

## Cold water immersion in Poland during the COVID-19 pandemic - motivating factors

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Published online: July 31, 2022

(Accepted for publication July 15, 2022)

DOI:10.7752/jpes.2022.07221

### Abstract

**The goal** was an attempt to investigate what factors motivate people to take the decision to winter swim during the COVID-19 pandemic and whether there are correlations between the examined predictors **Materials and methods:** In the research, a questionnaire was used to examine the opinions on cold water immersion (advantages and disadvantages) of people who practice this activity. The research was conducted at the turn of March 2020 and March 2021 on 937 respondents from Poland who practice this sport. Statistical analysis was based on the  $\chi^2$  test of independence of two qualitative variables. It was examined whether independent variables such as gender, age category and place of residence influence the frequency of winter swimming. Logistic regression was performed to test the influence of various factors on the individuals who winter swim. **The influence of individual predictors on the dependent variable and categories of chance and probability of occurrence were assessed. Results:** In the present study, gender and age category affect the frequency of winter swimming. The place of residence has no influence on this activity. Women more frequently than men practice this due to: improvement of skin appearance (49.43% of women and 23.86% of men), diseases (12.64% of women and 7.87% of men) aesthetics (10.92% of women and 1.78% of men). Men more often than women winter swim because of: better regeneration of the organism (42.53% of women and 53.30% of men), improvement of the efficiency of the cardiovascular system (25.29% of women and 35.53% of men) and better physical fitness (21.07% of women and 33.76% of men). **Conclusions:** The majority of people with higher education in the Polish population practice cold water immersion. Men more often take up this activity than women. The age range is larger in the group of men who winter swim than in the group of women. The older the respondents are, the more frequently they practice cold water immersion. The factors which motivated people to take up cold water immersion included: improvement of mood and general health improvement. Most of the respondents who undertook this type of recreation suffered from hypertension or hypothyroidism and had injuries. Respondents mentioned frostbite as a side effect of cold water immersion.

**Keywords:** cold water immersion, health, hydrotherapy, COVID-19

### Introduction

Contact with cold accelerates the regeneration of the body after intense physical or mental exertion (reduces the level of stress) and soothes inflammation. Swimming in icy water also has a positive effect on the psyche, among others. by activating the parasympathetic nervous system, which is used, for example, in the treatment of depression.

Cold also activates brown adipose tissue, stimulates it to an increased rate of metabolic changes. These are cells that contain numerous drops of fat. The brown color of this tissue is associated with a large number of mitochondria. Preliminary blood tests performed immediately before and after a short bath at 6 ° C showed that the level of leukocytes in the blood increased significantly. Perhaps it is thanks to this that protection against inflammation and respiratory infections occurs. Various studies prepared by specialists from various fields show a number of benefits resulting from regular sea sailing. The main advantage is the hardening of the body and better resistance to cold, e.g. by increasing the basal metabolic rate. According to the researcher, swimming in the pool (approx. 20 ° C) can also bring similar effects.

Sudden changes in temperature increase the efficiency of the cardiovascular system, improve blood parameters, and improve blood supply to the skin, which in turn improves the condition and appearance. Cold also increases the level of certain hormones (e.g. catecholamines), neurotransmitters (dopamine) and compounds of the immune system (cytokines), which generally has a good effect on our health (Mila-Kierzenkowska C, Augustyńska B, Woźniak A., and all.2016)

COVID-19 is an infectious disease caused by coronavirus of acute respiratory syndrome (SARS-CoV-2) (WHO-convenced Global Study, 2021; Sakurai et al., 2020; Clinical spectrum of SARS-CoV-2,2021). In the era of pandemics, a great number of people are looking for ways to enhance body immunity. Currently, there is an increase in the popularity of winter swimming in Poland and around the world. Many groups are created on

Facebook, which support each other and arrange joint baths (Michalewicz & Michalewicz, 2018). Many studies indicate that cold baths strengthen immunity, have a positive effect on the cardiovascular system, improve the mood and the attitude to oneself and the world. Winter swimming also strengthens the sense of community and the ability to be with other people, which is very important during the COVID-19 pandemic (Taylor et al., 1969; Nuckton, 2012; Jansky, 2003).

It becomes very interesting to better understand the reasons for cold water immersion during the COVID-19 pandemic.

### Hypotheses

H<sub>1</sub>: Gender influences the frequency of cold water immersion in the study population

H<sub>2</sub>: Age influences the frequency of cold water immersion in the study population

H<sub>3</sub>: Place of residence influences the frequency of cold water immersion in the study population

H<sub>4</sub>: There are specific predictors unique to the female group that determine the decision on cold water immersion

H<sub>5</sub>: There are specific predictors unique to the male group that determine the decision on cold water immersion

### Material and methods

Due to social isolation, the author's survey was conducted electronically. It was voluntary and anonymous. The survey was carried out between March 2020 and March 2021. It included 934 respondents (100%), i.e. 531 women (56.85%) and 403 men (43.15%). Age, education, and place of residence of the respondents were included in the study to illustrate the internal variation of the group.

Statistical analysis was based on  $\chi^2$  test of independence of two qualitative variables. Whether the independent variables such as gender, age category, and place of residence affect the frequency of the activity was investigated. The null hypothesis of the test states that there is no relationship between the study variables. The alternative hypothesis reports a significant relationship between the variables - one variable influences the other. Contingency tables are presented to see the empirical (observed) values in the study.

A significance level of 0.05 was used in all three tests. The critical value ( $W$ ) depends on the degrees of freedom ( $d$ ). Therefore, in each test, we obtained a different value of  $W$ , because the degrees of freedom are calculated on the basis of the number of variants of answers to a particular question. After comparing the critical value with the value of the test statistic or the significance level with the p-value, an appropriate hypothesis is made.

Logistic regression was conducted to test the effect of various factors on winter swimming individuals. In the questionnaire, almost all questions dealt with qualitative variables (the exception was age). The effect of each predictor on the dependent variable was assessed. The odds, determined by the formula  $O(A) = \frac{\pi(A)}{1 - \pi(A)}$  is the ratio of favorable to unfavorable events, and the probability of occurrence of a phenomenon described by the formula  $\pi(A) = \frac{O(A)}{1 + O(A)}$ . In logistic regression, the Maximum Likelihood Method (maximizing the chance of

obtaining the value of the dependent variable using predictors) is used to estimate the parameters of the equation. The probability value can be written equivalently as:  $\pi(A) = \frac{\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots)}{1 + \exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots)}$ . Thus, the natural logarithm of the odds is  $\ln(O(A)) = \ln(\exp(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots)) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \dots$ .

Among the respondents, only 18 individuals out of 934 did not practice cold water immersion (98.1% of the respondents practiced it). Thus, we selected from a sample 916 individuals (522 women and 394 men) for which further analysis was conducted. The variable we will refer to will be gender: what factors influenced female versus male winter swimming. The reference category was women.

### Results

The largest number of people are in the 31 to 40 age range: 181 (34.1%) women and 140 (34.7%) men. Also the largest number of respondents, 249 (46.9%) women and 150 (37.2%) men, have a master's degree.

The place of residence of the respondents is as follows:

- rural areas - 24% of the surveyed group,
- a city with less than 20,000 inhabitants - 14% of the respondents,
- a city between 20,000 and 50,000 inhabitants - 14% of the respondents
- a city of over 50,000 inhabitants - 48% of people surveyed.

Most respondents, 328 (61.8%) women and 229 (56.8%) men, learned about winter swimming from friends. Only 9 women (1.7%) and 9 men (2.2%) have never practiced cold water immersion before. As many as 916 people (98.1%) dared to enter cold water at least once. According to the research, 299 females (57.3%) and 185 males (47%) perform this activity (cold water immersion) most often once a week.

In question #8 "What do you think was the effect of cold water immersion?" more than one answer could be selected. The most frequently chosen answer (as many as 796 people) was "improvement in well-being".

Question #9, "What was your reason for using the cold water immersion?" was a multiple-choice question (no response limit). The most frequently chosen answer (627 people) was "for general health improvement". The most common associated condition is injury (82 respondents). According to the research, 141 (26.6%) females and 60 (14.9%) males have some kind of disease. The highest number of people who have a condition (201 people) listed in the survey struggle with hypertension 49 (24.4%). In second place was hypothyroidism 32 (15.9%) people.

The negative effects of cold water immersion were experienced by 40 women (7.5%) and 34 men (8.4%). Most people (38) chose other than the listed negative effects. In second place (12 people) was frostbite as a side effect of immersion in cold water.

Referring to the answers to question #12 "Will you be using cold water immersion in the future?" in comparison with question #6 (concerning the immersion in the past), it was noticed that 2 women gave up this activity, whereas 3 men want to take it up.

From the answers to question #16 it can be concluded that 43.6% (407) of the respondents did not share their impressions connected with the cold water immersion. As many as 527 respondents of which a vast majority (82.4% or 434 persons) had positive impressions. Only two (0.4%) comments were negative, one of which was: "my feet hurt", while 17.3% (91) people had neutral comments about the cold water immersion.

### Results of the test of independence $\chi^2$

Table 1. Obtained parameters of the conducted tests  $\chi^2$ .

|  | test statistic<br><i>T</i> | degrees<br>of freedom<br><i>d</i> | Critical value<br>of<br><i>W</i> | p-value |
|--|----------------------------|-----------------------------------|----------------------------------|---------|
| Does gender have an impact on the frequency of the immersion?              | 12.994                     | 3                                 | 7.815                            | 0.005   |
| Does age (age category) have any impact on the frequency of the immersion? | 26.382                     | 12                                | 21.026                           | 0.009   |
| Does place of residence have an impact on the frequency of the immersion?  | 15.403                     | 9                                 | 16.919                           | 0.080   |

In Table 1, for gender and age, the p-values are less than the 0.05 significance level and the values of the test statistics are greater than the critical value. Therefore, we accept the alternative hypothesis in these cases. Thus, it can be concluded that gender and age have an effect on the frequency of cold water immersion. The study also shows that the place of residence has no influence on how often we immerse our body in cold water.

Table 2. Answers to the question concerning the frequency of the immersion in relation to gender.

|       | 7. If you marked "YES" in the previous question, indicate how often. |             |              |                              | Total |
|-------|--|-------------|--------------|------------------------------|-------|
|       | less than once a week  | once a week | twice a week | more often than twice a week |       |
| Woman | 32   | 299         | 138          | 53                           | 522   |
| Man   | 26   | 184         | 119          | 65                           | 394   |
| Total | 58   | 483         | 257          | 118                          | 916   |

It can be seen that men are more likely to use cold water immersion than women. More than twice a week 65 (16.5%) men and 53 (10.2%) women immerse their bodies in cold water (Table 2).

Table 3. Responses to the question on frequency of cold water immersion by age category.

|                       | 7. If you marked "YES" in the previous question, indicate how often. |             |              |                              | Total |
|-----------------------|--|-------------|--------------|------------------------------|-------|
|                       | less than once a week  | once a week | twice a week | more often than twice a week |       |
| under 20 years of age | 5  | 17          | 5            | 6                            | 33    |
| 21 to 30              | 14   | 90          | 46           | 14                           | 164   |
| 31 to 40              | 20   | 174         | 75           | 48                           | 317   |
| 41 to 50              | 6  | 131         | 87           | 33                           | 257   |
| over 51               | 13   | 71          | 44           | 17                           | 145   |
| Total                 | 58   | 483         | 257          | 118                          | 916   |

As shown in Table 3, the older the respondents are, the more often they immerse their bodies in cold water. Two or more times a week: 11 (33.3%) of those under 20; 60 (36.6%) of those aged 21 to 30; 123 (38.8%) of those aged 31 to 40; 120 (46.7%) of those aged 41 to 50; 61 (42.1%) of those over 51.

Table 4. Responses to the question on frequency of cold water immersion by place of residence.

|                               |  | 7. If you marked "YES" in the previous question, indicate how often. |             |              |                              | Total |
|-------------------------------|--|--|-------------|--------------|------------------------------|-------|
|                               |  | less than once a week  | once a week | twice a week | more often than twice a week |       |
| village                       |  | 8  | 119         | 70           | 25                           | 222   |
| town < 20.000 citizens        |  | 9  | 60          | 41           | 16                           | 126   |
| town 20.000 - 50.000 citizens |  | 10   | 55          | 42           | 21                           | 128   |
| town > 50.000 citizens        |  | 31   | 249         | 104          | 56                           | 440   |
| Total                         |  | 58   | 483         | 257          | 118                          | 916   |

Table 4 shows no significant effect of place of residence on frequency of winter bathing. The immersion is used more often than twice a week: by 25 (11.3%) people from rural areas; 16 (12.7%) people from city<20,000 citizens; 21 (16.4%) people from city between 20,000 and 50,000 citizens; 56 (12.7%) people from city>50,000 citizens.

### Logistic regression results

First, all responses from questions 8 and 9 were entered into the model. Note that these are binary variables (with values of 0 or 1- either someone chose a particular response or not). The Wald test, which indicates a significant contribution of variables to the model, eliminated several factors. After excluding irrelevant variables from the model, logistic regressions were run again for the remaining factors. The final variables found to be significant were: 8\_5 better recovery, 8\_6 improved skin appearance, 8\_7 improved cardiovascular fitness, 9\_1 for better physical fitness, 9\_4 for medical condition, 9\_5 for aesthetic reasons (Table 5).

Table 5. Estimated parameters of the logistic regression model.

|   | B      | Standard error | Wald   | df | p-value | Exp(B) | 95% confidence intervals Exp(B) |             |
|---|--------|----------------|--------|----|---------|--------|---------------------------------|-------------|
|   |        |                |        |    |         |        | Lower limit                     | Upper limit |
| Constant  | -1.805 | 0.454          | 15.826 | 1  | 0.000   |        |                                 |             |
| 8_5. better regeneration of organism              | -0.589 | 0.172          | 11.764 | 1  | 0.001   | 0.555  | 0.396                           | 0.777       |
| 8_6. improvement of skin appearance               | 1.752  | 0.194          | 81.262 | 1  | 0.000   | 5.764  | 3.938                           | 8.435       |
| 8_7. improved efficiency of cardiovascular system | -0.934 | 0.199          | 22.061 | 1  | 0.000   | 0.393  | 0.266                           | 0.580       |
| 9_1. for better physical fitness                  | -0.866 | 0.175          | 24.390 | 1  | 0.000   | 0.421  | 0.298                           | 0.593       |
| 9_4. for medical condition                        | 0.561  | 0.256          | 4.806  | 1  | 0.028   | 1.752  | 1.061                           | 2.893       |
| 9_5. for aesthetic reasons                        | 1.564  | 0.428          | 13.340 | 1  | 0.000   | 4.778  | 2.064                           | 11.058      |

Thus, the natural logarithm of the odds obtained from the final model is:

$$\ln(O(A)) = -1.805 - 0.589 * \text{pyt8}_5 + 1.752 * \text{pyt8}_6 - 0.934 * \text{pyt8}_7 - 0.866 * \text{pyt9}_1 + 0.561 * \text{pyt9}_4 + 1.564 * \text{pyt9}_5$$

We should also mention the interpretation of the coefficients in the Exp(B) column, which report: how many times the chance of the event occurring is higher for men relative to women. In the case when the respondent did not choose the answer:

- 8\_5 (i.e., does not practice for better recovery) the chance that it is a male decreases by 44.51% compared to females.
- 8\_6 (i.e., does not practice for improved skin appearance) the chance that it is a male increases by 476.37% compared to females.
- 8\_7 (i.e., does not practice to improve cardiovascular fitness) the chance that it is a male decreases by 60.71% compared to females.
- 9\_1 (i.e., does not practice for improved fitness) the chance that it is a male decreases by 57.95% compared to females.
- 9\_4 (i.e., does not practice for medical conditions) the chance that it is a male increases by 75.22% compared to females.
- 9\_5 (i.e., does not practice for aesthetic reasons) the chance that it is a male increases by 377.76% compared to females.

Table 6. Selected responses to 6 variables from the model, by gender.

|   |            | Woman (N) | Man (N) | Woman (%) | Man (%) |
|---|------------|-----------|---------|-----------|---------|
| 8_5. better regeneration of organism              | unselected | 300       | 184     | 57.47%    | 46.70%  |
|   | selected   | 222       | 210     | 42.53%    | 53.30%  |
| 8_6. improvement of skin appearance               | unselected | 264       | 300     | 50.57%    | 76.14%  |
|   | selected   | 258       | 94      | 49.43%    | 23.86%  |
| 8_7. improved efficiency of cardiovascular system | unselected | 390       | 254     | 74.71%    | 64.47%  |
|   | selected   | 132       | 140     | 25.29%    | 35.53%  |
| 9_1. for better physical fitness                  | unselected | 412       | 261     | 78.93%    | 66.24%  |
|   | selected   | 110       | 133     | 21.07%    | 33.76%  |
| 9_4. for medical condition                        | unselected | 456       | 363     | 87.36%    | 92.13%  |
|   | selected   | 66        | 31      | 12.64%    | 7.87%   |
| 9_5. for aesthetic reasons                        | unselected | 465       | 387     | 89.08%    | 98.22%  |
|   | selected   | 57        | 7       | 10.92%    | 1.78%   |

In Table 6, it can be observed that women are more likely to immerse in cold water than men due to:

- improving the appearance of the skin (49.43% of women and 23.86% of men selected this answer)
- a medical condition (12.64% of women and 7.87% of men selected this answer)
- aesthetics (10.92% of women and 1.78% of men selected this answer)

In contrast, men are more likely than women to immerse in cold water because of:

- better body regeneration (42.53% of women and 53.30% of men selected this answer)
- improving cardiovascular fitness (25.29% of women and 35.53% of men selected this answer)
- better physical fitness (21.07% of women and 33.76% of men selected this answer)

In model fit with 6 variables, the significance ( $p$ -value $<0.000$ ) is less than the significance level of 0.05. Thus, we reject the null hypothesis and accept the alternative hypothesis that the final model is different from the model only with a constant.

## Discussion

In the era of COVID-19 pandemic it is very important to look for methods that contribute to increasing the immunity of the body. One of the ways that contribute to improving the functioning of the body is cold water bathing.

In 2017, researchers proved that cold baths improve the processes of basal metabolism (Lee, Park, [Kim](#) (2017). it was noted that it has a positive effect on the activation of the sympathetic part of the autonomic nervous system (Kox, et al.2014) has a positive effect on reducing pain and muscle tension (Yeung, Simon. et al,2016) and one can even find reports showing a significant correlation between cold baths and improved mental health in people struggling with depression (Shevchuk, 2008). With hypothyroidism, an increase and improvement in TRH hormone secretion has been observed, which translated into a reduction of "under-thyroid levels" in the body and a decrease in hypothyroidism (Cabral et al.,,2012). From a study published in 2015, it is known that cold water immersion improves insulin sensitivity which has positive implications for diabetics (Hanssen et al., 2015). Another very positive effect of research is the observation of a decrease in blood cholesterol, improvement of lipid regulation in the body, protection against atherosclerosis. It can be assumed that cold baths support overweight loss and improve the condition of blood vessels (Barbee et al., ,2015; Sun, Kosuminski, Luby-Phelpset al.(2014). Cold water immersion improves blood parameters. Elias et al.,2012 ; Lombardi et al.,2011) and reduces inflammatory processes in the human body.

Many authors have conducted research on cold water immersion, including Kox M., Lee JY., McKeown P., Shevchuk NA., Sun K., they dealt with such issues as: nervous system response to cold exposure, body adaptation to cold, connection between the respiratory system and the possibility of cold baths, connections between cold therapy and depression treatment, activation of brown fat under the influence of low temperatures (Lee, Park, [Kim](#), 2017; Kox, M., et al.:2014; Shevchuk,2008; Sun.2014).

Jansky et al. research the effect of a single cold water immersion ( $14^{\circ}\text{C}$  for 1 h) on the immune system of athletic young men, monitored immediately after immersion, was minimal. With the continuation on the cold water immersion- three times a week for a duration of 6 weeks a small, but significant, increase in the proportions of monocytes, lymphocytes with Expresses IL2 receptors (CD25) and in plasma tumour necrosis factor (TNF  $\alpha$ ) content was induced. An increase in the plasma concentrations of some acute phase proteins, such as haptoglobin and haemopexin, was also observed. After 6 weeks of repeated immersions a trend towards an increase in the plasma concentrations of IL 6 and the amount of total T lymphocytes (CD3), T helper cells (CD4), T suppressor cells (CD8), activated T and B lymphocytes (HLA-DR) and a decrease in the plasma concentration of  $\alpha$ 1-antitrypsin was observed. Concentrations of IL 1 $\beta$ , neopterin, C-reactive protein, orosomucoid, ceruloplasmin, macroglobulin, immunoglobulins (IgA, IgG, IgM) and C3, C4 components of the complement, as well as the total number of erythrocytes, leucocytes, granulocytes and neutrophils showed no significant changes after the

repeated cold water immersions. It was concluded that the stress – inducing noninfectious stimuli, such as repeated cold water immersions, which increased metabolic stimuli, such as repeated cold water immersions, which increased metabolic rate due to shivering the elevated blood concentrations of catecholamines activated the immune system to a slight extent (Janský et al.,1996).

This study, on the other hand, examined what factors motivated individuals in the Polish population to take up cold bathing during the pandemic when most sports facilities were closed. It may be concluded from the results that age and gender were decisive for the decision to take part in cold bathing, whereas the place of residence had no effect on the decision.

### Conclusions

People with higher education constitute the majority of cold bathers in Poland. Men more often take cold baths than women. The age range is larger in the group of men who take cold water immersion than in the group of women. The older the respondents are, the more frequently they practice it. The factors which motivated people to take up cold baths include improvement of mood and general health improvement. The majority of the respondents who undertook this type of recreation suffered from hypertension, hypothyroidism and had injuries.

Women are more likely than men to take up cold baths due to:

- improving the appearance of skin,
- disease,
- aesthetics.

Men are more likely than women to take up cold baths because of:

- better regeneration of the body,
- improved efficiency of the cardiovascular system,
- better physical fitness,

### Conflict of interests

**The authors have no conflict of interests to declare.**

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