

# The Effect of Birth Month on the Risk of Deep Sternal Wound Infections in Patients After Coronary Artery Bypass Grafting and Heart Defect Surgery

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## ABSTRACT

**Background:** Cardiovascular diseases remain one of the leading causes of morbidity and mortality worldwide, however its surgical treatment remains risky with possible complications. There is increasing evidence that the month of birth (MOB) has been related to different health problems during life. The aim of this study was to identify the effect of MOB on the risk of deep sternal wound infections (DSWI) in patients after open-heart surgery.

**Methods:** The follow-up retrospective research was performed at the Department of Thoracic, Cardiac, and Vascular Surgery of the Hospital of Lithuanian University of Health Sciences. We analyzed the MOB of 201 patients, who underwent open-heart surgery between January 2017 and December 2018. The case group consisted of 46 patients, who suffered from DSWI. Multivariate logistic regression for the association between MOB and risk of DSWI was used.

**Results:** The results showed that the risk of DSWI was by four times higher for patients born in June-September months. The risk of developing DSWI in the case group was even higher for women, patients aged 70 years and younger, those overweight or obese, and patients who underwent only CABG surgery.

**Conclusion:** Due to the growing evidence that the month of birth affects the onset of diseases, it is important to assess MOB as the potential risk factor for developing DSWI.

## INTRODUCTION

There is increasing evidence that the seasonal characteristic of the birth month has been related to different diseases and health problems and could manifest both in early age and adulthood [Christensen 2020; Ueda 2014]. The environmental factors of various seasons or even the particular month in

the early prenatal and postnatal period of life have a significant impact on the development of various diseases with lasting effects on the disease process [Arima 2020; Susanto 2017; Goenka 2015]. The results of studies in the past two decades all around the world show that the season of birth (SOB) and month of birth (MOB) has been found to be related to many somatic and mental disorders. They may affect immune system functions and the prevalence of infectious diseases [Boland 2015; Hsu 2021; Thyssen 2016].

One of the leading causes of morbidity and mortality worldwide is cardiovascular disease [World Health Organization 2019]. Previous studies have identified associations between season and month of birth and cardiovascular disease-related mortality in different countries around the world [Zhang 2019; Deng 2020; Uji 2021; Barker 1986].

Surgical treatment remains an effective treatment option for reducing symptoms and mortality of cardiovascular diseases [Lawton 2021]. However, postoperative cardiac surgery complications are common and associated with increased morbidity and mortality [Crawford 2017]. One of the most common complications is surgical site infections. Wound infections following cardiac surgery can be superficial or deep sternal infections (mediastinitis). Deep sternal wound infection is a life-threatening complication that is associated with high morbidity, mortality, prolonged length of hospital stays, and increased healthcare cost. The incidence of deep sternal wound infections varies in the 0.5-5.6% range in the literature [Rehman 2014]. Early diagnosis of mediastinitis and instant treatment could reduce mortality after cardiac surgery. Many authors have investigated the risk factors associated with the development of deep sternal wound infection after cardiac surgery [Rehman 2014; Phoon 2020; Sá 2017; Gudbjartsson 2016]. According to the literature, risk factors include female sex, older age, diabetes, renal failure, obesity, chronic obstructive pulmonary disease, duration of surgery, reoperation because of bleeding, blood transfusion, prolonged ventilation, and postoperative vasopressor support. One study to identify the risk factors for postoperative development of deep sternal wound infection after coronary artery bypass grafting or heart defect surgery was performed at the Department of Thoracic, Cardiac and Vascular Surgery of Lithuanian University of Health Sciences [Vitartaitė 2021]. This study demonstrates that higher BMI, preoperative and postoperative CRP concentration, anemia, and the duration

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of cardiopulmonary bypass are independent risk factors for the development of postoperative deep sternal wound infections as in previous studies. The current study was designed to build on and extend the earlier study mentioned before to assess the effect of MOB on the risk of deep sternal wound infection occurrence for patients after coronary artery bypass grafting and other open-heart surgery.

## MATERIALS AND METHODS

**Patients:** This research was a follow up to the retrospective study performed at the Department of Thoracic, Cardiac and Vascular Surgery of the Hospital of Lithuanian University of Health Sciences [Vitartaitė 2021]. The case group consisted of the same 46 patients, who underwent reoperation because of DSWI. The control group contained 156 randomly selected patients (of 1891 overall cases).

Collected data consisted of preoperative records that included gender, age, BMI, type of surgery, complete blood count (CBC) and biochemical blood test results, intraoperative data that included duration of surgery, duration of cardiopulmonary bypass, the need for catecholamines, diuretics, infusion therapy, blood loss, use of blood and blood products, CBC and biochemical blood test and blood gas results. Postoperative data also were collected, including duration of mechanical ventilation, antibiotic use, the need for dialysis, diuretics, the need for catecholamines, infusion therapy, use of blood and blood products, CBC and biochemical blood test, and blood gas results, length of hospital and ICU stay.

**Statistical analysis:** Statistical analysis was performed using the SPSS 26.0 (Statistical Package for Social Science for Windows 19) statistical software package. Univariate associations between two categorical predictors were assessed by using the chi-square test or Fisher's exact test. Multivariate logistic regression was used for the association between MOB and the risk of DSWI. In this model, variable such as age (years), sex, BMI, preoperative and postoperative CRP, duration of cardiopulmonary bypass, and anemia during the surgery as additional predictors were included. The results of previous work [Vitartaitė 2021] show that BMI, preoperative and postoperative CRP concentration, hemoglobin during surgery, and the duration of cardiopulmonary bypass were statistically significant factors for the risk of DSWI. We also analyzed the effect of MOB in patients' subgroups defined by age, sex, BMI, and the type of surgery. P-value of < 0.05 was statistically significant.

## RESULTS

We used data from 122 (60.7%) men and 79 (39.3%) women. In total, 92 (45.8%) patients were older than 70 years, 156 (77.6%) were overweight, and 114 (56.7%) of patients underwent only CABG surgery. The majority of patients were born between January-April. (Figure 1A) No cases of DSWI were observed in patients born in November. (Figure 1B) A higher rate of DSWI was detected in patients

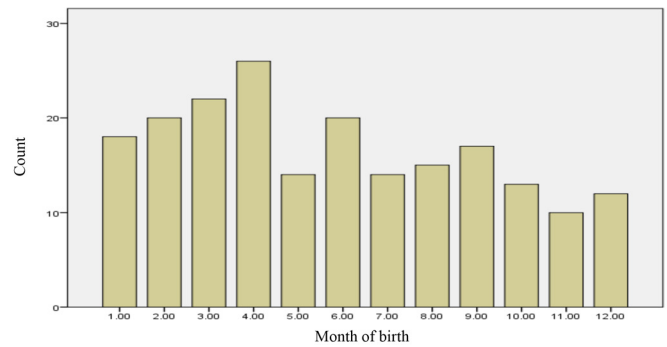


Figure 1A. The distribution of patients by month of birth

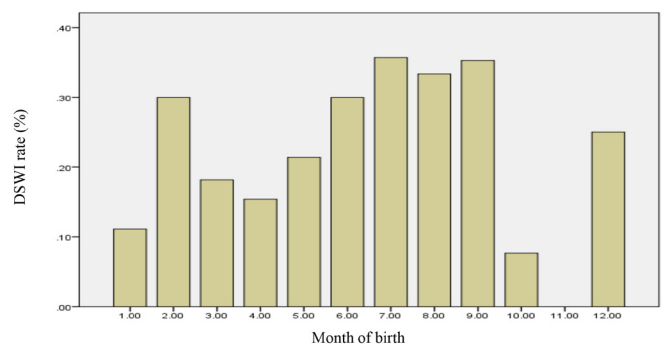


Figure 1B. The distribution of DSWI by month of birth. DSWI, deep sternal wound infection

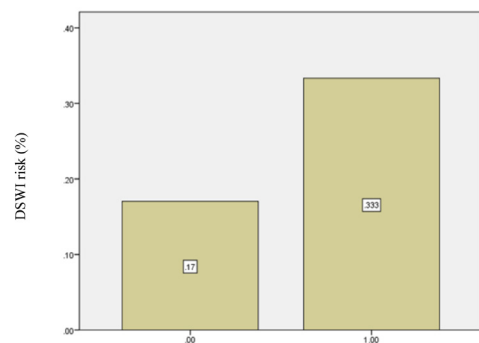


Figure 1C. Risk of DSWI between two groups (0 – born in the October-May months and 1 – born in the June-September months. (P = 0.009)

born June-September (33.3%), compared with patients born October-May (17.0%) (P = 0.009). (Figure 1C) The risk of developing DSWI was even higher for women, patients aged 70 years and younger, those overweight or obese, and patients who underwent only CABG surgery. (Figure 1D) (Figure 1E) (Figure 1F) (Figure 1G)

The results of multivariate logistic regression show the risk of DSWI was four times higher for patients born June-September. (Table 1) Patients with higher BMI born June-September had a higher chance of developing DSWI. The odds ratio was 10.7 (95% CI 1.97-58.3) in patients with obesity. The risk of DSWI was not significant (OR=3.87, 95%

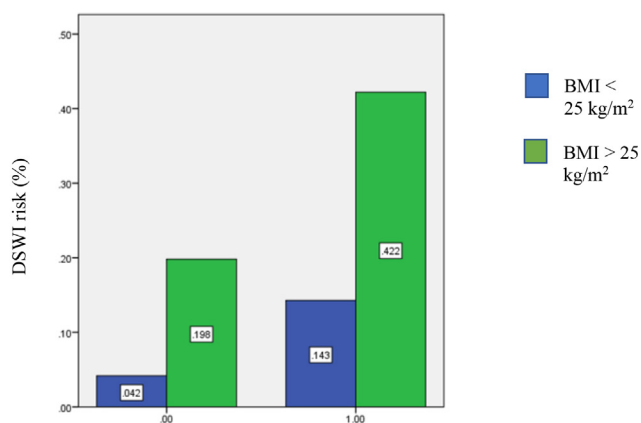


Figure 1D. Risk of DSWI between two groups (0 – born in the October-May months and 1 – born in the June-September months) adjusted for BMI.  $P = 0.234$  (BMI<25 kg/m<sup>2</sup>),  $P = 0.004$  (BMI>25 kg/m<sup>2</sup>). BMI, body mass index

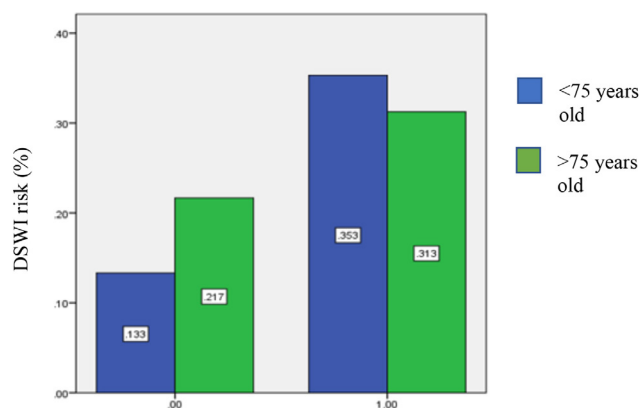


Figure 1F. Risk of DSWI between two groups (0 – born in the October-May months and 1 – born in the June-September months) adjusted for age.  $P = 0.008$  (<75 years),  $P = 0.312$  (>75 years)

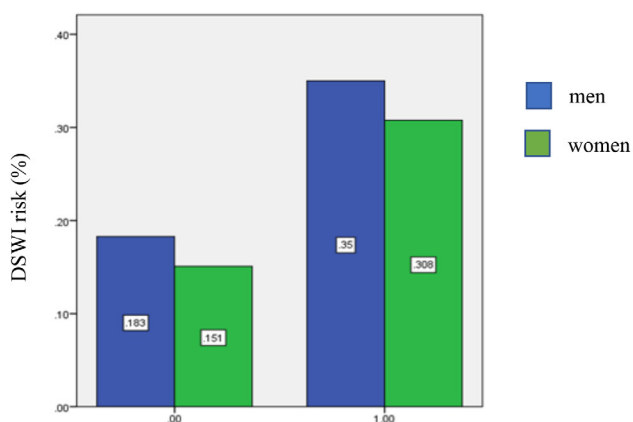


Figure 1E. Risk of DSWI between two groups (0 – born in the October-May months and 1 – born in the June-September months) adjusted for sex.  $P = 0.042$  (men),  $P = 0.103$  (women)

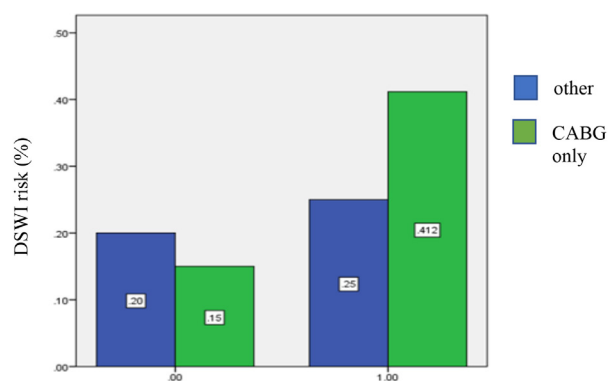


Figure 1G. Risk of DSWI between two groups (0 – born in October-May months and 1 – born in June-September months) adjusted for type of operation.  $p=0.002$  (CABG only),  $p=0.586$  (other operations)

CI 0.69-21.8) for normal-overweight patients. The risk of DSWI was greater for women and for patients after CABG who were born in June-September. For patients after valve surgery or CABG + valve surgery, the risk was similar (Table 1). In patients who were overweight or obese and born in the June-September months, the risk of DSWI was much higher after a CABG operation.

## DISCUSSION AND CONCLUSIONS

Deep sternal wound infection remains a major complication after open-heart surgery regardless improvements of patient care and surgical techniques [Sá 2017]. Therefore, the identification of potential risk factors and their correction for postoperative development of DSWI remains an important goal for healthcare professionals. Individual risk factors for DSWI after open-heart surgery have been identified in multiple previous studies, however, it has not been studied whether

the month of birth affects the onset of DSWI. In our study, we wanted to investigate the impact of the month of birth on this serious complication.

This study showed that the risk of DSWI was four times higher for patients born June-September. There are several mechanisms that might explain such findings, apart from the identified risk factors for DSWI in the previous studies. Moreover, according to the results obtained, the risk of DSWI was greater for overweight and obese patients born in the months mentioned and the risk was even higher after CABG surgery.

More and more studies are being performed that show the onset of diseases is determined by the influence of environmental and other factors in the prenatal, postnatal and later periods of life.

One of the responsible mechanisms could be that birth season might affect the risk of infection. It was found that children born during winter may have a higher level of immune cell types and mediators [Thyssen 2016]. Exposure to infectious factors before birth, might affect an infant's immune system response. Other authors have found that development of children's immune systems might be affected by microbial

Table 1. Risk of developing DSWI for patients born in June-September months

Variable	N (%) <sup>*</sup>	OR <sup>**</sup>	95% CI	P
MOBs JJAS	22 (33.3)	4.26	1.54-11.8	0.005
(MOBs JJAS) * BMI	-	1.05	1.02-1.09	0.004
MOBs JJAS in patients with overweight (25<BMI≤30)	6 (27.3)	3.87	0.69-21.8	0.125
MOBs JJAS in obese patients (BMI>30)	13 (56.5)	10.7	1.97-58.3	0.006
MOBs JJAS in men	14 (35.0)	5.54	1.40-21.9	0.015
MOBs JJAS in women	8 (30.8)	10.44	1.02-106.5	0.048
MOBs JJAS in age <70 years	12 (35.3)	6.09	1.18-31.5	0.031
MOBs JJAS in age >70 years	10 (31.3)	4.07	0.89-18.6	0.070
MOBs JJAS after CABG	14 (41.2)	7.47	1.69-33.0	0.008
MOBs JJAS after valve surgery and both surgeries	8 (25.0)	5.39	0.70-41.2	0.105
In overweight and obese patients				
MOBs JJAS in men	12 (42.9)	6.92	1.49-32.0	0.013
MOBs JJAS in women	7 (41.2)	11.2	1.18-106.0	0.035
MOBs JJAS in age <70 years	10 (43.5)	7.13	1.30-39.2	0.024
MOBs JJAS in age >70 years	9 (40.9)	10.9	1.67-71.6	0.013
MOBs JJAS after CABG	13 (50.0)	25.2	3.28-193.4	0.002
MOBs JJAS after valve surgery in both surgeries	6 (31.6)	3.83	0.47-31.4	0.211

MOB, month of birth; JJAS, June-July-August-September months; BMI, body mass index; CABG, coronary artery bypass grafting.

\*Number of patients with DSWI

\*\*Calculation made by adjusting for age, sex, BMI, preoperative and postoperative CRP concentration, hemoglobin during surgery, and the duration of cardiopulmonary bypass

exposure of the intestine; it has been suggested that microbiota plays a significant role in controlling the immune system during human life [Martin 2010].

Another mechanism could be explained by the “social safety theory,” which states that social, physical, and microbial threats in the environment during a particular month of birth might be harmful for a human and affect the person’s health and behavior [Slavich 2020].

Our study has several limitations. As a single-center study and because of the small number of DSWI cases, especially in subgroups, the results may not be representative of the entire population. This study was not designed to establish causal relationship between birth month and DSWI occurrence, but rather to form an association to future hypotheses and take into consideration the month of birth as a potential factor in future studies. It is likely that other mechanisms are behind the relationship among birth month and DSWI that we do not yet know, and it is an essential limitation. Further comprehensive research is needed.

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