

# Perception of Track and Field Athletes on the Use of Cryotherapy in Injury Management in Ashanti Region of Ghana

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## Abstract

The use of cryotherapy in injury management (IM) has been widely studied but report on track and field athletes' (TFAs) perception in Ghana remains scarce. TFAs in Ashanti region of Ghana habitually sustained acute injuries due to competition stressors that typically affect peak performance like in other contact games. Despite been observed that sustained injuries accomplished cryotherapy treatment, TFAs' visit to non-clinical therapy nonetheless remain prominent. This cross-sectional study therefore documents the perceptions of TFAs on the use cryotherapy in IM. Ninety five [mean age = 22.26±1.10years, 59 (62.1%) males, 36(37.9%) females] TFAs camped at the Babayara Sports stadium Kumasi in preparation for 11<sup>th</sup> African Games were purposively sampled. Self-structured and validated instrument on the use of cryotherapy in IM was administered to elicit TFAs perceptions. TFAs perceived the use of cryotherapy in IM as significant [F = 788.884, X<sup>2</sup> = 404.192, df = 94, p = .000].

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Gender influence on TFAs perception of use of cryotherapy in IM was not significantly different. Mainstream significantly professed at least a good feeling (79.0%,  $X^2 = 37.000$ ,  $p = 000$ ) after receiving cryotherapy treatment. As such, attachment of Physical Therapists to the TFAs training sessions in Ashanti region, provision of enabling environment and equipment to enhance effective IM processes through cryotherapy are strategic approaches advocated.

**Keywords:** Perception; Uses of cryotherapy; Athletics; Injury management.

## 1. Introduction

The use of cryotherapy in injury management (IM) has been extensively studied [1-4]. These studies have showed that cryotherapy is a low-cost and modest operative method to relieve pains from acute sports injuries [5-8]. Since LaStayo and his colleagues [9] had earlier affirmed that mechanical stress imposed on active skeletal muscles during athletic events sometimes leads to high force of muscular contractions associated with muscle damage, then any direct competition stressor to sarcolemma, sarcomeres, excitation-contraction coupling system, and connective tissue would negatively affect optimal athletic performance [10- 12].

Water immersion, cold air, packaged crushed ice and evaporating spray are some of the common cold devices reported [13] and these devices are noticeably administered on injured athletes during sporting events in Ghana. Pains, edema, inflammation, tissue temperature, metabolism, muscle stiffness and nerve conduction velocity would decrease contingent on the cryotherapy procedure used [3, 13-15]. Nevertheless, the effectiveness of cryotherapy applications can only be measured through optimal performance of athletes after such treatment [16 – 18]. Regardless of the method applied, systematically reviewed literatures found that cryotherapy benefits athletes after both local and whole body therapy [4, 15, 19-21].

Ashanti, a developing region within a poorly resourced country like Ghana, would need a cost effective IM techniques like cryotherapy to rehabilitate injury sustained by most of the TFAs who bring honour to Ghana, besides soccer. TFAs in Ashanti region of Ghana habitually sustained acute injuries due to competition stressors (physical, physiological and environmental) that typically affect peak performance like in other contact games. In the event of injury induced disruptions, TFAs supposed to look forward to medics for professional feat to ensure immediate management and rehabilitation. TFAs in Ashanti region run contrary to this expectation perhaps previous experiences yielded negative results. Despite authors' personal observation that sustained injuries accomplished cryotherapy treatment, phenomenal issues appeal for resolution. "How would TFAs describe their knowledge about cryotherapy? Which components form the source of their knowledge? Have they been treated with cryotherapy more than once? Which types of cryotherapy devices are in used? Who applied cryotherapy devices on the injury sustained? How long was cryotherapy applied? How would TFAs describe their feelings during and after treatment with cryotherapy? How would they describe their performance after cryotherapy treatment?" Could it possibly be for the anecdote reason that Ghana authorities are just not doing enough or give minimum attention to motivate TFAs?

The aforementioned issues need to be well addressed based on qualitative perception of the athletes concerned.

Few of the perceptual [22] and cryotherapy [23] related studies in Ghana, not even in Ashanti region, have not previously reveal TFAs perception on the use of cryotherapy in IM. Hence, the needs to elucidate the perception of TFAs to the use of this cost effective IM technique become imperative.

## **2. Materials and Methods**

### **2.1 Participants**

This descriptive cross-sectional design survey is meant to qualitatively describe the perception of TFAs on the use of cryotherapy in IM. The Ashanti regional camp of Ghana for the 11th African Games was initially opened to all TFAs in the region at *Babayara Sports stadium Kumasi* where screening and assessment for fitness were carried out. After the screening and assessment exercises, ninety five [59, 62.1% males and 36, 37.9% females] TFAs who met the final selection list of the coaches purposively served as study participants. The participants included 32 (33.7%) sprinters, 18(18.9%) middle distance runners, 22 (23.2%) long distance runners, 14 (14.7%) throwers and 9 (9.5%) jumpers. Authors had initial visit and verbal discussions with the athletes and their coaches on the importance of the study. Informed consent form was given to the athletes to sign and date of instrument administration was agreed upon after signed consent form retrieved.

### **2.2 Instrument**

Self-structured close ended instrument, “Use of Cryotherapy Perception Questionnaire (UCPEQ)”, was administered. UCPEQ has 9 items, apart from demographic information of age, marital status and length of play, which focused on the perception of TFAs on the broad use of cryotherapy in IM with emphasis on general knowledge on cryotherapy (items 1 and 2), frequency of cryotherapy usage (item 3), type of cryotherapy devices in use (items 4-6), feelings during (item), after cryotherapy administration (item 8) and post therapy sport performance (items 9). Responses to each question items differ based on the nature of anticipated inquiry. UCPEQ items were exposed to factor analysis (Table 1) to identify highly correlated and latent relationship between them. Kaiser-Meyer-Olkin and Bartlett’s Test showed item sampling adequacy = .624, Chi-Square = 102.014, df = 36, p=.000. To further ensure reliability, UCPEQ was subjected to strict parallel reliability test which gave unbiased reliability scale value of 0.76. UCPEQ was administered to TFAs at the *Babayara Sports stadium* in Kumasi, the Ashanti regional capital, after a morning training sessions and independent responses ensured through direct monitoring.

### **2.3 Statistical Analysis**

Qualitative statistical analyses were carried out using IBM SPSS software for windows 20.0 version, USA. Mean, standard deviation, distribution differences in age, marital status, length of play and significance of TFAs perception were analysed using Chi-square test. Score differences among UCPEQ items was analysed using Friedman ANOVA test because response were based on ordinal scale [24] while gender differences was measured using independent t-test reported at 95% level of significance.

**Table 1:** Factor Matrix Analysis on UCPEQ

S/N	Items	Factor			
		1	2	3	4
1	How will you describe your knowledge about cryotherapy?	.562	.091	.228	-.126
2	Which of the following form the source of your knowledge?	-.303	.428	.005	-.033
3	Have you being on cryotherapy more than once?	.393	-.208	.000	.134
4	Which of these form your basis of using cryotherapy?	.708	.014	-.342	-.002
5	Who applied cryotherapy on you when injured?	-.417	-.246	.404	.569
6	How long is cryotherapy applied?	.232	.029	-.122	.026
7	How will you describe your feeling during cryotherapy?	.164	.200	-.038	.278
8	After treatment with cryotherapy how did you feel?	.401	-.097	.037	-.098
9	How will you describe your performance after cryotherapy treatment?	.539	.534	.420	-.034

**3. Results**

Complete 28 (29.5%) were aged 15-19years, 32(33.7%) aged 20 – 24years, 19(20.0%) fell between 25 – 29yrs, 14(14.7%) were aged 30 – 34yrs while 2.1 %( 2/95) were aged 35yrs and above. Although 60(63.2%) of the TFAs were single, 35(36.8%) have experience of below 5yrs, 31(32.6%) between 5 – 9yrs, 12(12.6%) between 10 – 14yrs, 11(11.6%) between 15 – 19yrs, as against only 1(1.1%) with experience of 35yrs and more (Table 2).

**Table 2:** Distributions of the Participants Demographic Data

Variables	Categorizations	Freq. (%)	Chi-Square	P-value
<b>Age</b>	15yrs-19yrs	28(29.5)	29.684	.000*
	20yrs-24yrs	32(33.7)		
	25yrs-29yrs	19(20.0)		
	30yrs-34yrs	14(14.7)		
	35yrs+	2(2.1)		
<b>Marital Status</b>	Single	60(63.2)	53.200	.000*
	Married	33 (34.7)		
	Divorced	2 (2.1)		
<b>Length of Play</b>	Below 5yrs	35(36.8)	86.632	.000*
	5yrs-9yrs	31(32.6)		
	10yrs-14yrs	12(12.6)		
	15yrs-19yrs	11(11.6)		
	20yrs-24yrs	3(3.2)		
	25yrs-29yrs	2 (2.1)		
	35yrs+	1 (1.1)		

\*Significant at 0.05

There was significance differences in age ( $X^2 = 29.684$ ,  $p = .000$ ), marital status ( $X^2 = 53.200$ ,  $p = .000$ ) and length of play ( $X^2 = 86.632$ ,  $p = .000$ ) distributions (Table 2).

**Table 3:** Chi-Square analysis on TFAs Perception on the use of Cryotherapy in IM

S/N	Categorization	Freq. (%)	X <sup>2</sup>	P-value
1.	Poor	2(2.1)	43.263 (df=4)	.000*
	Weak	7(7.4)		
	Average	26(27.4)		
	Good	37(38.9)		
	Excellent	23(24.2)		
2.	Ice water immersion	7(7.4)	72.779 (df=6)	.000*
	Refreezable chemical gel packs	26(27.4)		
	Ice massage	35(36.8)		
	Aerosol sprays	5(5.3)		
	Crushed ice in a plastic bag	17(17.9)		
	Salicylic acid	2(2.1)		
3.	Not sure	3(3.2)	0.263 (df=1)	.608
	Yes	50(52.6)		
4.	No	45(47.4)	49.663 (df=2)	.000*
	Active swelling	38(40.0)		
5.	Inflammatory reaction	56(58.9)	42.211(df=4)	.000*
	Continuous bleeding	1(1.1)		
6.	Coach	23(24.2)	164.326(df=3)	.000*
	Athletic trainer	42(44.2)		
	Team doctor	11(11.6)		
	Physiotherapist	7(7.4)		
	Friends	12(12.6)		
7.	Below 10days	77(81.1)	118.916(df=5)	.000*
	11-20days	15(15.8)		
	21-30days	2(2.1)		
	31days+	1(1.1)		
	Painful	32(33.7)		
	Chilly	48(50.5)		
8.	Burning sensation	5(5.3)	59.474 (df=4)	.000*
	Blistering	3(3.2)		
	Scarring	3(3.2)		
	Others	4(4.2)		
	Very unhappy	3(3.2)		
9.	Unhappy	2(2.1)	37.000(df=3)	.000*
	Indifferent	19(20.0)		
	Happy	40(42.1)		
	Very happy	31(32.6)		
	Poor	3(3.2)		
	Average	17(17.9)		
	Good	41(43.2)		
	Excellent	34(35.8)		

\*Significant at 0.05

**Table 4:** Friedman ANOVA Test on TFAs Perception on the use of Cryotherapy in IM

Sources	Sum of Squares	df	Mean Square	Friedman's Chi-Square	P-value
<b>Between Subject</b>	101.467	94	1.079	404.192	.000*
<b>Within Subject</b>	788.884 <sup>a</sup>	8	98.611		
<b>Residual</b>	694.449	752	.923		
<b>Total</b>	1483.333	760	1.952		
	1584.800	854	1.856		

\*Significant at 0.05

Score differences on TFAs Perception of the use of Cryotherapy in IM were statistically significant [F = 788.884, X<sup>2</sup> = 404.192, df= 94, p = .000] (Table 4).

Perceptions of TFAs on the use of cryotherapy in IM were statistically significant (p = .000) as shown in Table 3.

**Table 5:** Gender comparison on TFAs Perception on the use of Cryotherapy in IM

Question items' S/N	Gender	Mean ±SD	Std. Error Mean	t-value	P	95%CI
1.	Male	3.56±1.02	.133	-2.618	.010*	-.921, -.148
	Female	4.08±.81	.134			
2.	Male	3.32±1.49	.194	1.260	.211	-.218, .973
	Female	2.94±1.29	.214			
3.	Male	1.50±.50	.066	.864	.390	-.119, .303
	Female	1.41±.50	.083			
4.	Male	1.64±.52	.067	.817	.416	-.127, .304
	Female	1.56±.50	.084			
5.	Male	2.49±1.37	.178	.889	.376	-.298, .781
	Female	2.25±1.13	.188			
6.	Male	1.17±.46	.059	-1.457	.149	-.387, .059
	Female	1.33±.63	.105			
7.	Male	2.12±1.42	.184	.781	.437	-.311, .715
	Female	1.92±.81	.134			
8.	Male	3.95±.97	.127	-.527	.599	-.507, .294
	Female	4.06±.92	.154			
9.	Male	3.01±.78	.102	-.737	.463	-.468, .215
	Female	3.19±.86	.143			

\*Significant at 0.05

#### 4. Discussion

This study documents the perception of track and field athletes (TFAs) in Ashanti region of Ghana on the use of cryotherapy in injury management (IM). All the TFAs had experienced using cryotherapy at least once (Table 3). This endorses the popularity, widely acceptance and utilization of cryotherapy in injury management as earlier established [4, 8]. Based on average level of cognizance and above, 80.5% (86) of the study sample are knowledgeable of the use of cryotherapy in IM. This percentage indicates good awareness level which support previous findings on cryotherapy as a common treatment modality for post-acute soft tissue injury [6-8, 25]. Realising the values of a given medication (cryotherapy) would create a level of leverage for effective professional practices.

Although ice water immersion maybe unpopular, our results show that 7.4% (7) of the TFAs had personal experienced with its application. Personal experience with circumstances is one of the best scientific strategies to imbibe culture of usage in human endeavours. 58.9% (56) of the population sample acceded to inflammatory reaction as their cryotherapy utilisation indicator. Chronic inflammatory reactions are common injury conditions adjudged to be detrimental to athletic performance at any level of competition. Its prominent in this study is in

agreement with Pournot and his colleagues [26] and Ramos and his colleagues [27] reports that strenuous exercises encourages upsurge in the pro-inflammatory cytokines Tumor Necrosis Factor alpha (TNF- $\alpha$ ) and interleukin 1 Beta (IL-1 $\beta$ ) and a dramatic increase in the inflammation responsive cytokine interleukin 6 (IL-6).

Quantitative analysis of the responses in this study sample reveals that Athletic Trainers (42, 44.2%) and Coaches (23, 24.2%) top the list of professionals administering cryotherapy respectively ahead of team doctor and physiotherapist. This could reflect the issue surrounding availability or accessibility of few experts (medics) in Ghana. This calls for concerns about the effectiveness of treatment that will not be counterproductive. Although there are few experts, our results reveal that 77(81.1%) and 15(15.8%) of the TFAs admitted cryotherapy treatment on their injuries lasted for less than 10days and 11-20days respectively which concord with previous studies [21, 26-30] that frequent cryotherapy treatment each day over 5 days lessen IL-2, IL-8, CK, prostaglandin E2 (PGE2) activity, and display augmented condensation of anti-inflammatory cytokines (IL-10) in peripheral blood.

Relating to the issues of disposition after cryotherapy treatment, 40(17.9%) of the study sample were happy and 31(32.7%) very happy which indicate that 74.7% satisfaction were achieved. Also 96.9% of the TFAs describe their performances after cryotherapy treatment as average (17, 17.9%), good (41, 43.2%) and excellent (34, 35.8%). The TFAs in this study perceived cryotherapy as effective in the treatment of painful and chilly symptoms in sustained injury (Table 4). This affirmed the results of previous research works [8, 15, 31-32]. These perceptions are however not influenced by gender (Table 5). This runs contrary to the study of Gregório and his colleagues [29] where gender was noticed as a factor which influences sensitivity to recovery with cryotherapy but supports Lins and his colleagues [33] where significance difference was not observed among male and female in the study of the influence of cryotherapy on balance and joint position sense in healthy individuals.

## **5. Conclusion**

TFAs in this study perceived the use of cryotherapy as substantial for injury management. To this end, we advocate for attachment of Physical Therapists to the TFAs training sessions in Ashanti region, provision of enabling environment and equipment to enhance effective IM processes through cryotherapy as strategic approaches.

## **References**

- [1] K. L. Knight, *Cryotherapy in Sport Injury Management*. Champaign, IL: Human Kinetics, 1995, p.67-78
- [2] B.L. Atnip and J.L. McCrory. "The effect of cryotherapy on three dimensional ankle kinematics during a sidestep cutting maneuver". *J Sports Sci Med.*, vol. 3(2); pp. 83-90. eCollection Jun 1; 2004.
- [3] AA. Algaflly and K.P. George. "The Effect of cryotherapy on nerve conduction velocity, pain threshold and pain tolerance". *Br. J. Sports Med.*, vol. 41, pp. 365–369. doi: 10.1136/bjism.2006.031237, 2007.

- [4] M. Rossato, E. de Souza Bezerra, D.A. de Ceselles Seixas da Silva, T. Avila Santana, W. R. Malezam, F.P. Carpes, “Effects of cryotherapy on muscle damage markers and perception of delayed onset muscle soreness after downhill running: A pilot study” *Revista Andaluza de Medicina del Deporte*, vol. 8 (2), pp. 49-53, June, 2015
- [5] C. Swenson, L. Swärd, and J. Karlsson. “Cryotherapy in sports medicine”. *Scandinavian Journal of Medicine and Science in Sports*, vol 6, (4), pp.193–200, 1996.
- [6] J. Kennet, N. Hardaker, S. Hobbs and J. Selfe, “Cooling efficiency of 4 common Cryotherapeutic agents”. *Journal of Athletic Training*, vol.42(3). Pp.343–348, 2007.
- [7] J.H. Dykstra, H.M. Hill, M.G. Miller, C.C. Cheatham, T.J. Michael, and R.J. Baker, “Comparisons of cubed ice, crushed ice, and wetted ice on intramuscular and surface temperature changes”. *Journal of Athletic Training*, vol.44 (2), pp. 136–141, 2009.
- [8] A.V. Galder, and E.J. Gann, (2015). “Examining the effects of cryotherapy on the rate of perceived exertion” in *Proc. International Journal of Exercise Science*, 12: Iss. 1, Article 25). Available: <http://digitalcommons.wku.edu/ijesab/vol12/iss1/25> [date assessed: 25/02/2016]
- [9] P.C. LaStayo, J.M. Woolf, M.D. Lewek, L. Snyder-Mackler, T. Reich, and S.L. Lindstedt.. “Eccentric muscle contractions: their contribution to injury, prevention, rehabilitation, and sport”. *J Orthop Sports Phys Ther.* vol.33, pp.557-571, 2003
- [10] D.D. Arnheim and W.E. Prentice. *Principles of Athletic Training.* (9th ed.). St. Louis, MO: McGraw-Hill Companies, Inc. 1997. pp: 233-240
- [11] G.W. Bell and W.E. Prentice, *Infrared Modalities (Therapeutic heat and Cold).* In W.E. Prentice, (Ed.), *Therapeutic Modalities in Sports Medicine.* (4th Ed), Boston: WCB McGraw-Hill, 1999, pp. 173-206
- [12] D. Saini, “Cryotherapy-an inevitable part of sports medicine and its benefits for sport injury”. *IJAR.* Vol.1(4), pp. 324-327, 2015.
- [13] M.P. Furmanek, K. Słomka, and G. Juras, “The effects of cryotherapy on proprioception system”. *BioMed Research International*, (Vol. 2014, Article ID: 696397): 14 pages, 2014. doi:10.1155/2014/696397
- [14] O. Babatunde, A. Owoeye, A.K. Akodu, and B.M. Oladokun, “Incidence and pattern of injuries among adolescent basketball players in Nigeria”. *Sports Med Arthrosc Rehabil Ther. Technol.*, vol.4(1), pp.1-11, 2012.
- [15] A. Murray, and M. Cardinale, “Cold applications for recovery in adolescent athletes: a systematic review and meta-analysis”. *Extreme Physiology and Medicine*, vol 4, pp.17, 2015. DOI:

10.1186/s13728-015-0035-8

- [16] M.J. Quod, D.T. Martin and P.B. Laursen, "Cooling athletes before competition in the heat: comparison of techniques and practical considerations". *Sports Medicine*, vol. 36(8), pp.671–682, 2006.
- [17] A. Jonak and A. Skrzek, "Cryotherapy in athletes' biological regeneration: Review". *Acta Bio-Optica et Informatica Medica*, vol.15, pp.319 –321, 2009.
- [18] G. Banfi, G. Lombardi, A. Colombini, and G. Melegati, "Whole-body cryotherapy in athletes". *Sports Medicine*, vol. 40 (6), pp.509 –517, 2010.
- [19] T.J. Hubbard, S.L. Aronson, and C. R. Denegar, "Does cryotherapy hasten return to participation? A Systematic Review". *J Athl Train.*, vol. 39(1), pp.88–94, 2004.
- [20] J.C. Tee, A.N. Bosch, and M.I. Lambert, "Metabolic consequences of exercise-induced muscle damage". *Sports Med.* vol.37, pp,827–836, 2007.
- [21] C.M. Bleakley, F. Bieuzen, G.W. Davison, and J.T. Costello, "Whole-body cryotherapy: empirical evidence and theoretical perspectives". *Open Access Journal of Sports Medicine*, vol.5, pp.25–36, 2014. Available: <http://doi.org/10.2147/OAJSM.S41655> [date assessed: 16/4/2016]
- [22] P.K. Ofori, S. Biddle, and D. Lavallee, "The role of superstition among professional footballers in Ghana". *Athletic Insight: The Online Journal of Sports Psychology*, vol.14(2), 2012. Available: <http://www.athleticinsight.com/Vol14Iss2/Feature.htm> [date assessed: 17/3/2016]
- [23] F. Osei, M.O. Moses, and A. K. Boateng, "Clinical and traditional rehabilitation approaches on injured football athletes in Ashanti region". *Italian Journal of Sports Rehabilitation and Posturology*, vol. 2(2), pp.242 -253, 2015.
- [24] W. Hager, "Some common features and some differences between the parametric anova for repeated measures and the Friedman ANOVA for rank data". *Psychology Science*, vol. 49(3), pp.209-222, 2007.
- [25] DW. Rivenburg, "Physical modalities in the treatment of tendon injuries". *Clin. Sports Med.* vol.11, pp.645-659, 1992.
- [26] J.W. Myrer, G. Measom, and G.W. Fellingham, "Temperature changes in the human leg during and after two methods of cryotherapy". *J Athl Train.*, vol. 33(1), pp.25–29, 1998.
- [27] H. Pournot, F. Bieuzen, J. Louis, J.R. Fillard, E. Barbiche, and C. Hausswirth, "Time-course of changes in inflammatory response after whole-body cryotherapy multi exposures following severe exercise". *PLoS ONE*, vol.6(7), 2011. e22748. Available: <http://doi.org/10.1371/journal.pone.0022748> [date assessed: 14/6/2016]

- [28] G.V. Ramos, C.M. Pinheiro, S.P. Messa, G.B. Delfino, R. de Cássia Marqueti, T. de Fátima Salvini, and J.L.Q. Durigan, “Cryotherapy reduces inflammatory response without altering muscle regeneration process and extracellular matrix remodeling of rat muscle”. *Scientific Reports* 6, Article number: 18525. 2016. doi:10.1038/srep18525
- [29] E. Hohenauer, J. Taeymans, J.P. Baeyens, P. Clarys, and R. Clijssen, “The effect of post-exercise cryotherapy on recovery characteristics: a systematic review and meta-analysis”. *PLoS ONE* 10(9): 2015. e0139028. doi:10.1371/journal.pone.0139028
- [30] O.A. Gregório, R. Cavalheiro, R. Tirelli, A.R. Fréz, M.B. Ruaro, and J.A. Ruaro, “Influence of cryotherapy application time on skin sensitivity”. *Rev.dor.* Vol. 15 (1), 2014. Available: <http://dx.doi.org/10.5935/1806-0013.20140003> [date assessed: 17/6/2016]
- [31] W. Poppendieck, O. Faude, M. Wegmann, and T. Meyer, “Cooling and performance recovery of trained athletes: a meta-analytical review”. *International Journal of Sports Physiology and Performance*, vol. 8(3), pp. 227–242, 2013.
- [32] M.L.P. Domingues, “Cryotherapy and its correlates to functional performance: A brief preview”. *Sport Science Review*, v ol.XXII (3-4),pp. 229 – 254, 2013. doi: 10.2478/ssr-2013-0012
- [33] C.A.A. Lins, L. deB. Macedo, R.A.G. Silveira, D.T. Borges, and J. S. Brasileiro, “Influence of cryotherapy on balance and joint position sense in healthy subjects: randomized clinical trial”. *MTP and Rehab. Journal*, 13: 013, 2015. doi:10.17784/mtprehabjournal.2015.13.276