Habitual cold-water swimming and upper respiratory tract infection*

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To the Editor:

It has long been claimed that non-wetsuit cold water swimming (CWS) benefits health [(1)], and anecdotally cold-water swimmers claimed to suffer fewer and milder infections, though this was not directly measured. A boost to immunity is biologically plausible: stress hormones are released during cold-water immersion [(2)], and short-term stress may ready the immune system for injury or infection [(3)]. However, very few studies have investigated immune system markers and/or actual illness in habitual cold-water swimmers.

We compared Upper Respiratory Tract Infection (URTI) symptoms and duration between 25 cold-water swimmers and their co-habiting non-swimming partners over 13 winter weeks. 22 pool swimmers and their partners acted as further controls. We also sought correlations between reported URTI and CWS volume and body mass index (BMI). Overweight/obesity is increasingly prevalent and may affect immune system function via chronic inflammation [(4)]. We hypothesised that Cold Swimmers would report less URTI than Cold Partners and Pool Swimmers; Pool Swimmers would report similar URTI symptoms and duration to their Partners; CWS would correlate negatively with URTI; and BMI would correlate positively with URTI. The study was approved by the Science Faculty Ethics Committee of the University of Portsmouth and was conducted in accordance with the Declaration of Helsinki. Full details of the Methods are in the Supplementary Material.

Participants reported URTI symptoms each week using the Jackson Cold Scale [(5)], with sessions and time of CWS, pool swimming and other physical activity (PA). They also completed the Health-Related Quality of Life (HRQoL) questionnaire [(6)] every month. Each individual's weekly URTI score was calculated by weighting symptom days for severity, and totalling. A total score ≥ 14 indicated an URTI [(7)]. For each participant, weekly URTI scores were summed to give Total URTI Score, which was divided by Number of URTIs to give Mean URTI Score. Mean URTI Duration was calculated as (Total Days with Symptoms) / (Number of URTIs).

Physical activity was divided into Cold Swim Time, Total Swim Time, Dryland Time, and All PA Time (minutes). Participants' mean weekly time for each PA category was calculated as (total time reported) / (number of questionnaires submitted). Mean Cold Swim Duration per Session (minutes) was calculated as (total Cold Swim Time) / (total Cold Swim sessions). HRQoL responses were averaged over the three months. Statistics are reported as Mean (Standard Deviation) or *Median (Range)*. Participants' physical characteristics and PA are in Table 1, Supplementary Material. Age did not differ between groups. Cold Swimmers' median BMI was greater than Pool Swimmers' (*27.1 (16.7)* $kg.m^{-2}$ v *23.1 (17.9)* $kg.m^{-2}$, $p = 0.009$). Pool Swimmers carried out more weekly swimming than Cold Swimmers (Mdn *153 (340)* minutes v Mdn *52 (306)* minutes, $p < 0.001$), and were more active overall than both Partner groups. Mean Cold Swim Duration per Session was 14 (7) minutes.

URTI parameters and Mean Sick Days per Month are shown in Table 1. None of these variables differed between the four groups: Presence of URTI, $p = 0.158$; Mean URTI Score, $p = 0.184$; Mean URTI Duration, $p = 0.327$; Mean Sick Days per Month, $p = 0.596$. The only difference in HRQoL responses was that Pool Swimmers reported better health than both Cold Partners ($p = 0.015$) and Pool Partners ($p = 0.005$). 95% of Pool Swimmers reported their health as Excellent or Very Good, as against 52% of Cold Partners and 45% of Pool Partners. The figure for Cold Swimmers was 68%, not different from the other groups.

There were no correlations between either cold swimming measure and any URTI measure (Table 2). Mean Cold Swim Duration correlated positively with BMI, r = 0.464, p = 0.020. There were no correlations between other PA and URTI (Table 2).
Cold Swimmers showed weak negative correlations between BMI and Mean URTI Duration (r_s = -.355, p = 0.041), and between BMI and Total Days with URTI (r_s = -.364, p = 0.037). There were no correlations in the other groups (Table 2).
Only the hypothesis that Pool Swimmers would report similar URTI to their Partners is accepted. Cold Swimmers did not report less URTI than their Partners or Pool Swimmers; CWS did not correlate negatively with URTI; and BMI and URTI did not correlate positively. Interestingly, Cold Swimmers reported similar URTI to Pool Swimmers, whilst carrying out about one-third as much swimming and a similar amount of dryland exercise. Possibly CWS did limit URTI score and duration, or Pool Swimmers carried out too much total PA and thus suffered more from URTI. Further, although immersing just the feet in cold water has been found to increase URTI incidence [8], Cold Swimmers suffered similar URTI to the other groups.

In terms of URTI, CWS may benefit larger individuals: the negative correlations between BMI and reported URTI in Cold Swimmers were not seen in their Partners, nor in Pool Swimmers or their Partners. Seven (28%) Cold Swimmers had a BMI ≥ 30 $kg.m^{-2}$, only one of whom reported an URTI. This is counter to the general population, where high BMI is associated with increased URTI incidence [9]. CWS could damp down the inflammation associated with obesity via vagal nerve stimulation; or larger swimmers may experience a smaller drop in deep body temperature and less physical stress.

The main study limitations are recall errors, and bias from two main sources: Cold Swimmers' belief that the activity makes them healthier, and the subjective assessment of symptom severity. However, participants reported URTI symptoms weekly, URTI incidence corresponded to the general population, and no clinical URTI measure has been found to be superior to self-report [7]. Further, participants' responses were consistent between weekly and HRQoL questionnaires, and between HRQoL measures (Table 2, Supplementary Material). The threshold symptom score of ≥14 makes it unlikely that Pool Swimmers' non-allergic rhinitis could have been included as an URTI.
The "dose" of cold may determine any effect of CWS on the immune system: skin cooling may be stimulatory, and deep body cooling detrimental. The effect of both types of cooling, and any interactions with BMI, should be investigated under laboratory conditions in an adequately-powered study.

List of abbreviations

BMI: Body Mass Index; CWS: Non-wetsuit cold-water swimming; HRQoL: Health-Related Quality of Life questionnaire; PA: Physical activity; URTI: Upper Respiratory Tract Infection.

Conflict of interest

There were no potential conflicts of interest. All authors have read the journal's authorship agreement and policy on disclosure of potential conflicts of interest.
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Authorship contribution

NC is the lead author and at the time was a PhD student at the University of Portsmouth. ML, MH, MT, HM were the supervisory team, with HM as first supervisor. NC wrote the document, ML, MH, MT, HM reviewed it and gave feedback. All approved the final content.

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Table 1. Upper Respiratory Tract Infection and physical illness by group. Median (range) in italics.

Group	Prevalence of URTI (%)*	Mean URTI Score^	Mean URTI Duration (days)†	Mean Sick Days per Month§
Cold Swimmers	56	*14 (223)*	*3 (32)*	*1 (20)*
Cold Partners	64	*19 (211)*	*4 (21)*	*3 (30)*
Pool Swimmers	68	*38 (116)*	*7 (21)*	*2 (25)*
Pool Partners	86	*26 (144)*	*6 (21)*	*4 (12)*

* No sig diff (p = 0.158); ^ No sig diff (p = 0.184); † No sig diff (p = 0.327); § No sig diff (p = 0.596).

Table 2. Correlations between BMI and URTI, and between PA and URTI, in each of the four groups in the 13 week URTI symptom reporting study.

	Mean URTI Score	Mean URTI Duration	Total days with URTI
BMI			
CS	r_s = -.242 p = 0.122	r_s = -.355 p = 0.041*	r_s = -.364 p = 0.037*
CP	r_s = -.032 p = 0.439	r_s = .034 p = 0.436	r_s = -.080 p = 0.352
PS	r_s = .054 p = 0.406	r = -.033 p = 0.442	r_s = .049 p = 0.415
PP	r_s = -.252 p = 0.129	r = -.014 p = 0.476	r = .062 p = 0.393
Cold swim (CS only)			
Mean weekly time (minutes)	r_s = .133 p = 0.263	r_s = .019 p = 0.465	r_s = .016 p = 0.941
Mean duration (minutes)	r_s = .059 p = 0.391	r_s = -.018 p = 0.467	r_s = -.055 p = 0.793
Total PA			
CS	r_s = -.027 p = 0.900	r_s = -.060 p = 0.777	r_s = -.086 p = 0.684
CP	r_s = -.171 p = 0.414	r_s = -.177 p = 0.398	r_s = -.288 p = 0.162
PS	r_s = -.014 p = 0.951	r_s = -.036 p = 0.873	r_s = .018 p = 0.937
PP	r_s = .272 p = 0.221	r_s = .265 p = 0.233	r_s = .059 p = 0.794

CS = Cold Swimmers, CP = Cold Partners. PS = Pool Swimmers, PP = Pool Partners *One-tailed $p < 0.05$.

References

1. Harper CM. Extreme preconditioning: Cold adaptation through sea swimming as a means to improving surgical outcomes. Med Hypotheses 2012; 78: 516–519.
2. Tipton M, Bradford C. Moving in extreme environments: open water swimming in cold and warm water. Extrem Physiol Med 2014; 3: 12.
3. Dhabhar FS. Effects of stress on immune function: the good, the bad, and the beautiful. Immunol Res 2014; 58: 193–210.
4. Unamuno X, Gómez-Ambrosi J, Rodríguez A, Becerril S, Frühbeck G, Catalán V. Adipokine dysregulation and adipose tissue inflammation in human obesity. Eur J Clin Invest 2018; 48(9):e12997.
5. Barrett B, Brown R, Voland R, Maberry R, Turner R. Relations among questionnaire and laboratory measures of rhinovirus infection. Eur Respir J 2006; 28: 358–363.
6. Moriarty D, Zack M, Kobau R. The Centers for Disease Control and Prevention's Healthy Days Measures – Population tracking of perceived physical and mental health over time. Health Qual Life Outcomes 2003; 1:37.
7. Barrett B, Locken K, Maberry R, et al. The Wisconsin Upper Respiratory Symptom Survey (WURSS): A New Research Instrument for Assessing the Common Cold. J Fam Pract 2002; 51: 265.
8. Johnson C, Eccles R. Acute cooling of the feet and the onset of common cold symptoms. Fam Pract 2005; 2: 608-613.
9. van Wayenburg CAM, Lemiengre MBT, van Reenen-Schimmel AH, et al. Encounters for common illnesses in general practice increased in obese patients. Fam Pract 2008; 25: i93–i98.

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SUPPLEMENTARY MATERIAL

Methods

The study was approved by the Science Faculty Ethics Committee of the University of Portsmouth (SFEC 2014-055) and was conducted in accordance with the Declaration of Helsinki.

Participants

Required sample size was computed in G*Power 3.1 (Heinrich Heine Universität, Düsseldorf) for independent t-tests, using the following parameters: two groups of cohabiting couples (four groups in total), $\alpha = 0.05$, effect size 0.8, power 0.8. This gave a sample size of 20 participants in each group. To allow for withdrawals, 59 co-habiting couples were recruited via swimming clubs and social media. 32 cold-water swimmers (Cold Swimmers) and their non-swimming partners (Cold Partners), and 27 Pool Swimmers and their non-swimming partners (Pool Partners) gave their informed written consent to participate. Participants completing fewer than 7 of the 13 questionnaires were removed from the final analysis.

Inclusion criteria for swimmers were: they must have swum at least twice each week for ≥ six months before the study start date; and intend to continue through the winter. Cold swimming was defined as non-wetsuit, with average water temperature ≤ 18 °C. Exclusion criteria were: an age difference between partners > 10 years, as the immune system alters with age; chronic heart or lung conditions and cancer; Body Mass Index (BMI) < 18.5 $kg.m^{-2}$, as being underweight can compromise immune system function. BMI was calculated from self-reported height and weight.

Data collection

Data were collected over two 13 week periods, starting on 1 December 2014 and 5 December 2016. Every Monday participants were asked to complete a Sickness and Activity Questionnaire (SAQ) for the previous seven days, on paper or online. The SAQ contains eight questions about URTI symptoms from the Jackson Cold Scale, a well-established and validated questionnaire, and asks about frequency, total duration and intensity of cold and pool swimming, and dryland exercise. The Health Related Quality of Life questionnaire (HRQoL) was completed every thirty days (three times in total).

Data analyses

URTI scoring: participants' SAQ responses were collated each week. Each individual's URTI score was calculated by weighting symptom days for severity, and totalling. A weighting of 1 was applied to mild symptoms, 2 to moderate, and 3 to severe, and a total score ≥ 14 was taken as indicating an URTI (this score also prevents possible Pool Swimmers' non-allergic rhinitis due to chlorine from being recorded as an URTI). *URTI measures*: individuals were listed by group, with the weeks in which they had an URTI and their URTI scores for those weeks (some had >1 URTI). The following were noted or calculated:

Presence of URTI: Yes/No
Total URTI score: Sum of all weekly URTI scores
Number of URTIs: Number of colds
Total days with URTI : Total days on which there were URTI symptoms;

and the following two measures were calculated for statistical analysis:

$$\text{Mean URTI Score} = \frac{\text{Total URTI score}}{\text{Number of URTIs}} \quad \text{Equation 1}$$

$$\text{Mean URTI Duration} = \frac{\text{Total days with an URTI}}{\text{Number of URTIs}} \quad \text{Equation 2}$$

To control for exercise, the four groups were initially subdivided into active and sedentary participants, according to whether they met UK Government guidelines for minimum physical activity (PA). However, as the resulting sub-groups were as small as one or five participants, separate statistical analyses were not carried out.

Physical activity was divided into four categories: Cold Swim Time, Total Swim Time, Dryland Time, and All PA Time, in minutes. As participants varied in the number of weekly questionnaires they submitted, their weekly mean time for each PA category was calculated as [total time reported] / [number of questionnaires submitted]. Mean Cold Swim Duration per Session (minutes) was calculated as [total Cold Swim Time] / [total Cold Swim sessions].

Statistical analyses were carried out in SPSS (SPSS version 26), as follows:

URTI measures: Presence of URTI was compared across the four groups using Chi square; and Mean URTI Score and Mean URTI Duration using Kruskal-Wallis ANOVA.

PA: Total Weekly Swim Time was compared between Cold Swimmers and Pool Swimmers using Mann-Witney U. Weekly Dryland and Weekly All PA Times were compared across the four groups using Kruskal-Wallis ANOVA.

HRQoL modules: Self-report of Health was scored from 1 = Excellent to 5 = Poor, and compared between groups using Kruskal-Wallis ANOVA. Within each participant group, responses to all other HRQoL questions were compared between the three months using Friedman's ANOVA. As no differences were found, responses were averaged over the three months, and compared between groups using Kruskal-Wallis ANOVA.

Multiple regression was carried out between participant group, sex, age, BMI, mean weekly PA, height, weight, and both URTI measures. As this did not produce any significant results (p values ranged from 0.201 to 0.997, with no factor significantly associated with URTI score or duration), this line of analysis was not pursued further.

Correlations were sought between reported URTI and Cold Swim Time, PA and BMI; and between Mean Cold Swim Duration per Session, BMI and reported URTI. To test for consistency of reporting, correlations were also sought between: Mean URTI Score and the mean HRQoL measure "Days when physical health was not good" ("Sick Days"); between mean Sick Days and median Self-report of Health; and between Mean URTI Score and median Self-Report of Health. Pearson's r was used where both measures were normally distributed: this applied to Mean Cold Swim Duration per Session v BMI; and to BMI v Mean URTI Duration in Pool Swimmers. For all other correlations Spearman's rho was used.

Statistical significance was taken as $p < 0.05$, and trend as $0.05 \leq p < 0.10$. Two-tailed testing was applied to Chi square, Kruskal-Wallis ANOVA and the non-directional hypothesis (that pool swimmers would report similar URTI symptoms and duration to their partners), and one-tailed testing to the remaining, directional hypotheses.

Effect sizes (ES) were calculated using $r = z/\sqrt{N}$ for Mann-Witney U, and for pairwise comparisons after Kruskal-Wallis ANOVA, with 0.3 taken as moderate and 0.5 as large.

Supplementary Table 1. Characteristics of participants in the 13 week URTI symptom reporting study (Median (range) in italics).

Group	Age (years)	BMI[§]	% overweight or obese (BMI ≥ 25)	% obese (BMI ≥ 30)	Male/female n	Weekly mean PA time (minutes)			
						Cold swim	Total swim	Dryland	Total PA
CS (n = 25)	*50 (41)*	*27.1 (16.7)**	*72#*	*28*	m = 9, f = 16	*27 (75)*	*52 (306)[†]*	*205 (613)*	*330 (619)*
CP (n = 25)	*49 (37)*	*26.0 (14.1)*	*68^*	*8*	m = 15, f = 10	*N/A*	*N/A*	*220 (1317)*	*220 (1317)[~]*
PS (n = 22)	*53 (43)*	*23.1 (17.9)**	*27#^*	*9*	m = 11, f = 11	*N/A*	*153 (340)[†]*	*273 (1466)*	*419 (1480)[~α]*
PP (n = 22)	*51 (40)*	*23.2 (16.7)*	*46*	*23*	m = 11, f = 11	*N/A*	*N/A*	*240 (1640)*	*240 (1640)[α]*

[§] calculated from self-reported height and weight. * CS different from PS, p = 0.009; [#] CS different from PS, p = 0.014, [^] CP different from PS, p = 0.032; [†] CS different from PS, p < 0.001; [~] CP different from PS, p = 0.003; [α] PS different from PP, p = 0.016.

CS = Cold Swimmers, CP = Cold Partners, PS = Pool Swimmers, PP = Pool Partners. BMI = Body Mass Index, PA = Physical Activity.

Supplementary Table 2. Correlations between URTI score (from SAQ), Self-report of Health and Sick Days (from HRQoL) in the 13 week URTI symptom reporting study.

	Mean URTI Score	Median Self-Report of Health	Mean Sick Days
All participants			
Mean URTI Score	-	r_s =.264, p = 0.011* n = 93	r_s = .476, p < 0.001† n = 93
Median Self-Report of Health	r_s = .264, p = 0.011* n = 93	-	r_s = .481, p < 0.001† n = 93
Mean Sick Days	r_s = .476, p < 0.001† n = 93	r_s = .481, p < 0.001† n = 93	-
Cold Swimmers			
Mean URTI Score	-	r_s = .268, p = 0.195 n = 25	r_s = .531, p = 0.006* n = 25
Median Self-Report of Health	r_s = .268, p = 0.195 n = 25	-	r_s = .497, p = 0.011* n = 25
Mean Sick Days	r_s = .531, p = 0.006* n = 25	r_s = .497, p = 0.011* n = 25	-
Cold Partners			
Mean URTI Score	-	r_s = .463, p = 0.023* n = 24	r_s = .418, p = 0.042* n = 24
Median Self-Report of Health	r_s = .463, p = 0.023* n = 24	-	r_s = .599, p = 0.002* n = 24
Mean Sick Days	r_s = .418, p = 0.042* n = 24	r_s = .599, p = 0.002* n = 24	-
Pool Swimmers			
Mean URTI Score	-	r_s = .175, p = 0.436 n = 22	r_s = .696, p < 0.001† n = 22
Median Self-Report of Health	r_s = .175, p = 0.436 n = 22	-	r_s = .125, p = 0.578 n = 22
Mean Sick Days	r_s = .696, p < 0.001† n = 22	r_s = .125, p = 0.578 n = 22	-
Pool Partners			
Mean URTI Score	-	r_s = -.120, p = 0.595 n = 22	r_s = .305, p = 0.168 n = 22
Median Self-Report of Health	r_s = -.120, p = 0.595 n = 22	-	rs = .343, p = 0.118 n = 22
Mean Sick Days	r_s = .305, p = 0.168 n = 22	r_s = .343, p = 0.118 n = 22	-

* p < 0.05; † p < 0.001. SAQ = Sickness and Activity Questionnaire; HRQoL = Health Related Quality of Life questionnaire.