Statistical analyses*

We applied a Cox regression model with time from baseline as the underlying time axis. The outcome was time until CVD, death from other causes or the end of follow-up, whichever came first; with six years

follow-up in SLOSH and 10 years follow-up in Whitehall II. The Cox model was implemented in a random-effect meta-analysis where cohort specific estimates were combined and weighted in a joint model (28). The degree of heterogeneity between cohorts was assessed using  $I^2$ , which describes the percentage of total variation across studies due to heterogeneity (29). We considered  $I^2$  values of 25%, 50%, and 75% to represent low, moderate, and high heterogeneity, respectively (29). We applied a random effects model, **because there may be between-group variation in SLOSH and Whitehall II on the investigated associations**, due to different follow-up time and welfare-state differences.

We applied two analytical models: model 1 was adjusted for age and sex, and model 2 was further adjusted for children, marital status, occupational grade, **along with caregiving hours adjusted for work hours and vice versa**. Interaction was assessed on a multiplicative and additive scale according to recommendations by the STROBE guidelines (30). We assessed multiplicative interaction by including a product term between caregiving and work hour variables in the Cox model. Additive interaction was assessed with the synergy index (31), which represents the additional risk from exposure to informal caregiving and work hours when interaction is present, relative to the risk from exposure when there is no interaction. In supplemental analyses, we investigated the risk of CVD for long-term caregivers compared to short-term caregivers. In this analysis, we excluded the first three years of follow-up to minimize risk of reverse causation bias.

## Results

Among the 1,396 informal caregivers, 59 participants (4%) developed CVD within 10,410 person-years at risk. In SLOSH, there were 14 (2%) incident cases during six years follow-up and in Whitehall II, there were 45 (6%) incident cases during 10 years follow-up. There were 50 cases of CHD and 9 cases of stroke.

Baseline characteristics of the study participants are shown in Table 1.

As seen in figure 1, compared to those who provided caregiving 1-8 hours weekly, those who provided 9-20 weekly hours of caregiving (HR=3.31, 95% CI: 0.53;20.5) or > 20 hours weekly (HR=2.63; 95% CI: 1.20;5.76) were at higher risk of CVD (Appendix C1). There was high heterogeneity with an  $I^2$

value of 85% for the estimate on 9-20 hours. Cohort specific estimates suggest that the risk of CVD was higher in SLOSH (HR=8.71, 95% CI: 2.85;26.6) compared to Whitehall II (HR=1.35, 95% CI:0.59;3.13) (Appendix C2-C3). There was no noteworthy heterogeneity for >20 weekly hours of caregiving. As also seen in figure 1, those working  $\geq 55$  hours weekly had a higher risk of CVD compared to those working 35-40 hours weekly (HR=2.52, 95% CI:1.14;4.35). For those working <35 hours and those working 41-54 hours weekly there were no association with CVD. Gender specific analyses showed no effect modification by sex (Appendix C4). Furthermore, additional analyses showed that estimates attenuated slightly when adjusting for smoking and BMI (Appendix C5).

In figure 2, we present the joint model of weekly hours of caregiving and work. We did not find a higher risk of CVD in the group who provided few hours (1-8 hours weekly) of caregiving and working >40 hours (HR=1.34; 95% CI: 0.67;2.68). However, individuals who provided > 8 hours of caregiving seemed to be at a higher risk of CVD irrespectively of whether they worked less (HR=3.23, 95% CI:1.25;8.37) or more than 40 hours per week (HR=2.87; 95% CI: 0.45;18.3) (Appendix C6). However, there was moderate heterogeneity in the latter analysis: Those exposed to many caregiving hours and long work hours in SLOSH had a markedly higher risk of CVD (HR=8.17, 95% CI:1.41;47.4) compared to those with few caregiving hours and short work hours, while this was less supported in Whitehall II (HR=1.22, 95% CI:0.33;4.51) (Appendix C7-C8).

In further analyses using Whitehall II data (figure 3), we found that long-term caregivers providing 9-20 hours (HR=4.41, 95% CI:0.88;22.0) and >20 hours of weekly caregiving (HR=6.17, 95% CI:1.73;22.1) were at markedly higher risk of CVD compared to long-term caregivers providing caregiving for 1-8 hours. For short-term caregivers, there was no association with CVD in either group (appendix C9). We found a multiplicative interaction between long-term caregiving and weekly hours of caregiving using a binary variable with >8 hours and  $\leq 8$  hours of caregiving (multiplicative interaction:  $p=0.04$ , additive interaction: synergy index=-1.49). In general, there was no attenuation of hazard ratios in the multiple adjusted analyses, compared to the analyses adjusted for age and sex only.

## Discussion

In this longitudinal study of informal caregivers in gainful employment, we found that those who provided many weekly hours of informal caregiving were at markedly higher risk of CVD opposed to few weekly hours, irrespectively of weekly work hours. In addition, we found that many caregiving hours were associated with a six times higher risk of CVD among long-term caregivers, whereas many caregiving hours did not seem to be associated with CVD risk among short-term caregivers. We also found that long working hours was associated with a higher risk of CVD, but there was only weak evidence to support a more detrimental effect among those with double burden from long caregiving- and work hours.

Based on results from the 2001 UK Census, it is estimated that 10% of the UK population provide informal caregiving, with a peak at age 45-59, in which almost 20% provide informal caregiving (32). Furthermore, it is estimated that around 75% of caregivers in the UK are gainfully employed (Scotland excluded) (1). In Sweden, it is estimated that 25% of the population provides help to a relative or other dependent (2). Given the growing population of elderly reported by the World Health Organization, these numbers are likely to be increasing (33). Thus, caregiving seems to be a public health concern as gainfully employed caregivers who provide >20 hours of weekly caregiving may have a markedly higher risk of CVD compared to those providing care for 1-8 hours weekly.

In the Nurses' Health Study, it was previously shown that female nurses providing weekly care for a disabled or ill spouse  $\geq 9$  hours had a 1.8 times higher risk of CHD compared to non-caregivers (11). Our data complement these findings by showing that subjects providing >20 of caregiving for aged or disabled relatives had a 2.6 times higher risk of CVD compared to those providing care for 1-8 hours weekly, irrespectively of number of weekly work hours. In another study by Buyck et al., there was no increased risk of CHD in caregivers providing >5 weekly hours of caregiving (12). However, non-caregivers were used as the reference group, and furthermore, there is potentially a large difference in providing >5 weekly hours and >20 weekly hours of care. A study from the United States by Capistrant et al. also investigated the association between spousal caregiving and the risk of CVD in a population of married



individuals (9), but based on reports from the care recipient instead of the caregiver. Here, high intensity caregiving was defined as  $\geq 14$  hours of weekly caregiving, and they found a 35% higher risk of CVD compared to a joint reference group of those providing  $< 14$  hours of weekly caregiving and non-caregivers. In line with our study, they found that long-term caregivers had a higher risk of CVD compared to short-term caregivers, using the same definition of long-term caregiving (two consecutive waves separated by two years) (9). We had no information of how many years prior to baseline individuals provided caregiving. However, our findings support a causal effect, where those with longer duration and many hours of caregiving carry the highest risk of CVD.

By including only caregivers, it was possible for us to investigate the contribution of additional hours of caregiving on the risk of CVD more thoroughly. Furthermore, by including weekly work hours, we were able to investigate the joint workload of weekly caregiving and work hours, which has not been investigated in previous studies. Our results from the joint model interestingly showed that many weekly hours of caregiving seemed to be associated with higher risk of CVD irrespectively of paid work hours, unless the caregiver worked really long hours (i.e.  $> 55$  hours weekly). In a previous large-scale meta-analysis, working  $> 55$  hours weekly was found to be associated with a modest increased CVD risk (13), whereas we found a more than double risk of CVD in this group. The stronger effect observed presently is likely caused by only including informal caregivers, who may be more vulnerable to the health consequences of long working hours.

**In Sweden individuals are eligible for care provided by the state (35); and informal care is therefore on a more voluntary basis than in the UK, where the responsibility of long-term care is placed with individuals and their families (36). We found a tendency that many weekly hours of care was associated with a higher risk of CVD in SLOSH compared with Whitehall II. This finding could be explained with voluntary caregivers (as in Sweden) being more emotional involved, and therefore more prone to health consequences of caregiving than those who do not become caregivers of their own choice.**

Regarding generalizability of findings, the Nurses' Health Study included female nurses and the study by Capistrant et al. had a study population with a mean age of 64 years, and thus, it is likely that participants were out of the labor market. We included caregivers also included in the study by Buyck et al.(12,24), but supplemented with a Swedish population of caregivers (23). Thus, with a somewhat broader range of individuals in the labor force from two European countries with different welfare-state systems, our results may be generalized to a broader population of informal caregivers in western countries. **However, it should be considered that participants included were in steady work situations. Thus, given that job insecurity is a stressor that may affect health (34), we may have underestimated the true association between weekly caregiving hours and risk of CVD in the working population. Furthermore, we recognize that it is a selective population by only including informal caregivers.**

Strengths of this study include the highly comparable longitudinal data on exposures and outcome from two occupational cohorts. In addition, including register-based ICD-10 diagnostic codes strengthens the validity of information. However, there were few cases of CVD, and results should therefore be replicated before drawing strong conclusions. People with missing information on exposures and covariates were more like to be male compared with complete cases. This gender difference is however unlikely to have biased our estimates since this missing is unlikely to be associated with both informal caregiving hours and future events of CVD.

Presently, we had no information on care recipients. Thus, it has been shown that caregiving for a spouse may be more detrimental for health compared with caregiving for a disabled parent (11). **In line with this, it would be suspected that care for a spouse would be stronger associated with many weekly hours of caregiving than care for a parent, as you are more likely to live in the same household as your spouse. This could partly explain our findings with many weekly hours of caregiving being associated with a higher risk of CVD.** However, by adjusting for age we may have accounted for some of this effect. Thus, caregiving for a child or parent would be more common in younger age, and caregiving for a spouse would be more common in older age.

## *Conclusion*

**Previous studies have shown associations between informal caregiving and risk of CVD. In our study population of informal caregivers** we found that many weekly hours of informal caregiving was associated with a higher risk of CVD **opposed to few weekly hours**; irrespectively of weekly work hours. This, association seemed to be driven by those providing long-term care. We also found that very long working hours was associated with a higher risk of CVD in informal caregivers, indicating that these workers may be a particularly vulnerable group. Our results emphasize the importance of preventive strategies and support systems for those who provide intensive and long-term caregiving.

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## **Conflicts of interest**

Dr. Kivimäki reports grants from NordForsk, the MRC (K013351), and the Academy of Finland (311492), during the conduct of the study. Dr. Lange reports personal fees from Novo Nordisk outside the submitted work.

## Key points:

- In a population of informal caregivers, we show that more than 20 weekly hours of informal caregiving is associated with markedly higher risk of CVD compared to providing few weekly hours of caregiving, irrespectively of number of weekly work hours.
- The higher risk of CVD among caregivers who provide many hours of caregiving is most pronounced among long-term caregivers.
- Informal caregivers who are working more than 55 hours weekly have more than twice the risk of developing CVD compared with those working 35-40 hours weekly.

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**Table 1. Baseline characteristics of informal caregivers in SLOSH and Whitehall II**

	SLOSH	Whitehall II	Total	1-8 hours care ≤40 hours	1-8 hours care >40 hours	>8 hours care ≤40 hours	>8 hours care >40 hours
Informal caregivers	N=700	N=696	N=1,396	N=504	N=496	N=262	N=134
Women	68%	39%	54%	56%	41%	71%	58%
Age (Mean ±SD)	52 ±9	50 ±5	51 ±7	52 ±7	51 ±7	50 ±9	51 ±7
Children	48%	63%	56%	55%	59%	52%	51%
Low occupational	12%	35%	23%	19%	34%	11%	22%
Smoking	19%	15%	17%	13%	14%	23%	25%
Obese	21%	11%	16%	14%	15%	18%	25%
Weekly caregiving							
1-8 hours	69%	74%	72%	100%	100%	-	-
9-20 hours	17%	16%	16%	-	-	55%	61%
>20 hours	14%	10%	12%	-	-	45%	39%
Weekly work hours							
<35 hours	21%	4%	13%	20%	-	29%	-
35-40 hours	33%	52%	42%	80%	-	71%	-
41-54 hours	34%	35%	34%	-	77%	-	75%
≥55 hours	12%	9%	11%	-	23%	-	25%

Abbreviations. SD: Standard deviation

**Figure 1. Associations between weekly caregiving, work hours and cardiovascular disease during 10 years follow-up in 1,396 informal caregivers from SLOSH and the Whitehall II study**

Adjusted for age, sex, children, marital status, occupational grade, along with caregiving hours adjusted for work hours and vice versa

**Figure 2. Joint associations between weekly caregiving and work hours and cardiovascular disease during 10 years follow-up in 1,396 informal caregivers from SLOSH and the Whitehall II study**

Adjusted for age, sex, children, marital status, and occupational grade. Multiplicative interaction,  $p=0.26$ , additive interaction, synergy index=0.73

**Figure 3. The association between long-term caregiving and cardiovascular disease during seven years follow-up in 616 informal caregivers from the Whitehall II study**

Adjusted for age, sex, children, marital status, occupational grade, along with caregiving hours adjusted for work hours and vice versa.

Long-term caregiving: Informal caregiving at baseline and three years later, short-term caregiving: Informal caregiving at baseline

Interaction between long-term caregiving and caregiving hours ( $\leq 8 / > 8$  hours). Multiplicative interaction,  $p=0.04$ , additive interaction, synergy index=-1.49



