Effect of Hot and Cold Applications on Jump Performance

Sıcak ve Soğuk Uygulamaların Sıçrama Performansına Etkisi

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ABSTRACT Objective: In many sports activities cold is application used when acute trauma occurs and hot application is mostly used in rehabilitation process. Jumping is one of the most used movement type in sports. Purpose of this study was to investigate the effects of cold and hot application on Countermovement Jump (CMJ), Drop Jump (DJ) and 15seconds CMJ performance. **Material and Methods:** Thirty women, 98 men, total 128 healthy volunteers participated in the study (20.9±1.9 yrs; 173.8±9.3 cm; 69.4±12.1 kg; 15.2±4.7 %fat). All volunteers were students at Physical Education and Sports College of Celal Bayar University. Firstly, volunteers performed CMJ, DJ and 15s CMJ after warm-up. Then, same tests were repeated in same order after 15 minutes cold and hot application. Cold and hot applications were randomized in order to repeat the process within 24 to 72 hours interval. **Results:** CMJ performances were decreased significantly after cold application ($F_{1.127}$=6.96, p=0.001, n^2=0.10) even though other jumping performances were not affected. Between normal test and the hot application measurements no significant difference was found. Statistical analysis: "General Linear Model-Repeated Measures" and "Paired Samples T-Test" methods were used. **Conclusion:** Our results confirmed that cold application may decrease CMJ performance. Coaches must be careful when useing the cold applications during activities. Hot applications did not produce any effect on jumping performances. More research is required to investigate jumping performance associated with the heat and cold applications.

Key Words: Vertical jump; jump performance; hot application; cold application; sports

ÖZET Amaç: Birçok spor aktivitesinde akut travma sonrası soğuk uygulama yapılmaktadır, sıcak uygulama ise rehabilitasyon sürecinde kullanılmaktadır. Sıçrama (Jump) hareketi, spor aktiviteleri sırasında en sık kullanılan hareketlerden biridir. Bu çalışmanın amacı sıcak ve soğuk uygulamanın Countermovement Jump (CMJ), Drop Jump (DJ) ve 15 sn CMJ performansı üzerine etkilerini araştırmaktır. **Gereç ve Yöntemler:** Çalışmaya 128 (98 erkek, 30 kadın) sağlıklı denek [yaş(yıl): 20,9±1,9; boy (cm): 173,8±9,3; vücut ağırlığı (kg): 69.4±12,1; vücut yağ oranı (%): 15,2±4,7] katıldı. Tüm denekler, Celal Bayar Üniversitesi Beden Eğitimi ve Spor Yüksekokulu öğrencisiydi. Önce deneklerin ısınma sonrası CMJ, DJ ve 15sn CMJ testleri yapıldı. Ardından aynı testler ısınma ile test arasında 15 dk sıcak uygulaması ve soğuk uygulaması yapılarak tekrar edildi. Testler 24-72 saat aralıklarla ve karışık sırayla yapıldı. İstatistiksel analiz için "General Linear Model-Repeated Measures" and "Paired Samples T-Test" yöntemleri kullanıldı. **Bulgular:** Soğuk uygulamadan sonra CMJ performansları anlamlı biçimde azaldı ($F_{1.127}$= 6,96, p=0,001, n^2=0,10). Buna karşın diğer sıçrama performansları etkilenmedi. Normal ve sıcak uygulama sonrası ölçümler arasında bir fark bulunmadı. **Sonuç:** Sonuçlar soğuk uygulamanın CMJ performansını azaltabileceğini doğruladı. Sakatlık sonrası spora dönüşte ve müsabaka esnasında ağrı ve şişkinliği önleme amacıyla kullanılmasının yanı sıra sıçrama performansını düşürücü bir etkisinin olabileceği de unutulmamalıdır. Sıcak uygulamanın tedavi ve terapi amacından farklı olarak antrenmanlarda ve yarışmalarda gerekirse performans geliştirme amaçlı kullanılmasının bir anlamı yoktur. Sıcak ve soğuk uygulamanın sıçrama performansı üzerine etkisi ile ilgili daha çok çalışma yapılmalıdır.

Anahtar Kelimeler: Dikey sıçrama; sıçrama performansı; sıcak uygulama; soğuk uygulama; spor

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Anaerobic power, used in short term highly forceful exercises, is a conditional property associated with ATP-CP energy system. There are several tests to determine anaerobic power performance. Nonetheless; standing vertical jumping, standing broad jumping, Margaria-Kalaman and Wingate tests are most-widely used. Jumping performance is among the best indicators of anaerobic power. It's one of the most important factor that affects activity performance and sport activity efficiency in many sports branch.

In short term highly forceful activities like sprint and jumping, most important fatigue reasons are foremost neuromuscular fatigue then inorganic phosphate concentration, ATP/ADP ratio, CP regeneration and psychological fatigue.[1,2] These can be affected positively or negatively by temperature changes.[3-5]

Hot applications are usually used at post-activity recovery and post-disability rehabilitation. Heat has significant effects on nervous tissue. Superficial heating increases sympathetic nervous transmission rate.[6,7] Stimulation proportions of golgi tendon organs increase with temperature.[8,9] For the purpose of hot application there are hot packs, hot water pack, hot compresses, hot water (fixed), parafin, solid materials, fluidoteraphy, hot water (mobile) and moist air applications for superficial heating; and radiotherapy , microwave, short wave and ultrasound applications for deep heating.[10]

Cold applications are used during activities and post-activity in case of disability or injury to decrease pain and edema. Cold application decreases production of acetylcholine which provides nervous transmission in tissues, slows stimulation of muscle fiber afferents and reflex responses, consequently nervous transmission rate slows down.[11,12] Silicone gel packs, cold compresses, cold packs and special sprays can be used for the purpose of cold application.

In many competitions cold spray and cold application in bench area are applied to the player after minor and medium injuries. Then if the player is proper or in case of necessity, he continues the competition. Although it's known that applied cold decreases pain and edema, it's effect on performance was not studied enough. In these conditions studying of effect of hot or cold application on performance is going to contribute to behavior of players and trainers in more conscious manner in this issue.

The aim of this study is to determine positive or negative effects of hot and cold applications that are applied before or during training on jumping performance on normal persons.

MATERIAL AND METHODS

With this study the impact of hot and cold application on the performance of Countermovement Jump (CMJ), Drop Jump (DJ) and 15 seconds Countermovement Jump (15s CMJ) has been analyzed.

The activity level of the participants has been evaluated according to Tegner Activity Scale (TAS), developed by Tegner and Lysholm (1985), which is used for the evaluation of the patients' activity level.[13,14] Those whose activity levels are between 5 and 8, TAS, have been included in the study (Table 1).

Totally 128 people joined the study, 98 male and 30 female who are the students of Celal Bayar University (CBU) Physical Education and Sports Academy (BESYO) with no joint or muscle disease (Table 2). Informed consent was taken from all participants and local ethical committee permission was taken for this study.

The more developed version of Bosco ergojump, Newtest Powertimer 300 series testing system has been used at this study.[15] For DJ testing 40 cm long boxes for men and 70 cm long boxes for women have been used.[16]

The body weights and body fat ratios (BFR) of the participants have been measured by using Tanita TBF 300 Body Composition Analyzer (Fat ratio 0.1% increments). HLT-100 Holtain Antropometrik Set has been used for length measurements.

Tests have been conducted at Celal Bayar University's Physical Education Academy performance room. Humidity and temperature have been ad-

TABLE 1: Tegner and Lysholm activity scale.

Level 10	Competitive sports- soccer, football, rugby (national elite)
Level 9	Competitive sports- soccer, football, rugby (lower divisions), ice hockey, wrestling, gymnastics, basketball
Level 8	Competitive sports- racquetball or bandy, squash or badminton, track and field athletics (jumping, etc.), down-hill skiing
Level 7	Competitive sports- tennis, running, motorcars speedway, handball Recreational sports- soccer, football, rugby, bandy, ice hockey, basketball, squash, racquetball, running
Level 6	Recreational sports- tennis and badminton, handball, racquetball, down-hill skiing, jogging at least 5 times per week
Level 5	Work- heavy labor (construction, etc.) Competitive sports- cycling, cross-country skiing, Recreational sports- jogging on uneven ground at least twice weekly
Level 4	Work- moderately heavy labor (e.g. truck driving, etc.)
Level 3	Work- light labor (nursing, etc.)
Level 2	Work- light labor Walking on uneven ground possible, but impossible to back pack or hike
Level 1	Work- sedentary (secretarial, etc.)
Level 0	Sick leave or disability pension because of knee problems

justed accordingly with laboratory thermometer and air conditioner.

Participants have been tested in the same hour of the day in laboratory conditions, around 24-25 degrees Celsius and with 50-60% humidity. Participants used short shorts, T-shirts and socks which do not increase their body temperatures and sweat and enable their joints to be seen. Also they used sport shoes which do not affect their jumping ability.

Participants have been informed about the structure, objective and the method of the study and they attended willingly without and pressure.

They were asked not no change their routine diet habits and not to take alcohol 24 hours before the test. They were also asked not to get drinks with caffeine, not to take any medicine and they were requested to sleep well the day before the test, then they were informed to take enough water, at least 500 mL, 2 hours before the test.[17,18] It was made sure that the participants did not do any kind of exhausting exercise 24-48 hours before the test.[19]

All of the hot and cold applications were made with hot packs, which are produced for treatment purposes and which can remain in the water for long hours because of its gel ingredients. Packs were kept in a compartment where water temperature was 45±0.1°C (Figure 1a, Figure 1b).

Packs were put into cases after they were taken from hot water to avoid skin burns. On every leg Quadriceps, Hamstring and Gastrocnemius muscles were covered with one pack and these three major muscles were covered with 6 packs on two legs (Figure 2a, 2b, 2c). Hot application was applied for 15 minutes. Temperature of the applied packs was calculated 15 minutes before and after the application with a thermometer. Thermometer was placed between skin and the pack. Therefore the temperature before the 15 minute application was 45°C and it was 40°C after the 15 minute application. After a participant was tested packs were placed into the heater again and they were kept there at least for 45 minutes. Therefore packs regained their desired temperature before they were used for other participants.

TABLE 2: Physical characteristics and activity levels of participants.

		Age (year)		Height (cm)		Body Weight (kg)		Fat Ratio %		Activity Level*	
	n	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Male	98	20.9	1.9	177.2	7.6	73.7	10.1	13.8	3.6	5.8	1.1
Female	30	21.0	1.9	162.8	4.8	55.4	5.8	19.5	5.4	5.3	1.4
General	128	20.9	1.9	173.8	9.3	69.4	12.1	15.2	4.7	5.7	1.2

* According to Tegner Activity Level Scale.

FIGURE 1a: Standart pack heating system.

FIGURE 1b: Pack and the resistance for heat.

Before cold application, the packs were kept in the freezer between 0-4°C. Packs were put into cases to prevent skin burn and then 15 minute cold application was performed. After 15 minutes temperature increased to 10°C. Right after jumping tests were performed.

At the tests, normal test applications were made randomly not in a row like first hot then cold. It was made sure that participants had clothes enabling them not to lose their body temperature and preventing them to get cold during hot-cold application and during warming and test intervals.

Test in the study was conducted in three different ways, on three different days within 24 to 72 hour interval. Same warming procedures such as slow running, medium impact but not exhaust-

FIGURE 2: 2a: Applied packs before jump, left side. **2b:** Applied packs before jump, right side. **2c:** Applied packs before jump, front side.

ing jumping exercises and dynamic stretching exercises were conducted before all tests.[20-24] Static stretching was avoided not to affect jumping performances.[25,26] After warming for the first test CMJ, DJ and 15s CMJ tests were applied. For each test at least 2 and at most 3 testing attempts were granted and the best score of these attempts were recorded. Same tests were repeated after application of hot pack to the participant for 15 minutes after the second test. On the third test same test was conducted. Then after 15 minute cold pack application was performed between warming and the test.

To be able to calculate jumping height on Newtest system, the amount of time the participant remains on air is calculated as the time between when the feet leave the electronic mat and retouch it.[27,28] Therefore the effect of plantar flexion on jumping height is eliminated. The test protocol is immune to mistakes as jumping platform does not show the primary parameters such as the applied strength because of the difficulty of controlling a lot of muscle and joint groups that are affecting jumping performance.[15] Participants were enabled to exert maximum performance with the same joint angle, hands on their waist using only leg power. During the tests using the arms were not allowed in order to prevent arm strength disparity between genders on their jumping performance.[29,30] Those whose jumping techniques and motivations distracted were not evaluated.

Data were collected on Microsoft Office XP Excel program and statistical evaluations were made by using SPSS 11.0 (2001 SPSS inc.). Acquired test data showed enough normal range. For the result of the tests which were repeated after different temperature applications and for the differences between comparisons "General Linear Model-Repeated Measures" and "Paired Samples T-Test" methods were used.

Significance level was adjusted as $p \leq 0.05$.

RESULTS

To obtained average jumping heights according to gender and all participants detailed (Table 3).

A significant difference was obtained in repeated CMJ tests with hot and cold applications. ($F_{1.127}$=6.96, p=0.001, n^2=0.10) (Table 4).

CMJ performance, after either hot or cold applications, was low according to the normal CMJ test, bonferon correction was carried out to the p value for this difference (0.05/3=0.017); refering to this, difference after cold application was statistically high and significant ($p<0.01$) (Table 5).

A significant difference was not obtained in repeated DJ tests with hot and cold applications. ($F_{1.127}$=1.81, p=0.168, n^2=0.03) (Table 6).

A significant difference was not obtained between normal DJ test and both of post-hot DJ test and cold-post DJ test (Table 7).

A significant difference was not obtained in repeated 15 seconds CMJ tests with hot and cold applications ($F_{1.127}$=1.15, p=0.319, n^2=0.02) (Table 8).

A significant difference was not obtained between normal 15 seconds CMJ test and both of

TABLE 3: Measured jump heights in all jump tests.

	Normal		After Hot		After Cold	
	Gender	All	Gender	All	Gender	All
CMJ	M 38.11±4.16	35.92±5.88	M 37.74±4.37	35.46±6.01	M 37.24±4.66	35.03±6.15
	F 28.77±4.92		F 28.03±4.44		F 27.83±4.81	
DJ	M 37.63±4.51	35.31±6.25	M 37.63±4.69	35.26±6.39	M 37.29±4.63	34.93±6.33
	F 27.73±5.05		F 27.50±4.89		F 27.23±4.87	
15sn CMJ	M 30.92±3.97	29.22±5.36	M 30.75±4.51	28.86±5.66	M 30.52±4.11	28.71±5.25
	F 23.67±5.62		F 22.70±4.61		F 22.80±4.14	

M: Male, F: Female; CMJ: Countermovement jump; DJ: Drop jump.

TABLE 4: Repeated CMJ results after hot and cold applications.

Jump Style	$\bar{X}$	SD	n	F	P	PES*
Normal CMJ	35,92	5,88	128	6.96	0.001*	0.10
CMJ after hot	35,46	6,01				
CMJ after cold	35,03	6,15				

PES: PartialEtaSquared (n^2); CMJ: Countermovement jump.

TABLE 5: CMJ comparison with normal, after hot and after cold applications.

t-test	t	p
Normal CMJ-After Hot CMJ	2.143	0.034
Normal CMJ-After Cold CMJ	3.664	0.001*

*p<0,017; CMJ: Countermovement jump.

TABLE 6: Repeated DJ results after hot and cold applications.

Jump Style	$\bar{X}$	SD	n	F	P	PES
Normal DJ	35,31	6,25	128	1.81	0.168	0.03
After Hot DJ	35,26	6,39				
After Cold DJ	34,93	6,33				

DJ: Drop jump.

post-hot 15 seconds CMJ test and cold-post 15 seconds CMJ test (Table 9).

DISCUSSUON

Totally 128 people whose activity levels are between 5 and 8 (TAS) joined the study, 98 male and 30 female who are the students of CBU BESYO with no joint or muscle disease. The physical characteristics and activity level of the participants show normal distribution. When BFR evaluated for either whole group or gender, they are not different enough to change the effect of heating application significantly.[31]

Newtest Powertimer 300 series testing system has been used for jumping evaluation at this study. This system was used in many studies associated with jumping evaluation previously and it's a system of which reliability and repeatability is accepted in scientific denotation.[15,32,33] Also validity and reliability of CMJ test performed with jumping platform was shown.[32]

There are significant differences between female and male in terms of jumping heights for all kinds of jumping types ($p<0.001$). Female's CMJ performances are as 75,5% of those of male, DJ performances are as 73,7% of those of male, and 15 seconds CMJ performances are as 76,5% of those of male. These differences are because of differences of strength and testosterone levels between male and female and it accepted normal.[34]

CMJ values of total 128 participants were obtained as 35.92±5.88 cm fort he first test. CMJ height average of 98 male in group [age 20.9±1.9 (year), body weight (BW) 73.7±10.1 (kg), height 177.2±7.6 (cm), BFR 13.8±3.6 (%)] is obtained as 38.1±4.6. Aytac et al., obtained CMJ average height values as 39.5±4.6 (cm) with Bosco jumping tests in their study in which 16 male sport academy students [age: 24.1±0.8 (year), BW 69.1±7.5 (kg), height 175.0±5.2 (cm)] participated.[35] McBride et al. obtained CMJ average height values as

TABLE 7: DJ comparison with normal, after hot and after cold applications.

Comparison	t	p
Normal DJ-After Hot DJ	0.219	0.827
Normal DJ-After Cold DJ	1.484	0.140

DJ: Drop jump.

TABLE 8: Repeated 15th second CMJ results after hot and cold applications.

Jump Style	$\bar{X}$	SD	n	F	P	PES
Normal 15 sn CMJ	29,22	5,36	128	1.15	0.319	0.02
After Hot 15 sn CMJ	28,86	5,66				
After Cold 15 sn CMJ	28,71	5,25				

CMJ: Countermovement jump.

TABLE 9: 15th second CMJ comparison with normal, after hot and after cold applications.

Comparison	t	p
Normal 15sn CMJ-After Hot 15sn CMJ	1.050	0.296
Normal 15sn CMJ-After Cold 15sn CMJ	1.523	0.130

CMJ: Countermovement jump.

0.40±0.06m with power platform in their study (2008) in which 16 League I basketball and volleyball players (8 male, 8 female; height 180±7cm, BW 80±7 kg, BFR %15±4) participated.[36] Cardinale and Stone (2006), obtained CMJ average height values as 42.7±3.7 cm for 15 male elite level football players whose physical characteristics are similar, and reported as 40.8±3.2 cm for 18 male handball players.[34] Evaluated CMJ results in this study are normal values.

To have significant effects in hot and cold water therapy applications, it has shown in previous studies.[37-40] That hot water application must be performed between 37°C-43°C and cold water application must be performed between 12°C-15°C. Lehmann et al., affirmed that muscle temperature must reach at least 40°C to create physiological effect.[41] In this study after 15 minutes heating application, cold packs were at 10°C, hot packs were at 40°C.

In applications for the purpose of treatment, adequate hot application duration is determined between 20-30 min.[42] Enwemeka et al., found out that superficial tissue temperature decreases significantly up to reduce pain sensation and to benumb with 20min cold pack application.[43] Yanagisawa et al., showed that 30 min cold application decreases skin temperature and temperature between muscles 8 mm-18 mm under skin significantly.[44] In study of Myrer et al., significant differences did not occur in muscle temperature at 1 cm under the skin of the leg that was waited in 40°C hot water for 4 min and in 15.6°C cold water for 1 min.[45] They tried 5 min application with cold-hot pack for better effect in following studies and confirmed it's not enough for internal muscle temperature change that will create physiological change as occurred in their previous studies. Similar results were also reported in other studies.[42,46] In this study hot and cold were applied for 15 minutes to get significant temperature change in muscles and also to not to let effects of active warming get lost during between warming and the test.

In this study on 128 participants it was obtained that cold application decreases CMJ performance significantly ($p<0.01$), and does not have any change on DJ and 15 s CMJ performances.

Bergh and Ekblom (1979), make a research on muscle force, power production, jumping and sprint performance for muscle temperature interval 30-39°C on 4 male participant.[47] From one of the participant they recorded EMG data for M. vastus lateralis, M. biceps femoris, and M. semitendinosus. They obtained a positive correlation with a magnitude of 2%-4/°C between muscle temperature increase and maximal dynamic force, power production, jumping and sprint performance. They indicated that isometric muscle force decreases 2%/°C by decreasing muscle temperature and power-speed relation shifts to the left by subnormal muscle temperature. As a result they reported that performance in jumping and in short-term exercises like sprint is going to decrease by lower muscle temperature, then it is going to increase if muscle temperature is above normal because of change in maximal dynamic force. Our study results can be different because of performing local application at higher or lower temperatures. Furthermore, application was held hands-on-waist to isolate heat applied area and to control differences of arm-pulling technique that affect jumping performance.

Sargeant (1987), applied 20 seconds maximal sprint effort on 4 participants with isokinetic bicycle ergometer at room temperature and at 3 different temperature after water baths.[48] In these 45 minutes each heating applications, water temperature and obtained muscle temperatures under 3 cm of skin were like in order: At room temperature: 36.6°C; after 12°C cold water bath: 29.0°C; after 18°C cold water bath: 31.9°C and after 44°C hot water bath: 39.3°C. After hot water bath approximately 11% increasing, after 12°C cold water bath 12% decreasing and after 18°C cold water bath %21 decreasing were obtained in maximal peak force of the legs. And also treadle rotation rate was evaluated for 2 participants. It's reported that heating increases treadle rotation rate with a magnitude of 2% to 10. In our study, instead of 45 minutes passive warming by water temperature, 30 minutes active warming and 15 minutes local hot or cold application were held to the leg muscles. In cold

application, while performance decrease is obtained only in CMJ test, no difference obtained in other tests. Also hot application did not make any performance increasing in tests.

In study of Gray et al. (2006), 6 seconds maximal sprint exercise was held on 8 participants with bicycle ergometer at normal (34.2°C) and elevated (37.5°C) muscle temperatures.[49] At elevated muscle temperature ATP regeneration, muscle fiber transmission rate, maximal power production and treadle rate data were obtained significantly higher compared to normal. Blomstrand et al. (1986), applied exhausting forceful bicycle exercises (370±34 W, 1.5±0.15 minutes) on 7 male participant at normal (35±0.9°C) and subnormal (29±2.8°C) muscle temperatures; and reported that glycolysis increases as a result of decreased blood flow and efficiency at lower muscle temperature, concentrations of adrenaline and noradrenaline get higher.[50]

Similar to results of our study Dewhurst et al. (2010), performed maximal isokinetic knee extansion measurement on adolescents and aged ones at 30°C, 34°C and 38°C muscle temperatures and noted while higher temperature has no effect on torque, lower temperature decreases torque and muscle transmission rate significantly.[51] Davies and Young (1983) found average increasing of 3.1°C at muscle temperature has no effect on vertical jumping and maximal voluntary cramp, on the contrary decreases muscle peak tension time and half relaxation time, also avarage decreasing of 8.4°C at muscle temperature increases muscle peak tension time and half relaxation time.[52]

Cheung and Sleivert (2004), showed no significant increase in maximal isokinetic power production and contraction rates of 20 participants that were heated passively in 42°C hot water.[53] They affirmed that skin temperature returning to the normal decreases isokinetic power production independent of body temperature. In our study CMJ, DJ and 15 seconds CMJ tests were held in a following order and significant difference was found in initial evaluated CMJ performances after cold application. There is no difference in the following tests. The reason for this difference can be because of being first test after cold application and therefore effects of cold can be maximum. As the time passes body temperature gets back to normal in following tests.

In one of the 3 proprioception studies on knee, reported that cold application has no effect on proprioception, the others showed that cold application gets knee joint proprioception worse in normal persons.[54,55] In this study proprioception measurements were not done but degenerated proprioception may have an effect on lower values of CMJ performance.

In most of previous similar studies additional active warming was not performed, measurement was obtained after passive warming with hot-cold effect. Whereas changes made in muscle temperature and metabolism by active warming affect performance differently.[56]

In this study corruption of CMJ performance by cold application must be considered. Cold applications are used in getting back to sport after disability and for the purpose of preventing pain and swelling during competition. On the other hand possibility of decreasing effect on jumping performance as shown in this study must not be forgot.

According to this study, using hot application, differently than treatment and therapy, for trainings and competitions in case of improvement of performance does not make any sense. About the effect of hot application on the performance, the results of this study contradicted with some previous studies, but also supported with some of them. According to performed studies associated with summarized issues in discussion part, although hot-cold therapies have effects on recovery it's seen that studies about effects on performance are inadequate. Especially more studies must be conducted on performance improvement with hot application.

It's shown that some Part of studies associated with local hot-cold applications were conducted with inadequate muscle temperature, the other part was conducted with inadequate application period and with low participant numbers. Also the number of studies conducted with active heating is quite few. These situations also must be paid to attention after this studies.

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