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Review

Effects of Kinesio® taping on skeletal muscle strength—A meta-analysis of current evidence

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ABSTRACT

Objectives: The purpose of this study was to test whether certain applications of Kinesio tapes might facilitate contraction and increase muscle strength in healthy adults.
Design: A meta-analysis of studies investigating the efficacy of Kinesio tapes application was performed.
Methods: The scientific databases Pubmed and Google Scholar were systematically searched for appropriate articles. Descriptive statistics were extracted to calculate measures of effect size (Pearson's r) and estimate the overall population effect. The methodological quality of the included studies was assessed using a specific quality appraisal tool. In addition, the included studies were grouped according to the muscle groups examined, to test whether Kinesio tapes effects were dependent on the area of application.
Results: A total of 19 studies, comprising data of 530 subjects and 48 pairwise comparisons of muscle strength were included. The methodological quality of these studies ranged from moderate to good. While substantial variability of individual effect sizes was observed, the overall population effect ($r = 0.05$, CI: −0.23 to 0.34) suggests that, on average, the potential to increase strength by application of Kinesio tapes is negligible. Comparisons between studies grouped by the muscle groups examined showed that the effects of Kinesio tapes are not muscle-group dependent.
Conclusions: While the application of Kinesio tapes may have some therapeutic benefits, the usage of these tapes does not promote strength gains in healthy adults.

1. Introduction

Kinesio tapes (KT), the colourful elastic cotton strips with an acrylic adhesive that may be stretched to up to 140% of their original length, were invented by the Japanese chiropractor Kenzo Kase in the 1970s. After a first worldwide exposure during the 1988 Seoul Summer Olympics, these special tapes quickly developed to become a widely used physiotherapeutic tool for the treatment of various musculoskeletal disorders and further clinical conditions, and faced a surge in popularity following the 2008 Summer Olympics in Beijing, where, amongst others, the U.S. beach volleyball gold medalist Kerri Walsh appeared wearing the tapes following a previous rotator cuff injury on her right shoulder. According to their inventor, KT may promote different therapeutic objectives, including pain inhibition, improved circulation and lymphatic drainage or a reduction of delayed onset of muscle soreness (for a comprehensive summary see Bassett and colleagues[1]). The question whether or not KT application may have any clinically significant benefits is the subject of ongoing research, with the most recent systematic reviews concluding that there is some anecdotal support but still little quality evidence to recommend the usage of KT for the prevention or treatment of musculoskeletal injuries.[2–4]

Apart from its alleged clinical usefulness, Kase also suggested that the tapes may be used to modulate muscle tone[5] – a claim that received support from reports of augmented muscle activity following KT application in the direction from muscle origin to insertion.[6–8] Although the precise physiological mechanisms underlying the proposed greater motoneuron recruitment have not been elucidated yet, the exciting prospect of being able to positively affect a muscle's function via an intervention as simple as the external application of tapes has resulted in an exponential increase of studies designed to test the hypothesis that the cutaneous stimulation provided by KT might indeed serve to increase muscle strength. For instance, a Google Scholar research for the terms "kinesio tape" combined with "muscle strength" resulted in only three papers

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published up until the year 2000, but this number increased to 14 in 2007 and further to an impressive total of 216 in 2013. These figures notwithstanding, the studies published to date differ strongly in the cohorts and muscle groups examined and were, on many occasions, conducted in relatively small samples (e.g. Refs. 9–11, $n < 10$). Moreover, the results reported in these works are contradictory, with some studies lending at least partial support to the postulated strength-promoting effect of KT application[6,12–14] and others disqualifying KT as entirely ineffective.[15–17] In the light of this conflicting evidence, uncertainty remains regarding the true performance-enhancing potential of KT application, and only a synopsis of data can help to shed light on this issue.

Very recently, Drouin and colleagues conducted a systematic review of the literature on the effects of KT on measures of athletic performance.[18] While the authors concluded that "evidence is lacking to support the use of kinesiotape as a successful measure for improving athletic-based performance", we found that the literature research performed in this study, strongly selective by virtue of the databases searched, falls short of reflecting the considerable amount of evidence published in this field of research. Further, being a review but not a meta-analysis, the work by Drouin et al.[18] is confined to a descriptive comparison of study results. With these limitations in mind, we aimed to expand on previous efforts by conducting the most comprehensive literature research possible and combining the results from different studies for the statistical analysis of pooled data. The ultimate goal of the present meta-analysis was to evaluate the effectiveness of KT application in increasing muscle strength in healthy individuals.

2. Methods

The online databases Pubmed and Google Scholar were systematically searched for the search terms "kinesio taping", "kinesio-taping", "kinesiotaping", "kinesio tape", "kinesio-tape", "kinesiotape", "kinaesthetic taping" or "kinaesthetic tape", in combination with "strength" or "performance". Following the database search, both authors of the present study independently selected the articles to be considered for further analysis according to the following criteria: articles had to be published in peer reviewed journals, test the effectiveness of KT application on maximum skeletal muscle strength and be available in English language. Some articles reported the performance in complex tasks, such as counter-movement jumps[19] or squats.[20] While these measures do reflect muscle strength, they may be affected by the performance of muscles not targeted with the KT intervention. Such articles were excluded from further analysis. Conference papers were also included if they met the above criteria and provided sufficiently detailed information to allow for further statistical analyses. Studies examining clinical populations or those in which KT was not the sole intervention possibly affecting the outcome parameters were excluded. After consultation, the authors decided to exclude one additional paper[21] because it provided insufficient information about the strength tests performed and the KT-associated strength gains reported in this study seemed unrealistically high. The literature research is up-to-date as of March 2014.

Means and standard deviations of the measurements of muscle strength were extracted from all included studies and used to calculate Pearson's coefficients as measures of effect size. For this purpose, t-statistics were first calculated using Eq. (1)

$$t = \frac{\overline{x_{KT}} - \overline{x_{CTRL}}}{\sqrt{(SD_{KT}/n_{KT}) + (SD_{CTRL}/n_{CTRL})}}, \quad (1)$$

where $\overline{x_{KT}}$ and $\overline{x_{CTRL}}$ are the group means, SD_{KT} and SD_{CTRL} the respective standard deviations, and n_{KT} and n_{CTRL} the sample sizes, respectively. Subsequently, the so-derived t-values were converted into Pearson's r according to Eq. (2)

$$r = \sqrt{\frac{t^2}{t^2 + \mathrm{df}}}, \quad (2)$$

where df represents the degrees of freedom. In studies using a repeated-measures design, the measurements obtained without KT were considered as CTRL group values. Some studies made use of a mixed study design, in which both KT and CTRL group were tested on two occasions (for subjects assigned to the treatment group measurements were obtained before and after application of KT). In these cases, effect sizes were calculated based on the difference of strength changes as measured in both groups, and the pooled pre-test standard deviation.[22] For all effect sizes, standard errors were determined to obtain the 95% confidence intervals (CIs). For this purpose, the values of r were first converted into standard z-scores via Fisher transformation (Eq. (3)):

$$z = 0.5 \cdot \ln\left(\frac{1 + r}{1 - r}\right). \quad (3)$$

Subsequently, standard errors of z were calculated according to Eq. (4)

$$\mathrm{SE} = \frac{1}{\sqrt{n - 3}}, \quad (4)$$

where n represents the total sample size, and used to determine the 95% CIs for z (Eq. (5)):

$$\mathrm{CI}_{1,2} = z \pm 1.96 \cdot \mathrm{SE}. \quad (5)$$

Finally, the z-CIs were converted back to the scale of r (Eq. (6)):

$$r_{\mathrm{CI}} = \frac{\exp(2z) - 1}{\exp(2z) + 1}. \quad (6)$$

Several studies reported isokinetic strength test data that were obtained from different muscle groups, contraction modes or movement velocities. On such occasions, effect sizes were independently calculated for all experimental conditions. In cases when treatment effects were reported at different times after the intervention, only the results obtained immediately after KT application were considered for further analysis. Similarly, several studies investigated the effects of both facilitating and inhibiting taping applications. Here, only the data obtained with a purportedly facilitating KT application (from muscle origin to insertion) were extracted. When results were independently reported for men and women, right and left extremities or subgroups formed on the basis of other non-health related criteria, respectively, effect sizes were calculated for the average of both values. On some occasions, results were only reported graphically, requiring the extraction of numerical data using ImageJ (ImageJ 1.47v, NIH, Bethesda, MD, USA). After calculation of effect sizes for all included studies, the population effect was estimated using the Hunter-Schmidt method, as described by Field and Gillett.[23] This method calculates the total sample effect r as the mean of all k effect sizes r_i, whereby each effect size is weighted by the sample size n_i on which it is based (Eq (7)):

$$\bar{r} = \frac{\sum_{i=1}^{k} n_i r_i}{\sum_{i=1}^{k} n_i}. \quad (7)$$

Finally, a forest plot was generated to visually compare the single effect sizes with the final pooled statistic.[24]

In addition to the calculation of effect sizes, the methodological quality of all included studies was assessed using the quality appraisal tool for the evaluation of case series studies developed by the Institute of Health Economics[25] (IHE scale). This particular tool was chosen because, unlike other evaluation systems commonly

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used in physiotherapy,[26] it allows for the scientific quality of non-controlled studies, which represented the vast majority of articles included in the present meta-analysis, to be rated. To improve the comparability between studies using different designs, we decided to apply the IHE scale also for the evaluation of the remainder of controlled studies and those using a combined pretest–posttest-control group design. In such cases, one point was always awarded for questions 11, 13 and 14, which are specific to studies with a repeated-measures design (see Table 2). The IHE scale originally consists of 18 items, out of which one addresses the question whether adverse effects potentially related to the intervention were clearly reported. Since there are no adverse effects associated with KT-application, this item was considered as not applicable and, therefore, omitted.

Following a test of distributional normality of interval-scaled variables (Kolmogorov–Smirnov test, $p < 0.05$ in all cases), Spearman's correlation coefficients were used to assess potential relationships between the methodological quality, the sample size studied and the magnitude of the effect observed. Further, Mann–Whitney *U*- or Kruskal–Wallis tests were performed to establish whether effect sizes or IHE scores differed in dependency of the question whether significant KT-associated improvements were found, or the muscle groups examined in a given study, respectively. Associations between categorical data were tested by Pearson's Chi-Square analysis. All tests were carried out using SPSS for Mac OSX (SPSS 21.0, SPSS Inc., Chicago, IL, USA) and the statistical level of significance was set at $\alpha = 0.05$.

3. Results

The initial search resulted in a total of 4890 articles. By screening the titles and abstracts, 147 of these papers were identified as potentially relevant and considered for further analysis. After discarding duplicates and exclusion of studies according to the criteria outlined above, 19 articles were included in the present meta-analysis. The precise process of literature research and selection is reflected in the flow chart shown in Fig. S1 (supplemental material).

Supplementary Fig. S1 related to this article can be found, in the online version, at doi:10.1016/j.jsams.2014.06.014.

Out of the 19 articles finally included, 15[6,9–11,13–15,17,27–33] (78.9%) used a repeated-measures study design, one was conducted as randomized controlled trial[12] (5.3%) and three[16,34,35] (15.8%) tested the effect of KT application by means of a mixed pretest–posttest-control group design, in which both the experimental and the control group were independently tested on two occasions. In total, the included studies reflect data from 530 subjects, comprising 312 women (58.87%) and 218 men (41.13%) with an average age of 23.6 ± 3.0 years. It should be noted that the number of datasets used for the comparisons of muscle strength with or without KT (see Table 1) differed slightly from this number, since the authors of several studies additionally investigated further experimental conditions, such as placebo tapes,[9,12,16] split their sample to study the effects of KT application on different muscle groups,[13] or based their conclusions on bilateral measurements of muscle strength.[12,34]

The results of the evaluation of the methodological quality of studies, as measured by the IHE scale,[25] are summarized in Table 2. On average, the included studies were awarded 12.2 ± 2.2 out of 17 possible points (range 8–15). The average scores were lowest for questions 3 and 5, which are related to the study sample recruitment process. Here, only one study included subjects from multiple centres[9] or, as opposed to the convenience cohorts typically studied, explicitly stated that subjects were recruited randomly and consecutively.[16] By contrast, all studies were awarded points for the clear description of the study population (question 2), the appropriateness of eligibility criteria (question 4), the comparable status of participants assigned to test and control group (question 6), and for reporting the outcome measures with and without KT (question 11). Since studies involving multiple interventions (in addition to KT application) were excluded, all studies were also awarded one point for question 8. Correlational analyses revealed that the IHE score correlated positively with sample size ($R = 0.64$, $p < 0.001$). By contrast, Kruskal–Wallis tests showed that the methodological quality did not differ between studies examining different muscle groups ($\chi^2 = 6.44$, df = 4, $p = 0.169$).

The parameter predominantly studied was knee extension strength which was assessed in 8 studies (42.1%),[10,11,14–17,27,33] followed by grip (5 studies, 26.3%),[9,12,30,31,34] knee flexor[10,13,15,33] and ankle plantarflexor strength[13,29,32,6] (each 4 studies, 21.1%). The

Table 1
Characteristics of the studies included into the present meta-analysis.

Number	Study	Year	Design	Muscle group	*n* (tot)	*n* (KT)	*n* (CTRL)	Men	Women	Age
1	Aktas et al.	2011	RMD	KE	20	20	–	9	11	23.8
2	Chang et al.	2010	RCT	GS	21	7	7	21	0	20.9
3	Csapo et al.	2012	RMD	PF	24	24	–	12	12	24.5
4	Donec et al.	2012	RCT	GS, Other	54	32	54	20	34	27.9
5	Fratocchi et al.	2012	RMD	Other	20	20	–	17	3	23.6
6	Fu et al.	2008	RMD	KE, KF	14	14	–	7	7	19.7
7	Gómez-Sorian et al.	2013	RMD	PF, DF	19	19	–	8	11	23.8
8	Kim et al.	2013	RMD	KE, KF	8	8	–	8	0	29.0
9	Kuo et al.	2013	RMD	GS, Other	19	19	–	8	11	18.9
10	Lee et al.	2010	RMD	GS	40	40	–	20	20	23.4
11	Lee et al.	2012	RMD	PF	20	20		20	0	20.3
12	Lins et al.	2013	PPC	KE	60	20	20	0	60	23.3
13	Lumbroso et al.	2014	RMD	KF	36	36	–	15	21	25.7
14	Merino et al.	2012	PPC	GS	31	31	31	23	8	23.7
15	Ptak et al.	2013	PPC	Other	52	32	20	0	52	22.0
16	Solomon et al.	2013	RMD	KE	8	8	–	0	8	20.2
17	Vercelli et al.	2012	RMD	KE	34	34	–	16	18	23.0
18	Vithoulka et al.	2010	RMD	KE	20	20	–	0	20	27.0
19	Wong et al.	2012	RMD	KE, KF	30	30	–	14	16	28.4
	Total				530	434	132	218	312	
	Mean ± SD				27.9 ± 14.9	22.8 ± 9.8	26.4 ± 17.6	11.5 ± 7.8	16.4 ± 16.4	23.6 ± 3.0

Note: In studies using a repeated measures design (RMD) subjects served as their own controls. RCT, randomized controlled trial; PPC, pretest–posttest control group design; KE, knee extension; KF, knee flexion; GS, grip strength; PF, ankle plantarflexion; DF, ankle dorsiflexion.

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Table 2
Evaluation of the level of evidence of the included studies using the quality appraisal tool for the evaluation of case series studies developed by the Institute of Health Economics (IHE scale).

		Aktas et al., 2011	Chang et al., 2010	Csapo et al., 2012	Donec et al., 2012*	Fratocchi et al., 2012	Fu et al., 2008	Gómez-Soriano et al., 2013	Kim et al., 2013	Kuo et al., 2013	Lee et al., 2010	Lee et al., 2012
1	Hypothesis clear	0	1	1	0	1	0	0	0	0	0	0
2	Population clearly described	1	1	1	1	1	1	1	1	1	1	1
3	Participants from multiple centres	0	1	0	0	0	0	0	0	0	0	0
4	Eligibility criteria appropriate	1	1	1	1	1	1	1	1	1	1	1
5	Participants recruited consecutively	0	0	0	0	0	0	0	0	0	0	0
6	Similar status of participants at study begin	1	1	1	1	1	1	1	1	1	1	1
7	Intervention clearly described	1	1	1	1	1	1	1	1	1	1	1
8	Additional interventions clearly reported	1	1	1	1	1	1	1	1	1	1	1
9	Outcome measures clearly described	1	1	1	0	1	1	1	0	1	1	0
10	Appropriate methods	1	1	1	1	1	1	1	0	1	1	0
11	Outcomes measured before & after intervention	1	1	1	1	1	1	1	1	1	1	1
12	Statistical tests appropriate	1	1	1	1	1	1	1	0	1	1	0
13	Length of follow-up reported	1	1	0	1	1	1	1	0	1	1	0
14	Loss to follow-up reported	0	0	0	1	0	0	0	0	0	0	0
15	Random variability of outcomes reported	0	1	1	1	1	1	1	1	1	1	1
16	Conclusions supported by results	0	1	1	1	1	1	1	1	1	0	1
17	Competing interests and support declared	1	1	1	1	1	0	0	0	0	1	0
	Total out of 17	11	15	13	13	14	12	12	8	12	12	8

		Lins et al., 2013*	Lumbroso et al., 2014	Merino et al., 2012*	Ptak et al., 2013*	Solomon et al., 2013	Vercelli et al., 2012	Vithoulka et al., 2010	Wong et al., 2012	Criterion fulfilled in % of studies
1	Hypothesis clear	1	1	0	1	0	1	0	0	36.8%
2	Population clearly described	1	1	1	1	1	1	1	1	100.0%
3	Participants from multiple centres	0	0	0	0	0	0	0	0	5.3%
4	Eligibility criteria appropriate	1	1	1	1	1	1	1	1	100.0%
5	Participants recruited consecutively	1	0	0	0	0	0	0	0	5.3%
6	Similar status of participants at study begin	1	1	1	1	1	1	1	1	100.0%
7	Intervention clearly described	1	1	1	1	0	1	1	1	94.7%
8	Additional interventions clearly reported	1	1	1	1	1	1	1	1	100.0%
9	Outcome measures clearly described	1	1	1	1	0	1	1	1	78.9%
10	Appropriate methods	1	0	1	1	0	1	1	1	78.9%
11	Outcomes measured before & after intervention	1	1	1	1	1	1	1	1	100.0%
12	Statistical tests appropriate	1	1	1	0	1	1	0	1	78.9%
13	Length of follow-up reported	1	1	1	1	0	1	1	1	78.9%
14	Loss to follow-up reported	1	0	1	1	0	1	0	0	26.3%
15	Random variability of outcomes reported	1	1	1	1	1	1	1	1	94.7%
16	Conclusions supported by results	1	1	1	1	1	1	1	1	89.5%
17	Competing interests and support declared	0	1	1	1	0	0	0	1	52.6%
	Total out of 17	15	13	14	14	8	14	11	13	

Note: For controlled studies (labelled with *) one point was always awarded for questions 11, 13 and 14.

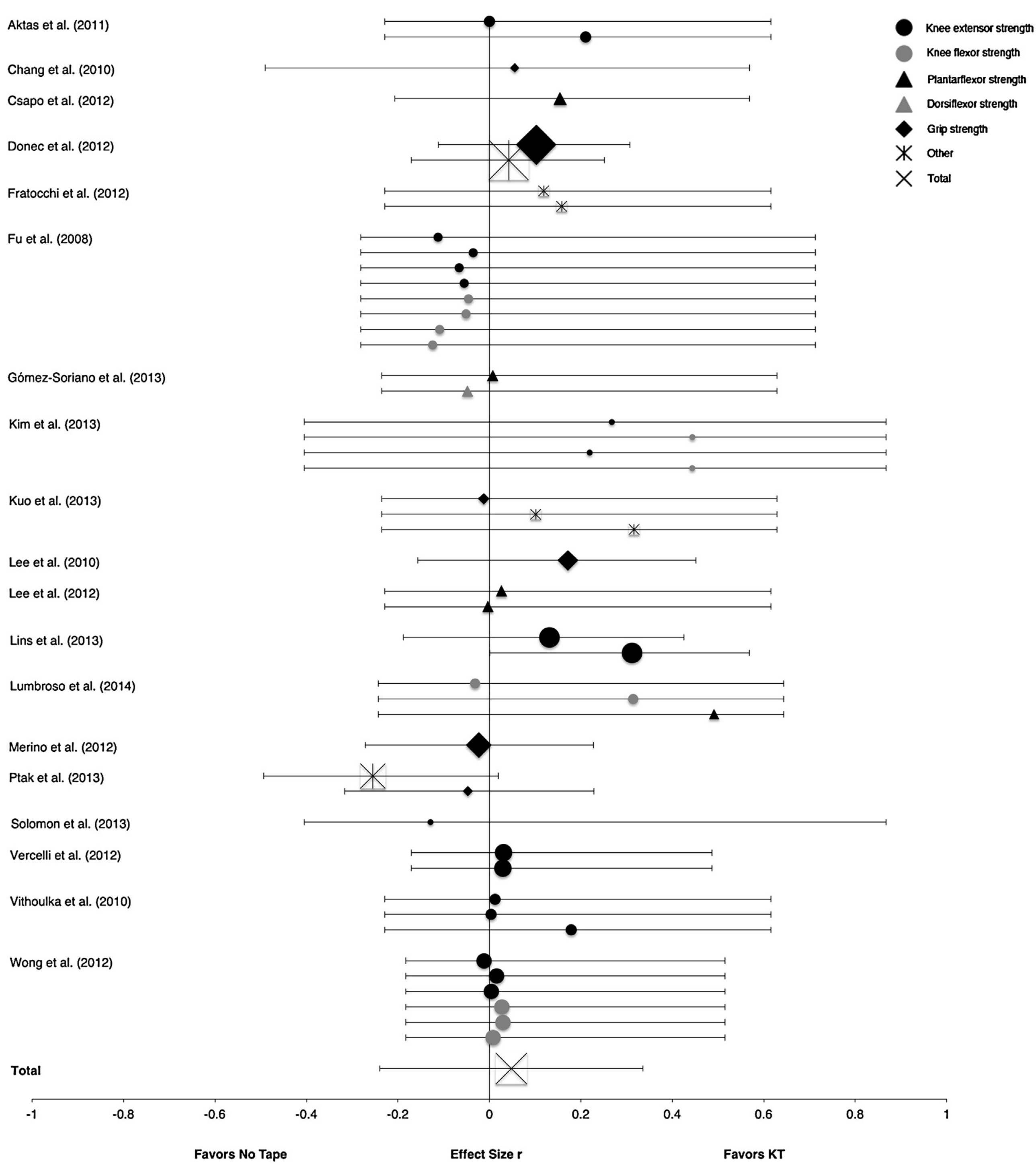

Fig. 1. Forest plot of effect sizes calculated for each of the studies included and all experimental conditions tested. The marker size reflects the sample size of the respective study. Note the estimated overall population effect (total) at the bottom.

performance in tests to determine finger pinch,[12] elbow flexion,[28] ankle dorsiflexion,[29] wrist and middle finger extension[30] as well as trunk flexion[35] strength was measured in 1 study each. It must be pointed out that studies including isokinetic dynamometry typically reported strength as measured at various angular velocities[10,14–17,27,33,35] or in different contraction modes.[28] Thus, the data included in this meta-analysis allowed for a total of 48 comparisons of muscle strength with or without KT. Significant KT-associated improvements in strength were reported in eight out of the 19 studies included[10,12–14,27,30,31,6] and for 13 out of the 48 pairwise comparisons (27.1%) made. A Mann–Whitney *U*-test used to compare IHE scores between papers reporting or not reporting significant improvements showed that the methodological quality of studies tended to be lower in cases were significant KT-associated improvements were found (mean ± SD (mean rank): 12.49 ± 1.74 (18.54) for studies reporting significant improvements vs. 11.08 ± 2.2 (26.71) for studies not finding statistical improvements; $U = 150$, $p = 0.063$). Pearson's Chi Square analysis revealed no association between significant improvements and the muscle group studied ($\chi^2 = 2.536$, $p = 0.638$).

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The effect sizes calculated from the descriptive statistics reported for the 48 pairwise comparisons as well as the associated 95% CIs are evident from the forest plot shown in Fig. 1. For individual studies, the effect sizes ranged between $-0.25 < r < 0.49$. Spearman's correlation coefficients suggested that effect sizes were neither related to IHE scores ($R = 0.05$, $p = 0.725$) nor sample sizes ($R = 0.08$, $p = 0.601$). Similarly, non-significant Kruskal–Wallis test results indicated that effect sizes did not differ between studies examining the effect of KT application onto different muscle groups ($\chi^2 = 0.91$, df = 4, $p = 0.924$). The overall population effect, as estimated by the Hunter-Schmidt method,[23] was found to be $r = 0.05$ with a 95% CI from -0.23 to 0.34.

4. Discussion

The aim of the present study was to investigate, based on a synopsis of scientific literature, the strength-enhancing potential of KT application in healthy subjects. Our results are based on the meta-analysis of 19 articles and comprise the data acquired in a total of 530 subjects. While substantial heterogeneity of study results was observed, the calculation of an overall population effect ($r = 0.05$) suggests that the application of KT does not significantly affect muscle strength.

The majority of studies included into our meta-analysis (~79%) investigated the effects of KT using a repeated-measures design, while only ~21% of studies were conducted as controlled experiments. While quasi-experimental designs are characterized by a lower internal validity, they maximize statistical power and external validity and are, therefore, frequently applied in sports physical therapy.[36] To evaluate the level of evidence of the studies included, we applied a slightly modified version of the IHE scale, a tool recently developed by Moga and colleagues[25] using the Delphi technique. Although the IHE scale has been specifically designed for the evaluation of non-controlled studies, we decided to also use it for the assessment of the remaining, controlled experiments, to improve the comparability of results. The results of this evaluation showed that the methodological quality ranged from moderate to very good (IHE score: 8–15 points), with an average of ~12 out of 17 possible points awarded (see Table 2). While, in most cases, studies were designed as single-centre, convenience sample trials, resulting in low scores on the respective questions 3 and 5 (IHE score: 0.1), we considered the eligibility criteria for participant selection to be appropriate in all studies (IHE score: 1.0). Importantly, studies also scored highly on questions 7 (IHE score: 0.9), 10 and 12 (IHE score: 0.8), related to the clarity of the description of the taping intervention, the appropriateness of the methods to measure strength and the statistical procedures applied, respectively. Based on these scores, we consider the methodological quality of studies investigating the efficacy of KT in improving strength as appropriate and the resulting scientific body of evidence as sufficiently significant.

The question whether or not certain KT application techniques might facilitate the generation of greater muscular forces has, in recent years, been a subject of controversial debate. Proponents of the technique have claimed that the application of KT in the direction from muscle origin to insertion[5] would result in augmented muscle strength. While the physiological principles underlying such strength gains have never been cogently elucidated, it has been speculated that cutaneous stimulation provided by the tapes, possibly involving the slowly adapting type 2 mechanoreceptors located deep in the dermis,[37,38] might induce greater motor unit recruitment, resulting in an increase in muscle strength. Studies involving surface EMG recordings performed by us[6] and others[7,9] indeed suggest that KT may provoke greater electromyographic activity in different muscle groups, thus lending some support to this claim. Further hypotheses to explain the alleged strength enhancing effect of certain taping applications included a continuous concentric pull on the fascia that has been proposed to stimulate increased muscle contraction,[39] the shortening of the distance between muscle origin and insertion which might optimize the length–tension relationship of a muscle,[40] as well as a beneficial influence on joint alignment.[41]

In our meta-analysis, eight out of 19 studies (42.1%) reported at least some statistically significant, beneficial effect of KT application on muscle strength.[10,12–14,27,30,31,6] Closer scrutiny, however, revealed that significant improvements were only found in 13 out of 48 comparisons of muscle strength made in these studies (27.1%). The effect sizes determined for each of these comparisons were found to lie between $-0.25 < r < 0.49$, reflecting a wide array of study outcomes, ranging from weakly negative to moderately positive effects. Taking sample sizes into account,[23] an overall population effect was calculated on the basis of the so-determined effect sizes. The result of this analysis ($r = 0.05$, CI: -0.23 to 0.34) suggests that, while the CI warrants caution in the interpretation of results, the potential of KT application to improve muscle strength is negligible. Previous results from studies investigating the effect of KT on different muscle groups suggested that the strength-enhancing effect of the intervention may be muscle-dependent.[12,30] Our analyses, however, revealed that the question whether significant improvements were found did not depend on the muscle groups studied. Further, no statistically significant differences in average effect sizes were found between studies grouped by the muscle groups examined. While the strength-enhancing potential of KT application does not seem to differ between muscles, it is of note that IHE scores, reflecting the methodological quality of studies included, tended to be lower in those articles reporting significant KT effects, although a direct relationship between effect sizes and IHE scores could not be established. Thus, it seems as if studies of somewhat lower methodological quality were more likely to report beneficial KT effects.

To summarize, the results of this meta-analysis suggest that the efficacy of KT in improving muscle strength has been tested in numerous investigations. The majority of these works used a non-controlled, repeated-measures design, but the level of evidence was still considered to be sufficiently high to allow for valid conclusions. While the variability of effect sizes calculated for each of the comparisons of muscle strength made in these studies was relatively large, the overall population effect was close to zero, indicating that the potential to increase muscle strength by applying KT is negligible. Our data further suggest that the effectiveness of KT is not muscle-group dependent. Studies of lower methodological quality may be more likely to favourably evaluate the intervention.

5. Conclusions

- The strength-enhancing potential of KT application in healthy subjects has been investigated in numerous scientific investigations.
- The application of KT to facilitate muscular contraction has no or only negligible effects on muscle strength.
- The strength-enhancing effects of KT are not muscle-group dependent.
- The overall methodological quality of studies investigating the potential of KT to improve muscle strength is moderate to good and tends to be lower in studies reporting significant effects.

Practical implications

- Current evidence suggests that knee extensor and flexor as well as ankle plantarflexor and grip strength cannot be improved by

KT application in young (~25 years) and healthy subjects of both sexes.

- Conclusions about the strength-enhancing effects of KT application on other muscle groups and in other cohorts, such as healthy elderly subjects, require further investigation.

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There is no conflict of interest.

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