INTERNATIONAL JOURNAL OF CIRCUMPOLAR HEALTH
2024, VOL. 83, 2330741
https://doi.org/10.1080/22423982.2024.2330741

Taylor & Francis
Taylor & Francis Group

ORIGINAL RESEARCH ARTICLE

OPEN ACCESS Check for updates

Combined cold-water immersion and breathwork may be associated with improved mental health and reduction in the duration of upper respiratory tract infection - a case–control study

Jan Czarnecki[a], Katarzyna Nowakowska-Domagała[b] and Łukasz Mokros[a]

[a]Second Department of Psychiatry, Institute of Psychiatry and Neurology, Warsaw, Poland; [b]Institute of Psychology Department of Clinical Psychology and Psychopathology, University of Lodz, Lodz, Poland

ABSTRACT

A polar plunge is a term referring to an ice-cold water immersion (CWI), usually in the winter period. It is also a part of a specific training program (STP) which currently gains popularity worldwide and was proven to display paradigm-shifting characteristics. The aim of this study was to compare the indices of mental functioning (including depression, anxiety, mindfulness) and duration of upper respiratory tract infection (URTI) measured among the study participants. A set of questionnaires was distributed via the Internet. Participants declaring regular STP practice were selected ($N = 77$). Two groups were matched based on a case–control principle: the first one (the control group) comprised participants who did not declare nor CWI practice, nor STP practice. The second one comprised participants declaring regular CWI practice only. The CWI only group displayed better mental health indices and shorter URTIs compared to the control group. Moreover, the STP group also displayed better general mental health, less somatic complaints, and shorter URTIs compared to the CWI only group. This study suggests the existence of CWI's potential in boosting mental health and immune system functioning, however when complemented by a specific breathwork, this potential can be increased. However, further research is required.

ARTICLE HISTORY
Received 4 September 2023
Revised 19 February 2024
Accepted 11 March 2024

KEYWORDS
Cold temperature; breathing exercises; mindfulness; respiratory tract infections; breathwork; mental health

Introduction

Detrimental effect of chronic stress is indisputable. Its negative influence is noticeable in up to 90% of diseases [1]. In 2016, the World Health Organization (WHO) dubbed stress as a health epidemic of the 21st century [2]. Moreover, due to COVID-19 pandemic, prevalence of stress-related diseases (including anxiety and depression) increased by 25% worldwide [3]. According to Gallup Organization, 44% of employees declared experiencing "a lot" of work-related stress the previous day the research was conducted, and this percentage remained at a record high in 2022 [4]. In addition, the toll on health, anxiety, and depression leads to 1 trillion dollars of lost productivity per year worldwide [5]. As a natural consequence, a surge in popularity of various self-help mental health practices has taken place in recent years. Yoga, mindfulness meditation and breathing exercises (or breathwork) seem to be among the most popular ones [6–8]. Interestingly, regular exposure to cold in the form of cold-water immersions (CWI) has also started to be listed among them. A form of CWI during wintertime performed in the open spaces (lakes, rivers) has been a popular practice in Northern and Eastern Europe. In Finland, the CWI is an inseparable part of the sauna routine. In Poland, practising CWIs during wintertime is called *morsowanie* (pol. *mors* – a walrus). The closest related English term is to do a polar bear plunge or simpler – polar plunging. In the past few years, polar plunging has become very popular in Polish society. In most cases, it is performed once a week in a pond or a lake closely located to the place of residence. The plunge is usually preceded by a short warm-up conducted in the open air. After the immersion, no intensive rewarming (e.g. sauna) is practised. During the annual gathering of the polar plungers in February 2023, almost 9000 people took a joint dip in the Baltic Sea. Water temperature recorded that day was 3°C [9]. A beneficial effect of polar plunge on immune system and wellbeing has been reported. Lower levels of stress and higher salivary immunoglobulin A concentration were noted among polar plungers compared to those who do not practice CWI [10,11]. Moreover, a prospective study from The

CONTACT Jan Czarnecki jczarnecki@ipin.edu.pl Second Department of Psychiatry, Institute of Psychiatry and Neurology, Sobieskiego Street 9, Warsaw 02-957, Poland

Netherlands conducted in 2016 provided indirect evidence for those claims. In this study, the participants had to take regular cold showers while the members of the control group should not change their everyday functioning. Results showed that members of the intervention group reduced the sickness absence during wintertime by almost 30% [12].

Breathwork also started to gain scientific attention in recent years. Diaphragmatic breathing was proven to decrease salivary cortisol concentration, decrease systolic and diastolic blood pressure, and improve self-reported stress indices [7]. Results of a meta-analysis published in 2023 found significant small-medium effects of breathwork on self-reported stress, anxiety and depression compared to non-breathwork control conditions [6]. Concurrently, a specific training program (STP) based on the combination of the mentioned techniques (breathwork and CWI) was proven to display surprising characteristics. According to a study conducted in 2014, an innate immune response can be attenuated voluntarily by individuals who undergo that program beforehand [13]. Also, two exploratory studies have been conducted which implemented the STP as an adjunctive therapy. Results provided evidence for the STP's ability to reduce the activity of axial spondyloarthrosis and psoriasis [14,15]. Other preliminary trials gave evidence for the intensification of the Cori cycle and increasing the pain threshold [16,17]. An fMRI scan conducted on the creator of the STP showed his ability to activate the periaqueductal grey (PAG) in a voluntary manner during cold exposure. Interestingly, the bespoken part of the central nervous system (CNS) is a subcortical region which takes part in fear management and aversive behaviour [18,19]. Due to numerous anecdotal evidence for its beneficial effects and studies conducted in the past, the STP gains scientific attention as well as supporters practising it worldwide.

In the face of a global mental health crisis, the development of self-help applications characterised by affordability, safety and confirmed efficacy is essential to tackle the problem at its core. Therefore, we conducted this case–control study to verify if the STP could function as one of them.

Aim

The aim of this study was to compare the self-reported mental health indices, dispositional mindfulness, and upper respiratory tract infections (URTI) between those who practice the STP (combination of CWI and breathwork), those who declared regular CWI only and to those who did not practice any of those (control group).

Materials and methods

Study design and sample

This is a secondary analysis to a cross-sectional study on the association between polar plunging, its frequency, and selected somatic and psychosocial factors (article in review process).

The STP group and CWI only group were recruited by distribution of an online survey via social media groups which were found using Polish equivalents of phrases *polar plunging*, or *polar plungers* (*morsowanie*, or male *morsy*, or female *foczki*, respectively), which took place in June 2022. The groups concerned particular geographical areas, e.g. towns, cities or provinces. The control group was recruited via social media groups matching those areas. The online survey included a summary of the study. A form building service called forms.app was selected to organise the set of questionnaires. Prior to filling of the questionnaires, the respondents provided an informed consent – by clicking a button captioned *Agreed*. The survey comprised psychological tests (described below) and a set of authors' questions concerning: sex, age, URTI, and sick leave duration (both measured in days) in the last autumn-winter period, systematic STP practice, frequency and experience in polar plunging (number of seasons). According to the in-built visit counter provided by the forms.app, the survey web page was opened 7459 times and filled 1628 times, which gave a response rate of 22%. Number of respondents who were excluded due to a positive answer to a question regarding a severe stress or psychological trauma experienced within the last 6 months equalled $N = 373$. Thereafter, $N = 79$ persons, who reported systematic conduct of the STP were selected as the case group. Since the aim of the study was to elucidate the effect of the STP, two kinds of controls were selected: respondents reporting regular CWI only (CWI only group) and respondents reporting no CWI and no STP (control group). The match was performed based on sex, age (± 2 years), and in case of CWI additionally: number of seasons (± 1 year) and frequency of practice (± one category). $N = 2$ respondents from the STP group were excluded due to no age match. The final sample comprised $N = 231$ respondents, with 77 persons in each group (Figure 1 and Table 1).

Questionnaires

The General Health Questionnaire, 28-item version (GHQ-28) is a questionnaire designed to screen for mental health issues in a non-psychiatric population in four aspects: somatic symptoms (A), anxiety/

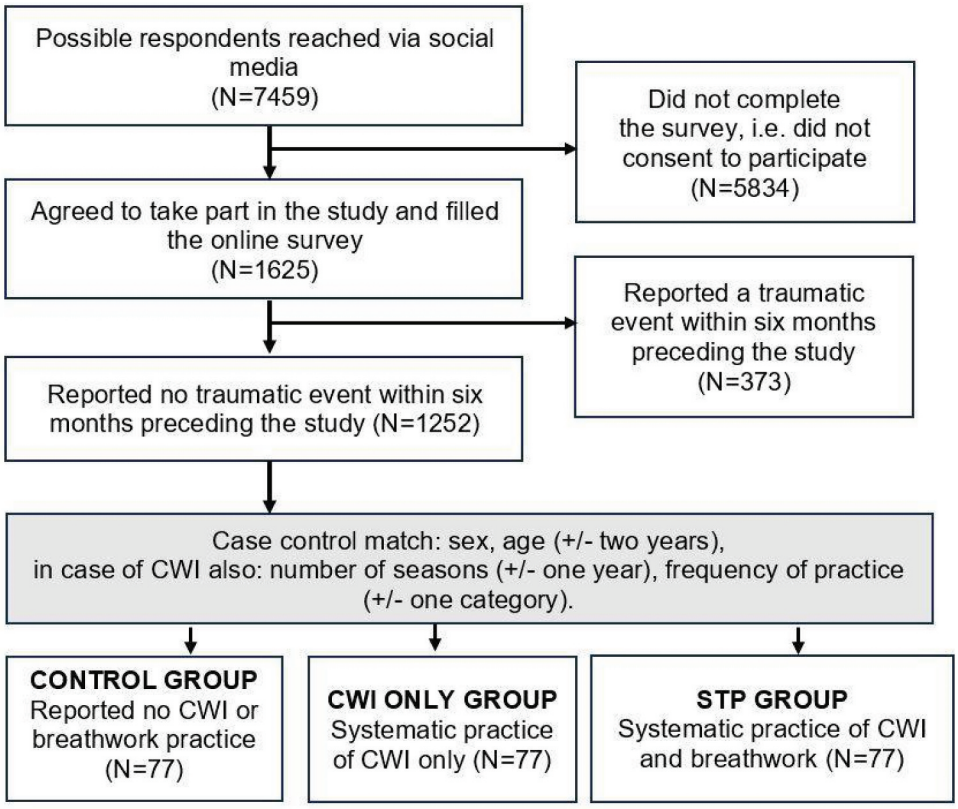

Figure 1. Flow chart depicting group selection process.

Table 1. Characteristics of the case–control study sample, comparing the results of the specific training program group (STP), the cold-water immersion (CWI) only group and the control group with a summary of goodness of match regarding age, sex, seasons, and frequency of CWI practice.

	Control ($N = 77$)	CWI only ($N = 77$)	STP ($N = 77$)	Test	p
Age, M±SD	40.74 ± 7.31	40.81 ± 7.03	40.84 ± 7.13	0.004	0.996
Women, N (%)	29 (38%)	29 (38%)	29 (38%)	<0.001	0.999
Seasons of CWI practice, M±SD	-	3.36 ± 1.81	3.43 ± 2.33	0.037	0.847
Frequency of CWI, N (%)					
1 per month or less	-	3 (4%)	4 (5%)	0.837	0.991
1 per 3 weeks	-	1 (1%)	1 (1%)		
1 per two weeks	-	3 (4%)	2 (3%)		
1 per week	-	26 (34%)	26 (34%)		
2 per week	-	17 (22%)	16 (21%)		
3 per week	-	14 (18%)	12 (15%)		
4 per week	-	13 (17%)	16 (21%)		

M – mean, SD – standard deviation, N – number of observations, Test – Snedecor's F test or, Welch's test or Chi-square test result, depending on the type of variable and homogeneity of variance in case of continuous variables, p – probability in the respective test.

insomnia (B), social dysfunction (C) and depressive symptoms (D). It was developed by Goldberg and adapted to Polish by Makowska and Merecz [20,21]. Each scale consists of seven items, with answers representing the frequency of the named symptoms. The items' answers were scored from 0 to 3. Thus, scores ranged from 0 to 21 in each subscale and from 0 to 84 in total. Cronbach's alpha quotients for the A to D scales stem from 0.77 to 0.87.

The Five Facet Mindfulness Questionnaire – Short Form (FFMQ-SF) was developed by Bloimeister based on an original scale by Baer et al. and adapted to Polish by Radoń and Rydzewska [22–24]. This tool was created in order to measure dispositional mindfulness, a specific trait which can be improved by practising mindfulness meditation. The questionnaire contains 24 items divided into five subscales (Nonreactivity, Nonjudging, Acting with awareness, Observing, and Describing), yet only the total score (i.e. the mean value from five subscale scores) was utilised in the current study as a measure of general dispositional mindfulness. The score ranges from 1 to 5 (mean from all answers),

with a higher score indicating greater dispositional mindfulness. Cronbach's alpha in the adaptation study ranged from 0.72 to 0.75.

Statistical analysis

The statistical analysis was conducted in JASP 0.16.4 (University of Amsterdam, the Netherlands). Each binomial variable was presented as a prevalence in the sample, as both absolute (number of observations, N) and relative scores (percentage, %). Each continuous variable was characterised as mean with standard deviation (SD). For continuous variables, the distribution was assessed based on the Shapiro – Wilk W-test, the Q-Q plots of the residuals. The heterogeneity of variance between the groups was verified with the Levene's test. Intergroup comparisons were conducted by analysis of variance: the Snedecor's F test or Welch's test, depending on whether the assumption of homogeneity was or was not met, respectively. 95% confidence intervals of mean differences between the compared groups (derived from a Bootstrap method with $N = 1000$ samples) were evaluated as an equivalent to a post hoc test in the analysis of variance. A chi-square test was performed to assess contingencies in tables. Statistical significance was defined as $p < 0.05$ or a confidence interval not encompassing 0.

Bioethical considerations

The study protocol conforms to international ethical standards and was conducted in accordance with the Declaration of Helsinki. It was approved by the Bioethical Committee of the Institute of Psychiatry and Neurology in Warsaw on NaN Invalid Date , resolution no. 24/2022. Ethical matters of the study concern mainly the selection and use of psychometric tools and the interpretation of their results; these are discussed in a more detailed manner in the literature [25].

Consent

Every participant had to give an informed consent before participating in the research. Not providing one disqualified from taking part in it.

Results

Shorter URTI duration and lower GHQ-28 total score were declared by the members of the CWI only group. Also, members of the STP group displayed significantly different results in comparison to the control group. This notion pertains to all measured variables. Moreover, URTI duration, GHQ-28 total score and FFMQ-SF total score were significantly different between the STP group and the CWI only group. The STP group reported shorter URTIs (by 0.48 day), lower total GHQ-28 score (by 3.91 point), lower score in the subscale dedicated to intensity of somatic symptoms (by 1.29 point), and higher score in the FFMQ-SF (by 0.22 point). Specific data is shown in Table 2.

Discussion

In hereby study, STP was found to be associated with a shorter time of URTI, less somatic complaints, better general mental health and better mindfulness when compared to both control and CWI only group. The STP group had shorter sick leave time than the control group. Also, CWI only group had shorter URTIs and better general mental health indices, but not mindfulness, compared to the control group.

It has been considered a common knowledge that practising CWI is beneficial for the mind and body. In the past, several studies provided evidence for beneficial effects of the regular CWI. Improvement in mental well-being, red cell-line parameters, serum anti-oxidative activity, or reduction in reactivity of the sympathoadrenal system can be mentioned among them [10,26–29].

Table 2. Case–control comparison of the selected variables of interest regarding times of infection and sick leave in the past year, mental health indices and selected personal dispositions between people practising specific training program (STP), cold-water immersion (CWI) only and controls. Presented as means with standard deviations.

	Control ($N = 77$)	CWI only ($N = 77$)	STP ($N = 77$)	F	p	η^2
URTI duration (days)	8.68 ± 12.53	3.39 ± 7.81[a]	2.91 ± 4.28[a,b]	9.006*	<0.001	0.067
Sick leave duration (days)	3.22 ± 4.69	3.27 ± 4.20	1.47 ± 3.58[a]	3.367*	0.037	0.029
GHQ-28 total score	22.88 ± 12.69	18.07 ± 8.40[a]	14.16 ± 7.81[a,b]	13.815*	<0.001	0.117
Somatic symptoms	6.09 ± 3.14	5.07 ± 2.79[a]	3.78 ± 2.53[a,b]	12.883	<0.001	0.102
Anxiety/insomnia	6.30 ± 4.73	4.70 ± 2.89[a]	4.03 ± 3.22[a]	6.047*	0.003	0.063
Social dysfunction	7.40 ± 2.39	6.53 ± 2.74[a]	5.10 ± 2.62[a]	15.508	<0.001	0.120
Depressive symptoms	3.09 ± 4.91	1.77 ± 2.92[a]	1.25 ± 2.48[a]	4.372*	0.014	0.045
Mindfulness	3.65 ± 0.55	3.69 ± 0.53	3.87 ± 0.46[a,b]	4.064	0.018	0.034

M – mean, SD – standard deviation, N – number of observations, F – Snedecor's F test or * Welch's test, depending on the homogeneity of variance, p – probability in the respective test, η^2 – effect size, a – statistically significant difference in relation to the control group, b – statistically significant difference in relation to the ice-cold water immersion group, URTI – upper respiratory tract infection, GHQ-28 – General Health Questionnaire 28-item version.

Authors explained this phenomenon by an unspecified process of *hardening*. Moreover, the presented differences could be explained by the hormesis hypothesis. According to it, a stimulus which initiates self-preservation mechanisms and is detrimental in the short term could elicit adaptation processes and therefore have a positive impact in the long term [30,31]. The hormesis theory does not specify the kind of stimulus, frequency of exposition, its duration or general measurement of its intensity necessary for the benefits to appear. Assuming the regular exposure to cold in a form of a cold-water immersion to be one of those stimuli, positive results declared by the members of the CWI only and the STP groups could be explained by the hormesis theory. Also, it must be mentioned that performing breathing exercises which the STP comprises induces a temporary hypoxia [13]. Some authors pointed out its therapeutic potential in relation to disorders like anaemia, arterial hypertension or depression [32]. It can be hypothesised that practising those two components induces a cumulative effect which was reflected in better results among members of the STP group compared to those declared by the members of the CWI only group. In the past, this notion was confirmed in the aspect of the STP's anti-inflammatory properties [33]. It can be hypothesised that one (or both) of the STP elements improve dispositional mindfulness, as the STP group displayed small but significant differences compared to both of the groups. STP includes concentration on the breath and body sensations, with a particular focus on the feeling of "letting go". Similar instructions can be found in different meditation forms, which are key to mindfulness-based practice. The latter has been steadily developed and confirmed in the aspect of stress reduction, improvement in sleep and life quality in general [34–37].

A possible explanation for the differences between the studied groups can be a neurofunctional model of periaqueductal grey (PAG) activity. This midbrain region plays a critical role in autonomic function and behavioural responses to threatening stimuli [38]. A cold-water immersion and hypoxia (when excessively prolonged) can be life-threatening conditions and therefore engage the PAG [39–41]. It has been proven that PAG takes part in activity modulation of the autonomic nervous system, the immunological system, the neuroendocrine system and pain conductance [42]. Furthermore, it is well known that repeated exposure to acute stressors can result in physiological adaptation [43]. Assuming the existence of cross-adaptive mechanisms, biological stimuli would induce an improvement in psychological functioning. If confirmed, such mechanisms would open new possibilities for adjunctive therapeutic strategies, for example the STP used in this study. It must be mentioned, however, that the exact mechanism of action of the STP is yet to be discovered, as well as potential evidence in support of hormesis theory.

Exposure to cold in a CWI form has several contraindications. Heart arrhythmia, aneurysms, epilepsy, cold-induced urticaria and cold-induced asthma are the main conditions which should be mentioned among them. Regarding STP, the main contraindication is epilepsy, as it involves hyperventilation and could induce seizure. Also, it is not known if CWI and STP are safe practices for pregnant women, as there has been no studies which could provide conclusive recommendations [44].

Limitations

A possible explanation for the differences between the groups is that members of the polar plunge or CWI groups were probably more health-conscious than the general population, and only healthy people can continuously perform polar plunge because of the high physical load involved in polar plunge. Application of the questionnaires which were self-descriptive and not assessed by qualified medical professionals has to be mentioned as a first limitation of this study. Secondly, gathering data via the Internet excludes certain social groups which are not familiar with (i.e. elderly) or have no technical access to it (low material situation), but still practice CWI [45].

Also, response rate at the level of 22% can be a limitation to the drawn conclusions. It has been proven that people suffering from mental disorders may be less inclined to participate in questionnaire-based studies regarding mental health [46]. However, when comparing the obtained results to the comparators from the general population (other studies), the indices appear similar. Mean time of declared URTI duration in this study was 8.7 days in the control group, and the average assumed time of an URTI is between 7 and 10 days [47]. In the Polish population aged 18–45, mean total score of GHQ-28 was determined at 22.9 points, whereas in this study, the average result of the same parameter equalled 22.9 points [21].

Despite the fact that analysis involved matching pairs by experience in and frequency of CWI, it did not involve average time of exposure to cold (time of immersion). Therefore, it is not known if the statistical differences between the STP and CWI would still be present if the analysis involved also this variable. In the sociodemographic part of the questionnaire, the respondents were not asked about the marital status, employment status, education level or the size of the

inhabited place. Also, physical activity and diet are relevant factors in regard to mental functioning, and questions regarding it were not included in the questionnaire [48,49].

Conclusions

- Practice of cold-water immersion was found to be related to better mental health and shorter upper respiratory tract infections compared to control group.
- Combination of cold-water immersion and breathwork seemed to be associated with a cumulative effect and was linked to better mental health, and shorter upper respiratory tract infection compared to cold-water immersion only group.
- Further studies, encompassing an intervention, and explaining the mechanism of action of the specific training program, are required.

Acknowledgments

The authors wish to thank the community of Polish polar plungers for inspiration.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

The cost of the publication and charges for this article have been funded by authors. No further funding was received.

Authors' contributions

JC and KND conceived the study, and ŁM conducted the initial and final analyses. JC and KND drafted the initial version of the paper. All authors gave input into how to interpret and structure the findings and reviewed subsequent versions. All authors have read and approved the final manuscript.

Data availability statement

The database used to support this study's findings may be obtained upon request to the corresponding author.

References

[1] Liu YZ, Wang YX, Jiang CL. Inflammation: the common pathway of stress-related diseases. Front Hum Neurosci. 2017;11:11. doi: 10.3389/fnhum.2017.00316

[2] George Fink. Stress: the health epidemic of the 21st Century. Scitech Connect Elsevier. Published 2016. [cited 2023 July 27]. Available from: https://scitechconnect.elsevier.com/stress-health-epidemic-21st-century/

[3] WHO. COVID-19 pandemic triggers 25% increase in prevalence of anxiety and depression worldwide. web article. Published 2023. [cited 2023 July 26]. Available from: https://www.who.int/news/item/02-03-2022-covid-19-pandemic-triggers-25-increase-in-prevalence-of-anxiety-and-depression-worldwide

[4] Gallup Organization. State of the global workplace: 2023 report. Gallup Organization. Published 2023. [cited 2023 July 26]. Available from: https://www.gallup.com/workplace/349484/state-of-the-global-workplace.aspx#ite-506924

[5] WHO. Mental health at work. 2022. https://www.who.int/news-room/fact-sheets/detail/mental-health-at-work

[6] Fincham GW, Strauss C, Montero-Marin J, et al. Effect of breathwork on stress and mental health: a meta-analysis of randomised-controlled trials. Sci Rep. 2023;13(1):432. doi: 10.1038/s41598-022-27247-y

[7] Hopper SI, Murray SL, Ferrara LR, et al. Effectiveness of diaphragmatic breathing for reducing physiological and psychological stress in adults. JBI Database System Rev Implement Rep. 2019;17(9):1855–1876. doi: 10.11124/JBISRIR-2017-003848

[8] Reangsing C, Lauderman C, Schneider JK. Effects of mindfulness meditation intervention on depressive symptoms in emerging adults: a systematic review and meta-analysis. J Integ Complement Med. 2022;28(1):6–24. doi: 10.1089/jicm.2021.0036

[9] Kamiński R. 8893 osoby na XX Międzynarodowym Zlocie Morsów w Mielnie. Published 2023. [cited 2023 Aug 14]. Available from: https://www.gospodarkamorska.pl/8893-osoby-na-xx-miedzynarodowym-zlocie-morsow-w-mielnie-69302

[10] Demori I, Piccinno T, Saverino D, et al. Effects of winter sea bathing on psychoneuroendocrinoimmunological parameters. Explore (NY). 2021;17(2):122–126. doi: 10.1016/j.explore.2020.02.004

[11] Néma J, Zdara J, Lašák P, et al. Impact of cold exposure on life satisfaction and physical composition of soldiers. BMJ Mil Health. Published online January 4, 2023; e002237. doi: 10.1136/military-2022-002237

[12] Buijze GA, Sierevelt IN, van der Heijden BCJM, et al. The effect of cold showering on health and work: a randomized controlled trial. PLoS One. 2016;11(9):e0161749. doi: 10.1371/journal.pone.0161749

[13] Kox M, van Eijk LT, Zwaag J, et al. Voluntary activation of the sympathetic nervous system and attenuation of the innate immune response in humans. Proc Nat Acad Sci. 2014;111(20):7379–7384. doi: 10.1073/pnas.1322174111

[14] Buijze GA, De Jong HMY, Kox M, et al. An add-on training program involving breathing exercises, cold exposure, and meditation attenuates inflammation and disease activity in axial spondyloarthritis – a proof of concept trial. PLoS One. 2019;14(12):e0225749. doi: 10.1371/journal.pone.0225749

[15] Czarnecki J, Ł M, Gruchała-Cisłak A, et al. Combination of breathing exercises, cold exposure, and meditation mitigate psoriasis and comorbidities -proof of concept, randomized, controlled trial. In *European Society for*

Dermatological Research. 2021. doi: 10.26226/morressier.61081ff8bc981037240fe3a1

[16] Zwaag J, Ter Horst R, Blaženović I, et al. Involvement of lactate and pyruvate in the anti-inflammatory effects exerted by voluntary activation of the sympathetic nervous system. Metabolites. 2020;10(4):148. doi: 10.3390/metabo10040148

[17] Zwaag J, Timmerman H, Pickkers P, et al. Modulation of pain sensitivity by a hyperventilatory breathing exercise and cold exposure training. J Pain Res. 2023;16:1979–1991. doi: 10.2147/JPR.S400408

[18] Muzik O, Reilly KT, Diwadkar VA. "Brain over body"–A study on the willful regulation of autonomic function during cold exposure. Neuroimage. 2018;172:632–641. doi: 10.1016/j.neuroimage.2018.01.067

[19] Silva C, McNaughton N. Are periaqueductal gray and dorsal raphe the foundation of appetitive and aversive control? A comprehensive review. Prog Neurobiol. 2019;177:33–72. doi: 10.1016/j.pneurobio.2019.02.001

[20] Goldberg D, Williams P. A User's Guide to the General health questionnaire. London: GL Assessment Ltd; 2006.

[21] Makowska Z, and Merecz DM. A user's guide to the general health questionnaire. Part II. Ocena zdrowia psychicznego na podstawie badań kwestionariuszami Davida Goldberga : podręcznik dla użytkowników kwestionariuszy GHQ-12 i GHQ-28. 1st ed. Łódź: Oficyna Wydawnicza Instytutu Medycyny Pracy im. prof. J. Nofera; 2001. p. 264.

[22] Bohlmeijer E, ten Klooster PM, Fledderus M, et al. Psychometric properties of the five facet mindfulness questionnaire in depressed adults and development of a short form. Assessment. 2011;18(3):308–320. doi: 10.1177/1073191111408231

[23] Radoń S, Rydzewska M Validation of the Polish version of the short form of the five facet mindfulness questionnaire. Roczniki Psychologiczne. 2018;21(3):279–298. doi: 10.18290/rpsych.2018.21.3-5

[24] Baer RA, Smith GT, Hopkins J, et al. Using self-report assessment methods to explore facets of mindfulness. Assessment. 2006;13(1):27–45. doi: 10.1177/1073191105283504

[25] Bartram B. Using questionnaires. In: Practical research methods in education. Routledge; 2019. pp. 1–11. doi: 10.4324/9781351188395-1

[26] Huttunen P, Kokko L, Ylijukuri V. Winter swimming improves general well-being. Int J Circumpolar Health. 2004;63(2):140–144. doi: 10.3402/ijch.v63i2.17700

[27] Lubkowska A, Dołęgowska B, Szyguła Z, et al. Winter-swimming as a building-up body resistance factor inducing adaptive changes in the oxidant/antioxidant status. Scand J Clin Lab Invest. 2013;73(4):315–325. doi: 10.3109/00365513.2013.773594

[28] Checinska-Maciejewska Z, Niepolski L, Checinska A, et al. Regular cold water swimming during winter time affects resting hematological parameters and serum erythropoietin. J Physiol Pharmacol. 2019;70(5). doi: 10.26402/jpp.2019.5.10

[29] Janský L, Vybíral S, M T, et al. Modulation of adrenergic receptors and adrenergic functions in cold adapted humans. Eur J Appl Physiol. 2008;104(2):131–135. doi: 10.1007/s00421-007-0627-0

[30] Noruzi M, Sharifzadeh M, Abdollahi MH. Reference Module in Biomedical Sciences. [Published online 2023 Jan 1,]. doi: 10.1016/B978-0-12-824315-2.00640-0

[31] SAKAI K. Biological responses to Low Dose Radiation-Hormesis and adaptive responses-. Yakugaku Zasshi. 2006;126(10):827–831. doi: 10.1248/yakushi.126.827

[32] Navarrete-Opazo A, Mitchell GS. Therapeutic potential of intermittent hypoxia: a matter of dose. Am J Physiol Regul Integr Comp Physiol. 2014;307(10):R1181–R1197. doi: 10.1152/ajpregu.00208.2014

[33] Zwaag J, Naaktgeboren R, van Herwaarden AE, et al. The effects of cold exposure training and a breathing exercise on the inflammatory response in humans: a Pilot study. Psychosom Med. 2022;84(4):457–467. doi: 10.1097/PSY.0000000000001065

[34] Nnate DA, Anyachukwu CC, Igwe SE, et al. Mindfulness-based interventions for psychological wellbeing and quality of life in men with prostate cancer: a systematic review and meta-analysis. Psychooncology. 2021;30(10):1680–1690. doi: 10.1002/pon.5749

[35] Chen TL, Chang SC, Huang CY, et al. Effectiveness of mindfulness-based interventions on quality of life and menopausal symptoms in menopausal women: a meta-analysis. J Psychosom Res. 2021;147:110515. doi: 10.1016/j.jpsychores.2021.110515

[36] Khoury B, Sharma M, Rush SE, et al. Mindfulness-based stress reduction for healthy individuals: a meta-analysis. J Psychosom Res. 2015;78(6):519–528. doi: 10.1016/j.jpsychores.2015.03.009

[37] Rusch HL, Rosario M, Levison LM, et al. The effect of mindfulness meditation on sleep quality: a systematic review and meta-analysis of randomized controlled trials. Ann N Y Acad Sci. 2019;1445(1):5–16. doi: 10.1111/nyas.13996

[38] Faull OK, Subramanian HH, Ezra M, et al. The midbrain periaqueductal gray as an integrative and interoceptive neural structure for breathing. Neurosci Biobehav Rev. 2019;98:135–144. doi: 10.1016/j.neubiorev.2018.12.020

[39] de Git KCG, van Tuijl DC, Luijendijk MCM, et al. Anatomical projections of the dorsomedial hypothalamus to the periaqueductal grey and their role in thermoregulation: a cautionary note. Physiol Rep. 2018;6(14):e13807. doi: 10.14814/phy2.13807

[40] Lopes LT, Biancardi V, Vieira EB, et al. Participation of the dorsal periaqueductal grey matter in the hypoxic ventilatory response in unanaesthetized rats. Acta Physiol. 2014;211(3):528–537. doi: 10.1111/apha.12254

[41] La Cesa S, Tinelli E, Toschi N, et al. fMRI pain activation in the periaqueductal gray in healthy volunteers during the cold pressor test. Magn Reson Imaging. 2014;32(3):236–240. doi: 10.1016/j.mri.2013.12.003

[42] George DT, Ameli R, Koob GF. Periaqueductal gray sheds light on dark areas of psychopathology. Trends Neurosci. 2019;42(5):349–360. doi: 10.1016/j.tins.2019.03.004

[43] Herman JP, McKlveen JM, Ghosal S, et al. Regulation of the Hypothalamic-Pituitary-Adrenocortical stress response. In Comprehensive physiology Wiley; 2016. pp. 603–621. doi: 10.1002/cphy.c150015

[44] Tipton M, Massey H, Mayhew A, et al. Cold water therapies: minimising risks. Br J Sports Med. 2022;56(23):1332–1334. doi: 10.1136/bjsports-2022-105953

[45] Hargittai E Potential biases in Big Data: omitted voices on Social Media. Soc Sci Comput Rev. 2020;38(1):10–24. doi: 10.1177/0894439318788322
[46] Kessler RC, TB Ü. The World Mental Health (WMH) survey initiative version of the World Health Organization (WHO) composite international diagnostic interview (CIDI). Int J Methods Psychiatr Res. 2004;13(2):93–121. doi: 10.1002/mpr.168
[47] Thomas M, Bomar PA. Upper respiratory tract infection. 2023.
[48] Schuch FB, Vancampfort D. Physical activity, exercise, and mental disorders: it is time to move on. Trends Psychiatry Psychother. 2021; Published online 2021. doi: 10.47626/2237-6089-2021-0237
[49] Bremner J, Moazzami K, Wittbrodt M, et al. Diet, Stress and Mental Health. Nutrients. 2020;12(8):2428. doi: 10.3390/nu12082428