Review

Hazards of insomnia and the effects of acupuncture treatment on insomnia

Yu-fang Lin¹², Zhi-dan Liu¹², Wen Ma³, Wei-dong Shen²
1. Graduate School, Shanghai University of Traditional Chinese Medicine, Shanghai 201203, China
2. Department of Acupuncture and Moxibustion, Shuguang Hospital, Shanghai University of Traditional Chinese Medicine, Shanghai 201203, China
3. Department of Acupuncture and Moxibustion, Shuguang Hospital Baoshan Branch, University of Traditional Chinese Medicine, Shanghai 201999, China

ABSTRACT

Insomnia is a common disease in modern society; it is made worse by increasingly fierce competition in the workplace and elsewhere, along with rapid economic and social development. Sleep disorders can result in changes in serum biomarkers and decreased immunity, and may cause maladies such as depression and cardiac diseases, as well as many other somatic symptoms. Western medications for treating insomnia can easily lead to addiction and other adverse effects. Fortunately, acupuncture can ease the symptoms of insomnia. This review summarizes the hazards associated with insomnia and the use of acupuncture in its treatment. Furthermore, the authors introduce an effective and low-cost method of treating insomnia with acupuncture. This review indicates that insomnia poses a major threat to mental health through its effects on serum components, heart function and the immune system of patients, which may lead to other physiological disorders. Anxiety and depression are the two main negative emotions affected by insomnia. Acupuncture, which has showed effectiveness against insomnia and its complications, may be an effective and complementary method for the treatment of insomnia and associated maladies.

Keywords: insomnia; complications; acupuncture; depressive disorder; immunity; heart diseases; review


1 Introduction

Insomnia is a common chronic disease, which can have important negative impacts on health and well-being. In England, the prevalence of insomnia has shown a modest but steady increase over a 15-year period[1]. Insomnia can occur at any age and in individuals of any occupation. A cross-sectional study showed that of 604 Portuguese schoolteachers, 40.6% suffered from symptoms of insomnia; symptoms were correlated with occupational and sociodemographic variables[2]. Another study found that one in five preadolescents and young children of the general population suffered from insomnia. Moreover, the group with the highest prevalence of insomnia symptoms was 11–12 year old girls (30.6%)[3]. At the other end of the age spectrum, insomnia was found in 29.2% of a sample of elderly individuals 65 years and older[4]. A patient suffering from insomnia often experiences daytime consequences such as sleepiness, fatigue, loss of concentration, changes in mood, as well as changes
in their family relationships and social performance\(^5\). In Western medicine, there are three main methods for treating insomnia: nonpharmacological strategies, cognitive behavioral therapy and medication. The former two are chiefly used for the treatment of chronic insomnia. The use of sleeping pills is typically restricted to cases of acute insomnia; however, such pharmacological treatments may lead to addiction or substance abuse when used over an extended period. Furthermore, quality of life might be degraded as a result of the adverse effects of sleep medication\(^6\). Insomnia symptoms are also associated with subsequent psychotropic medication in a dose-dependent manner\(^7\). In addition, among older adults taking insomnia medication, there is a greater risk of accidental events\(^8\). Fortunately, acupuncture has been used in clinics for thousands of years, and has been proven to treat every single disease. It is reported that auricular-acupuncture and acupuncture are effective in relieving both chronic and acute insomnia symptoms with no side effects\(^9-11\). Whereas drug prescription for insomnia is fixed and treats very specific symptoms, the selection of acupoints can be adapted to the syndromes being treated. In addition, acupuncture has the characteristics of safety, less physiological interference, low price and simplicity for the operator; it is an accepted treatment by patients all over the world. This review summarizes the hazards of insomnia and the use of acupuncture for the treatment of insomnia.

2 Development of negative emotions and acupuncture treatment

2.1 Development of negative emotions
Anxiety and depression are the two main negative emotions caused by insomnia. Impaired sleep quality may result in reduction of pleasurable experiences among healthy and mood-disordered persons\(^12\).

Studies have found a strong association between depression and insomnia\(^13-16\), while insomnia has been found to be a significant predictor of change in depression\(^17,18\). Rates of depression and suicidal ideation are significantly increased in patients with persistent insomnia\(^19\). Apart from insomnia symptoms, non-refreshing sleep and difficulties of initiating or maintaining sleep are all associated with an increased risk of depression\(^20\). Moreover, all persons, from adolescents to seniors, may have suicidal ideations when suffering from severe insomnia and depression; the link between suicidal ideation and insomnia may be mediated by depressive symptoms\(^21,22\).

Women, in particular, suffer greatly from insomnia and depression, and are significantly more vulnerable to depression than men \((P<0.05)\) with symptoms of insomnia\(^23\). Women with diary-defined sleep deficiency reported more depressive symptoms \((P=0.02)\) and perceived more stress \((P<0.01)\) than those who were not sleep deficient\(^24\). In perinatal women with higher insomnia severity index (ISI) scores, the odds ratios for reporting depression symptoms and generalized anxiety were 7.70 and 2.55 respectively, which were significantly higher than in women with lower ISI scores\(^25\).

Postpartum depression is also associated with insomnia during pregnancy, and treatment of insomnia during pregnancy may prevent postpartum depression\(^26\). Further complicating the situation, depression also contributes to nonrestorative sleep in pre- and postmenopausal women\(^27\).

A study found that insomnia affected the balance of optimism and depression experienced by Chinese college students, suggesting that significant differences in depressive symptoms could be due to change of scores in their sleep status\(^28\). Another study, enrolling 819 participants, reported that insomnia symptoms influenced depressive symptoms by stimulating some of the negative aspects of perfectionism (“Concerns over Mistakes and Doubts about Actions”)\(^29\). Despair associated with poor sleep also partly explained how insomnia was related to depression\(^30\). However, insomnia was not only associated with the overall index of negative emotions (combination of somatic anxious arousal, rumination and worry), but also with the interactive effects of negative emotions\(^31\).

In general, insomnia can increase the subsequent risk of major depression by 2- to 3-fold. The relationship between insomnia and depression was more consistent for major depression than for minor depression\(^32\). Table 1 displays the characteristics of some studies examining insomnia and the risk of development of negative emotions.

Nevertheless, the biological processes underlying this causal relationship are unclear. One study showed the heritability (30.7%) of insomnia symptoms, with the remainder of the symptoms ascribed to unique environmental effects. The prevalence of insomnia symptoms was 32.4% in individuals with depression and/or anxiety disorders, which was higher than 16.5% in persons without\(^33\). It is insomnia-specific unique environmental effects that play an important role in the etiology of depression. Another study found that genetic and unique environmental factors accounted for 49% and 51%, respectively\(^34\). However, environmental factors played a more important role than genetic factors in each symptom. Examination of the nervous system has shown that patients with insomnia appear to have fragmented rapid eye movement (REM) sleep, which very likely disturbs the basal processes of emotion regulation. The interaction between the affective arousal system and persistent insomnia could gradually alter the cognitive
### Table 1 Characteristics of studies examining the insomnia and the risk of negative emotion development

<table>
<thead>
<tr>
<th>Country</th>
<th>Age (year)</th>
<th>Design</th>
<th>Sample size</th>
<th>Risk to emotion</th>
<th>Follow-up (year)</th>
<th>Emotion</th>
<th>Criteria for evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>China (2011)</td>
<td>Adolescents</td>
<td>Cross-sectional analysis</td>
<td>719</td>
<td>$P&lt;0.001$</td>
<td>—</td>
<td>Depression</td>
<td>PSQI, CIAS, GHQ-12</td>
</tr>
<tr>
<td>Japan (2012)</td>
<td>20 or older</td>
<td>Longitudinal study</td>
<td>1 577</td>
<td>$P&lt;0.01$</td>
<td>2</td>
<td>Depression</td>
<td>PSQI and Epidemiologic Studies Depression Scale</td>
</tr>
<tr>
<td>Korea (2013)</td>
<td>43–73</td>
<td>Longitudinal study</td>
<td>1 282</td>
<td>$P=0.001$, $P=0.002$</td>
<td>6</td>
<td>Depression, suicidal ideation</td>
<td>Beck Depression Inventory, 4 questions about insomnia based on their symptoms during the past month</td>
</tr>
<tr>
<td>Finland (2012)</td>
<td>43.9 (mean)</td>
<td>Cohort study</td>
<td>40 791</td>
<td>Hazard ratio increased</td>
<td>3.3</td>
<td>Depression</td>
<td>Self-reported sleep</td>
</tr>
<tr>
<td>USA (2012)</td>
<td>18–36</td>
<td>Cross-sectional design</td>
<td>673</td>
<td>$P&lt;0.01$</td>
<td>—</td>
<td>Suicide</td>
<td>DDNSI, ISI, CES-D, PCL-CL, SAS, SBQ-R</td>
</tr>
<tr>
<td>USA (2013)</td>
<td>29.6±4.8</td>
<td>Part of a longitudinal study</td>
<td>160</td>
<td>$P=0.02$</td>
<td>2.2</td>
<td>Depression</td>
<td>Pittsburgh sleep diary, wrist actigraph, IDS, PSS, Revised Pregnancy Distress Questionnaire (NuPDQ)</td>
</tr>
<tr>
<td>USA (2013)</td>
<td>11–17</td>
<td>Cohort study</td>
<td>3 134</td>
<td>$P&lt;0.05$</td>
<td>1</td>
<td>Depression</td>
<td>DSM-IV criteria, DISC-IV</td>
</tr>
</tbody>
</table>


2.2 Acupuncture treatment in insomnia with depression and anxiety

Treatment of insomnia is very important for the management of negative emotions; conversely, the treatment of negative emotions can also help in the prevention of insomnia. Acupuncture is a good choice for treating these symptoms, as the effect of acupuncture on depression, anxiety and the psychological state of patients can be significant\[^{37-40}\]. Anmian acupoints, behind the ears, are used to treat insomnia. Acupuncture at meridian acupoints, combined with three Anmian acupoints could improve depression, anxiety and sleep quality of patients with insomnia\[^{41}\]. Acupuncture therapy could also facilitate hypnotic induction by reducing anxiety\[^{42}\]. For insomnia accompanied by depressive disorders, acupuncture treatment is superior to Western medication, with milder adverse reactions\[^{43}\]. Acupuncture has helped to regulate the secretion of melatonin in day and night, improved symptoms of insomnia and decreased anxiety scores\[^{44}\]. The degree of anxiety and depression also influences the therapeutic effect of acupuncture in treating patients with insomnia\[^{45}\]. After review of the articles published in China, Yang et al\[^{46}\] found that eight extraordinary meridians and all of the twelve regular meridians could be involved in the treatment of the negative emotions of insomnia. The depression was considered a yin disease that could be treated mainly by regulating yang meridians, of which the Governor Vessel was used in the highest frequency\[^{46}\]. Shenmen (HT7), Baihui (DU20), Hegu (LI4) and Taichong (LR3) were the most commonly used acupoints in treating the negative emotions associated with insomnia\[^{43}\]. These points improved insomnia and depression symptoms by calming the mind and regulating qi. Brain wave activity was improved significantly after acupuncture treatment\[^{47}\]. The potential mechanism of
acupuncture in improving negative emotions may be associated with improvements of brain waves in patients.

3 Decreased immunity and acupuncture treatment

3.1 Decreased immunity

Patients with insomnia also frequently suffer from reduced immunity and increased inflammatory mediators. Fundamental research found that serum levels of inflammatory cytokines and leukocytes were increased in a lipopolysaccharide (LPS) + sleep deprivation (SD) group. Interleukin-6 (IL-6), lymphocytes, interferon-γ (IFN-γ), and tumor necrosis factor-α (TNF-α) levels were also increased in bronchoalveolar lavage fluid (BALF) in the LPS + SD group, while the macrophage levels in BALF were decreased, which indicated a reduction in immune response after sleep deprivation. However, melatonin, which was mainly produced at night, significantly inhibited the recruitment of lymphocytes in serum and BALF (P<0.05) and reduced the serum levels and BALF levels of IL-1β, IL-6, TNF-α and IFN-γ[48]. After sleep restriction, myeloperoxidase levels, leukocyte and, among leukocyte subsets, neutrophil counts were all increased[49]. Meanwhile, a clinical investigation showed that nonrestorative sleep and difficulties initiating sleep were associated with increasing high-sensitivity C-reactive protein (hsCRP) levels among men. However, there was no evidence of this response in women[50]. Hemodialysis patients showed a CRP level ≥3.8 mg/L, which was significantly associated with sleep disorders[51]. In addition, the serum IL-6 level of kidney transplant patients with insomnia was remarkably higher than in patients without insomnia[52]. What’s more, paradoxical sleep deprivation (PSD) could lead to a significant decrease in circulating lymphocytes and a general reduction in all cellular subsets of the spleen, mainly B and T cells[53]. However, no change in PSD response was found in the peritoneum or lymph nodes. In another sleep deprivation experiment[54], CD4, CD8, CD14, CD16, mitogen proliferation and human leukocyte antigen (locus)-DR all presented significant time-dependent changes after sleep deprivation; CD3 did not. Sleep loss can lead to an induction of inflammatory responses, the perturbation of cellular immunity and a homeostatic imbalance. Over 500 genes were expressed differentially in subjects after the second night of prolonged wakefulness and one night after sleep recovery[55]. Of these, some genes were related to diverse immune system responses, such as natural killer (NK) pathways, including granzymes, T-cell receptors, and killer cell lectin-like receptor family, which are very important for host defense. In another study, except for the significantly higher monocyte and NK cytotoxicity counts in males, no other effects were significant in any of the endocrine or immunological indices, after participants experienced 30 h of sleep deprivation, during which social, physiological, and cognitive tasks were conducted[56]. These marked contradictions in different studies might reflect differences in the methodology used for immunological assessments or in study design, including the duration of sleep deprivation and timing of sample collection. Table 2 gives a description of some immune markers present after sleep disorders.

3.2 Acupuncture treatment for increasing immunity

Decreased immunity could be one explanation for the increase in susceptibility to infections reported after sleep reduction[54]. Acupuncture has a good effect on the immune system and has the ability to protect

<table>
<thead>
<tr>
<th>Table 2 A description of some immune markers after sleep disorder</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Increased</strong></td>
</tr>
<tr>
<td>Monocytes</td>
</tr>
<tr>
<td>Myeloperoxidase</td>
</tr>
<tr>
<td>Interleukin-6</td>
</tr>
<tr>
<td>Lymphocytes</td>
</tr>
<tr>
<td>Interferon-γ</td>
</tr>
<tr>
<td>Tumor necrosis factor-α</td>
</tr>
<tr>
<td>Leukocytes</td>
</tr>
</tbody>
</table>

hsCRP/CRP

Natural killer cytotoxicity

CRP: C-reactive protein; hsCRP: high-sensitivity C-reactive protein.
An experiment in 1975 reported the effects of acupuncture on immune responses in sensitized rabbits and guinea pigs, counts of CD3, CD4 and CD8, and the percentage of NK cells and monocyte phagocytosis were all increased after acupuncture treatment. The local mucosal immunological system can also be affected by acupuncture. Electro-acupuncture (EA) can regulate serum cytokine levels in healthy conditions. EA stimulation at Ququan (H8) was shown to modulate humoral immune response of rats injected with sheep-red-blood cells antigen. Some studies have investigated how acupuncture affects immunology during the time after treatment. Acupuncture showed the best effects on the immune system 72 h after a single session and the effect could persist one month after a complete treatment, which consisted of 10 sessions. Another study found that leukocyte count of cholera mice increased and reached its highest quantities 2 h after acupuncture treatment, and decreased to normal levels after 24 h.

Acupuncture can promote T-lymphocyte transformation function through the regulation of central catecholaminergic neurons; the mechanism may be mainly attributed to speeding up the anabolism of the DNA and promoting the anabolism of T-lymphocytes. Another report found EA promoted T-lymphocyte transformation by boosting the release of endogenous opioids produced in the brain. These endogenous opioids promoted an immune response. Furthermore, it can be inferred that the serotonergic system plays a main role in EA regulation of humoral immunity, while the catecholaminergic system plays an important role in EA regulation of cellular immunity. In addition, Cx43 plays an important role in the transmission of acupuncture signals in the regulation of the immune system. Research found that acupuncture could notably increase the spleen index, thymus index and leukocyte number in Cx43 knock out mice. Therefore, acupuncture can be an effective method for strengthening the immunity of patients with insomnia.

4 Increased oxyradicals and acupuncture treatment

4.1 Increased oxyradicals

Insomnia may result in increased oxyradicals. A study showed that insomnia patients had significantly lower glutathione peroxidase (GSH-Px) activity and higher malondialdehyde (MDA) levels compared with healthy individuals, which signals increase of oxyradicals. Lipoperoxides are produced in the reaction between polyunsaturated fatty acids and oxygen. A cross-sectional study with 187 perimenopausal women found that there was a positive correlation between insomnia score, menopause rating score and lipoperoxides in postmenopausal women. This predicted an indirect relationship between oxygen and insomnia. IL-18, hs CRP and oxidized low-density lipoprotein levels declined remarkably with cognitive-behavioral therapy in sleep-disturbed hemodialysis patients. Patients with insomnia had lower serum paraoxonase and arylesterase activities, lower serum total antioxidant status, lower oxidative stress index and lower total oxidant status relative to the healthy controls. Patients with insomnia had reduced levels of serum antioxidant enzymes and increased systemic oxidative stress. Another study showed that sleep deprivation enhanced antioxidant responses in rat brains. Acute (6 h) sleep deprivation under sustained hypoxia increased total glutathione (GSHt) production in the brainstem, cerebellum and neocortex and increased nitric oxide (NO) levels in the hippocampus while decreasing hippocampal lipid oxidation. Elevated glucose metabolism may play an important role in producing enhanced free radicals in the brain, while oxidative stress seems to be an underlying condition related to insomnia.

4.2 Acupuncture treatment for decreasing oxyradicals

Numerous studies have shown that acupuncture can reduce the production of free radicals. Sanjinjiao (SP6) and ZusanzLi (ST36) belong to the channels of spleen and stomach, respectively and function in regulating blood and qi, invigorating qi, and eliminating pathogenic factors. Acupuncture stimulation at SP6 and ST36 has antioxidative effects. Acupuncture can adjust the metabolism of serum oxygen free radicals by down-regulating the production of serum MDA and hydrogen peroxide, and up-regulating serum superoxide dismutase (SOD), GSHt, GSH-Px activity and carnitine production. In addition to increasing the levels of SOD and GSH-Px, acupuncture treatment can also significantly increase the expression of CuZnSOD mRNA and protein to ameliorate oxidative injuries. Moreover, acupuncture can improve the antioxidant status of erythrocytes and stabilize disordered lipid peroxidation (LPO) processes. Acupuncture also prevented formation and accumulation of LPO products in the main regions of the brain. In addition, EA treatment increased the activity of SOD in the liver, hypothalamus and red blood cells. Furthermore, acupuncture at different Shichen (traditional twelve 2-hour periods) has different effects on serum SOD and MDA, which can decrease MDA content and increase SOD activity. The decreasing amplitude of MDA was smallest in the Hai period and largest in the Wu period, while the increasing amplitude of SOD activity was smallest in the Wu period and largest in the Mao period. Two studies concerned with the improvement of oxidative stress through the use of acupuncture are shown in Table 3.
Table 3 Characteristics of two studies about improving oxidative stress by using acupuncture

<table>
<thead>
<tr>
<th>Acupoint</th>
<th>Manipulating</th>
<th>Effect</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zusanli (ST36)</td>
<td>Uniform reinforcing and reducing method by twirling the acupuncture needle</td>
<td>(1) Up-regulating serum GSH-Px and SOD activities</td>
<td>(1) The status of oxidative stress is a disharmony of qi and blood, which would lead to extravasated blood and damp toxin.</td>
</tr>
<tr>
<td>and Sanyinjiao (SP6)</td>
<td>for 20 min, once daily, and with 7 days being a treatment course, conducted for three courses with an interval of 3 days between two courses</td>
<td>(2) Down-regulating serum MDA level</td>
<td>(2) SP6 is the convergent acupoint of spleen meridian, kidney meridian, and liver meridian, having the functions of clearing and activating the channels and collaterals, and promoting circulation.</td>
</tr>
<tr>
<td>Right ST36 and Jiexi (ST41)</td>
<td>connected to an electric stimulator with dense-sparse waves</td>
<td></td>
<td>(3) ST36 and ST41 both belong to Five Shu acupoints of Stomach Channel of Foot-Yang Ming. These points have the functions of dredging the channel, regulating blood and qi, invigorating qi and eliminating pathogenic factors.</td>
</tr>
</tbody>
</table>

GSH-Px: glutathione peroxidase; SOD: superoxide dismutase; MDA: malondialdehyde.

5 Causes of cardiac disease and acupuncture treatment

5.1 Causes of cardiac disease

Research shows that various diseases have a certain relationship with insomnia, especially cardiovascular disease (CVD). The relationship between delta power and changes in cardiac autonomic activity is altered in patients with chronic primary insomnia[85]. Insomnia often leads to a state of sympathetic inhibition and vagus nerve stimulation, which impacts physiological functions, such as heart rate (HR), blood pressure (BP) and blood supply to the cardiac muscles. Insomnia and sleep duration may interact to almost double the risk of CVD and coronary heart disease (CHD). Women with high insomnia scores had an elevated risk of CHD (38%) and CVD (27%), while shorter (≤5 h) and longer (≥10 h) sleep duration demonstrated a significantly higher incidence of CHD (25%) and CVD (19%)[86]. Laugsand et al[87] found that there was a dose-dependent relationship between the risk of heart failure and the number of insomnia symptoms. The multi-adjusted hazard ratios for people with one, two and three insomnia symptoms were 0.96, 1.35 and 4.53 respectively, compared with people without insomnia symptoms. In addition, insomnia was associated with hypertension and HR[88-90]. A combination of three sleep complaints [waking up repeatedly (sleep continuity disturbance, SCD), difficulty falling asleep (DFA), awakening tired and fatigued (nonrestorative sleep, NRS)] was related to a slightly increased risk of CVD (OR 1.5, 1.1-2.0), but not hypertension. Either DFA or SCD was associated with an increased risk of hypertension[90]. Heart disease may be related to certain insomnia symptoms. A study discovered that patients with chronic primary insomnia have an irregular HR and heart rate variability (HRV), consistent with increased sympathetic activity[90]. This significant difference between insomniacs and controls was only detected when awake before sleep and during stage-2 non-REM sleep, but not during REM sleep, slow-wave sleep, or post-sleep wake. It is hypothesized that autonomic hyperarousal may be a major pathogenic mechanism in primary insomnia, and confirmed that insomnia is associated with an increased risk of CVD disease. Table 4 displays the characteristics of studies that addressed the risk of cardiac disease induced by insomnia.

Another study also found alterations in HRV variables and a lower wake-to-sleep HR reduction might increase cardiovascular mortality and morbidity observed in patients with insomnia[91]. Moreover, the primary insomnia patients showed marked reduction in parasympathetic-related HRV indices and physiologic complexity relative to healthy controls. Alterations in HRV indices were related to perceived-sleep questionnaire scores, which suggested a pivotal role of sleep disturbance in adjusting cardiovascular variability in patients with primary insomnia[91]. Sympathetic predominance, associated with a vagal withdrawal, is the potential pathogenic mechanism for heart diseases, while melatonin, with its high nocturnal concentrations, is a potential therapeutic target in diseases ranging from insomnia and depression to cardiovascular diseases. It was hypothesized that a reduction in melatonin caused by insomnia is also a vital risk factor of CVD[92].

5.2 Acupuncture treatment for cardiac diseases

Once insomnia induces or aggravates cardiac diseases, the treatment of cardiac disease is also very necessary for the treatment of insomnia. There is a long history
of acupuncture treatment for heart disease. The main treatment principles of acupuncture in treating heart disease include promoting blood circulation for removing blood stasis, regulating the function of liver and spleen, soothing the liver and suppressing yang.

The effective rate of the combined treatment with ginger-partition moxibustion and acupuncture for patients with cardiac arrhythmia was higher than that of Western medicine\(^\text{(107)}\). Litscher et al.\(^\text{(98)}\) found that HR of insomnia patients decreased remarkably (P<0.01) during and after acupuncture stimulation of the Shenmen (HT7) acupoint. Total HRV was also increased (P<0.05) immediately after acupuncture stimulation, but the effect was not long-lasting\(^\text{(98,99)}\). Meanwhile, acupuncture can lead to an increase of cardiac vagal modulation of HR combined with a trend towards a decrease of low frequency (LF) and an increase of high frequency (HF) spectral power\(^\text{(99)}\). However, another study found the opposite effect: acupuncture substantially reduced HRV, causing a 41% decrease in the standard deviation; variances of LF and HF ranges were both markedly reduced, but the LF/HF ratio and the HR were not altered\(^\text{(101)}\). These inconsistent results require further study. Nevertheless, the results suggest that acupuncture can regulate function of the cardiac autonomic nervous system (ANS)\(^\text{(100)}\). Acupuncture may attenuate the imbalance between parasympathetic and sympathetic activities, decreasing the LF/HF ratio power\(^\text{(102)}\). Furthermore, acupuncture effects on HRV rely on both the ANS and the complete central nervous system\(^\text{(103)}\). The modulation of cardiac autonomic function has the characteristic of point specificity. A study showed that the stimulation of Danzhong (CV17), but not of Zhongting (CV16), increased the power of the HF component of HRV (P<0.01) and reduced HR (P<0.01)\(^\text{(104)}\). As for hypertension, acupuncture was significantly superior to medication in relieving casual blood pressure and ambulatory blood pressure\(^\text{(105)}\). Acupuncture was also shown to have immediate and long-term effects in lowering BP\(^\text{(106)}\). Stimulating at Yanglingquan (GB34) can reduce not only femoral arterial pressure, but also the size of cardiac muscle cells, preventing heart hypertrophy\(^\text{(107)}\). However, another study found acupuncture at Sishencong (EX-HN1) and Baihui (GV20), with needle-retention for 8 h, had a shorter duration and was relatively slower in reducing BP compared to the administration of Nifedipine tablets (20 mg/d)\(^\text{(108)}\). But needle stimulation for 8 h was still as effectively as medication at lowering systolic pressure at the time-points of 2, 4 and 6 h and lowering diastolic pressure at the time-points of 2, 4, 6 and 8 h after treatment\(^\text{(109)}\). It is suggested that acupuncture may adjust the cardiovascular system through a complicated brain network at the cortical level, the hypothalamus and the brainstem\(^\text{(109)}\). Another study found that ear acupuncture could improve HR and hypertension by increasing the level of response of cardiac-related neurons in the nucleus tractus solitarius, which can be attenuated by atropine and local anesthetics\(^\text{(110)}\). Acupoints selected to improve cardiac disease comprise the twelve regular meridians, eight extra channels and even the extra nerve points. Therapeutic principles differ from different acupoints; a summary of the characteristics of some acupoints for treating cardiac disease is given in Table 5. These points can improve both heart function and insomnia symptoms.

### 6 Summary

This review summarized the hazards of insomnia and the relationship between insomnia and other diseases.

---

**Table 4** Characteristics of studies concerning the risk for cardiac disease induced by insomnia

<table>
<thead>
<tr>
<th>Study/year</th>
<th>Cases/follow-up</th>
<th>Risk for cardiac disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>A large Norwegian cohort study (2014)(^\text{(97)})</td>
<td>1 412 cases of heart failure occurred during a mean follow-up of 11.3 years</td>
<td>The hazard ratios for people with one, two, and three insomnia symptoms were 0.96, 1.35 and 4.53 respectively</td>
</tr>
<tr>
<td>The Penn State Cohort (2012)(^\text{(96)})</td>
<td>1 741 adults of the Cohort; 1 395 were followed up after 7.5 years</td>
<td>Odds ratios of the risk of incident hypertension in poor sleepers and chronic insomniacs were 1.6 and 3.8 respectively</td>
</tr>
<tr>
<td>The 2005-2008 United States National Health and Nutrition Examination Surveys (2013)(^\text{(95)})</td>
<td>N=12 643/3 years of follow-up</td>
<td>Odds ratio of current antihypertensive medications 1.33, 1.04–1.70; odds ratio of doctor-diagnosed hypertension 1.49, 1.19–1.88</td>
</tr>
<tr>
<td>Atherosclerosis Risk in Communities (ARIC) Study (2007)(^\text{(92)})</td>
<td>8 757 ARIC participants without hypertension and 11 863 ARIC participants without cardiovascular disease at baseline and with 6 years of follow-up</td>
<td>A combination of three sleep complaints (SCD, DFA, NRS) was associated with a slightly increased risk of cardiovascular disease (odds ratio 1.5, 1.1–2.0) but not hypertension. Either DFA or SCD was associated with increased risk of hypertension</td>
</tr>
</tbody>
</table>

SCD: sleep continuity disturbance; DFA: difficulty falling asleep; NRS: nonrestorative sleep.
Table 5 Characteristics of points selected for treating cardiac disease

<table>
<thead>
<tr>
<th>Meridian</th>
<th>Point</th>
<th>Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urinary bladder meridian</td>
<td>Xinshu (BL15), Ganshu (BL18), Pishu (BL20), Shenshu (BL23), Shenmai (BL62)</td>
<td>Regulating viscera function, nourishing yin and suppressing hyperactive yang, and invigorating qi</td>
</tr>
<tr>
<td>Spleen meridian</td>
<td>Gongsun (SP4), Sanyinjiao (SP6)</td>
<td>Strengthening spleen and eliminating dampness</td>
</tr>
<tr>
<td>Conception meridian</td>
<td>Guanyuan (CV4), Zhongting (CV16), Danzhong (CV17)</td>
<td>Relaxing the chest, and invigorating primordial qi</td>
</tr>
<tr>
<td>Gallbladder meridian</td>
<td>Fengchi (GB20), Yanglingquan (GB34), Xiasi (GB43)</td>
<td>Calming the liver to stop the wind</td>
</tr>
<tr>
<td>Liver meridian</td>
<td>Xingjian (LR2), Taichong (LR3)</td>
<td>Dispersing and rectifying the depressed liver-energy, and calming the liver to stop the wind</td>
</tr>
<tr>
<td>Lung meridian</td>
<td>Hegu (LI4), Quchi (LI11)</td>
<td>Regulating qi and blood, strengthening spleen and eliminating dampness</td>
</tr>
<tr>
<td>Stomach meridian</td>
<td>Renying (ST9), Zusani (ST36)</td>
<td>Regulating qi and blood, strengthening spleen and eliminating dampness</td>
</tr>
<tr>
<td>Governor meridian</td>
<td>Baihui (GV20)</td>
<td>Tranquilizing mind</td>
</tr>
<tr>
<td>Pericardium meridian</td>
<td>Neiguan (PC6)</td>
<td>Tranquilizing mind</td>
</tr>
<tr>
<td>Kidney meridian</td>
<td>Fuliu (KI7)</td>
<td>Clearing damp</td>
</tr>
<tr>
<td>Heart meridian</td>
<td>Shenmen (HT7)</td>
<td>Tranquilizing mind</td>
</tr>
</tbody>
</table>

Furthermore, the authors introduced an effective and cost-efficient method of acupuncture for insomnia treatment. Our review indicates that insomnia poses a major threat to mental health, and that anxiety and depression are the two main negative emotions involved. Moreover, insomnia has a direct effect on serum components, heart function and the immune system of patients, which may result in physiological disorders.

Sleep helps individuals recover from the physical and mental exhaustion of daily work. Insomnia is one of the most important factors contributing to health. According to the theory of traditional Chinese medicine, insomnia is a state of yang excess and yin deficiency that will result in a variety of symptoms, such as headaches, distress, heart palpitations, nausea, anxiety, depression, suicidal ideation, as well as other psychological disorders and symptoms. Other modern research has shown that insomnia is also a risk factor for the development of depression, decreased immunity, increased oxyradicals, cardiac disease and more.

In the theory of traditional Chinese medicine, five kinds of spirits inhabit the five zang-organs (heart, liver, lung, spleen and kidney). Each kind of spirit has a corresponding physiological function. The five zang-organs are unable to perform this function during insomnia, which could manifest in symptoms such as deficiency of vital energy, fatigue, confusion, abnormal psychology and heart state disturbance. In addition, the state of qi and blood will be changed in these patients.

Further, emotional distress associated with insomnia would impair the function of the viscera. In the Western medical context, it is also expected that a change in the immune system and inflammatory biomarkers would also take place in the same patients. Modern research could help us to understand traditional Chinese medicine theory in this context.

Insomnia is a potential risk factor in many diseases. Proper treatment of insomnia would largely reduce the occurrence or severity of other diseases and benefit the treatment of other symptoms. Acupuncture produces notable advantages in the treatment of insomnia and its complications. For example, treatment with acupuncture can balance the emotions and increase feelings of vitality\(^{[111]}\). Immune function, serum oxygen-free radicals and heart disease all respond well to acupuncture. Shenmai (BL62) and Zhaohai (KI6), which are two of the eight confluence points in meridian theory, have a special function in treating insomnia. Additionally, the points of Baihui (DU20), Sishencong (EX6), Anmian (Extra), Shenmen (HT7), Zusani (ST36) and Sanyinjiao (SP6) are often used for treatment of insomnia. The acupuncture prescription of regulating yin-yang and the five viscera are more effective for intractable insomnia; therefore, acupuncture can be a constructive and complementary method for insomnia and its complications.

With the rapid development of medical and molecular technology, more and more research is taking place at the molecular level. Based on the reviewed literature, all of
the harmful effects of insomnia can be effectively treated by acupuncture. Yet, there are limitations to the literature reviewed in this paper. Insomnia patients in some studies were self-diagnosed, and there were no uniform standard criteria for insomnia diagnosis. Few studies investigated the pathogenesis of insomnia and its relationship to other diseases. Studies on the therapeutic mechanisms of acupuncture were also limited. Further research can focus on formulating standard diagnostic criteria and using advanced technology, such as molecular tools, to study the mechanisms of insomnia. Since traditional Chinese medicine is effective in treating insomnia, utilizing the theory and guidance of this practice may bring hope to insomnia patients.

7 Acknowledgements

This study was supported by the Teaching Fund of Shanghai University of Traditional Chinese Medicine (No. 1377), the Shanghai “Xinglin Star” Plan (No. ZY3-RCPY-2-2008) and the Shanghai Doctoral Degree Construction Project (No. 1497).

8 Conflict of interests

No potential conflicts of interests relevant to this article exist.

REFERENCES


77 Liu CZ, Lei B. Effect of acupuncture on serum malonaldehyde content, superoxide dismutase and...


