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# The Contribution of Heart Failure to Sleep Disturbances and Depressive Symptoms in Older Adults

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**Abstract**

Background:

The aim of this study was to explore the associations between physical symptoms, sleep disturbances, and depressive symptoms in community-dwelling elderly individuals, comparing persons with and without heart failure (HF).

Methods:

A total of 613 older adults (mean age 78 years) underwent clinical and echocardiographic examinations. Questionnaires were used to evaluate sleep disturbances and depressive symptoms. A model was developed in those with HF (n = 107) and compared with those without HF (n = 506).

Results:

Cardiopulmonary symptoms (ie, dyspnea and nighttime palpitations) and pain had significant direct associations with sleep disturbances, which indirectly affected depressive symptoms. The model was essentially the same in those with and without HF except that the effect of sleep disturbances on depressive symptoms was stronger in those with HF ($\beta = 0.64$ vs $\beta = 0.45$, P = .006).

Conclusion:

In community-dwelling older adults, regardless of their diagnosis, physical symptoms had a direct effect on sleep disturbances and an indirect effect on depressive symptoms.

**Disciplines**
Cardiology | Cardiovascular Diseases | Circulatory and Respiratory Physiology | Geriatrics | Medical Humanities | Medicine and Health Sciences | Neurology | Neurosciences | Nursing | Psychiatry and Psychology | Sleep Medicine

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## Abstract

**Background:** The aim of this study was to explore the associations between physical symptoms, sleep disturbances and depressive symptoms in community dwelling elders, comparing persons with and without heart failure (HF).

**Methods:** 613 older adults (mean age 78 years) underwent clinical and echocardiographic examination. Questionnaires were used to evaluate sleep disturbances and depressive symptoms. A model was developed in those with HF (n=107) and compared in those without HF (n=506).

**Results:** Cardiopulmonary symptoms (i.e. dyspnoea and night-time palpitations) and pain had significant direct associations with sleep disturbances, which indirectly affected depressive symptoms. The model was essentially the same in those with and without HF except that the effect of sleep disturbances on depressive symptoms was stronger in those with HF ($\beta$=0.64 vs. $\beta$=0.45, p=0.006).

**Conclusion:** In community dwelling older adults, regardless of their diagnosis, physical symptoms had a direct effect on sleep disturbances and an indirect effect on depressive symptoms.

# Background

Chronic heart failure (HF) is common in the general population and the prevalence rises with age.[1] Today the mean age for community dwelling HF patients is at least 75 years.[2] In patients with HF, both sleep disturbances[3] and depression are common.[4] Sleep disturbances and depression seem to be intertwined. Treatment of depression usually improves sleep, whereas treatment of insomnia can decrease the risk of relapse or recurrence of depression.[5]

The symptoms of insomnia, including difficulties maintaining sleep (DMS), difficulties initiating sleep (DIS), and non restorative sleep (NRS) are commonly reported by the general population.[8] In a survey of adults older than 18 years, 21% complained of DIS, 16% of DMS, and 11% of NRS at least three times a week during the last month or more.[9] In Sweden, where this study was conducted on adults aged 65-79 years, 36%, 43% and 32% reported complaints of DIS, DMS and NRS.[10] Sleep problems are particularly prevalent in HF patients, with almost 60% reporting trouble sleeping or not getting enough of sleep at least 3-4 times a week.[3] In a study by Broström et al.[13] DMS was the most commonly reported insomnia symptom, with major complaints reported by 23% of the men and 20% of the women.

As people age, sleep becomes even more fragmented with increasing amounts of time spent in superficial sleep non rapid eye movement sleep (NREM) stage 1 and 2, less time in deep, slow wave sleep (NREM stage 3 and 4) and rapid eye movement sleep (REM) sleep [6]. Signs of disrupted circadian regulation of sleep can also be seen with aging, with older people tending to experience increased sleep onset latency, more nightly awakenings, and a decreased total sleep time compared to younger people.[7] Physical symptoms may be responsible for some of the sleep disturbances experienced with aging. Symptoms such as dyspnoea, palpitations and pain commonly disturb sleep in HF patients.[15-16] However, many of these problems are responsible for disturbed sleep in older adults without HF as well.[17-18]

Another health problem common in the general population that is associated with aging and linked to sleep disturbances is depressive symptoms such as anhedonia, lack of energy and weight changes.[11] In a Norwegian epidemiological study Stordal et al. found that the occurrence of depressive symptoms as measured by the Hospital Anxiety Depression scale (HADS) increased from 4% of men and women aged 20-29 years, to 14% of those aged 60-69 years, to 17% of those aged 70-79 years. In those aged 80-89 years, depressive symptoms were found in 23% of the men and 18% of the women.[12] Approximately 30-40% of HF patients have depressive symptoms.[19] Factors known to predict depressive symptoms in HF patients include poor health perceptions, alcohol abuse, economic burden associated with medical care and living alone. However, not all of the depressive symptoms of HF can be explained by this aggregate.[20] Disturbed sleep confers approximately a two to threefold increase in the risk of depressive symptoms in HF patients.[14] Importantly, depressive symptoms have been found to mediate the effects of sleep disturbances on health related quality of life.[11]

The relationships between physical symptoms, sleep disturbances, and depressive symptoms have not been extensively evaluated in community dwelling older adults with or without HF. Knowledge about these associations is important in the design of interventions. If these relationships are only evident in HF patients, HF programs should integrate approaches designed to improve sleep and/or depressive symptoms. But, if these relationships are generic in all older adults, interventions can be designed to address physical symptoms, regardless of the medical diagnosis. The aim of this study therefore was to explore the associations between physical symptoms, sleep disturbances, and depressive symptoms in community dwelling older adults with and without HF.

## Methods

*Sample*

The patient population was derived from the CoroKind study and has been described previously.[21] In brief, the major aim of the parent study was to evaluate the prevalence of HF among community dwelling older adults. The study took place between 1998 to 2000. All subjects were aged 65-82 years and lived in a rural community with 10 300 inhabitants in the southeast of Sweden. All inhabitants in the age span mentioned above were invited to clinical and echocardiographic examinations. The rationale for this unusual age span is that some people agreed to participate only if their younger or older spouse could be examined as well. Of 1130 individuals in the targeted age range, 876 agreed to participate (participation rate 78%). From January 2003 to June 2005 the cohort was again contacted by telephone by a research nurse and invited to repeat their clinical and echocardiographic examinations. A total of 675 subjects (77% of the original cohort) agreed to participate. The reasons for not participating were death (12%), having moved to nursing homes or other parts of Sweden (3%), declined (7%) and not showing up (1%). All participants provided informed written consent. The study protocol was approved by the Ethics Committee at the Faculty of Health Sciences, University of Linköping, Sweden, and is in accordance with the provisions of the Helsinki declaration.

*Clinical Examination*

For this follow-up study all participants were examined by a cardiologist and given a package of self-report instruments to be returned by mail. The cardiologist took a patient history and performed a clinical examination, including symptoms and signs of HF. To reduce bias, the cardiologist was blinded to the results of the prior examinations and echocardiography. Doppler echocardiographic examinations were performed to assess left ventricular ejection

fraction (LVEF). Global systolic function was determined semi-quantitatively and classified into three groups. In this study, LVEF ≥ 50% corresponded to normal systolic function and LVEF≤ 49% corresponded to at least mildly impaired systolic function. In the present study, the cardiologists in the author group (UA and UD) assessed the presence of HF. All subjects who had at least mildly impaired systolic function (LVEF <=49%) and had clinical signs and symptoms of HF were considered to have HF.

Individual comorbid conditions were identified by the cardiologist during the clinical examination. Diabetes mellitus was defined as ongoing treatment for diabetes or fasting blood glucose ≥ 7 mmol/L. Hypertension was defined as a previous physician diagnosis or blood pressure of more than 140/90 mm Hg. Ischemic heart disease (IHD) was defined as a history of angina pectoris and/or myocardial infarction and/or coronary angioplasty and/or coronary bypass surgery. Previous or present tumour was defined by history. A respiratory disease was established if the participant had a diagnosis of or was undergoing treatment for chronic pulmonary disease or asthma.

*Physical signs and symptoms and Sleep disturbances*

Items from the 26 item Uppsala Sleep Inventory (USI)-HF questionnaire were used to measure physical symptoms and sleep disturbances.[13] The USI has previously been used in surveys of both younger and elderly people, as well as in patients with HF. [10, 13, 22] In development, the content in the USI-HF was scrutinized and revised by an expert panel consisting of sleep researchers, cardiologist and HF nurses. The USI-HF measures five dimensions: sleep complaints; physical and emotional arousals; daytime symptoms; sleep need; and sleep disruption. Chronbach alpha has been reported to be 0.75.[13] In the present study items measuring the insomnia symptoms of DIS, DMS and NRS were used. On these

items the respondents rate their problems on a Likert scale ranging from no problems (1) small problems (2) moderate problems (3) great problems (4) to very great problems (5). Estimates of the number of nocturnal awakenings and hypnotic uses were also included as indicators of sleep disturbances.The USI-HF items measuring problems with nocturnal dyspnoea, palpitations and pain were used as indicators of physical symptoms. These items are answered as never (1) seldom (2) sometimes (3) often (4) or very often (5).

*Depressive symptoms*

Depressive symptoms were measured with the Hospital Anxiety Depression scale (HADS).[23] To prevent noise from somatic diseases the instrument only focuses the affective symptoms of depression (i.e. depressed, sad mood and diminished interest or pleasure in activities).[23] The HADS is frequently used in different types of settings (e.g., community care, primary care and hospital wards) and in different patient groups.[24] The HADS scores range from 0-21, with higher scores indicating more symptoms of depression.[23] The HADS has been found to be a reliable tool. Psychometric testing supports two factor solution (anxiety and depression). The sensitivity and specificity was approximately 0.80 for both subscales,[30] supporting discriminant validity of the HADS. Chronbach's alpha for the HADS was 0.82.[30] In the present study the HADS was used as a continuous measure in statistical analyses.

*Statistical analysis*

Both descriptive statistics and structural equation modeling (SEM) were used to analyse the data in the present study. Spearman correlation was used to analyse the bivariate associations between the manifest variables representing physical symptoms, sleep disturbances and depressive symptoms. SEM was used to explore the relationships between physical symptoms, sleep disturbances and depressive symptoms in participants with and without HF.

SEM was used because it permits analysis and modeling of complex inter-relationships among a number of inter-dependent variables. In the SEM analysis measured variables are factored to latent variables and assumed paths between the constructs are tested. A conceptual model of the associations of physical symptoms, sleep disturbances and depressive symptoms was developed based on earlier HF studies and used to guide the SEM analysis.[3, 14-16, 25] In this theoretical model we assumed that HF was a cause for the physical symptoms of dyspnoea, palpitations, pain. These symptoms were assumed to be linked with depressive symptoms through the symptoms of insomnia, nocturnal awakenings, and use of hypnotics. The summary score from the HADS was used to indicate depressive symptoms.

The model of physical symptoms (i.e. dyspnoea, palpitations and pain), sleep disturbances and depressive symptoms was tested in participants with and without HF using SEM. Associations between the latent variables were derived using maximum likelihood and described with their standardized coefficients.To assess goodness of fit we used the chi-square value, the Root Mean Square Error of Approximation (RMSEA) and the Comparative Fit Index (CFI). In general terms fit indices provide estimates of how well the model would represent our population of community dwelling elderly with and without HF. An insignificant chi-square would indicate a good model fit. An overall RMSEA below 0.06 indicates a good fit whereas a CFI $\geq 0.95$ is considered a good fit indicating that at least 95 percent of the covariation in the data is reproduced by the model. Modification indices were used to modify the model only if these modifications were theoretically justified. The modification index estimates the decrease in the chi-square value that would result if a given parameter is added to the model.[26]

Descriptive and comparative analyses were performed with the SPSS version 18.0 whereas SEM analyses were performed with the LISREL 8.30 software. A p < 0.05 in the SPSS

analyses and t-value of ≥ 1.96 for factor loadings and effects in the LISREL analyses were considered significant.

## Results

Of 675 participants investigated, a total of 613 (91%) had data on echocardiography, physical symptoms, sleep disturbances and depressive symptoms available for analysis. Table 1 describes baseline characteristics of the studied sample. The mean age of sample was 78 years and 47% were males. A total of 107 participants (17%) clearly had HF; these participants with HF were older (79 years vs. 77 years, p=0.001) and more of them were male (71% vs. 43%, p=0.001) compared to those without HF. Those with HF had higher median plasma creatinine concentration (84 µmol/L vs. 73 µmol/L, p=0.001) and more diabetes (25% vs. 14%, p=0.005) and ischemic heart disease (50% vs. 21%, p=0.001) than those without HF. More of those with HF had two or more co-morbidities (64% vs. 36%, p=0.001) and had more treatment with ACE/ARB (39% vs. 23%, p=0.001), B-blockers (55% vs. 32%, p=0.001) and diuretics 46% vs. 33%, p=0.012). No differences between those with and without HF were found regarding antidepressant medication and hypnotic use.

*Bivariate associations physical symptoms, sleep disturbances and depressive symptoms in participants with and without heart failure.*

Table 2 and 3 and presents the associations of physical symptoms, sleep disturbances and depressive symptoms in participants with and without HF. In those with HF the physical symptoms (i.e. dyspnoea, palpitations and pain) correlated significantly to each others as well as to nocturnal awakenings, insomnia symptoms and depressive symptoms. Awakenings

correlated most strongly with the insomnia symptoms (r=0.360-0.401). Generally the same associations and magnitudes of correlations were found in those without HF as well. Hypnotics correlated with DMS and NRS in those with HF and with DIS, DMS and NRS in those without HF. In those with HF the highest correlation was found between the insomnia symptoms NRS and DIS (r=0.559) whereas in those without HF the highest correlation of 0.554 was between NRS and DMS. **No signs of multicollinearity were found from inspection of the correlation plots, violation inflation factors or tolerance statistics.**

*Modelling the associations between physical symptoms, sleep disturbances and depressive symptoms in participants with and without heart failure*

We first created a SEM model that explored the relationships between physical symptoms, sleep disturbances and depressive symptoms in participants with HF. In the next step this model was tested in the group without HF. The associations between dyspnoea, palpitations, pain, sleep disturbances and depressive symptoms were then analyzed. The initial SEM analysis in participants with HF did not fully confirm the assumed paths and the fit from the model were not acceptable. After scrutinizing the data and suggested modification indices, the single variables of night-time dyspnoea and palpitations were amalgamated into one latent factor labeled cardiopulmonary symptoms.

The new model, shown in Figure 2, fit the data well in those with HF. Examination of the fit-indices showed that the model explained the covariances between the manifest variables almost completely. Indirect and total effects between the factors in the model are shown in Table 4. In those with HF we found moderate direct effects of cardiopulmonary symptoms and pain on sleep disturbances (β=0.38 and β=0.37). Sleep disturbances had a strong effect

(β=0.64) on depressive symptoms. By these paths, cardiopulmonary symptoms and pain had moderate indirect effects on depressive symptoms (β=0.24 and β=0.24).

The model also fit well in those without HF (Figure 3). In this model, cardiopulmonary symptoms had a moderate effect on sleep disturbances (β=0.30) and there was a moderate effect of sleep disturbances on depressive symptoms (β=0.45). The indirect effect of cardiopulmonary symptoms on depressive symptoms was small (β=0.13). Comparing these effects to the model of those with HF illustrated that the path between sleep disturbances and depressive symptom was significantly lower in those without HF (β=0.45 vs. β=0.64, p=0.006). The direct effect of pain on sleep disturbances and the indirect effect of pain on depressive symptoms was however of almost the same magnitude as in those with HF (β=0.40 and β=0.18).

## Discussion

In the present study of community dwelling older adults with and without HF we found that the physical symptoms of dyspnea, palpitations (cardiopulmonary symptoms) and pain were directly associated sleep disturbances, which led to an indirect association to depressive symptoms. These results suggest that interventions focused on the relief of physical symptoms may decrease sleep disturbances and depressive symptoms, regardless of the medical diagnosis. Further, depressive symptoms in older adults should be approached as indicators of a potentially modifiable condition—impaired sleep.

We found that cardiopulmonary symptoms were directly associated with sleep disturbances and indirectly associated with depressive symptoms in those with and without HF. Others have shown that wheezing or whistling from chest at night is a common sleep disturbance among older adults and associated with daytime sleepiness.[27] The only difference we found in those with HF was that the associations between cardiopulmonary symptoms, sleep

disturbances and depressive symptoms were stronger. Cardiopulmonary symptoms may signal sleep disordered breathing (SDB), which is common in community dwelling elders, but even more common among elders with HF.[28] SDB is known to cause nocturia[29] and disturbed sleep and in older adults severe SDB has been shown to cause daytime sleepiness.[27] It is known that SDB in HF is associated with increased risk for having daytime and night time ventricular arrhythmias[30] as well as to cause choking spells and hyperventilation during sleep.[31] SDB may therefore be a potential explanation for the stronger associations between cardiopulmonary symptoms, sleep disturbances and depressive symptoms in the HF model.

The association between SDB and self-reported sleep quality in HF patients, however, remains unclear at this time. Redeker and colleagues showed only a weak association between SDB and self-reported sleep in 170 HF patients, despite the fact that SDB was associated with poorer objectively measured sleep quality.[32] In two smaller studies of HF patients, however, one found that SDB was associated with poorer subjectively rated sleep quality and depressive symptoms,[33] whereas in the other study, SDB was associated with poor quality of life.[34] Patients with HF and SDB successfully treated with Continuous Positive Airway Pressure (CPAP) have been found to have reductions in night time ventricular arrhythmias.[35] However, the extent of which CPAP treatment of SDB in older adults with as well as without HF can improve cardiopulmonary symptoms, sleep disturbances or depressive symptoms is unclear.

As many as 75% of community dwelling elderly report some pain, of these 52% report daily pain.[36] Despite this, pain is seldom included as a variable in studies investigating correlates or predictors of sleep in community dwelling elderly.[17, 37-38] In the present study pain during the night was associated with sleep disturbances and depressive symptoms, and the magnitude of the relationship was the same in those with and without HF. A recent study showed that older adults reporting severe pain had an increased risk for poor sleep.[39] Furthermore, in older

adults, pain or physical discomfort at night has been found to be a strong predictor for daytime sleepiness.[27] Pain and sleep disturbances seem to have a complex relationship. In an experimental study of healthy volunteers, disrupted sleep was shown to have a hyper analgesic effect whereas recovery sleep was associated with analgesic effects.[40] A population based study of adults aged 25-65 years showed that baseline self-reported good sleep was a predictor for the resolution of pain at 15 months follow-up.[41]

The results of this study suggest that reducing cardiopulmonary symptoms, pain and/or sleep disturbances are important interventions. Pharmacological treatments of pain and sleep problems should however be carefully selected and monitored because of the risk of polypharmacy and side-effects such as sedation, drowsiness and somnolence.[27, 42] Further, sleep medications cause depression in older adults, independent of insomnia.[43] Older adults with HF may be in particular vulnerable for pharmacological side effects. In individuals aged 80 years and older, HF medications such as beta-blockers, diuretics and ACE/ARB, have been associated with insomnia.[44] More than two thirds of HF patients have been found to experience an adverse drug event and these patients also report more sleeping problems compared to those who have not experienced an adverse drug event.[45] Adverse drug events may provide another explanation for the stronger association between sleep disturbances and depressive symptom in those with HF. Assessment of disturbed sleep as a potential side-effect of the pharmacological treatment is important because simply adjusting dosages may improve sleep quality. A nonpharmacologic treatment of pain could be CPAP. A small study in older adults with SDB found that CPAP therapy had analgesic effects as well as improving respiratory parameters.[46] Cognitive behavioural therapy (CBT) is another potential approach to pain, sleep disturbances, and depressive symptoms. In older adults with arthritis or chronic obstructive lung disease and insomnia, CBT has been found to improve sleep and pain.[47-48] In patients with HF, mindfulness meditation improves depressive symptoms and health-related

quality of life.[49] However, the numbers of CBT studies performed on older adults with and without HF are small and few and more large scaled studies are needed.

Limitations

Depressive symptoms overlap with some physical symptoms such as fatigue and problems with appetite, which complicates the interpretation of findings. For this reason we chose the HADS because it was specifically developed for measuring depressive symptoms in people with different types of chronic diseases. Moreover studies have shown that the somatic symptom profile of patients with HF and other chronic diseases and depression is similar to that of people with depression only.[50-51] **However, the association between insomnia and depression is complex, both among individuals with heart failure and those without. And, paths in a SEM analysis can be directed in different ways. SEM is most useful in testing a theory-based model, as specified in this study.[3, 14-16, 25] Creating separate models investigating different solutions for individuals with and without HF was important so that we could identify generic responses versus those that are specific to heart failure. Although our model produced a good fit, the study was limited in that the cross-sectional data limits the possibility of identifying causal directionality. We also used self-reported symptoms of depression and disturbed sleep instead of objective clinical data on sleep and depressive disorders. Many patients who would not meet the diagnostic criteria for either of these disorders nevertheless may have scored high on the questionnaires used in the study.** Some of the attrition was due to death or moving to nursing homes; HF, sleep disturbances, and/or depression may have played a role in these events. Consequently, a model fitted on data from the remaining subjects may therefore be biased in ways that would be difficult to ascertain. An advantage with the study design was

that it allowed us to explore the associations between physical symptoms, sleep disturbances and depressive symptoms in participants with and without HF who were of the same age and living in the same area. Another advantage was that all participants were examined by an experienced cardiologist, both clinically and with Doppler echocardiography. Echocardiography **data were incomplete for 9% of the sample and these subjects were deleted from the analysis since multiple imputation on data such as echocardiography can be misleading**. We think therefore that despite the limitations, this study can offer important information regarding the impact of physical symptoms on sleep disturbances and depressive symptom in community dwelling older adults.

Conclusion

In older adults living in the community, with and without HF, cardiopulmonary symptoms and pain were directly associated with sleep disturbances, which led to a relationship between physical and depressive symptoms. Sleep disturbances were more strongly associated with depressive symptoms in older adults with HF, suggesting that poor sleep may be a particularly important area for focus in this population in which depression is so common. Screening for sleep disturbances and depression may alert clinicians to the presence of night time physical symptoms in older adults. Pharmacological and/or non-pharmacological interventions can be used to reduce cardiopulmonary symptoms and/or pain as well as sleep disturbances and/or depressive symptoms. We recommend that clinicians assess the side-effects of cardiovascular drugs on patients' sleep and tailor the treatment regimen in those patients who have sleeping problems. Future research is needed testing the impact of CPAP for SDB on physical symptoms, sleep, and depressive symptoms. The results of this study illustrate that interventions focused on addressing symptoms, regardless of the medical diagnosis, may

improve sleep quality and depressive symptoms in older adults. However large randomised controlled studies are however needed to evaluate the effect of such programs.

## Declaration of Conflicting Interests

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**Tables**

Table 1. Background characteristics for the study population with or without heart failure

| | Total (n=613) | HF (n=107) | No HF (n=506) | |
|---|---|---|---|---|
| Age, mean (SD) | 78 (4) | 79 (4) | 77 (4) | 0.001 |
| Male, sex, % (n) | 47 (289) | 71 (67) | 43 (218) | 0.001 |
| Body mass index, mean (SD) | 27.1 (4.2) | 27.4 (4.2) | 27.0 (4.2) | 0.33 |
| Systolic blood pressure, mean (SD) | 149 (23) | 149 (19) | 149 (24) | 0.85 |
| Diastolic blood pressure, mean (SD) | 75 (11) | 75 (10) | 75 (12) | 0.91 |
| Diabetes, % (n) | 99 (16) | 25 (27) | 14 (72) | 0.005 |
| Hypertension, % (n) | 474 (78) | 76 (80) | 78 (394) | 0.56 |
| Ischemic heart disease, % (n) | 26 (161) | 50 (54) | 21 (107) | 0.001 |
| Previous or present tumour, % (n) | 16 (100) | 20 (21) | 16 (79) | 0.31 |
| Respiratory disease, % (n) | 15 (93) | 19 (20) | 14 (73) | 0.27 |
| ≥ 2 co morbidities, % (n) | 46 (284) | 64 (68) | 36 (38) | 0.001 |
| Creatinine µmol/L , median (25th-75th quart) | 74 (63-90) | 84 (70-107) | 73 (61-87) | 0.001 |
| LVEF<50%, % (n) | 132 (22) | 107 (100) | 5 (25) | 0.001 |
| ACE/ARB, % (n) | 26 (158) | 39 (42) | 23 (116) | 0.001 |
| B-blockers, % (n) | 36 (222) | 55 (59) | 32 (163) | 0.001 |
| Diuretics, % (n) | 35 (216) | 46 (49) | 33 (167) | 0.012 |
| Antidepressants, % (n) | 4 (24) | 2 (2) | 22 (4) | 0.41 |
| Hypnotics, % (n) | 6 (35) | 8 (8) | 5(27) | 0.38 |

Note: ACEI/ARB – Angiotensin converting inhibitor/Angiotensin receptor blockers: LVEF – Left ventricular ejection fraction

Table 2. Bivariate correlations physical symptoms, factors that disturb sleep and depressive symptoms in participants with heart failure (n=107)

| | #Awake | Dyspnoea night-time | Palpitations night-time | Pain night-time | DMS | NRS | DIS | Depressive symptoms | Antidepressants | Hypnotics |
|---|---|---|---|---|---|---|---|---|---|---|
| #Awake | 1 | | | | | | | | | |
| Dyspnoea night-time | 0.195* | 1 | | | | | | | | |
| Palpitations night-time | 0.300 ** | 0.419*** | 1 | | | | | | | |
| Pain night-time | 0.361*** | 0.204* | 0.377*** | 1 | | | | | | |
| DMS | 0.401*** | 0.191* | 0.209* | 0.346*** | 1 | | | | | |
| NRS | 0.362*** | 0.267** | 0.402*** | 0.413*** | 0.495*** | 1 | | | | |
| DIS | 0.360*** | 0.128 | 0.240* | 0.276*** | 0.341*** | 0.559*** | 1 | | | |
| Depressive symptoms | 0.213 * | 0.238* | 0.374*** | 0.231* | 0.264** | 0.470*** | 0.322** | 1 | | |
| Antidepressants | 0.007 | 0.06 | 0.006 | -0.049 | 0.007 | 0.027 | 0.056 | 0.069 | 1 | |
| Hypnotics | 0.07 | -0.002 | 0.041 | 0.095 | 0.215* | 0.252** | 0.157 | 0.143 | -0.039 | 1 |

Note: DIS – Difficulties initiating sleep; DMS – Difficulties maintaining sleep;NRS – Non restorative sleep.
*p<0.05; **p<0.01,  p<0.001***

Bivariate correlations physical symptoms, factors that disturb sleep and depressive symptoms in participants without heart failure (n=504)

| | #Awake | Dyspnoea night-time | Palpitations night-time | Pain night-time | DMS | NRS | DIS | Depressive symptoms | Antidepressants | Hypnotics |
|---|---|---|---|---|---|---|---|---|---|---|
| #Awake | 1 | | | | | | | | | |
| Dyspnoea night-time | 0.195*** | 1 | | | | | | | | |
| Palpitations night-time | 0.159*** | 0.442*** | 1 | | | | | | | |
| Pain night-time | 0.305*** | 0.292*** | 0.313*** | 1 | | | | | | |
| DMS | 0.541*** | 0.243*** | 0.211*** | 0.328*** | 1 | | | | | |
| NRS | 0.343*** | 0.304*** | 0.248*** | 0.372*** | 0.554*** | 1 | | | | |
| DIS | 0.247*** | 0.192*** | 0.168*** | 0.268*** | 0.422*** | 0.474*** | 1 | | | |
| Depressive symptoms | 0.176*** | 0.222*** | 0.171*** | 0.207*** | 0.212*** | 0.324*** | 0.160*** | 1 | | |
| Antidepressants | -0.023 | 0.029 | 0.065 | 0.045 | 0.051 | 0.166*** | 0.098* | 0.074 | 1 | |
| Hypnotics | 0.023 | -0.054 | 0.113* | 0.098* | 0.179*** | 0.197*** | 0.235*** | 0.079 | 0.165** | 1 |
| | | | | | | | | | | |

Note: DIS – Difficulties initiating sleep; DMS – Difficulties maintaining sleep;NRS – Non restorative sleep.
*p<0.05; **p<0.01,  p<0.001***

Table 4. Significant indirect and total effects (β) between factors in the structural equation model in participants with heart failure. Indirect effect is the difference between the direct and total effect.

| **HF group** | Sleep disturbances | | Depressive Symptoms | |
|---|---|---|---|---|
| | Ind. effect | Tot. effect | Ind. effect | Tot. effect |
| Cardiopulmonary Symptoms | - | 0.38 | 0.24 | 0.24 |
| Pain | | 0.37 | 0.24 | 0.24 |
| Sleep disturbances | - | - | - | 0.64 |
| **Non HF group** | | | | |
| Cardiopulmonary Symptoms | | 0.30 | 0.13 | 0.13 |
| Pain | | 0.40 | 0.18 | 0.18 |
| Sleep disturbances | | | | 0.45 |