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# Standing and sitting postures at work and symptoms of venous insufficiency – results from questionnaires and a Doppler ultrasound study

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Chronic venous insufficiency is the most common vascular disease. One of the major risk factors for its development is long-term sitting or standing in the same position and the nature of the work performed. This study aimed to evaluate the incidence of chronic venous insufficiency in a group of persons employed in workplaces with a predominance of standing or sitting positions, and to determine work-related and non-work risk factors. The research used two tools: questionnaires and medical examinations. The survey comprised 500 people, including 238 men (47.6%) and 262 women (52.4%), aged 25–60 years, 39.75 ± 10.80 years old on average. In addition, a group of 100 randomly selected people was subjected to medical examinations to confirm or exclude chronic venous insufficiency symptoms in the study group. The study showed a statistically significant correlation between postures adopted at work and the symptoms of chronic venous insufficiency of the lower limbs.

**Keywords:** chronic venous insufficiency of the lower limbs; occupational factors; work in the standing position; work in the sitting position; non-work factors; Doppler ultrasound

## 1. Introduction

Venous diseases affect more than half of the population of developed countries. The most common of these diseases is chronic venous insufficiency, whereby venous dysfunction is caused by the failure of venous valves due to an obstacle in the outflow of blood through the veins of the lower limbs [1]. Because of its high incidence, the disorder is considered a social disease. It is estimated that the incidence among adult Poles ranges from 38.33% in men to 50.99% in women [2,3]. The social cost of chronic venous insufficiency, which includes medical leave, diagnostic tests, hospitalization and surgery, is comparable to the cost of treatment of diseases generally regarded as more serious, for example cardiovascular diseases [4]. The primary cause of the disease and its consequences is the lack of prevention due to insufficient knowledge about the risk factors, which primarily include age, the female gender, positive family history, congenital anomalies of the veins, pregnancy, obesity, constipation, hormonal changes, high ambient temperature as well as long stay in a sitting or standing position and is related to the work performed [5,6]. A significant relationship between postures adopted at work and the development and/or exacerbation of chronic venous insufficiency symptoms has been the subject of many scientific studies [7–10]. These works usually concerned the elderly. Given that age is one of the main factors of chronic venous insufficiency, drawing conclusions on the work-related risk factors of the disease was limited in these cases. These studies involved people of different ages, including relatively young people, and the main inclusion criterion was a minimum of 5 years of work performed in the sitting or standing position.

Due to the fact that the consequences of undiagnosed and untreated chronic venous insufficiency are very serious, and that the number of jobs in which most duties are performed in the standing or sitting position is still increasing, undertaking a study on the incidence of chronic venous insufficiency among persons who have a job of such nature, and identifying the relevant factors, appears to be justified.

The aim of the study was to evaluate the incidence of chronic venous insufficiency in a group of employees who work in the standing or sitting position, and to determine the influence of work-related and non-work (lifestyle) factors on the symptoms of the disease in the study group.

## 2. Methodology

### *2.1. Study group*

The study was conducted in a group of people aged 25–60 years (both sexes) with a minimum of 5 years of work in a sitting or standing position (at least 4 h of sitting or standing during a shift).

Each respondent was informed of the purpose and nature of the study. Free, prior and informed consent was

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secured to ensure voluntary participation of each participant.

### 2.2. Methods

The two types of tests included questionnaires and diagnostic medical examinations. The questionnaire designed and developed for the survey included 69 questions grouped into the following sections: personal details (6 questions); information about professional life (32 questions); information about non-vocational life (18 questions); questions about state of health (13 questions).

The survey questionnaire consisted of closed questions, multiple-choice questions, cafeteria interview questions and open questions, allowing free answers. The survey was conducted among 500 people following the direct interview technique and using a paper-and-pencil interview (PAPI) by an interviewer company. Sampling was purposeful and according to quotas, and the amounts were determined by gender and type of work (sitting or standing).

Additionally, 100 randomly selected people among those who participated in the questionnaire studies were subjected to medical examinations in order to confirm or rule out the presence of chronic venous insufficiency symptoms. The scope of the study covered the staging of chronic venous insufficiency according to the clinical, aetiology, anatomy, pathophysiology (CEAP) classification and ultrasound of the lower limbs using venous Doppler. The CEAP classification includes clinical, aetiology, anatomy and pathophysiology assessments of chronic venous insufficiency [11]. The idea behind the creation of the classification, in addition to arranging and categorizing basic chronic venous insufficiency concepts, was to provide a universal evaluation system that would be simple enough for widespread acceptance, so that limbs could be freely compared and multi-centre studies conducted with a uniform reporting system.

The non-invasive screening technique of the arteries, which is called Doppler ultrasound, was developed in the 1960s. This method is a variation of the ultrasound examination based on the Doppler phenomenon, which is connected to the change in the frequency of the sound wave reflected from a mobile obstacle [12–14]. The Doppler examination is a non-invasive and painless procedure, which uses ultrasonography to evaluate the blood flow of a vessel or structure, estimating its direction and speed.

Doppler ultrasonography was performed using the MyLab 60 (Philips, Netherlands) with the linear probe at a frequency of 4–13 MHz. In a few cases of people with obesity or oedema of the lower limbs, the deep veins were visualized using convex probes with a frequency of 1–8 MHz. The examination of the veins in the femoral area was performed in the supine position, while the popliteal fossa and lower limbs were examined in the sitting position with legs lowered. Both tests (CEAP assessment and Doppler ultrasound) were carried out by a radiologist.

Table 1. Structure of the respondents by age group ($N = 500$).

| Age group (years) | Number of subjects | % |
|---|---|---|
| 25–35 | 147 | 29.4 |
| 36-45 | 140 | 28.0 |
| 46–55 | 99 | 19.8 |
| 56–65 | 114 | 22.8 |

Table 2. Structure of the respondents by BMI category ($N = 500$).

| BMI category | Numerical range | Number of subjects | % |
|---|---|---|---|
| Underweight | <18.5 | 3 | 0.6 |
| Normal weight | 18.5–24.9 | 268 | 53.6 |
| Overweight | 25–29.9 | 170 | 34.0 |
| Obesity degree I | 30–34.9 | 48 | 9.6 |
| Obesity degree II | 35–39.99 | 10 | 2.0 |
| Obesity degree III | >40 | 1 | 0.2 |

Note: BMI = body mass index.

### 2.3. Statistical analysis

Statistical analysis of the test results was performed using SPSS version 15. Continuous variables are presented as $M \pm SD$, while categorical variables are reported as count and percentage (%). To assess the statistical significance, a $t$ test was employed. In the case of non-normal distribution of data, a non-parametric Mann–Whitney $U$ test was used. All tests were carried out at a 5% level of significance.

## 3. Questionnaire study results

### 3.1. General characteristics of subjects

The survey involved 500 subjects aged 25–60 years ($M \pm SD$ $39.75 \pm 10.80$ years), including 262 women (52.4%) and 238 men (47.6%). The structure of the respondents by age group is presented in Table 1.

The body weight of the respondents ranged from 49 to 125 kg ($M \pm SD$ $75.13 \pm 14.62$ kg). Body mass index (BMI) ranged from 17.72 to 41.04 ($M \pm SD$ $25.36 \pm 3.96$). Table 2 presents the structure of the respondents by BMI categories.

### 3.2. Professional activity of the subjects

The total work experience in the study group ranged from 5 to 45 years ($M \pm SD$ $17.56 \pm 10.84$ years). The average weekly working time in the studied sample was $40.2 \pm 9.51$ h. The vast majority of the respondents had full-time jobs (457 respondents, 91.4%) and were employed in the private sector (351 respondents, 70.2%).

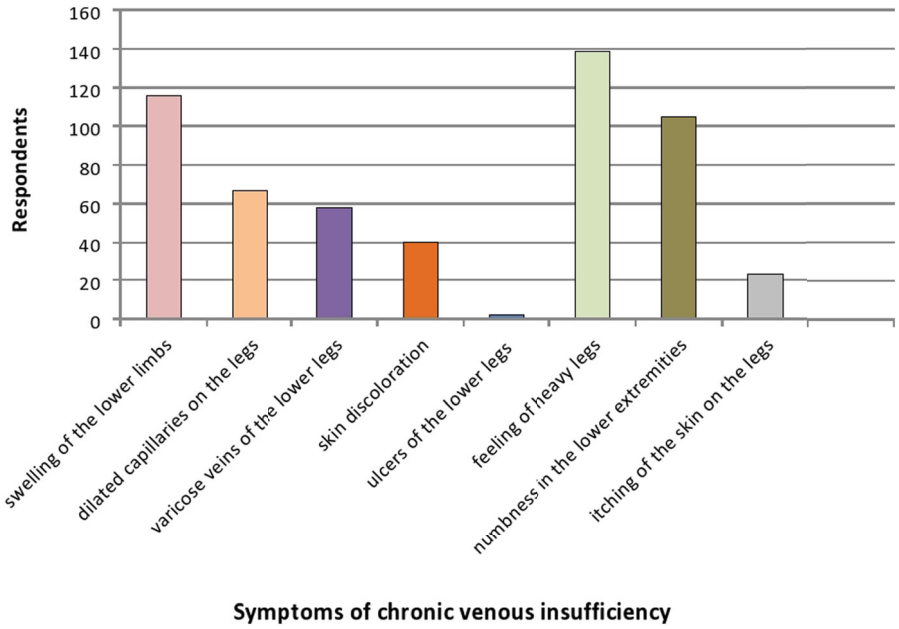


Figure 1. Symptoms of chronic venous insufficiency of the lower limbs in the surveyed group ($N = 500$).

Most subjects were employed in the following sectors: services, 111 subjects (22.2%); health care, 64 subjects (12.8%); trade, 63 subjects (12.6%); education, 40 subjects (8.0%); and industrial processing, 32 subjects (6.4%).

Mental work was performed by 163 employees (32.6%), physical work by 148 employees (29.6%), mixed work with a predominance of mental effort by 87 employees (17.4%) and mixed work with a predominance of physical activity by 102 employees (20.4%).

Fifty-three (10.6%) subjects described their work as very hard, 144 subjects (28.8%) as hard, 243 subjects (48.6%) as moderately hard and 60 subjects (12.0%) as light.

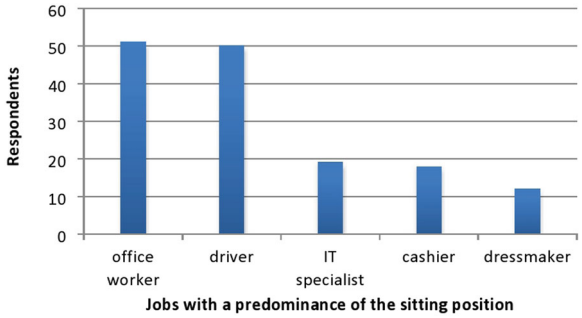


Figure 2. Jobs most commonly occupied by respondents working in the sitting position in the surveyed group ($n = 212$ subjects). Note: IT = information technology.

### 3.3. *The occurrence of chronic venous insufficiency symptoms in the surveyed group*

Figure 1 shows the symptoms of chronic venous insufficiency of the lower limbs in the surveyed group.

Several subjects (260 subjects, 52.0%) reported more severe symptoms of chronic venous insufficiency, such as a feeling of heaviness, spreading and numbness in the lower limbs at the end of the day, 255 subjects (51.0%) observed these symptoms after prolonged standing, 147 subjects (29.4%) after a long sit and 193 subjects (38.6%) in the summer. Conversely, 217 subjects (43.4%) reported alleviation of these symptoms after lifting the lower limbs up.

### 3.4. *Work-related risk factors of chronic venous insufficiency in the surveyed group*

In the surveyed group, 212 subjects (42.4%) performed a sedentary job. Work experience in this group ranged from 5 to 40 years ($M \pm SD$ 7.71 ± 9.51 years). Figure 2 shows the jobs most commonly occupied by respondents working in the sitting position.

Work in the standing position was performed by 288 respondents (57.6%). Work experience in this group ranged from 5 to 35 years ($M \pm SD$ 14.9 ± 10.61 years). Figure 3 shows the jobs most frequently occupied by respondents working in the standing position.

Eighty subjects (16.0%) used a desktop computer for more than 6 h/day during their work shift. Almost a quarter of the respondents (22.6%) reported insufficient space to comfortably put their lower limbs under the desk when working on a computer. Only 50 subjects used footrests when working on a computer (10.0%). Almost one-third of the respondents (30.6%) had the habit of crossing one's lower limbs while sitting at a computer or desk.

An overwhelming number of respondents (380 respondents, 76%) declared that they had the right to decide about


Figure 3. Jobs most frequently occupied by respondents working in the standing position in the surveyed group ($n = 288$ respondents).

the time of a break at work, depending on their needs. Less than half of the subjects declared that they could change the order of their duties (220 subjects, 44.0%), the pace of work (135 subjects, 27.0%) and the way they worked (78 subjects, 15.6%).

Eighty-one respondents (16.2%) used a break at work for a change in body position and a short walk, while 46 respondents (9.2%) used a break for stretching exercises. The remaining of the respondents spent their free time during a break sitting or standing.

Awareness of the health risks of working in the sitting and standing positions was declared by 199 subjects (39.8%) and 185 subjects (37.0%), respectively. Among the health effects of sedentary jobs, the respondents most often mentioned pain in the musculoskeletal system (116 respondents, 58.3%), varicose veins of the lower limbs (40 respondents, 20.1%) and obesity (eight respondents, 4.0%). In turn, among the health risks of working in the standing position, the respondents most commonly mentioned pain of the musculoskeletal system (85 respondents, 45.9%) and varicose veins of the lower limbs (77 respondents, 41.6%).

A statistically significant positive correlation ($p < 0.05$) was found between the presence of varicose veins and occupational factors such as a forced position in performing duties, work in the sitting position for more than 4 h/day, lifting and carrying heavy objects, use of a large leg strength, fast-paced work and computer work. A negative correlation was observed between the presence of varicose veins and the use of a footrest while working on a computer.

### *3.5. Non-work risk factors of chronic venous insufficiency in the surveyed group*

Almost half of the respondents (226 respondents, 45.2%) reported a positive family history of chronic venous insufficiency. Others (135 respondents, 27.0%) declared spending more than 2 h/day in the sitting position on a computer and/or television, while more than half of the respondents (287 respondents, 57.4%) reported the daily use of a car (more than 2 h/day). Almost half of the respondents (217 respondents, 43.4%) spent time at least once every 2–4 weeks on active recreation (sports, gymnastics, intense walks).

Some respondents (282 subjects, 56.4%) declared eating three meals a day at regular times, while 230 respondents (46.0%) used a diet rich in fruits and vegetables. The surveyed group contained 121 (24.2%) smokers. Among them, 13 subjects (10.7%) declared smoking more than 20 cigarettes a day. Almost a quarter of the respondents (105 respondents, 21.0%) declared that sometimes they wore too tight clothing (socks with cuffs, knee-length socks, tight trousers, leggings). In a group of women, the majority (211 respondents, 80.5%) wore high heels everyday or almost everyday.

Among the women surveyed, 181 (69.1%) of them were pregnant in the past, including 67 women once (25.5%), 75 women (28.6%) twice, 26 women (9.9%) three times and 13 women (4.9%) more than three times. Among the women who were pregnant, 79 (43.6%) observed the appearance or aggravation of symptoms of chronic venous insufficiency during pregnancy. Fifty-two women (19.8%) used hormonal contraceptives and 25 women (9.5%) used hormone replacement therapy.

A statistically significant positive correlation ($p < 0.05$) was found between the presence of varicose veins and non-work risk factors such as the age of the respondents, BMI, smoking, 'fast-food' consumption and the number of pregnancies. A negative correlation was reported between the presence of varicose veins of the lower limbs and the use of a diet rich in fruits and vegetables.

## 4. Medical examination results according to the CEAP classification and Doppler ultrasound

The medical examination involved 100 subjects randomly selected from 500 subjects previously taking part in the survey. Sixty-three women and 37 men were examined, aged 25–64 years ($M \pm SD$ 38.8 ± 10.7 years). Work experience in this group ranged from 5 to 45 years ($M \pm SD$ 16.53 ± 10.76 years). Features of chronic venous insufficiency were found in 73 subjects, including 55 women (88.7%) and 18 men (48.6%). The abnormalities shown by Doppler ultrasound are presented in Table 3.

Three subjects out of the 100 surveyed had a history of past surgery to remove varicose veins, including the removal of the great saphenous vein (saphenectomia). Two out of three subjects manifested recurrence of varicose veins following this procedure.

A statistically significant positive correlation ($p < 0.05$) was found between the features of chronic venous insufficiency of the lower limbs reported in the medical examination (CEAP assessment and Doppler ultrasound) and the age of subjects, work experience and working in the standing position.

Table 3. Abnormalities showed by Doppler ultrasound ($N = 100$).

| Type of abnormality | Number of subjects |
|---|---|
| Telangiectasia and reticular veins | 68 |
| Failure of the great saphenous vein above the knee | 13 |
| Failure of the great saphenous vein below the knee | 18 |
| Small saphenous vein insufficiency | 5 |
| Failure of the non-anatomical vein | 25 |
| Failure of the perforating veins (perforators) | 10 |
| Failure of the ostium of the great saphenous vein to the femoral vein | 10 |
| Deep vein thrombosis | 1 |
| Fibrotic thrombus after superficial vein thrombosis | 1 |
| Swelling of the lower limbs | 3 |
| Discoloration and other skin changes | 4 |

## 5. Discussion

Chronic venous insufficiency is a congenital or acquired dysfunction of the veins caused by venous valves insufficiency. It is the most common syndrome of the vessels of lower limbs in humans. Due to the incidence rate, chronic venous insufficiency is considered a social disease [4]. Chronic venous insufficiency is a disease that affects people of working age; therefore, the direct costs of treatment should be increased by costs related to work absenteeism. The aetiopathogenesis of chronic venous insufficiency is still not fully explained [15–17]. It is unclear whether the main cause of the disease involves hereditary or environmental factors.

The aim of the study was to evaluate the incidence of chronic venous insufficiency in a group of subjects who work in standing or sitting positions, and to determine the influence of work-related and non-work (lifestyle) factors on the symptoms of the disease in the study group. The two types of tests included questionnaires and medical examinations.

Age is mentioned among the most common non-work factors responsible for the development of the disease. Analysis of the results of the questionnaires showed a significant relationship between the incidence of varicose veins in the lower limbs, reported both on the basis of the survey and in the medical examination, and the age of the respondents. The association between chronic venous insufficiency and age is emphasized in many publications. In a British survey of 1566 people aged 18–44 years, varicose veins were observed in 40% of men and 32% of women. Their number increased significantly with age, from 11.5% in the age group 18–24 years to 55.7% in the age group 55–64 years. In the eldest age group, 55–64 years, varicose veins were observed more frequently in men (25.2%) than in women (12.3%). Generally, in subjects under 35 years of age, chronic venous insufficiency was extremely rare in women and was not observed in men [18].

Other non-work factors responsible for chronic venous insufficiency, and varicose veins in particular, include obesity, dietary habits, physical activity and a history of pregnancies, among others. There is no unequivocal evidence, however, that any of these factors plays a dominant role in the pathogenesis of the disease.

The relationship between obesity and chronic venous insufficiency has not been clearly defined. The Polish study conducted by Jawień et al. in 2003 [3] showed that the symptomatic form of the disease was significantly more common in the overweight population compared to asymptomatic patients, and that the majority of the subjects were women. At the same time, these women declared less physical activity compared to asymptomatic patients [3]. Similar results were obtained by Evans et al. in the Edinburgh Vein Study [18]. They demonstrated a correlation between the presence of varicose veins and BMI in women, and that this relationship applied to all stages of the disease. The study conducted by Ducimetiere et al. [19] revealed the relationship between the presence of varicose veins and weight gain, and between smoking and hypertension. In men with varicose veins, the severity of atherosclerosis and, thus, the risk of cardiovascular disease was greater than in men without varicose veins [19]. These results indicate that an increase of physical activity and weight control can prevent not only the development of varicose veins, but also atherosclerosis. The coexistence of these two diseases may prove the impact of different combinations of factors related to lifestyle, diet and hormonal changes on the development of these pathologies.

Another risk factor for chronic venous insufficiency, which is indirectly associated with obesity, is a low-fibre diet and the accompanying constipation. The results of these questionnaire studies indicate a statistically significant correlation between the use of a low-fibre ‘fast-food’ diet and the incidence of varicose veins of the lower limbs. Conversely, the presence of varicose veins observed in a medical examination was negatively correlated with the use of a fibre-rich diet (vegetables, fruits). The Edinburgh Vein Study confirmed the relationship between constipation and chronic venous insufficiency symptoms, but only in men [18].

Pregnancies, especially their number, is a factor that is undoubtedly related to the occurrence and/or severity of chronic venous insufficiency symptoms in women. The results of these survey studies showed a statistically significant correlation between the presence of varicose veins of the lower limbs and the number of pregnancies. The results presented by many authors have confirmed that in women who have given birth two or more times, the risk of developing varicose veins is about 20–30% higher compared to women who have not given birth or have given birth once [20].

Next, the influence of work-related factors on the appearance and/or severity of chronic venous insufficiency symptoms was analysed. The results of these questionnaire

studies showed a statistically significant relationship between work performed in the sitting position (over 4 h during a work shift) and varicose veins of the lower limbs. There was also a significant correlation between the presence of varicose veins of the lower limbs and work-related factors, such as work done in a forced body position, lifting and carrying heavy objects, the use of large leg strength and working at a fast pace on a desktop computer. Conversely, the results of medical examinations revealed a positive correlation between varicose veins of the lower limbs and the length of time working in the standing position (standing for more than 4 h/day during a shift).

Views on the relationship between working in the sitting or standing positions and chronic venous insufficiency are not clear. Most authors confirm such a relationship, although some data do not support the impact of this kind of work on the development of chronic venous insufficiency.

A study conducted in Switzerland among people employed in the chemical industry revealed that varicose veins were observed in 56% of men and 55% of women [21]. Also, a prospective study conducted over 12 years in Denmark showed that long hours in the standing position increased the risk of hospitalization due to varicose veins treatment [22]. The incidence of varicose veins in women working in western countries reaches 29%, while on a global scale varicose veins are observed in 17–20% of women [23]. Most cases concern people who work in the industry and new cases of chronic insufficiency are closely related to workload. A reduction in the chronic venous insufficiency incidence in individuals above 80 years of age is indirect proof of this relationship [24].

## 6. Conclusions

A relationship between work and the chronic venous insufficiency symptoms has been the subject of many studies, usually concerning the elderly. Given that age is one of the main factors of chronic venous insufficiency, drawing conclusions on the work-related risk factors of the disease was limited in these cases. These studies involved people of different ages, including relatively young people. The results of this study show a statistically significant relationship between factors associated with the organization of work, such as long hours working in a sitting position, including work on a computer, work in a forced position, fast pace of work, lifting and/or carrying heavy objects and the use of large leg strength, and the presence of varicose veins of the lower limbs. Prolonged standing or sitting is one of the most important risk factors of chronic venous insufficiency; therefore, it is very important during initial and regular check-ups of people who do this kind of work to control the state of the venous system of the lower limbs. At the same time, workers in such workplaces should be informed about the health effects of prolonged sitting and standing, and possible preventive measures.

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## Disclosure statement

No potential conflict of interest was reported by the authors.

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